LAND USER BASED LAND DEGRADATION AND LIVELIHOODS ASSESSMENT: APPLICATION IN SUSTAINABLE MANAGEMENT OF LAKE NAIVASHA -KENYA

By

DAVID ONSARE NYANTIKA

A thesis submitted in (partial) Fulfillment of the Requirements for the degree of Master of Science (Environmental Management).
South Eastern Kenya University (SEKU).

October 2015

DECLARATION

I, David Onsare. Nyantika, declare that this thesis is my original work and has not been submitted or presented for the award of a master's degree in any other University/college/institution.

Name__David Onsare Nyantika _____

Ad/No___150I/NRB/20114/2012_____

Signature_____

Date_____

SUPERVISOR'S APPROVAL

"We confirm that the work reported in this thesis was carried out by the candidate under our supervision and has been submitted with our approval as University supervisors"

1. Dr. Peter Njuru

Signature: _____

Date: _____

2. Dr. Zablone Owiti

Signature: _____

Date: _____

DEDICATION

I have the honour and rare privilege to dedicate this MSc in Environmental Management thesis to my late parents Judson Miyogo Nyantika and Pauline Bochaberi ,who not only believed in education, but in the attainment of a holistic education. Their investment in character development for their children has seen me make these strides in life against all odds. I also want to thank my beloved brother Charles Ratemo who carried through their dreams by making personal sacrifices to see the larger Nyantika family make it in life, through a single minded focus and firm belief in his core values of, hard work, working smart, making sacrifices in life and trust in God. I thank our heavenly father who has been the foundation of what my family is today.

ACKNOWLEDGEMENT

The completion of this thesis report would not have been possible without the support and guidance of my supervisors: Dr. Peter Njuru and Dr. Zablone Owiti. Their advice and wise counsel extended beyond this report, and has been invaluable to me in facing work challenges, for which I'm sincerely grateful; I would also like to thank Dr. Matheus Kauti for his critical inputs on the use of the sustainable livelihood framework in assessing the effects of land degradation on livelihoods of households. Special thanks also go to Professor Jacob Kibwage for his insightful and thought provoking feedback during the course Environmental management studio which formed the basis for my research proposal write up.

I would also like to thank the administrators and my colleagues at National Agricultural and Livestock Extension program (NALEP) for financial/moral support throughout my time of pursuing the course work and research on environmental management program. Most of all I would like to thank my family for their unwavering support for the 2 years during which I pursued my degree. My wife, Joyce, shouldered additional burdens during the many nights and weekends I was either in class or doing homework. Her support of me in this program and throughout my career means so much to me. To my children, thank you for your individual and continual motivational support I hope that I have instilled in you the values of learning and education throughout your entire lives.

ABSTRACT

The study was carried out to determine the effectiveness of using a land user based land degradation and livelihood assessment approach, with the overall aim of improving the sustainable management of Lake Naivasha. The study focused on two sub-catchments of Wanjohi and Turasha within the Lake Basin. A cross-sectional survey was selected for this study to allow for triangulation on information collected and to be able to infer the results from the sample to the larger population. The study population was all the inhabitants of Wanjohi and Turasha watersheds within Lake Naivasha Basin. A sample of 209 inhabitants of the two sites was selected as respondents. A structured questionnaire, actual field measurements of land degradation and a checklist were used to collect the data. The Data analysis was done using the statistical package for social sciences (SPSS) and presented using descriptive statistics, frequency tables, percentages and pie charts. The findings from the study have established that Land user based land degradation and livelihoods assessments approaches/tools can significantly improve the appreciation of the magnitude of land degradation, its impacts on livelihoods, role of appropriate interventions and level of adoption of the recommended intervention regimes by the land users. Land degradation also results in a narrow scope of livelihood strategies for households, aggravating poverty levels in many households leading to more environmental degradation and low crop and livestock production. It was also established that a well-managed green water credit scheme can go a long way in supporting the sustainable management of the lake through supporting other alternative livelihoods and also in improving water use efficiency at farm level. The results from this study can inform policy formulation by the relevant government environmental agencies to address effects of land degradation in the country through adoption of a land user based land degradation and livelihoods assessment to improve on technology adoption and promote the use of innovative solutions like the green water credit schemes.

TABLE OF CONTENTS

LIST OF TABLES.

LIST OF FIGURES

LIST OF PLATES

CHAPTER 1: INTRODUCTION

1.1 Background

Land is our natural ally. But the natural conditions of land and soils are not eternal, and must be protected. One of the most significant components of land is the soil, a geo-resource we have that ensures water, energy and food security for present and future generations. Healthy soils are also vital for building resilience and adapting to climate change (Don, 2012).This important function of soil has over the years been undermined by the process of land degradation.

Land degradation is fundamentally the depletion, removal and loss of biodiversity that occurs as a result of human activity and natural disasters, such as fire, deforestation, poor crop, animal husbandry practices, quarrying, human settlement patterns and physical geography and climatic changes, particularly drought (FAO, 1996; Michael and Murmaghan, 2003 and WHO, 2005). Land degradation is increasing in severity and extent in many parts of the world, with more than 20% of all cultivated areas, 30% of forests and 10% of grasslands undergoing degradation (Bai *et al*., 2008).

It is estimated that about 2.6 billion people worldwide are affected by land degradation and desertification in more than a hundred countries, affecting over 33% of the earth's land surface (Adams and Eswaran, 2000, Eswaran *et al*., 2001 and Snel and Bolt, 2003) notes that land degradation affects the ecosystem structure and function. It is a global development and environmental challenge which led to the establishment of the United Nations Convention to Combat Desertification (UNCCD) and also addressed by the other two Rio Conventions, namely the Convention on Biodiversity, and the United Nations Framework Convention on Climate

Change (UNFCCC); and highlighted in the Millennium Development Goals (UNCCD, 1992; UNEP, 2008). In Africa, land degradation and desertification processes result from both human activities and climatic variability (UNEP, 2008).

An estimated 65% of Africa's agricultural land is degraded due to erosion and/or chemical and physical damage and 31% of the continent's pasture lands and 19% of its forests and woodlands are classified as degraded (UNEP, 2008, FAO, 2005). Overgrazing has long been considered the primary cause of degradation in Africa but it is now thought that rainfall variability and long-term drought are more important determinants (UNEP, 1997).

For Kenya a report by UNEP (1997) indicates that 64% of Kenya's land area is potentially subject to moderate desertification and about 23% is vulnerable to severe to very severe desertification. In the northern rangelands, 12.3% of the land surface area suffered from severe land degradation, 52 % to moderate land degradation, and 33% faced slight vulnerability to degradation. The same study identified degradation in Arid and semi-arid (ASALs) as a potential precursor to widespread desertification. In the early 2000s, approximately 30% of Kenya was affected by severe to very severe land degradation (UNEP, 2002), and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai *et al*. 2008). The droughts of 1970 and 2000 accelerated soil degradation and reduced per-capita food production (GoK, 2002).

It is often assumed that land degradation only affects soil fertility, however, the effects of land degradation often more significantly affect receiving water courses (rivers, wetlands and lakes) since soil, along with nutrients and contaminants associated with it, are delivered in large

quantities to these ecosystems(Sujatha *et, al.,* 2000). Land degradation therefore has potentially disastrous effects on water resources. In Kenya the effects of massive land degradation has been witnessed in Lake Victoria where there has been widespread invasion of the lake by the water hyacinth weed (*Eichhornia crassipes*), which has caused heavy financial losses due to low fish catches, high cost of water treatment and transport hitches.

One other important natural resource in Kenya that has undergone similar ecosystem degradation is Lake Naivasha, it is a globally important 'wetland ecosystem" (Torrion, 2002). `It is an important source of economic wealth for the country in the form of ecotourism, geothermal energy production, and floriculture. Despite the contribution of the basin to the National economy, the land is no longer fertile, the fisheries are almost lost, and Lake Naivasha has become the sink of all residential and industrial wastes.`

Regulation of water abstraction and wastewater discharge is extremely weak, with a survey by Robert *et al*. (2006) showing that over 80% of water withdrawals do not have a valid permit and that over half of the water used in the basin is technically illegally abstracted. The same report indicates that the Water Resource Management Authority (WRMA) that is responsible for enforcement of rules/regulation to manage the Lake sustainably lacks both the funding and political support needed to deliver on its mandate.

Brecht *et al* .(2005) highlighted the Water related impacts and a risk in Naivasha that includes depletion of basin flows and lowered groundwater and lake levels due to over-abstraction and drought. The lake water quality has deteriorated through high nutrient and sediment inflows that

emanates from run-off and pollution from agricultural chemicals and untreated human waste. Other environmental challenges include habitat degradation, riparian encroachment, invasive species like the water hyacinth and reduction in biodiversity and fishery production.

WWF (2010) indicated that during the dry spells such as that seen in 2009, water use becomes unsustainable as more water is extracted than flows into the Lake, and that increasing demands for extraction. And an increasing likelihood of dry and hot periods under climate change means that Lake Naivasha faces a severe and immediate water management challenge. Ultimately, a failure to address this challenge may lead to hydrological and ecological balance, and contribute to social and economic impacts that will be felt nationally. The arising risks that have emerged from failure to manage the Lake resources should be shared by the national and county governments, communities, private sector and environmentalists; this therefore presents a shared opportunity for collective action.

An assessment by local stakeholders supported by WWF (2010), did indicate critical opportunities which included, improving institutions, creating and strengthening innovative partnerships and the development of a stewardship standard to guide, incentives and differentiate responsible water use in the basin. Besides that quality technical knowledge and information was also noted to be fundamental.

In the past, various assessment methods have been used in an attempt to avail relevant scientific information. The problem has however been low adoption and or adaptation by land users of the interventions recommended by experts which has been attributed to use of various assessment

methods such as Geographical Information Systems (GIS) through use of Remote Sensing and modelling which are expert-based (Omuto *et al*., 2009 and John *et al*., 1988) and communicates little to the land user on the magnitude of the land degradation problem. Clearly a gap exists between the research conducted, the results and the utilization of the findings for sustainable management of the basin that has had more than a fair share of research undertakings (Lal, 1998).

Onyango *et al*. (2011) indicated that in spite of a wide range of research work conducted in the study area, a significant amount of the output has not reached the relevant stakeholders. Moreover, stakeholders have decried the language used in disseminating scientific research, arguing it was not comprehensible for use by an ordinary stakeholder. This suggests that as much as they would be interested in using the findings to address environmental conservation issues, most stakeholders experience language barrier that compounds their problem. Therefore they suggested a number of solutions including: the need to digest research findings with the participation of the land users, make more research findings easily available and accessible to stakeholders, and the need for the formation of a stakeholder advisory board to serve as a link between the research community and local stakeholders in the sustainable management of resources in the Lake Naivasha basin.

To address the above research gaps, the current research used a land user based land degradation and livelihoods assessment methodology, which emerged in the earlier 1990s, to explore the impacts of land degradation on the choice of livelihoods of the land users both upstream and downstream within the Lake Naivasha Basin. The study further explored the applicability of

payment for environmental services (PES) or the Green Water Credit (GWC) scheme in the sustainable management of the Lake.

The findings of this study aims to contribute to an information database for reference by technical and policy makers on how best to improve levels of adoption of technical recommendations by land users. The location of Lake Naivasha and the two study sites are shown in Figures 3 and 4 on page 28.

1.2.1 Statement of the Problem

Land degradation is a global environmental and development issue. Up-to-date quantitative information is needed to support policy and action for food and water security, economic development, environmental integrity and resource conservation. To meet this need, the Global Assessment of Land Degradation and Improvement (GLADA) recommend the use of Remote Sensing technique to identify degraded areas and areas where degradation has been arrested or reversed. This screening is normally followed up within the parent GLADA program by actual field investigations to establish the situation on the ground. Findings therefore remain provisional until validated in the field (Sujatha *e t al*., 2000).

Unfortunately in the case of Lake Naivasha, much of the research work done so far on land degradation assessment has been based on use of Remote sensing/modelling, without validation of the same using actual field assessment approaches (Omuto *et al*., 2009 and Torrion *et al*., 2002). This has led to the recommendation of inappropriate technologies that does not suit the

local contexts, leading to low adoption of the recommendations given, in an attempt to reverse the evident land degradation in the basin. This research was therefore designed and carried out using the land user land degradation/livelihood assessment framework with the prime objective being to address the above sited challenges.

1.2.2 Objective of the Study

The purpose of this study was to evaluate the effectiveness of using a land user based land degradation and Livelihood assessment approach in the sustainable management of Lake Naivasha.

1.3 The Specific Objectives of the study were

1. To assess the effectiveness of land user based land degradation assessment approach in the sustainable management of Lake Naivasha.
2. To establish the links between land degradation and impacts on livelihoods of the inhabitants of the Lake.
3. To explore the applicability of Green Water Credit (GWC) scheme in reversing land degradation and in supporting alternative livelihoods leading to sustainable management of the Lake.

1.4 Research Questions

This study sought to answer the following questions:

1. What is the effectiveness of using land user based land degradation approaches in the sustainable management of Lake Naivasha?
2. What are the impacts of land degradation on the livelihoods of the inhabitants of Lake Naivasha Basin?
3. What is the contribution of Green Water Credit (GWC) on reversing land degradation and sustainable management of Lake Naivasha Basin?

1.5 Significance/Justification of the Study

NEMA (2004) indicates that "Lake Naivasha supports the vital horticultural sub sector that contributes 36% of Kenya's GDP and employs over 75,000 people. The lake provides water to over 300,000 inhabitants and to wildlife and is also linked to geothermal electricity generation. However, during dry spells such as that seen in 2009, water use becomes unsustainable as more water is extracted than flows into the lake. Increasing demands for extraction and increasing likelihood of dry and hot periods under climate change mean that Lake Naivasha faces a severe and immediate water management challenge. Ultimately, a failure to address this challenge is likely to lead to hydrological, ecological imbalance, thus resulting in social and economic crisis". Additionally, over the years the lake has experienced great challenges pertaining to increased sediment and nutrient loads, communal conflicts over the water resources, decrease in fish catches, and invasion by the destructive water hyacinth (Francesca *et al*., 2011). With the inevitable negative effects of climate variability the aforementioned challenges will greatly be magnified.

Therefore this study made use of land user based land degradation and livelihood assessment methodology in order to close the gap between experts and land users within the Lake, and that by promoting participation of land users in land degradation assessment there would be an improvement in the appreciation of the problem of land degradation by land users, leading to development of socially acceptable technical interventions and livelihood options that have potential to reverse land degradation in the Lake.

Much of the literature cited indicate an extensive use of modelling, remote sensing and researcher based plot level measurement of land degradation, same case as sustainable livelihoods assessment for Kenya. In Kenya apart from an independent study on green water credit scheme for the upper Tana River Watershed by Kauffman *et al*. (2007) minimal research work has been done on Green Water Credit scheme.

Studies conducted so far have paid limited attention to the linkage between land user based land degradation and livelihood assessment methodology and green water credit on the sustainable management of Lake Naivasha. This research was therefore designed to fill that research gap, show how to use the sustainable livelihoods framework in assessing the links between land degradation and livelihoods for the inhabitants of the Lake and the applicability of GWC in reversing the effects of land degradation, supporting other alternative livelihoods and thereby contributing to the sustainable management of the lake.

The results from this study are intended to facilitate policy makers and other service providers to develop relevant policies and technological interventions that are re-aligned to the realities on the ground, make contribution to the knowledge base on integration of green water credits in reversing land degradation and promoting sustainable livelihoods, contributing to social

inclusion of the resource poor and vulnerable communities leading to the sustainable management of Lake Naivasha.

1.6 Definition of terms

Land degradation: Generally signifies the temporary or permanent decline in the productive capacity of land (UN/FAO, 1997). For purposes of the study land degradation was treated as a concept in which the value of the biophysical environment is affected by one or more combination of human-induced processes acting upon the land.

Livelihoods: This study adopted the definitions given by Carswell (1997) Carney (1998) and DFID (2001). Which describes "Livelihoods as comprising of resources or assets (human, natural, social, physical and financial capital) and access to use these that enable strategies to be employed in order to survive and attain desirable livelihood outcomes such as income, food security, well-being and sustainable use of natural resources" In this research, livelihoods are represented by livelihood strategies each household undertakes as a response to land degradation.

Sustainable development: Refers to a mode of human development in which resource use aims to meet human needs while ensuring the sustainability of natural systems and the environment so that these needs can be met not only in the present, but also for generations to come (Brundtland,1987). More recently, it has been suggested that a more consistent analytical breakdown is to distinguish four domains of economic, ecological, political and cultural sustainability. This is consistent with the UNESCO move to make 'culture' the fourth domain of sustainability. Other important sources refer to the fourth domain as 'institutional' or as 'good

governance (UNESCO, 2005). A livelihood is sustainable when it can cope with and recover from stress and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base (Chambers and Conway, 1991). This research adopted the two definitions as given by Brundtland (1987), UNESCO (2005), Chambers and Cornway (1991) which combines aspects of economic, ecological, political, cultural and institutional domains that encamp uses sustainable development/livelihoods, this was evaluated in this study through assessment of the five assets of, social, physical and human capital assets.

Green Water Credits (GWC): are payments or rewards for water and land management services provided by upstream land users, which in turn benefit downstream water users by providing them better-quality water and a more reliable supply(IFAD/ISRIC, 2010; Droogers *et, al*. (2006) and IFAD/ISRIC (2007). Green water credit in this study was taken to mean any form of reward made to land users to support sustainable use of land resource and water.

1.7 Limitations of the Study

The research sought specifically to determine the relationship between land degradation and livelihoods assessment in the sustainable management of Lake Naivasha. Focus for this study was narrowed down to two watersheds (Wanjohi and Turasha). The study did have some limitation, the main one being the field measurements for individual indicators of land degradation that had the potential of undermining the study. An attempt was made to overcome this limitation through the use of triangulation (measurements of a variety of other indicators)..The other limitation emanates from the fact that the

Lake and its basin have extensively been researched on, it was possible some of the respondents could have provided the type of information they have always been giving other researchers who have undertaken studies in the two watersheds. This limitation was addressed through conducting prior sensitization workshops with key stakeholders to highlight on the objectives of the study, importance of the study to the community. And on how different it was to other studies that had already been carried out in the basin.

The said limitation was also managed through triangulation which involved confirming findings by interviewing different respondents, using other interviewing instruments and by interviewing more focus groups.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In this chapter a critical review of existing literature on the topic under study is presented, this includes previous work done focusing on land degradation assessment, using a variety of assessment approaches and then zeroing in on land user based land degradation and livelihoods assessment. Relevant information on the issues of Green Water Credits and the schemes application in promotion of sustainable livelihoods and management of a water resource is also provided.

2.1 Land degradation.

Land degradation generally signifies the temporary or permanent decline in the productive capacity of the land (UN/FAO (1997). Another definition by Michael and Murmaghan (2003) describes it as, "the aggregate diminution of the productive potential of the land, including its major uses (rain-fed, arable, irrigated, rangeland, forest), its farming systems (e.g. small holder subsistence) and its value as an economic resource." This link between degradation (which is often caused by land use practices) and its effect on land use is central to most definitions of land degradation.

The decline in land quality caused by human activities has been a major global issue since the 20th century and will remain high on the international agenda in the 21st century (Eswaran *et al*., 2001). The immediate causes of land degradation are inappropriate land use that leads to degradation of soil, water and vegetative cover and loss of both soil and vegetative biological diversity, affecting ecosystem structure and functions (Snel and Bot, 2003). Degraded lands are more susceptible to the adverse effects of climatic change such as increased temperature and

more severe droughts. Land degradation encompasses the whole environment but includes individual factors concerning soils, water resources (surface, ground), forests (woodlands), grasslands (rangelands), croplands (rain fed, irrigated) and biodiversity (animals, vegetative cover, soil) (FAO, 2005). The complexity of land degradation means its definition differs from area to area, depending on the subject to be emphasized. In Europe, soil erosion is regarded as one of the major and most widespread forms of land degradation, and as such poses severe limitations to sustainable agricultural land use. In general, deterioration of resources in Europe comes as a result of climate change, land use and human activities. Soil erosion in Europe is mainly caused by water and to a lesser extent by wind (Gobin *et al*., 2004).

According to the expert-based Global Assessment of Human-induced Soil Degradation (GLASOD) survey, about 15% of land is degraded (Oldeman *et al*., 1991). The highest proportions were reported for Europe (25%), Asia (18%) and Africa (16%); the least in North America (5%). As a proportion of the degraded area, soil erosion is the most extensive, causing more than 83% of the area degraded worldwide (ranging from 99% in North America to 61% in Europe); nutrient depletion causes a little over 4%, but 28% in South America; salinity less than 4% worldwide but 7% in Asia; contamination about 1% globally but 8% in Europe; soil physical problems 4% worldwide but 16% in Europe (Oldeman *et al*., 1991).

The phenomenon is most pronounced in the dry lands, which cover more than 40% of the earth's surface (Dobie, P, 2001). Around 73% of rangelands in dry land areas are currently degraded, together with 47% of marginal rain-fed croplands and a significant percentage of irrigated

croplands (UNCCD, 1991, 1994). Overgrazing has damaged about 20% of the world's pastures and rangelands (FAO, 1996).

In Africa, land degradation and desertification processes result from both human activities and climatic variability (UNEP, 2008). An estimated 65% of Africa's agricultural land is degraded due to erosion and/or chemical and physical damage. 31% of the continent's pasture lands and 19% of its forests and woodlands are also classified as degraded (UNEP, 2008; FAO, 2005). Overgrazing has long been considered the primary cause of degradation in Africa but it is now thought that rainfall variability and long-term drought are more important determinants UNEP(1997,2000) Land degradation is especially widespread in Sub-Saharan Africa, affecting 20-50% of the land and some 200 million people (Snel and Bot, 2003; Kaplanga, 2008). A study by UNEP (1997) showed that 64% of Kenya's land area was potentially subject to moderate desertification and about 23 per cent were vulnerable to severe to very severe desertification: in the northern rangelands, 12.3 per cent suffered from severe land degradation, 52 per cent to moderate land degradation, and 33 per cent faced slight vulnerability to degradation.

In the early 2000s, approximately 30 per cent of Kenya was affected by very severe to severe land degradation (UNEP, 2002) and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai *et al*., 2007). One of the most important natural resource areas in Kenya that has been shown to have had massive degradation is Lake Naivasha.

Lake Naivasha watershed is experiencing a rapidly growing population and the economy of the surrounding area also depend on the basin's water resources for water supply and wastewater disposal, and the needs of small-scale agriculture; tourism and wildlife conservation; cattle ranching and grazing; fisheries and power generation. Increasing demands for extraction and increasing likelihood of dry and hot periods under climate change mean that Lake Naivasha faces a severe and immediate water management challenge (NEMA, 2004). In a recent assessment by local stakeholders supported by WWF, several opportunities for management of Lake Naivasha were identified and included improving institutions, innovative partnerships and the development of a stewardship standard to guide, incentives and differentiate responsible water use in the basin(Lal *et al.*, 1997).

Quality data and relevant information is the key to improving the participation of the stakeholders in catchment management. Scientists around the world have in the past developed and used assessment and monitoring tools in the study of land degradation. These tools; include expert opinion, modelling, field observations, monitoring and measurements, productivity change estimates and remote sensing and GIS. Whereas these methods have been used widely, the problem has been low adoption by land users of the interventions that are recommended by experts (Michael *et al.*, 2007; Onyango *et al.*, 2011).

Thomas *et al.* (2010) further indicates that the reasons for failure of research finding to translate into utilization include historical, social, economic, cultural, organizational factors. These assessment methods which are expert based communicate little to the land user on the magnitude of the land degradation problem. To address these gaps, the land user based methodology was

used in this research an attempt to address the gaps that have been identified in the other land degradation approaches.

2.1.1 Land degradation assessment: the professional view

Stocking *et al*. (2003) provided guidelines of land degradation assessment. These guidelines indicate that "erosion-induced loss in soil productivity may occur through a variety of processes including loss of nutrients and organic matter in eroded sediments that reduce the total stock of nutrients in the remaining soil that will be available to future crops (expert view). Reduction in plant-available water capacity, through the selective depletion of organic matter and clays by erosion, which increases the chances of drought event stressing future crops; increase in bulk density, surface crusting and other physical effects of soil degradation prevent seed germination and disrupt early plant development. Reduced depth of topsoil and exhumation of subsoil by long term soil erosion decrease the available soil volume for plant roots, increasing acidity through selective removal of calcium cat ions on the exchange complex, affects nutrient availability, encourages P-fixation induces free aluminium causing severe toxic effects and a reduction in micro-faunal and micro-floral populations (affects beneficial processes)"

2.1.2 Land degradation assessment: the Land users view

Local people see land degradation in entirely different ways. For example, a woman increasingly engaged in collecting firewood and fetching water will worry about the scarcity of these natural resources and the burden of having to travel long distances to gain them. A male herder of livestock in the same village will have concerns in searching for elusive dry season pastures. So, there are different perspectives within local society, which need to be reflected in

any field level assessment of land degradation. A farmer's perspective will usually be different from, and the ascribing of cause and effect quite unrelated to, the scientific explanation (Stocking *et al.,* 2003).

The classic example of this is the explanation of soil formation by the Burungee of Tanzania, as discovered by the anthropologist Wilhelm Östberg. The Burungee see stones on the surface of the soil. To them it is evidence that "the land is coming up" and that soil formation is active(Stocking *et al.,* 2003).To the scientist, stones are the residual left after erosion, and are clear evidence of the very opposite of soil formation. The field indicator approach adopts the evidence of land degradation in the field through what farmers have said they see, the effects that they have described, and how their farming practices have had to change to cope. Obviously, the field assessor will have processed these messages, and the result will not be exactly as farmers see land degradation. Nevertheless, the principles of field observability and farmer relevance are essential in deciding what to include and what to exclude. There are three main advantages of adopting a farmer-perspective approach to land degradation assessment. First, measurements are far more realistic of actual field level processes. Secondly, assessments utilize the integrated view of the ultimate client for the work, the farmer. Thirdly, results provide a far more practical view of the types of interventions that might be accepted by land users.

2.2 Sustainable rural livelihood framework (SRLA)

Many rural livelihoods depend on the natural environment, thus any permanent diminution in the productivity of that environment will have adverse effects on the ability of families and household units and communities to support them. The factors that affect the decision to degrade

or conserve land are related to the resources available to the land user. In his studies on sustainable livelihoods, Ellis (2000) subdivided the assets the households can have in what is known as the Sustainable Rural Livelihoods Framework (SRF) into a number of different elements or 'capital assets'. These categories of assets (Physical, Social, Financial, and Human and Natural capital assets) can be used to describe the various types of 'capital', or resources, available to land users. As such they provide a framework for analysing the situation of land users, which may be helpful in identifying sets of circumstances that may combine to make some households more likely to degrade their land than others (Stocking *et al.*, 2003). The capital assets under the sustainable livelihood framework are presented in Table 1.

Table 1: Capital assets under the sustainable rural livelihood framework

Capital Asset	*Description of capital assets*
Natural	Environment (topography, soil, water) and the livestock, crops and other plants that together support Livelihoods.
Physical	Incorporates infrastructure, purchased goods and manufactured items such as tools which are used to produce livelihoods
Human	Comprises the innate and learned skills of the land users and their ability to work(including good health) which combine to allow land users to secure their livelihoods
Social	Social relationship such as access to membership of networks, societies, groups and co-operatives, relationships of trust, allegiances
Financial	Comprises access to cash (including remittances from migrants) or to credit which enable the land user to make choices about investments in natural ,human or other forms of

Adapted from Stocking & Murnaghan (2006)

Livelihoods based on agriculture are closely linked with and dependent on the environment. But agricultural activities also powerfully shape the environment. Agriculture is, in fact, a human

activity that affects the greatest proportion of the earth's surface, it is the single biggest user of fresh water (Pagiola and Holden 2001)and is still by far the largest single source of livelihoods and income (Bai *et al*., 2008).

It is specifically through land use that the interaction of livelihoods and the environment is most clearly demonstrated. Land use acts as an interface between the two as it forms a unifying concept in which socio-economic and agro-ecologic variables coincide (Kruseman *et al*., 1996). However, some environmental changes are caused by natural processes and would happen without a human influence, and some changes are human induced but set in motion outside of the immediate realm and scope of the land user and his land. As the interaction usually happens in time with varying time lags of response and impact, it is not always easy to detect the underlying cause-effect relationships.

2.3 Payment for watershed services

Pfaff *et al*. (2007) indicates in their study conducted in Costa Rica that payments for environmental services (PES) are a means of creating a market in environmental/ecosystem services. They link those who value a given service with those who can provide it. Most early PES initiatives were in Latin America, which remains the region with the most PES schemes, followed by Asia, and lastly Africa. Payments for watershed functions seeks to link upstream land use and management with downstream water use and management to realize benefits for upstream and downstream participants in the scheme and others in the area – not to mention for the environment (Dent *et al*., 2007). The ideal is a voluntary agreement between at least one buyer and one seller of ecosystem services (or land-use changes presumed to provide an

ecosystem service). PES schemes have become increasingly popular with donors over the last few years; yet despite their widespread application, by their nature they are not primarily intended as a tool for poverty reduction (but they can be tailored for poverty alleviation purposes) Tiffen (2003).

According to FAO (2007) the problem is that poor rural people lack the prerequisites for participation in PES. Often, they do not have secure land tenure system in place, rewards are easily usurped by the elite, and they lack the assets (human capital, natural resources, etc.) to provide the level of service needed to yield the desired impacts. Part of the solution to this dilemma may be to eschew PES schemes that simply seek market creation. Rather than clinging to economic principles, develop a variant of PES that builds on the reality faced in rural areas. This means allowing for market support, subsidies and a means of directing PES benefits to poor people – in short, developing pro-rural-poor PES. This is where Green water credits come in.

2.3.1 Green Water Credits scheme

Over the last two and half decades, most of Kenya's cropland has lost its topsoil, at the same time its population has more than doubled, boosting demand for power and water. This scenario is the norm rather than the exception in Lake Naivasha Basin. This is where Green water credits (GWC) offers a tried and tested means of providing Kenya with food, water and power security(Dent *et al*, 2007) .

Dent (2005) points out that GWC is a particular case of payment for an environmental service, .one innovative and essential feature, is that the credit goes to the service provider-for the

service-not the landowner It is not a subsidy it is a long term contract-fair payment for essential work with sustained benefits, it is not a replacement for farm income, but more of a diversification of farm income.

From another perspective green water credits can be seen as payments, in cash or kind, made to rural people (farmers and grazers) for specified water management activities. Recognition and payment for this service will result in the delivery of more secure and better quality water supplies. In the simplest case, the downstream users of water pay the upstream producers, directly or indirectly IFAD/ISRIC (2010) and Droogers *et al*.(2006)proposes the setting up of a global facility to draw upon international public and private finance, for example through debt swaps, insurances and investment protection service fees.

The logic behind green water credit is that rewarding the upstream land users will result in better land management which will promote efficient use of rain water leading to less land degradation, more biomass production and increased water percolation that is necessary in recharging ground water aquifer. This will support sustainable livelihood strategies for downstream land users

As shown in figure 3 below "Green water is that portion of rain- water held in the soil and available to plants; it can only be used in situ by plants. Soils also feed groundwater and stream flow that can be tapped for use elsewhere for drinking, irrigation, urban and industrial use, and environmental flows- this is dubbed blue water" (Dent *et al.* 2007).We cannot generate more rain water, but green water resources can be better managed, enhancing downstream delivery of water, by increasing infiltration at the soil surface.

This reduces destructive runoff and increases banking of the water in the soil. It also reduces the direct evaporation from the soil that is unproductive as it does not pass through the plants. Rainwater transmitted by the soil recharges groundwater and stream base flow

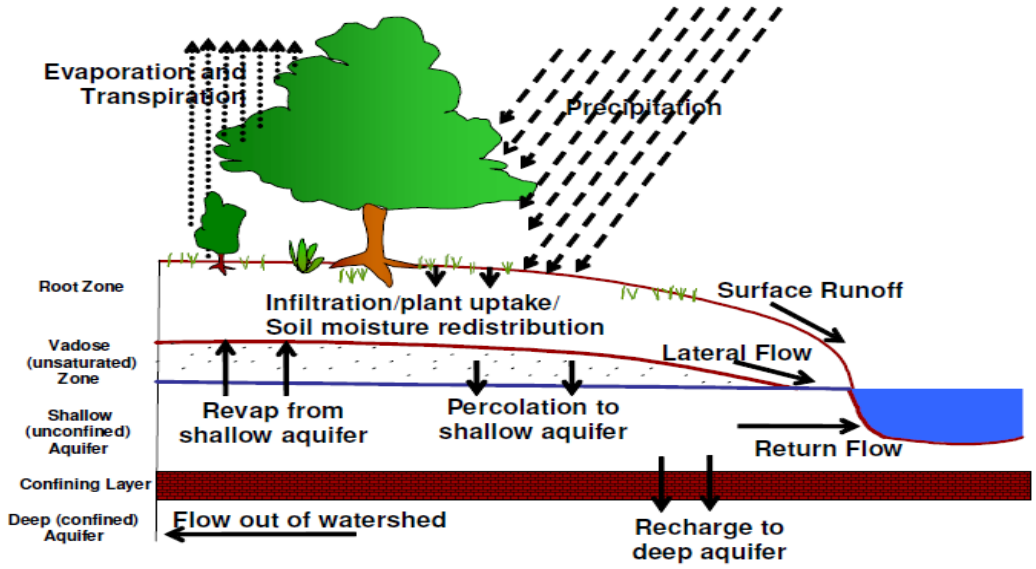

Figure 1: Main land rain water phase processes (Adapted from ISRIC (2006))

2.3.2 Main challenges to implementing green water credits

According to Cohen (2008) market creation remains one of the key challenges in starting up Green Water Credit Schemes. Market creation involves putting an economic value on environmental services and bringing together willing buyers and providers – examples include emissions trading, nutrient trading, wetland mitigation and GWC and or PES. Yet the goal of market creation is exactly what may impede GWC and or PES schemes from being pro-rural-poor. If they are indeed intended to be pro-rural-poor, then it is arguably necessary to depart

from the economic tenets of the schemes. Watershed-based PES schemes are not, by definition, pro-poor. They are not intended for this purpose, they are intended to secure watershed functions such as downstream water supply. If they are to be made to fit into a poverty-reduction box, they must be tailored to fit this role. The ideal of GWC or PES is to link those who value ecosystem services with those who can provide them so as to create a market. In the context of developing countries, poor rural people may not be the best vehicle to achieve this end.

The bottom line is that if donors and governments are willing to accept a compromised version of PES in order to target poor rural people, then PES schemes for watershed services can indeed benefit them, but PES might not be the right name for such schemes hence the name GWC (Droogers *et al*., 2006).

2.4 Literature gaps

Much of the literature on studies done on Lake Naivasha indicates an extensive use of remote sensing, modeling and researcher based plot level measurement of land degradation, and all those studies indicate massive level of land degradation within the Lake basin, what has not been shown in the reports was an attempt to facilitate the participation of the land owner in land degradation assessment, linking up land degradation and impacts on livelihoods

Also for Kenya, the literature cited above indicates, independent studies on Green Water Credit Scheme for the upper Tana River Watershed that were done by IFAD/ISRIC (2007).The studies focused more on remote sensing and modeling on land degradation types and effects of interventions aimed at reversing land degradation. The studies indicated a good participation by

land users in watershed management through implementation of various soil and water conservation measures, The research does not show the determinants for participation of the vulnerable and resource poor households in the GWC or PES schemes, The reports also have not indicated how one can work out the level of reward and payment for water management practices to the participating service providers. This research therefore was designed to use the land user based land degradation approach and determine its impacts on livelihood strategies, and the contribution of GWC scheme can be used in poverty reduction strategies and in promoting alternative livelihood strategies for sustainable management of Lake Naivasha.

2.5 Conceptual frame work

In this research an attempt was made to clearly indicate that land user based land degradation and livelihoods assessment(the independent variables)are key in improving the land user's knowledge base and therefore acceptance of the magnitude of land degradation and in improving the adoption level of interventions to reverse impacts of land degradation in Lake Naivasha basin (dependent variables). The research demonstrated that a land user based land degradation and livelihoods assessment is vital in the promotion of sustainable land management and livelihoods of the inhabitants of Lake Naivasha and can be applicable to other water towers or watersheds that are under threat from man-made land degradation.

Independent Variables		Dependent Variables
➢ Land user based land degradation assessment. ➢ Land user based livelihood assessment framework. ➢ Proper application of GWC scheme. ➢ Land user based Information generation on LD.		➢ Land users appreciation of the magnitude/impacts of LD. ➢ Key in determination of impacts of LD on livelihoods strategies. ➢ Promotion of alternative livelihood strategies in the sustainable management of Lake Naivasha Basin ➢ Improved adoption of measures to reverse LD in Lake Naivasha Basin ➢ The key in linking upstream and downstream inhabitants of Lake Naivasha.

Figure 2: Conceptual Framework

There are obviously many ways to study land degradation, livelihoods, land use and environment interactions. There are also very many ways to separately study the three components. Also, some methodological questions and challenges arise in planning the study. First, there is the practical need of studying dynamic processes - some of them long-term processes - in a short period of time. Secondly, understanding change both in the livelihoods and the environment without real baseline studies can be difficult. Thirdly, as most of the processes are linked to a wider spatial and temporal setting, an appropriate spatial and temporal scale for

the study can be hard to determine. Fourthly, there is the challenge to decide how many sites are needed to find general patterns in Lake Naivasha Basin. Fifth, there are a huge variety of foci and approaches that can be used, and the most appropriate ones that are also feasible, should be selected.

In this study a compromise was made between availability of resources (time, skills, and financial resources) and the optimal quantity and quality of information needed to draw credible conclusions. When a long-term study of change over decades cannot be planned due to constraints of resources, and no historical baseline data are available from other sources, an approach that relies partly on local observations and perceptions needs to be adopted. The studies on livelihoods, including questions on environmental change affecting livelihoods, represent this approach.

CHAPTER 3: RESEARCH METHODOLOGY

3.0 Introduction

This chapter presents the study sites and a detailed description of the research methodology that was used to meet each objective of the study. This includes a description of research design, sampling techniques, instrumentation and data analysis techniques.This study was conducted between November 2013 and January 2014 through a cross-sectional sample survey design. The survey covered two sub-basins of the lake: Turasha and Wanjohi sub-watersheds. The data for the study was collected using designed questionnaires, semi-structured interviews, group discussions, transect walks, photography and document analysis techniques.

3.1 Study Sites

Figure 3 below is a map of Kenya showing the location of Lake Naivasha, according to WWF (2010) the Lake has an area of about 139 Km^2. It is a shallow lake (average depth of 6m and a maximum depth of 30 m) located at an altitude of about 1885m above sea level and has a watershed area of approximately 3400 Km^2. In the recent past the population within the Lake basin has rapidly grown from 43,867 in 1969 to the current figure of about 350,000, based on GOK (2009). The lake is located in a semi-arid environment and it is fed by only two perennial rivers, Malewa and Gilgil whose origins are in Wanjohi and Turasha sub-catchments' respectively,. This was one of the main reasons why the two sub-catchments were purposively selected for a detailed study. The two sites as shown in figure 4, have also witnessed massive land degradation in the recent past due to over-cultivation as a result of increase in population, changes in weather patterns (less rainfall in some areas) and the common practice of farming without implementing soil and water conservation measures.

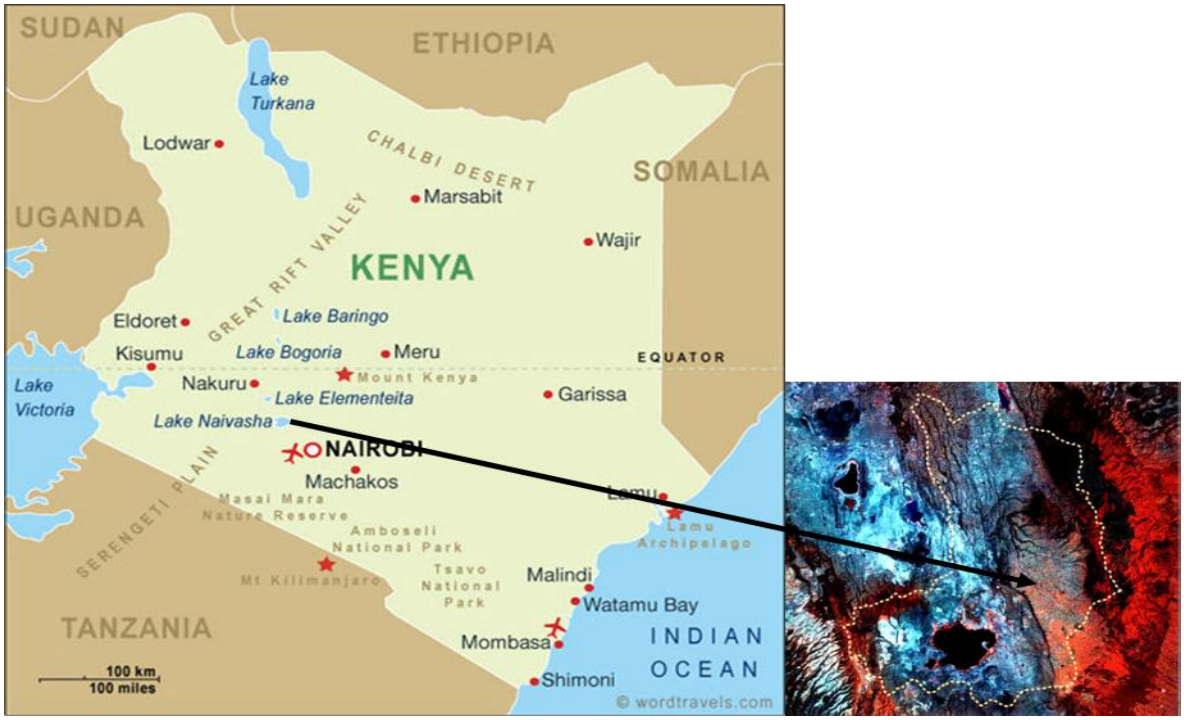

*Figure 3. Kenya (left) and the Lake Naivasha Basin (right). (Source: Becht (2007**))***

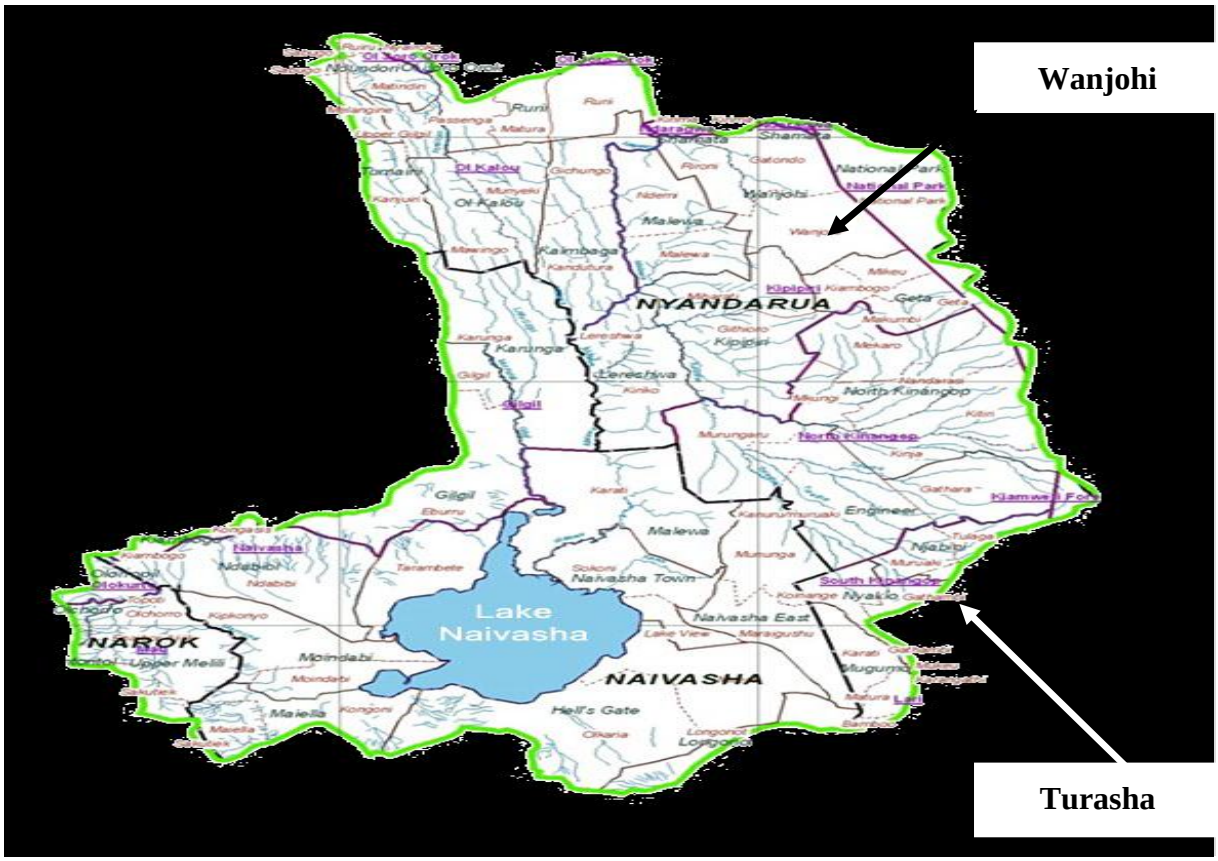

Figure 4 Lake Naivasha catchment showing study sites(Adapted from WWF (2011))

3.2 Research Design

The study was designed to evaluate three objectives namely: (1) to evaluate the effectiveness of land user based land degradation assessment in the sustainable management of Lake Naivasha; (2) to establish he links between land degradation and its livelihoods of the inhabitants of the lake catchment; and (3) to explore the applicability of Green Water Credit (GWC) Scheme in reversing land degradation in the sustainable management of the lake.

To address the first objective, a land user based land degradation assessment was undertaken through actual identification by land users of indicators of land degradation, participatory field measurements following designed field assessment formats, in order to determine the extent of land degradation (independent variable). In addition to actual field measurements, randomly sampled households were subjected to semi-structured interviews to determine their perception of land degradation and potential interventions. For the second objective some aspects (tools) of the sustainable rural Livelihood framework as given in Table 1 (based on impacts of land degradation on the capital assets) alongside the questionnaire were used for assessment of the impacts of land degradation on livelihoods of households (dependent variable) on the two study sites. Therefore for objectives 1 and 2 a confirmatory and exploratory research approach was used (examining data sets while looking for relationships between variables)

For objective three on exploring the applicability of Green water Credit Scheme, the research was designed in such a way that there were focus group interviews with strategic institutions like CARE-Kenya, WWF ,WRUA,WRMA and MOAL&F and other institutions that are jointly implementing a Payment for environmental services scheme in both Turasha and Wanjohi sub-

watersheds. The format given in Table 3 alongside the questions in part 2 of the questionnaire were used to further establish the relationship between land degradation and livelihoods at household level for both beneficiaries and non-beneficiaries of the CARE-Kenya/WWF initiative, and then an evaluation on the application of the same or a modified form of GWC in the sustainable management of the Lake was also carried out. The research was designed to combine both field and historical survey designs.

The livelihood surveys have a historical perspective covering the scope of the interviewees' memory. The sustainable rural livelihood framework(SRL) (Carswell 1997; Carney 1998; DFID 2001) which analysis the livelihood strategies adopted by different households using the capital assets(human ,natural, social, financial and physical)has been widely adopted as a useful analytical tool for structuring livelihoods related development research and especially as a framework guiding participatory planning of development interventions. As Ashley (2000) indicates, it has an instinctive appeal, and is useful in generating insights in how households utilize capital assets to make a living and in making recommendation domains, it synthesizes perspectives of different disciplines and provides an explicit focus on what matters to poor people.

Some aspects of the SL framework were thus used to structure the livelihood strategies in the study areas that have either contributed to land degradation or in conserving the land. Information was collected on the different livelihood strategies and the means that farmers use to adapt to long-term trends and short term shocks. Perceived problems with crops, livestock, trees, off-farm activities, and other spheres of life were documented. Temporal change was also

emphasized. To measure priorities and values related to livelihood objectives, farmers were asked questions about on-farm and off-farm activities on and off-farm assets they would think most desirable in order to improve their livelihoods. Where applicable, farm revenue measurement was used as a livelihood outcome. Individual household interviews – rather than group interviews – was considered the most feasible because a lot of quantitative household specific data was needed to study interrelationships of livelihood assets and outcomes results and discussion (Berry *et al*., 1991).

In this study, a diagnostic and prescription approach was applied to effectively promote land users participation in sustainable management of the ecosystem. Whereas in a traditional response approach, the expert(s) rushes into the community and makes repairs, in this approach input from as many players working in the community were incorporated to determine where the environmental degradation came from and then the environment and community were concurrently dealt with. At the end, the healthy community was envisaged to recover in a healthy environment. The study was limited to two sub-watersheds: upper Turasha and Wanjohi, due to the severity of land degradation in the two study sites.

3.3 Sample Size

The sample size for the study was determined using the Creative Research Systems Statistical Calculator which is a Public Survey Software that uses the formula:

$$\frac{Z^2 * (p) * (1 - p)}{C^2}$$

Where:

Z = Z value (e.g. 1.96 for 95% confidence level)

p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed)

c = confidence interval, expressed as decimal (e.g. ±5)

The two watersheds of Turasha and Wanjohi have each Households estimated at 10,262 and 14,563 respectively. A confidence level of 95% and a confidence interval of 65% ±5 was used in this study (this was chosen because respondents were randomly selected within the two sub-watersheds) when this was plugged into the statistical calculator for each watershed, the sample size for Turasha was 99 Households; while that for Wanjohi was 95 households giving a total of 194 households (respondents). An additional 15 households were added to cover the non-responsive respondents giving a total of 209 households for the survey in the two study sites.

The 209 households were randomly selected within the framework of upstream land users. Within the sampled sub-watersheds, both purposive and random sampling techniques were used to select representative individuals and group respondents for data collection. Once in the sub-watersheds (upstream) the group/opinion respondents were also selected randomly with an eye for gender, youth, and the vulnerable as members of a group. Individual land user's respondents were also selected on the basis of their links with the lake but keeping cognizance of gender, youth and the vulnerable.

3.4 Data Collection Method(s)

To ensure that proper and accurate data was collected the researcher and enumerators made a preliminary visit to the study area for awareness creation, characterization/pre-testing of field measurement form, using a participatory process with selected local community/communities

representatives and resource people. The main objective of the characterization exercise was to determine the context within which land degradation and sustainable land management are occurring. The characterization provided a rational basis for selecting the location and the required number of representative community transects. This was followed with the pre-testing of some questionnaires to a sample of respondents randomly selected. The researcher and the enumerators then went through the completed questionnaire/field measurement forms for editing / cleaning up process, and also in determining the views, opinions, perceptions, feelings and attitudes. As Touliatos & Compton, (1988) points out, such information is best collected through the use of questionnaire interviews and actual field measurement. Appropriate data collection techniques and instruments/tools (including: Focus group interviews, key informant questionnaire and interviews, observation checklists and field measurement forms) were used to target various respondents.

3.4.1 The Research Instruments

As shown in Table 2, the key instruments that were used in the survey included: Focus Group Discussions (FGD) Guide, Key Informant (KI) Questionnaires and Interviews, Administered Questionnaires, Observations Checklists, Photography, Sustainable rural livelihoods assessment framework and field assessment forms for rill and gully erosion among others.

Table 2: List of research instruments and targeted respondents

TYPE OF INSTRUMENT	TARGET RESPONDENTS
Focus Group Discussions (FGD) Guide	Different Genders/age groups of farmers
Key Informant (KI)	Selected Members of Stakeholders Forums

Questionnaires and Interviews	Selected Large scale flower/livestock Farmers Key Informants from Research Institutions – (ILRI, UNEP, KARI, KEFRI, ICRAF, ILRI etc.) Key Informants from Entrepreneur Umbrella Bodies – Agribusiness- Kenya, SEED Trust, ADCL, etc. Identified agricultural development community organizations e.g. NGO, CBOs, FBOs, CARE,WWF
Observations Checklists	Vulnerable Groups (if any) Community Opinion Leaders/ VCGs Grass root institutions
Administered Questionnaires	To randomly selected Household heads/young and old
Field measurement forms	For sampled household farms, upstream/ downstream, for Visible LD indicators

3.4.2 Research procedure.

In this research both qualitative and quantitative data was collected from a sample of 209households and from selected focus groups interviewees and respondents and observation was made during transect walks and drives within the lake basin. This exercise took about 30 days. In this study both field surveys and measurements and focus group interviews techniques were used. The data collected was then cleaned, collated and electronically entered for analysis. The SPSS package was used to organize the data and information into tables' figures and bar charts for data analysis.

3.5 Quality Control

The test-retest method of estimating the instruments reliability was used in this study; this involved administering the questionnaires to the same group of people at least twice during the

pretesting period. The results responses that were given were almost the same .Thus the first set of scores was correlated with the second set of scores. Correlation ranged between 0 (low reliability) and 1 (high reliability) the questionnaires were then modified to improve their validity and reliability coefficient to at least 0.70. Instruments with validity and reliability of at least 0.70 are accepted as valid and reliable in research (Korthuis, *et al*., 1993).Validity in this context is the extent to which research results can be accurately interpreted and generalized to other populations. It is the extent to which research instruments measure what they are intended to measure (Oso and Onen, 2008).

Reliability of a research instrument concerns the extent to which the instrument yields the same results on repeated trials. Although unreliability is always present to a certain extent, there will generally be a good deal of consistency in the results of a quality instrument gathered at different times. The tendency toward consistency found in repeated measurements is referred to as reliability (Carmines and Zeller, 1979).In scientific research; accuracy in measurement is of great importance. Scientific research normally measures physical attributes which can easily be assigned a precise value. Reliability can be evaluated through a variety of ways, but for this study the researcher selected the retest method.

A retest method is a test in which the same test is given to the same respondents after a period of time. The reliability of the test (instrument) can be estimated by examining the consistency of the responses between the two tests. If the researcher obtains the same results on the two administrations of the instrument, then the reliability coefficient will be 1.00. Normally, the correlation of measurements across time will be less than perfect due to different experiences

and attitudes that respondents have encountered from the time of the first test. For this study the questionnaires and the field assessment forms were applied at a two weeks interval by different interviewers during the pre-testing session to the same respondents and the results were surprisingly almost similar.

3.6 Data analysis and interpretation

The qualitative and quantitative data that were collected from the field were cleaned, collated and electronically entered for further analysis. Qualitative data that was collected through the questionnaires, interviews, observations and documentaries was organized into tables, graphical displays, then coded, summarized into groupings and then subjected to exploratory analysis and cross-tabulation. Further, for the data obtained from the focus group interviews, observation checklists and key informant interviews the researcher used correlation analysis technique, which is a measure of association between two or more scores or between two or more variables that are obtained from the same group of subjects This was then correlated with the quantitative data sets from the questionnaire and the field measurements.

As for the quantitative data collected through the questionnaires the statistical package for the social sciences (SPSS) was used to organize the data and information obtained from the field survey questionnaires into usable form by generating basic statistics information in the form of bar charts, pie-charts, percentages, and frequencies, to facilitate cross-tabulation amongst the variables of the research. This allowed for both descriptive and inferential statistical analysis to be done by the researcher.

CHAPTER 4: RESULTS AND DISCUSSIONS

4.0 Introduction

The main objective of this study was to test the application of land user based land degradation assessment framework, and its linkages and impacts on livelihoods of the inhabitants of Lake Naivasha Basin. The study also explored the applicability of Green Water Credit Scheme (GWC) in reversing the effects of land degradation, supporting other alternative livelihoods and thereby contributing to the sustainable management of the lake.

4.1 Socio-economic Characterization of the respondents in the study area

This section contains data on general information that was collected from the two study sites. This was done to lay the foundation on which to base the findings on the three study objectives. As indicated in Figure 5 below, during the study 71% male and 29% female heads of households of different age groups in the two watersheds were sampled and interviewed. This was important so as to get representative views of the different groups on the state of Lake Naivasha Basin. The average number of people in each household was found to be 3, but some households had up to 14 individuals. The present average farm holding was 2 acres. In an area that has a fragile ecosystem like the two study sites, and with further increase in population pressure and the inevitable consequences of climate change large scale land degradation will be quite evident.

Table 5: Socio-Economic Characteristics of Household Heads in the Study Area (N=209)

Socio economic variable	Wanjohi	Turasha	Total
Gender of Household Head			
Male	73	76	149
Female	31	29	60
Household size	6.13	5.21	5.67
Land size (acres)	3.25	4.77	4.01

The first inhabitants settled in the two study sites in 1964, Ministry of Agriculture (1998) but over the years more and more people have moved to the area through land buying from the earlier settlers, resulting in subdivision of land into un-economical units. These uneconomical units are used over and over again by the land owners in an attempt to make a living leading to massive land degradation, high run-off generation-low use of rain water(Green water) low yield of crops and livestock and hence prevalence of poverty in the two study areas,

Table 3 shows the social groupings that exist in the study areas. Wanjohi has a fairly large number of such groupings, but the main ones are self-help groups with a total percentage of 45.1% and women groups at 35.2%.Turasha on the other hand had few social groupings with women groups leading with 62.1% and dairy co-operatives at 12.5%. The social groupings identified during the study do have a potential of being used for the implementation of recommended soil and water conservation technologies and other alternative livelihoods. It is important to note that group considered to be, the poorest of the poor), exists in Wanjohi sub-watersheds, they are families of people whose land was taken by colonialist and have not been re-settled by the government, they survive on land leasing and are involved in illegal activities

like charcoal burning and grazing in the government forest leading to massive land degradation in parts of the Aberdare forest

Table 3: Major social groupings found in the two study sites

Major social groupings	Wanjohi		Turasha	
	Frequency	Percentage	Frequency	Percentage
Religious	32	35.2	0	0.0
Water Use	1	1.1	6	5.8
The poorest of the poor)	2	2.2	0	0.0
Tree Planting	0	0.0	0	0.0
Women groups	2	2.2	64	62.1
Self-help Groups	41	45.1	6	5.8
Dairy farmers Co-operative Society	0	0.0	13	12.6
Co-operative Society	0	0.0	9	8.7
Irrigation	0	0.0	0	0.0
Bee-keeping	0	0.0	4	3.9
None	3	3.3	0	0.0
Others	10	11.0	1	1.0
Total	**91**	**100.0**	**103**	**100.0**

As indicated in Table 4 below, 91.3% of the respondents in Wanjohi indicated that demand for irrigation water is higher than for domestic use (68.8%) whereas for Turasha the figures were 31.2% and 8.7% for domestic and irrigation use respectively. The higher usage of water in Wanjohi for both irrigation and domestic use is due to the fact that Wanjohi is a bit dry and has more intensive dairy farming than Turasha, which has silt soils on the surface with an underlying layer of marram soil, this results in very low water infiltration and soil moisture holding capacity and necessitates the use of irrigation water to meet the water deficit for crop production (Low water(Green Water) use efficiency). The use of water in Turasha for irrigation has occasionally caused conflicts with the mid and downstream water users who rely on the many streams that emanate from the Aberdare Ranges.

Table 4: Competing claims on water use

Region	Domestic use		Irrigation	
	Frequency	Percentage	Frequency	Percentage
Wanjohi	150	68.8	190	91.3
Turasha	68	31.2	18	8.7
Total	218		208	

A further analysis on respondents awareness on their rights concerning the use of water and land was carried out and as indicated in Table 5,only 50% of the people in the two watersheds are aware. There is therefore, need for awareness creation, this is necessary to create social responsibility within the community.

Table 5: Level of awareness of land and water rights

Awareness	Wanjohi		Turasha		Total	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Yes	102	50	102	50	204	98.1
No	2	0.98	0	0	2	1.9
No response	0		2		2	
Total	**104**		**104**		**208**	

When the analysis was carried out on the basis of gender awareness on their basic rights on land and water, the results as shown in Table 6 indicates that about 79.1% and 27.9% of male and female respondents respectively are aware of the existence of those rights. The low level of women respondents who are aware of their water and land use rights implies that any service provider working or intending to work in the two study sites will need to do more sensitization on women than men. A high level of awareness is very vital in mobilizing the communities to agitate for their rights when they are infringed upon by any other person, and also in mobilizing local resources to sustain ably manage both land and water resources.

Table 6: Existing gendered differences in land and water rights

Awareness	Gender			Total	
	Female	%	Male	%	
Yes	58	27.9	146	79.1	204
No	2	0.96	2	0.96	4
Total	**60**		**148**		**208**

The findings shows that the first people settled in both Wanjohi and Turasha in 1964, Ministry of Agriculture (1998) during the earlier stages the land parcels ranged from10 to 20 acres per household, but with the inevitable subdivisions the average acreage has reduced to 2 acres resulting in overuse of land to sustain livelihood strategies of the households consequently massive land degradation. The two areas have a fair distribution of all age groups and social groupings and quite a number of female headed households implying any technologies that will be promoted in tackling livelihood strategies and land degradation should take this into consideration, otherwise there will be low adoption and adaptation of the same.

It is important to note also that the people are aware of their basic rights to land and water use and that they form a critical component of the people supposed to review the same laws/regulations/rules. The knowledge also on competing claims over the water resource is critical in the planning of sustainable management of this scarce natural resource.

4.2 Effectiveness of land user based land degradation in the sustainable Management of Lake Naivasha

The first objective of this research was to assess the effectiveness of using land user based land degradation assessment in the sustainable management of Lake Naivasha. The results for addressing this first objective of the study are presented in the following section.

4.2.1 Local Indicators of land degradation

The respondents of the two study areas were asked to name local indicators that they associated with land degradation, Table 7 presents the findings.

Table 7 Local Indicators of land degradation

Indicators	Wanjohi		Turasha	
	Frequency	Percentage	Frequency	Percentage
Loss of soil fertility	22	21.15	1	0.97
Salinity	2	1.92	0	0.00
Murram	0	0.00	17	16.50
Stunted growth	1	0.96	18	17.48
Rills	2	1.92	26	25.24
Gullies	0	0.00	4	3.88
Root exposure	0	0.00	2	1.94
Lack of vegetation cover	0	0.00	23	22.33
Deposition of soil along river courses	45	43.27	0	0.00
Existence of hardpans	0	0.00	4	3.88
Soil accumulation on lower parts of farm	32	30.77	8	7.77

As shown in the table, Turasha respondents gave more indicators than those in Wanjohi. The main indicators for land degradation in Turasha were, rills in farms at 25.2%,lack of vegetative

cover at22.3%, stunted crop growth 17.5% and exposure of murram soils in farms at 16.5%(refer to plates4.3 and 4.4).As for Wanjohi the key indicators identified were, deposition of soils along river banks at 43.3% and low soil fertility(linked to low crop yield) at 21.2%(plate 4.5).The identification by land users of the indicators for land degradation and confirmation of the same on the ground, was key in this research in evaluating the knowledge base of the land users about land degradation, facilitating their appreciation of the magnitude of land degradation and in coming up with participatory technical solutions to reverse and address the causes of land degradation. This approach allows technical people to identify technological; and capacity building gaps in a participatory manner and this is a main element in facilitating high adoption and adaptation rate of recommendation regimes.

The field survey further included an evaluation of land use types in the two study sites and as shown in Figure 5, about 58% of the land in Turasha and 33% in Wanjohi, is mainly used for crop production, while 10% and 38%is used for livestock production in the two study sites respectively. Livestock breeds in Wanjohi include sheep, goats, poultry and other emerging Livestock breeds (Quell birds, Guinea fowls and Rabbits). Dairy production is high in Turasha than in Wanjohi. Other minor land use types that exist in the two study sites were beekeeping, farm forestry either as woodlots, and trees along farm boundaries. The analysis on land use types is fundamental, in ascertaining causes of land degradation and links to land use types. And in the case of Turasha and Wanjohi the causes have to do with crop and livestock production.

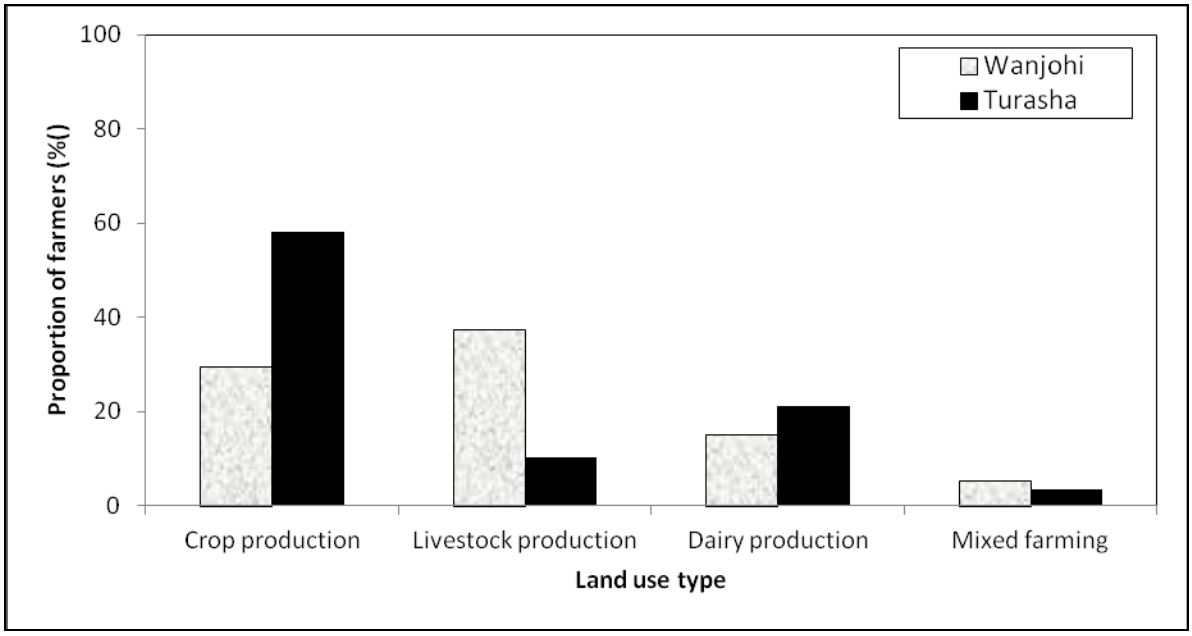

Figure 5: Main land use types

The study further analysed other minor land use types in the two sites, the indication in Figure 76 is that very minimal land has been set aside for timber and non-timber production purposes (medicinal and bee keeping) with 71% used for crop production, followed by grazing land and Fuel wood at 11% each while forestry production for timber take about 7%.This figures indicate a low level of farm forestry farming for timber production, the households in the study sites do access timber from elsewhere(most likely from government plantation forests).There is an opportunity here to promote farm forestry in the two study sites to address both environmental economic and social needs.

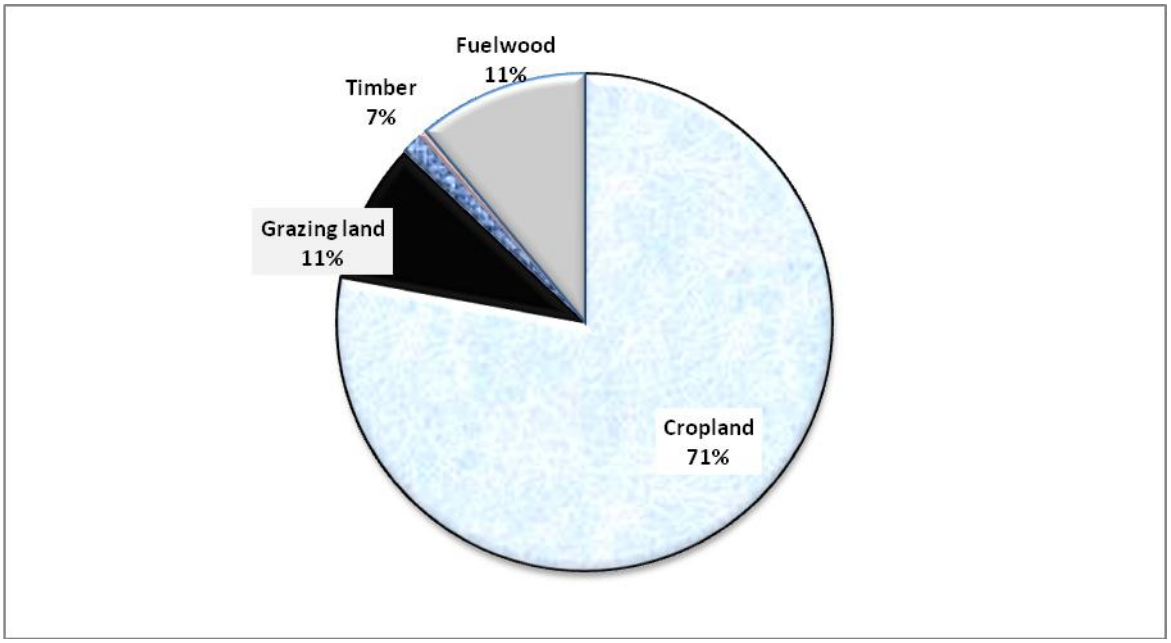

Figure 6: Main natural resources community uses for production/livelihoods

During the research an assessment of the types of water resources and number of households that utilizes them was also done, as shown in figure 7, about 88.9% of the household in the study areas draw water either directly or by pipes from the many streams found within sites those that emerge from the Aberdare's, only 16% for Turasha and 2% for Wanjohi use the roof water, while run-off water harvesting was almost non-existent. As earlier indicated in table 4 the conflicts over water can be minimized if there is maximum use of all the water resources available in the community more so the rain water harvesting.

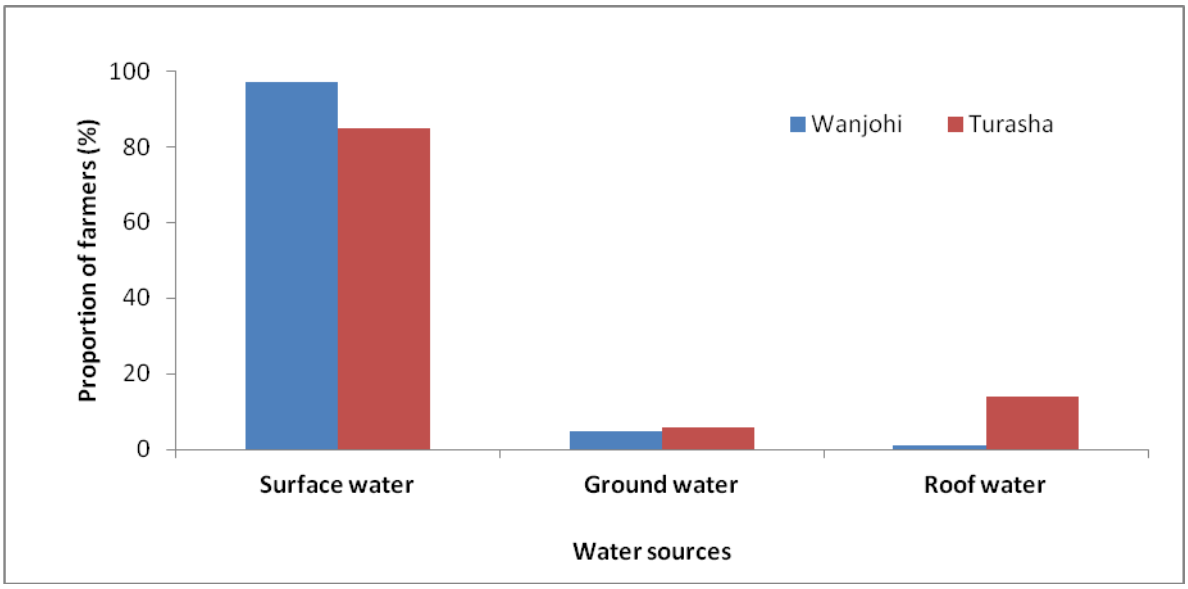

Figure 7: Main water resources available and used by the community

Table 8 presents the main land degradation types and or causes as identified by the land users in the two study areas, according to the local respondents. In Wanjohi overgrazing with 74%, other type's at 11.5 % (poor farming practice) and tethering of livestock at 10.4% were the main land degradation types. For Turasha cattle tracks at 79.2%, free range grazing at 14.9% and others 5.0 % (land clearance) were the main land degradation types. This land degradation types as identified by the community all contribute to low rain water infiltration into the ground (that is low Green Water use efficiency**)**, which leads to low biomass production in both Crop and Livestock production.hThis state of affairs contributes to more land degradation, and as will be demonstrated later households livelihood strategies are negatively impacted leading to poverty and a repetition of the cycle. This ability of the land users in identifying land degradation types was done to evaluate the knowledge base of the respondents and is vital in identifying linkages between causes/interventions.

Table 8Main land degradation types and causes common in the areas

Main degradation types	Wanjohi		Turasha	
	Frequency	Percentage	Frequency	Percentage
Overgrazing	71	74.0	1	1.0
Cattle tracks	4	4.2	80	79.1
Tethering	10	10.4	0	0.0
Free range grazing	0	0.0	15	14.9
Others	11	11.4	5	5.0

Plates 4 to 6 further shows the various forms of land degradation,, plate 4. shows a tractor operator ploughing wet soils up and down the slope, this compacts the soil leading to less rain water usage and infiltration and more run-off that facilitate land degradation, plate 5 shows part of the Aberdare's that has been deforest rated by illegal human activities, the bare land contributes massive run-off which together with farm run-off contribute to the extensive road damage through gully erosion in the study sites as shown on plate 6.. These types of land degradation are all linked to human activities that are undertaken in an effort to support livelihoods. This is further shown in table 9 where in Wanjohi 83.4% of the households interviewed indicated that land overuse without soil and water conservation measures in the farms is the main leading cause of Land degradation followed by lack of capital and lack of knowledge at 7.2% and 5.2% respectively. For Turasha the main cause of land degradation was lack of capital at 77.3% and the practice of ploughing up and down the contours at 17.5%.lack of capital here means households cannot implement soil and water conservation neither measures in their farms nor invest on other alternative livelihoods.

Table 9Main causes of land degradation

Main Causes	Wanjohi		Turasha	
	Frequency	Percentage	Frequency	Percentage
Land over use/without soil and water conservation Measures	81	83.8	0	0.0
Soil contamination	3	3.1	0	0.0
Lack of capital	7	7.2	75	77.3
Lack of knowledge	5	5.2	1	1.0
Lack of Soil & Water Conser-measures (farms)	1	1.0	1	1.0
Ploughing Up and Down	0	0.0	17	17.5
Total	**97**	**100**	**94**	**100**

During the households interviews and the transect walks, it was found that leasing of land for cultivation was one of the main contributors to land degradation due to the fact that the lease owners do not give land conservation priority since they know they are there for a short time and hence priority for them is exploitation of the natural resources for maximum economic returns.

Plate 4.: Ploughing wet soil up/down the slope

Plate 5: Deforestation of the Aberdares-Wanjohi

Plate 6: Gully erosion on Roads –Turasha

Plate 7: Stunted growth in maize field

Plate 8: Poor pasture/vegetative growth-Turasha

Plate 9: Heavy sediment Loads in Rivers

Plate 10: Sparse vegetative cover in dry areas

As shown in Figure 8 below actual field measurements of rill and gully erosion were carried out during the field survey (measurement number in the figure indicates number of sites were paired measurements for both gully and rill erosion were done) to calculate actual soil lost through these forms of Land degradation in both Wanjohi and Turasha, the average Soil loss through rill erosion was 120.4 tons/hectare whereas for gully erosion the average for all the sites measured was about 30.7 tons/hectare. These measurements included assessment of gully erosion along the farm roads where average soil loss was 387.5 tons per hectare.

The usage of these field evaluation methods alongside identification of observable field indicators, in which the land users participated in the actual field measurements, facilitated their understanding on the magnitude of land degradation more so when the soil loss was calculated in tons/hectare then converted to 7 tons lorries/hectare. The participation and appreciation of land degradation by land users is important in technology innovations and improvement in adoption of the promoted technical options to mitigate on the effects of land degradation (Michael *et at.*, 2003).

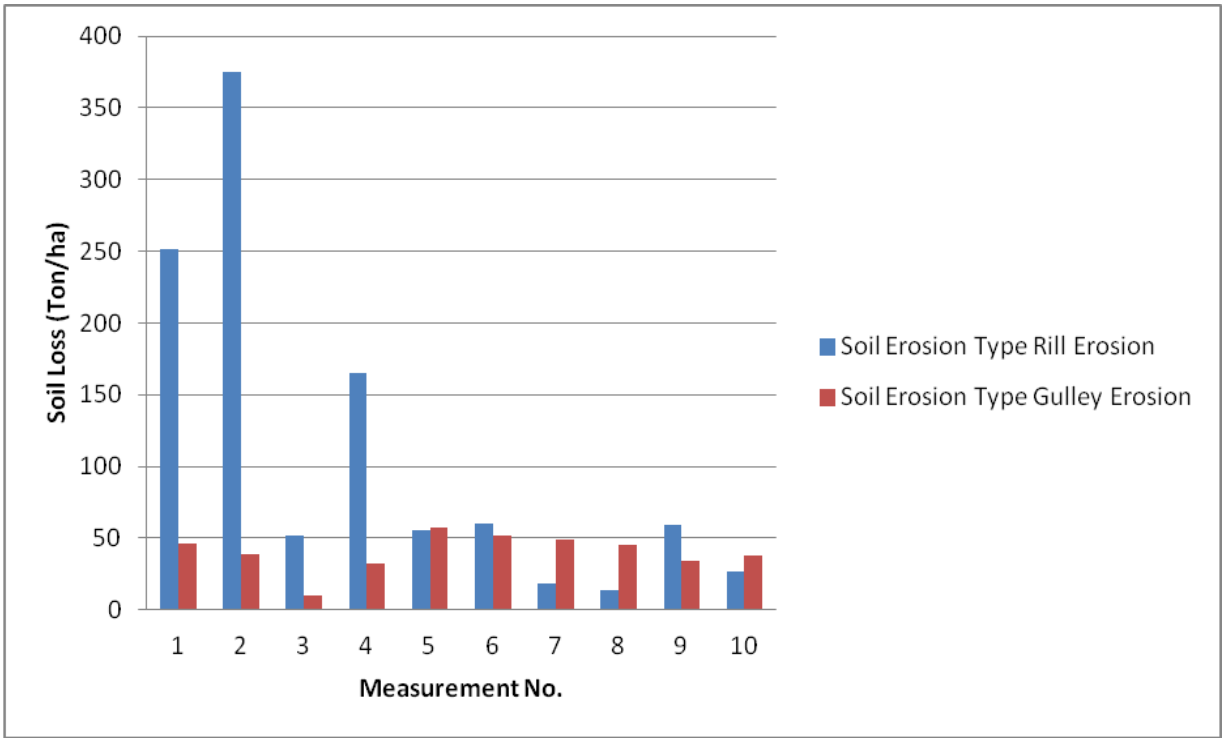

Figure 8: Land degradation assessment using rill/gully erosion indicator types measurements

The sampled households documented the list of livestock management practices and related benefits as shown in Table 11.In Turasha the main benefit of good livestock management (Zero grazing practice) was improvement of soil fertility through manure additions to farms at 58.8% followed by reduction of cattle tracks at 22.5%. On the other hand, for Wanjohi zero grazing contributing to reduction in cattle tracks at 48% and reducing overgrazing through zero grazing at 21.2% were given as the main benefits. This implies that households that are not practicing zero grazing currently in one way or another are contributing to land degradation that is common in the two sites.

Table 10 Benefits linked to good livestock management practices

Benefits	Wanjohi		Turasha	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Manure addition to farms-improve soil fertility	5	4.8	60	58.8
Zero-grazing reduces cattle tracks	50	48	23	22.5
Zero grazing reduces animal diseases	10	9.6	7	6.8
Zero grazing reduces incidents of overgrazing	22	21.2	10	9.8
Zero grazing allows practice of cut and carry from GOK forests	17	16.4	5	4.9
Total	**104**	**100**	**102**	**100**

From the table above, it's indicative that the system of livestock management used by the households in the study areas determines whether livestock keeping leads to sustainable land management or to enhancement of land degradation as noted earlier in Table 8 where overgrazing was one of the high causes of land degradation, and therefore there is need to address this if land degradation has to be reversed for sustainable management of lake Naivasha.

During the survey the respondents in Wanjohi and Turasha were also asked to indicate whether they are aware of any ongoing initiative linked to reversing land degradation within their respective watersheds, as shown in Figure 9 over 90%% of the respondents in the two sites indicated that they are aware of an ongoing initiative to reverse land degradation, they also are aware that the current initiative is jointly supported by Care Kenya and World Water (WWF) Fund supports planting of grass along the contours, rehabilitation of riparian lands and that those who have been supported have realised an increase in farm productivity, this level of knowledge was key when it came to analysis of success or failure of the given effort and identifying technical gaps that should be addressed before undertaking any new interventions.

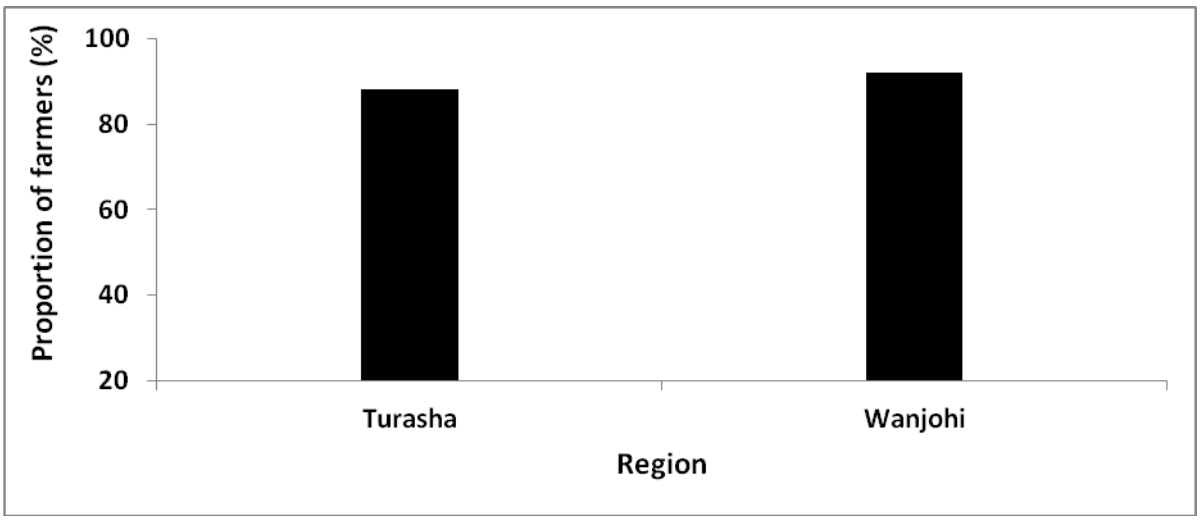

Figure :9 Areas where land conservation/restoration/improvement has been achieved

In summary, with regards to evaluating the effectiveness of land user based land degradation assessment and its application in the sustainable management of Lake Naivasha, it is important to note that this approach enabled the land users to participate in the actual identification of the main land degradation types and there causes ,they also identified the indicators of land degradation(evidence for land degradation),, participated in actual field measurements where they were able to quantify soil losses in their farms (Figure 8)and highlight how they are coping with the impacts of land degradation in their farms. The respondents also were able to indicate the benefits of good livestock management practices and good land management as promoted by WWF and Care Kenya in some farms.

In this approach, where land users participate in the diagnosis of land degradation processes is vital in identifying in a participatory manner appropriate interventions and key in improving adoption and adaptation of any technologies that will be promoted in the area leading to a more

sustainable management of the natural resources within the lake basin. It's important also to note that this approach easily identifies entry points for any stakeholder wanting to work with the community. Therefore a land user based land degradation assessment framework when properly applied can be very effective in the sustainable management of Lake Naivasha due to links within actual land degradation type(s) to relevant technical interventions.

4.3 Links between land degradation impacts on Livelihoods.

The second objective of this study was to evaluate the links/impacts of land degradation on livelihoods. To achieve this objective the study used the sustainable rural livelihood assessment framework(SRLF) to establish the impacts of land degradation on the livelihood strategies as represented by the main capital assets (Natural, Physical Social, Financial and Human).The results given in Table 13 were collected from the focus group interviews specifically the Water Resource Users Associations(WRUAs) with the input of various technical officers and other opinion leaders from(NGOS, Civil Society Groups, Large scale Flower farmers and local politicians).

Data was collected and analyzed under the research question what are the impacts of land degradation on the livelihoods of the inhabitants of Lake Naivasha Basin. The results are presented in Table 11 and Figures 10-14.

During the study the respondents were asked to list down the main impacts of land degradation on livelihoods in the two study areas, As shown in Table 11 Frequent crop failure with 38.8 % and increased incidents of poverty with 34% were given as the main impacts of land degradation,

followed by low access and use of natural resources at 12.6%,poor access to markets at 5.3% damage to road network at 4.3%.The listed impacts of land degradation, directly or indirectly also have an impact on the scope of livelihood strategies that households can undertake in an effort to make a living. Table 12 further explains in detail the impacts of land degradation on household a asset which determines whether a household can undertake priority interventions to reverse land degradation or contribute to more land degradation.

Table 11:Main impacts of land degradation:

LIVELIHOOD PROBLEMS	Frequency	Percent
Increased incidents of Poverty	72	34
Low Access and use of Resources	26	12.6
Poor Access to Markets	11	5.3
Frequent Crop Failure	80	38.8
Water Scarcity	3	1.4
Damaged Road Network	9	4.3
Total	206	100

Table12: Sustainable livelihoods assessment framework findings for the two study areas

Capital Asset	*Description of capital assets*	*Positive Effects of Change in Capital*	*Negative Effects of Change in Capital*	Comments
Natural	**Natural capital:** Environment (e.g topography, soil, water).	>Implementation of soil and water conservation measures in farms has reduced reliance on Government forests for animal grazing	.>Before conservation, value of land had decreased significantly	>There is need for all stakeholders to massively invest on on-farm conservation
Physical	**Physical capital** incorporates infrastructure, purchased goods and manufactured items	>Road network has been improved. Farm produce able to reach nearby market centers that have grown. This has led to job creation within the community	>Road network expansion has come with high level of sediment loads to rivers. Due to poor management of road run-off/runoff from farms this has led to Silting of cattle dips, and damage to water	>Linkages between road makers /MOAL&F staff are fairly wanting

			pans	
Human	**Human capital**: this element of capital comprises the innate and learned	>.As a result of conservation and increased incomes school attendance has gone up schools absenteeism is now minimal	>Households whose farms are badly degraded don't manage to produce enough…Children do not go to school. >	>High illiteracy levels has negatively affected the ability to learn by land users
Social	**Social Capital**: social relationship such as access to or membership of networks	>Many social groupings /cooperative societies have emerged to deal with environmental issues >	>Those whose farms were badly degraded were shunned by others…seen as beggars	>Massive land degradation affects existing social networks. Leading to many household embracing poverty
Financial	**Financial capital** comprises access to cash	>Those whose farms were conserved increased earning by as much150%/unit area	>Land degradation leads to reduced earning/unit area. >More land degradation. Increases incidents of social conflicts	>In the two watersheds Turasha had a more pronounced effect on the financial capital asset as a result of massive land degradation

Table 12 above is a summary of the findings on the impacts of land degradation to the basic assets that defines the livelihoods of households in the two study sites. As can be seen land degradation affects all the 5 capital assets (Natural, social financial, human and physical) more so the natural capital asset on which the livelihoods of many rural people are based, this in turn impacts negatively on the other four capital assets. The massive positive impacts that have come as a result of investments on the natural capital asset through on-farm soil and water conservation is worth noting, more so by any stakeholder working/planning to work within the lake basin:

Earnings per unit area and value of land have gone up, viable social grouping have emerged in the two watersheds, acquisition of new skills and attendance to formal education has improved, other alternative livelihoods have emerged and re-investment on land is quite visible resulting in sustainable use of the natural resources.

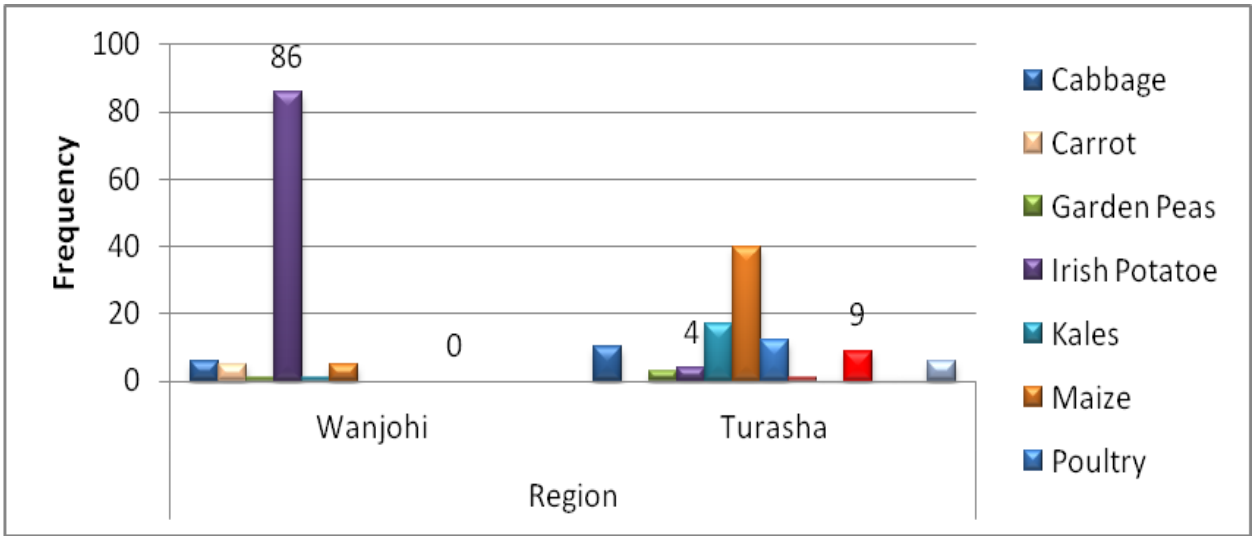

Figure :10 Main Livelihood/production activities –rain season for subsistence

As indicated in Figure10 and 11 the effects of land degradation are more evident in Turasha which even during the rainy season the land users investment on crop enterprises is only for subsistence purposes instead of investment on high value crop enterprises which can generate income, the land here consists of small parcels that are badly degraded due to poor farming practices like ploughing up and down the slope, absence of vegetative cover and little crop residue after harvesting. Wanjohi watershed seems to have a potential for conversion of a number of enterprises from subsistence to income generation.(both for the rain and dry seasons) if land degradation is reversed.

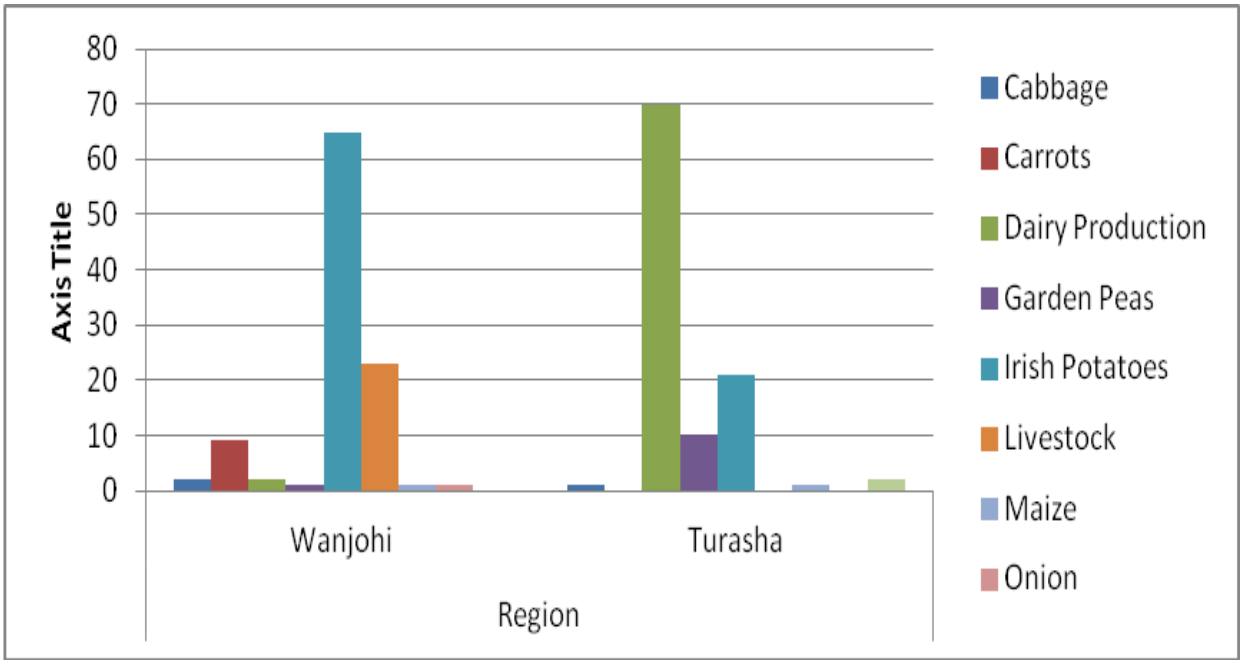

Figure :11 Main LH/production activities- rainyseason for income

Figures 12 and 13 below further indicates that of the two watersheds, Wanjohi seems to have more options for dry season income generation than Turasha (which relies only on Dairy and Garden pea farming), but generally the two watershed operates more on subsistence even on enterprise which can easily be converted to provide income to the households(the higher levels of land degradation coupled with low rain water use efficiency and infrastructural challenges have contributed to most households operating at subsistence levels),this situation of operating at subsistence level cannot withstand the shocks and impacts that are associated with land degradation

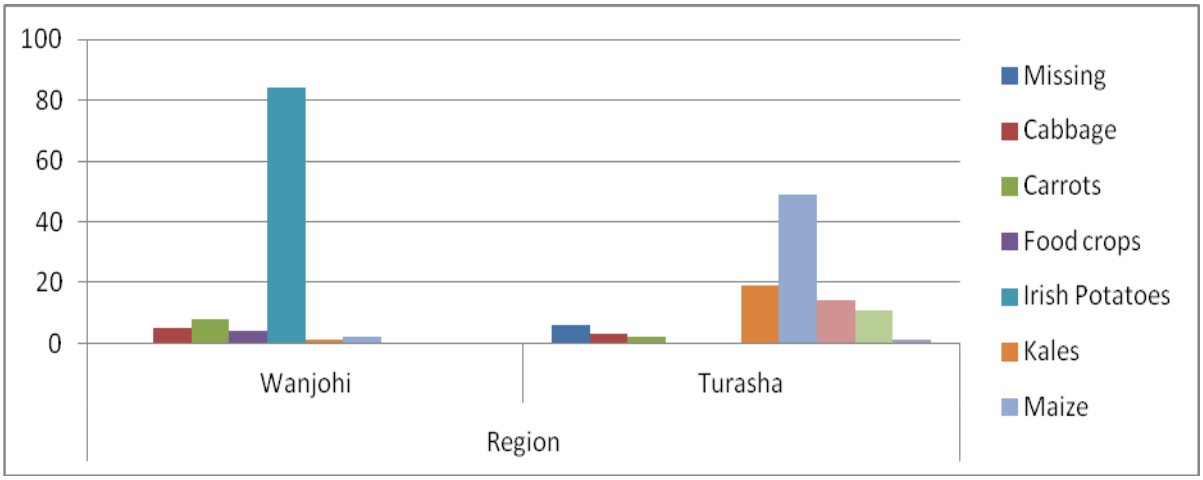

Figure :12 Main LH/production activities – dry season for subsistence

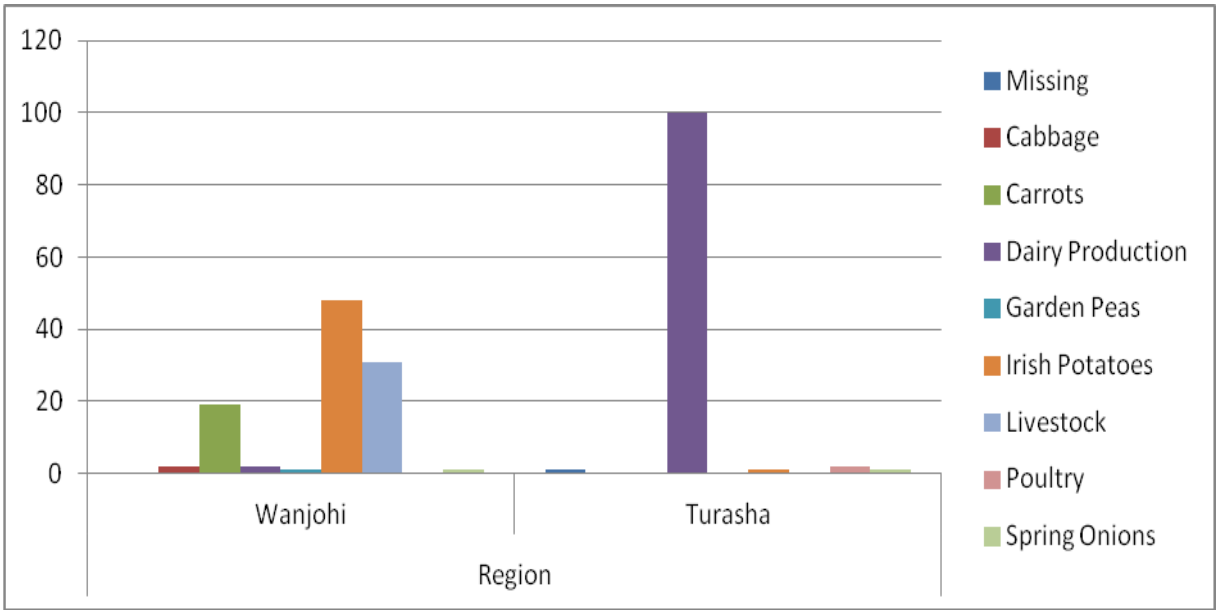

Figure :13 Main LH/production activities during – dry season for income

The study further revealed that about 60% of male headed households and 25% female headed households of the households are affected more by poverty than any other difficulties or problems that are linked to land degradation in the two study sites (Figure 14). The other problems like access to resources, access to markets, frequent crop failure and water scarcity

accounted for less than 20% , during the transect walk it was also noted that the impacts at individual household level and basin level are quite high.

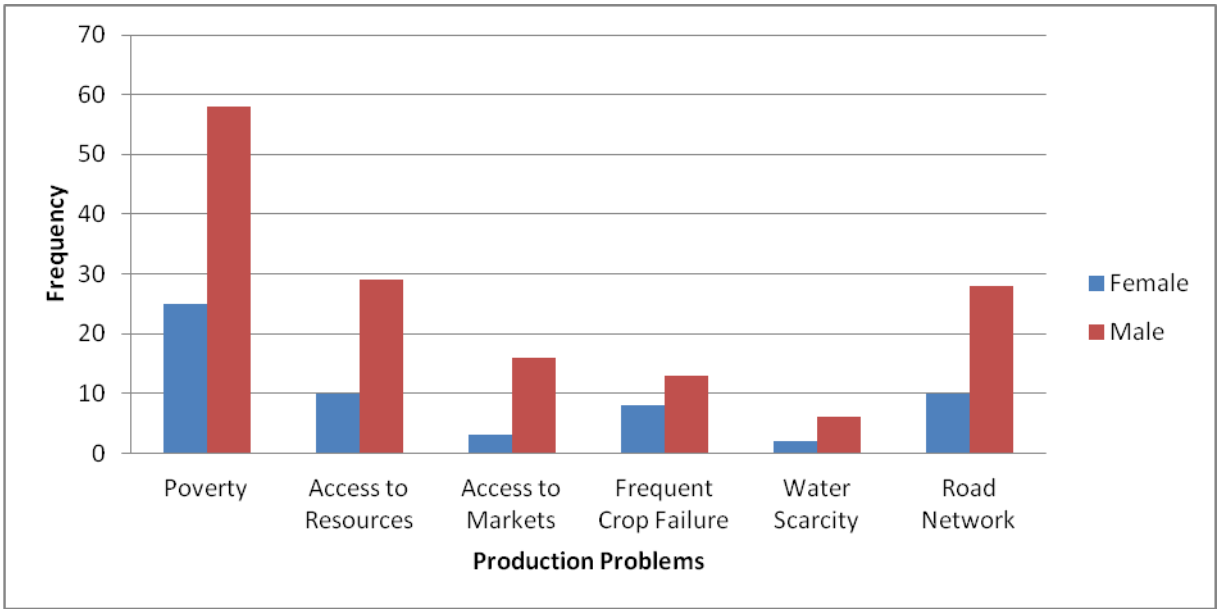

Figure 14: Main livelihood/production problems based on gender

As shown earlier on the livelihood framework land degradation affects both the social, economic and ecological lives of the people living in the two watersheds(Figs 12 and 13: Table 8).Therefore addressing the issue of land degradation is key in reversing the negative impacts it causes to peoples livelihood strategies.

In order to evaluate the links between land degradation using land degradation indicators and causes, the ordinal regression statistical model was used to measure the strength of the relationship between land degradation and livelihoods, the results as tabulated in Table 12 indicate that the Ordinal Regression Model was significant(χ^2 =16.431, P=0.01) but the model explained only 8% of the variability (land degradation indicators or causes).Irish potatoes and Livestock Production livelihood strategies had significant impact on land degradation indicators.

Irish potatoes are heavy extractors of soil nutrients, this depletion in farms where they are produced every season, leads to reduced vegetation cover which accelerates land degradation. As indicated earlier, overgrazing and cattle tacks in livestock production systems make land more prone to degradation.

Table 13 Ordinal regression analysis: indicators of LD and impacts on LH

Pseudo-R Square							
Nagelkerke			8%				
Model Fitting Information							
Model	**-2 Log Likelihood**		**Chi-Square**		**df**	**Sig.**	
Intercept Only	243.317						
Final	226.386		16.931		6	0.010	
Goodness of Fit							
			Chi-Square		**df**	**Sig.**	
Pearson			181.781		60	.000	
Deviance			134.948		60	.000	
Parameter Estimates							
Threshold	**Estimate**	**Std. Error**	**Wald**	**df**	**Sig.**	**Interval**	
						Lower Bound	**Upper Bound**
Livelihoods							
~~I.Potatoes~~I. Potatoes prod-	.973	.286	11.582	1	**.001**	.413	1.534
Carrots prod-	.429	.427	1.012	1	.314	-.407	1.265
Dairy Production	.219	.560	.153	1	.696	-.879	1.317
Cabbages prod-	-.607	.898	.457	1	.499	-2.366	1.153
Maize prod-	.736	1.035	.506	1	.477	-1.292	2.764
Livestock prod-	1.611	.638	6.365	1	**.012**	.359	2.862

In summary with regards to establishing the links between land degradation and its impacts on the livelihoods of the inhabitants of the lake it has been shown that land degradation, can cause direct or indirect adverse impacts on livelihood strategies at individual household level. Table 8

indicated how land degradation has eroded all the five capital assets. Which are the vital components which household use to construct their livelihoods strategies.

Overall it was demonstrated through the study that land degradation in the two study sites has adversely affected the livelihood options of the inhabitants, making more of the households to operate at subsistence levels, due to low options on livelihood strategies, resulting in social conflicts over natural resources such as water, damage to government forests as a result of trying to support families, the narrow scope of livelihood strategies for households has resulted making many households to become poor, which has led to more environmental degradation and low crop and livestock production…These negative impacts can easily be reversed through investments in soil and water conservation efforts at farm level and at basin level.

4.4 Applicability of Green Water Credit (GWC) scheme in reversing impacts of land degradation on livelihoods

In order to evaluate the applicability of Green Water Credit (GWC) scheme in reversing the impacts of land degradation on livelihoods, data was collected and analysed as follows.

During the study the respondents indicated that they were aware of an initiative by Care Kenya and WWF of paying farmers in the two study sites to undertake environmental conservation at farm level and in the riparian sites, and as indicated in Table 9,98% of the respondents in each of the two study regions indicated a need for GWC(a form of Payment for Environmental Services (PES),the high demand for the GWC initiative implies its implementation in the Lake basin will not encounter many challenges.

Table 14: Indication of demand for GWC scheme

Response	Wanjohi		Turasha	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Yes	102	98	102	98
No	2	1.9	2	1.9
Total	**104**	**100**	**104**	**100**

In order to test whether the current initiative of payment for environmental services (PES)has any correlations with the identified demand for GWC the Pearson's (2-t) test was used with the demand being the dependant variable and current payment initiative independent variable. The results as indicated in Table 15 shows a very high correlation factor of r=0.8) implying that as payment level is varied the demand for the service proportionately changes positively. This finding indicates that any initiative undertaken by any service provider in trying to sustainably manage Lake Naivasha should endeavour to have a component of GWC, since there is high demand for it in the basin.

Table 15: Test of correlation between current PSE initiative & Demand for GWC

	Existence of an initiative for payment for watershed services	**Existence of a demand for payment for ecosystem services**
Pearson Correlation	1	.008
Sig. (2-tailed)		.904
N	208	208
Pearson Correlation	.008	1
Sig. (2-tailed)	.904	
N	208	208

The respondents were further asked what form of payment they would prefer if GWC scheme was to be introduced. As shown in Table 16 the responses varied from 50% for compensation in the two sites, 29.1% and 25.2 % (Wanjohi), 33% and 25.2% (Turasha) as incentive and reward respectively.

The fact that the current beneficiaries would want Green Water credit scheme to have another face of either a reward or an incentive is important in introducing the GWC in the two study sites. One should conserve their land without expecting payments, but beneficiaries of one's efforts have a choice to reward or give the person an incentive to continue being a good steward.

Table 16: Perception on Green water credit (GWC) scheme

Payment mechanism	Wanjohi		Turasha	
	Frequency	Percentage	Frequency	Percentage
Incentive	20	9.7	52	23.4
Reward	68	32	52	23.4
Investment	14	6.7	05	2.2
Compensation	103	439.8	103	46.4

During the focus group interviews and through the questionnaire the respondents when asked about compensation and on who has to compensate who, identifiedtwo classes of players in the compensation arrangement, the beneficiaries downstream, those who currently are benefiting from environmental services offered by the upstream managers (stewards) . As shown in Table 17, about 58%of the respondents in the two sites felt that all beneficiaries downstream should compensate upstream land users for ecosystem services. there is also 20.6% of the sampled households in Wanjohi who felt that beneficiaries downstream should compensate all upstream people whether they are providing ecosystem services or not. The 7.9% in Turasha who indicated that a reward system can be one such approach to managing GWC, were relevant to this study, Land conservers be rewarded for proper land use, by beneficiaries of environmental services not necessarily all upstream inhabitants.

This ability to separate the two groups is important in the application of payment for environmental services like Green Water Credit scheme in the two study areas. This level of

awareness is essential in addressing technical gaps, facilitating adoption and adaptation rates and overall improving resource management. (Only those land users who have intervened at farm level to reverse land degradation qualifies for GWC as a reward)

Table 17 Compensation regimes (arrangement)

Compensation regimes	**Wanjohi**		**Turasha**	
	Frequency	Percentage	Frequency	Percentage
Beneficiaries to compensate all upstream people	21	20.6	9	8.9
All beneficiaries downstream to compensate upstream land users	59	57.8	59	58.4
Downstream to compensate upstream	22	21.6	25	24.8
Beneficiaries to compensate stewards	0	0	8	7.9
Total	**102**	**100**	**101**	**100**

The study further endeavoured to find out the best mechanism for GWC or PES mode of payment as shown in table 18. For Wanjohi 38.9% and 38.5% of the sampled households felt payment in kind or voucher systems respectively can be the best mechanism of payment, the table further indicates that 79.8% and 12.5% in Turasha would prefer payment in cash or in kind respectively. During the survey it was found that the voucher payment mode currently in use by Care Kenya and WWF has its challenges especially abuse by some of the WRUA officials. There is better management of the current initiative in Wanjohi than in Turasha. The results further indicates that there will be need to create awareness and capacity build the players in the study regions and the Lake Basin as a whole if the GWC scheme is to work.

Table18: Best mechanism for GWC mode of payment

Type of payment	Wanjohi		Turasha	
	Frequency	%	Frequency	%
Credit	0	37.5	1	0.96
Voucher	39	24	7	6.7
Cash	25	38.5	83	79.8
Payment in kind	40	38.9	13	12.5
Total	**104**	**100**	**104**	**100**

The research also analysed the best institutional arrangement that can manage the GWC scheme if introduced in the area, as shown in Table 19, 82.7% and 54.8% of the respondents for Turasha and Wanjohi respectively indicated that a stakeholder fora consisting of various institutions will be better placed to manage such a scheme, the28.9% for Turasha who felt WRUA are equal to the task of managing the scheme indicates some reservations that they have on the set up and operations of the WRUAs, the respondents felt a more neutral body consisting of technical people, non-governmental actors and beneficiaries would be best placed to manage a scheme like the Green Water Credit.

Table 19: Best institutional arrangement for GWC scheme

Institution	Wanjohi		Turasha	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Water Users Association	28.9	28.9	4	3.9
Stakeholders from various Institutions	54.8	54.8	86	82.7
Farmer Based Institutions	4.8	4.8	0	0
Government Officials	10.6	10.6	0	0
Total	**104**	**100**	**104**	**100**

Notwithstanding the earlier findings that the current initiative is faced with many challenges Table 20 below Shows 100% and 72.7% of the respondents for Turasha and Wanjohi respectively, felt that green water credit scheme can effectively be used to promote other off-farm alternative livelihood strategies (cottage industry, agro-processing, facilitate capacity

building, and be a source of initial working capital for off-farm incomes, employment creation and promotion of environmental conservation activities) which will reduce reliance on -farm livelihood strategies and thereby less land degradation within the lake basin.

.This indicates a high sense of awareness of how a GWC facility should be made to work in the area.

Table20: Use of GWC to promote alternative Livelihoods

Response	**Wanjohi**		**Turasha**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Yes	86	72.7	104	100
No	18	17.3	0	0
Total	**104**		**104**	

Some more interviews were conducted with Focus Groups and Opionion Leaders within the lake basin, who indicated that, GWC scheme can be use to sustain ably manage Lake Naivasha, through:

1. Support to a forestation and reforestation activities within the Aberdare's and the farms.
2. Controlling siltation of the rivers, through carrying out on -farm soil and water conservation activities and therefore ensuring big volume of clean water flows in to the lake
3. Support poor households to implement soil and water conservation measures
4. Support river bank protection. reduce incidents of flooding and water pollution
5. By helping the land users to control soil erosion through education and material support like grass strips and tree seedlings to prevent siltation of the lake
6. Support promotion of other alternative livelihood options.

Furthermore as shown on plates 11 and 12, proper use of GWC, like promoting on farm tree planting and riparian protection, can result in sustainable natural resource use within the Lake.

Plate 11: Clean Stream waters-Turasha **Plate 12 Establishment of woodlots - Wanjohi**

4.5 Recommendations to improve the environmental conditions of Lake Naivasha

WRUA representatives and other opinion leaders were assembled together and taken through a prepared checklist and asked how the environmental conditions of the Lake can be improved. The following suggestions were given:

1. The Aberdare forest should be protected at all costs, through involvement of the community and other interested players.

2. Individual households should be encouraged to plant more trees in their farms e.g. Grevillea, Cyprus, croton spp, Nandi flame, Casuarina spp,

3. Different service providers should make deliberate efforts to support alternative sources of income so as to reduce pressure on the limited natural resources within the Lake.

4. Land users should be supported to implement recommended soil and water conservation measures at farm level.
5. Prevent logging in protected government forests
6. Use of efficient irrigation methods should be supported by all players
7. Grass strips should be planted in steep slope area to prevent soil erosion
8. Priority should be given to rehabilitation and maintenance of riparian zones
9. Efforts should be made in Promoting water harvesting and ensure that large water users like flower farms can almost exclusively use water harvested from the green houses

In conclusion, it was established that the demand for GWC in the two sites is quite high, the respondents further differentiated the upstream ecosystem provides as the people to be rewarded by the beneficiaries of the ecosystem services (downstream).The study also found that the best bet institution to manage GWC is a stakeholder fora consisting all main actors in natural resource management. The research further showed that both upstream and downstream inhabitants of the lake stand to benefit if they collaborate through the support of key stakeholders to initiate and manage a GWC scheme that will facilitate rain water use efficiency resulting in increased biomass production, promote other alternative livelihoods for the inhabitants thereby lessening the strain on the Lakes natural resources and alleviate poverty that was identified as the key impact of the land degradation in the basin. In a sense GWC is a vital component of any initiative that is geared towards sustainable management of Lake Naivasha, for this initiative to work the current challenges of corruption within some of the institutions, weak institutional set up, inadequate technical backup, appropriate compensation level, form and appropriate technical options need to be addressed for the scheme to work sustainably.

CHAPTER 5: CONCLUSIONSAND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the conclusions and recommendations that were drawn on the basis of each objective of the research.

5.2 Summary of the Key Findings

The study came up with a number of findings that could be taken up by stakeholders concerned with sustainable management of the lake Naivasha and other important water towers in Kenya:

1. The research established that land user based land degradation and livelihoods assessment is effective in improving the appreciation of the magnitude/ scale of land degradation by land users and that this approach can improve the adoption and or adaptation of recommended interventions.

2. The study research showed that there is a link between and degradation and livelihoods, a narrow scope of livelihoods facilitates land degradation and vice versa, land degradation results in a narrow scope of livelihood strategies for households, making many households poor thus leading to more environmental degradation and low crop and livestock production. These negative impacts can easily be reversed through investments in soil and water conservation efforts at farm level and at basin level.

3. Lastly, it was established through the study that here is demand for GWC which if well managed can go a long way in supporting the sustainable management of the lake through supporting other alternative livelihoods and through improving water use efficiency at farm level and watershed level leading to increased production and income per unit area.

4. Integration of Local knowledge with scientific knowledge is very important in designing intervention for reversing land degradation.

5.3 Recommendations from the study

From the key findings, the following are some of the recommendations made to ensure that land degradation within Lake Naivasha and other water towers in Kenya are successfully reversed:

1. Key government agencies like the Ministry of Agriculture Livestock and Fisheries (MOALF)/other service providers need to use a land user based land degradation/livelihoods assessment methodology and also produce necessary guidelines.

2. Establishment of the fund that is provided for in the National environment management authority (NEMA Act of 1999) should be actualized in the form of green water credit (GWC) scheme. And be up scaled in the management of other water towers in the country where there are initiatives in reclaiming badly degraded watersheds.

3. There is need to carry out further research to identify the determinants for promoting/improving the participation of the vulnerable/resource poor households in the GWC/PES schemes,

REFERENCES

Adams, C.Eswaran, H, (2000), Global land resources in the context of food andEnvironmentalSecurity. Pp.35-50. in: Gawande SP, eds. *Advances in Land Resources Management for the 20th Century*. New Delhi: Soil Conservation Society of India.

Ashely, C. (2000), Applying Livelihood Approaches to Natural Resource management,**e**xperiences in Namibia and Kenya,Journal of Arid Environments 08/2013; 95:1–13. DOI:10.1016/j.jaridenv.2013.03.010 ·.

Bai, Z..&Dent, D. (2007).Land degradation and improvement in South Africa. Report 2007/03, ISRIC – World Soil Information, Wageningen.

Bai**,**Z, Dent, D. 2008. Global Assessment of Land Degradation and Improvement: Pilot study in Kenya. Report 2008/01, ISRIC – World Soil Information, Wageningen.

Berry L., D. Campbell, and J. Olson.(1991). "Alternative and Sustainable Systems of Production and Livelihoods in Marginal Lands." Background Document, UN Conference on Environmentand Development, Rio.1991.

Brecht, R., Higgins S., Odada E. (2005) Lake Naivasha a Brief. In: Managing lakes and their basins for sustainable use, ILEC, Kyoto.

Carmines .G and Zeller, R. (1979), Reliability and Validity assessment, Sage University Press**.**

Carney,D,Drinkwater,M,Rusinow,T, Nefjesi,K, Wanimali,S, and Singh,N,(2000),Livelihoods Approached Compared,In, Forum for Operationalizing sustainable Livelihoods Approach,Proceedings Annex4,,Puntignano(Siena), 7-11 March 2000.

Carney D. (1998).Implementing the sustainable rural livelihoods approach. In: Carney D. (ed), Sustainable Rural Livelihoods: What Contribution Can We Make? Department for International Development (DFID), London. pp. 3-26.

Carswell G. (1997). Agricultural intensification and rural sustainable livelihoods: A 'think piece'. IDS Working paper 64.

Chambers, R. and Conway, G. R., (1991.) Sustainable Rural Livelihoods: Practical Concepts for the 21stCentury. Discussion Paper 296, Institute for Development Studies (IDS), University of Sussex: Brighton de Janeiro, UN Sudano-Sahelian Office.

Cohen, A. (2008). Prerequisites and semantics: The challenges of implementing pro-poor payments for watershed services. Technical Background Report: Rural Poverty Portal. Rome: IFAD.

GOK(2009) Census Report.Kenya National Bureau of Statistics. Government press 2009.

David, D, (2005), Water for food and Ecosystems: Make it Happen, Wageningen,the Netherlands: ISRIC/FAO-World soil Information.

Dent, D., and Kauffman.J,(2007). The spark has jumped the gap: green water credits proof-of-concept. Wageningen, the Netherlands: ISRIC/FAO – World Soil Information.

DFID (2001) Sustainable livelihoods framework guideline sheets section 2.DFID policy papers, 2001.

Dobie P. (2001). Poverty and the dry lands. United Nations Development Programme,Drylands Development Centre Nairobi, Kenya.

Don, K. (2012) UNCCD Secretariat Policy BriefsDobie P. 2001. Poverty and the dry lands. United Nations Development Programme, Drylands Development Centre Nairobi, Kenya.

Droogers, P.Kauffman,S Dijkshoorn, W. Immerzeel, Huting, J.(2006.) Green Water Credits: Basin Identification. Report 1.ISRIC Report.

Ellis, F.(2000).Rural Livelihoods and Diversity in Developing Countries.Oxford University PressOxford, UK. This book looks at the application of the sustainable rural livelihoods framework to developing countries,

Eswaran, H., lal, R., Reich, P.(2001). Land degradation.An overview conference on land Degradation and desertification.Khonkaen, Thailand: Oxford Press, New Dehli, India

FAO (1996).Average land degradation in GLASOD Erosion degrees. Rome: Food and Agriculture Organization of the United Nations FAO report

FAO (2005). Payment schemes for environmental services in watersheds. Rome: Food and Agriculture Organization of the United NationsFAO report (2005)

FAO (1996). Our Land, Our Future. Rome: UN Food and Agriculture Organization; UNEP report 2002.

FAO (2007). State of Food and Agriculture: Paying farmers for Environmental services.Rome: Food and Agriculture Organization of the United Nations FAO report(2007)

Francesca ,G, Robert J. Kenneth M., Nic P, Jonathan G, Elena T, David M. (2011). A Review of all diversity in Lake Naivasha Kenya: Developing conservation action to protect East Africa lakes from the negative impact of alien species. Biological Conservation 144(11): 2585-2596.

Goblin A, Jones, R, Kirkby, M, Campling P, Govers G, Kosmas C, Gentile,R. (2004).Indicators for Pan-European assessment and monitoring of soil erosion by water. Environmental Science and Policy7 (2004) 25-38.

GOK(2009).National Census Report, Government press.

HCDA(2007).Horticultural Crop Development Authority report.Government Printing press Kenya.

IFAD/ISRIC (2007). The Spark has jumped the Gap, Green Water Credits Proof -of- Concept, ISRIC-World soil information report (2007) 64 pages.

IFAD/ISRIC (2010).Soil and terrain conditions for the upper Tana River Catchment,KenyaWageningen: ISRIC-World Soil Information, 2010 (Green Water Credits Report 10)-`136pages.

John.T and Norma H. Compton (1988), Research methods in human ecology/home economics:Iowa State University Press (Dec. 1988), ISBN-13: 978-0813807195.

Kapalanga,A, Taimi Sofia (2008). Review of Land degradation assessment methods Land Restoration Training Programme Final project 2008Keldnaholt, 112 Reykjavík, Iceland.

Methods research dissertation report for an MSC Agricultural University of Iceland.

Kauffman ,J, (2007) Green and blue water resources and assessment of improved soil and water management scenarios using an integrated modeling framework. ISRIC/IFAD study report .

Korthuis P, Asch ,S, Mancewicz ,M,(1993) Measuring medication: do interviews agree with medical record and pharmacy data? Med Care.2002; 40:1270-82.

Kruseman,G,Robet,A,Keyvehorn,H, Engsdisk,H and Van Keulen (1996),Analytical Framework for dismantling the concept of sustainable land use, Agricultural systems,50:191-207.

Lal ,R, Blum W, Valentin C, Stewart BA, (1997). Methods for Assessment of Land Degradation. www.ott.wrcc.osmre.gov/library/hbmanual/ rusle.htm#downloadhandbook,

Lal, R.(1998) methods for assessment of soil degradation, CRC, Press Boca Raton ,New york,558pp.

Michael,A,Albert,A,Fretheim,C,&Maiga,D, (2007) Factors influencing the Utilization of research findings by health policy-makers in a developing country: the selection of Mali's essential medicines.

Michael,S&Murnaghan,M (2003): Land degradation & Sustainable livelihoods. Field Assessment Manual.

Michael,S and Murnaghan,M (2006): Capital assets under the sustainable rural livelihood framework:

Ministry of Agriculture(1998).Annual report, government press.

NEMA-KENYA (2004).National Environment Management Authority: State of the environment report.Government press, 2004.

Oldeman ,L.Hakkeling,R.Sombroek,W. (1991).World map on the status of humaninduced soil degradation,with explanatory note(second revised edition). ISRICWageningen, UNEP, Nairobi.

Omuto C, Vargas R. (2009). Combining pedometrics, remote sensing and field observations for assessing soil loss in challenging drylands: A case study of northwestern Somalia. Land Degradation & Development 20:101–115.

Onyango G,Wegulo,F,Shivoga,W. (2011) Utilization of research findings for Sustainable management of lake Naivasha-Kabarak University First International Conference.

Oso, W. and One, D. (2008): A general guide to writing Research Proposal and report. A Hand Book on beginning Researchers. 2 nd edition, Makerere UniversityPress, Uganda.

Pagiola, S. and Holden, S. (2001). Farm Household Intensification Decisions and the Environment. In Lee, D and Barrett, B. (eds.), Tradeoffs or Synergies? Agricultural Intensification, Economic Development and the Environment.CABI Publishing, New York

Pfaff, A. Kerr, L. Lipper, R. Cavatassi, B. Davis, Hendy,J and Sanchez, A. (2007). Will buying tropical forest carbon benefit the poor? Evidence from Costa Rica.*Land Use Policy* 24**:** 600-610

Robert .B, Eric ,O, Sarah,H. (2006). Lake Naivasha Experience and Lesson Learned Briefs.

Snel M, Bot A. (2003). Draft Paper: Suggested indicators for Land Degradation Assessment of Dry lands. FAO, Rome

Sujatha,G.Dwivedi,R.Sreenish,K.Ventakaratnam,L.(2000). Mapping and monitoring degradaed lands in parts of JanupurDistrict,ofuttarpredesh,using temporal spacebonemultispectoialdata:international journal of remote sensing,21(3) 529-531

Thomas,K, Beat,W, Julius, K. (2010) Reporting bias in medical research - a narrative review2003. UNEP 1997.

Tiffen,M. (2003). Intensification in an Urbanising Context: The Case of Dryland Sub-Saharan Africa. Paper presented at "Reconciling Rural Poverty Reduction and Resource conservation: Identifying Relationships and Remedies," Cornell University, May 2-3,

Torrion and Jessica.A.(2002) Land Degradation Detection, Mapping and Monitoring in the LakeNaivasha Basin,

Touliatos,J and Compton, N. (1988):Research methods in Human Ecology and Home Economics: 1st edition Ames: Iowa state university press

UNCCD (1992). The Rio Declaration on Environment and Development, United Nations Rio de Janeiro Earth summit report.

UN/FAO(1997). National Land degradation assessment and mapping in Kenya.United Nations report.

UNEP(2000).The key challenge is to reduce poverty. New approaches that put the poor at the top of the environment and development agenda" GEO 2000, Global Environment report.

UNEP(2002)."Diversity and Homogeneity: Fostering Innovativeness in Local Environmental Management" United Nations report.

UNEP.(2008). Africa: Atlas of Our Changing Environment. Division of Early Warning andAssessment (DEWA) United Nations Environment Programme(UNEP). Nairobi 00100, Kenya

UNEP(2000).Global Environment Outlook. 2000. The State of the Environment – Africa, Latin America and theCaribbean. Land and Food, Chapter 2. UNEP, internet website: http://www.unep.org/geo2000/ English/0053.htm, accessed July 29, 2014

UNESCO (2005).UNESCO's 2005 convention on the protection and promotion of the diversity of cultural expressions first quadrennial report by the United Kingdom.

WHO (2005).Ecosystems and human well being, World health report.

WWF(2010).Shared risks and opportunities in water resource: Seeking a sustainable future for Lake Naivasha, programme, Gpagasys,RSA.

APPENDICES

Appendix 1.1: Sample Questionnaire

QUESTIONNAIRE FOR DETERMINING LAND USER BASED LAND DEGRADATION AND LIVELIHOODS ASSESSMENT: APPLICATION IN SUSTAINABLE MANAGEMENT OF LAKE NAIVASHA-KENYA

1. Questionnaire checklist for Focus group/Individual Households interviews

1.1 What is the

(a) Name of respondent: ……..

(b)Number of people in the household…….

(c)Estimate Land holding (acres) …….

1.2 What is the history and pattern of settlement in the area…

……
……

1.3 What are the main important land use types in the area/as differentiated by the community……
……
……..

1.4 What is the main water resource s available and used by the community in the area?

1.5 What are the main livelihood / production activities during the

i) rainy and ii) dry seasons differentiated into subsistence/income generation

……
……..……

1.6 What are the main natural resources that the community uses for production /livelihoods? (e.g. Cropland, grazing land, fuel wood, timber, medicinal plants, dry season water sources

……
……..……

……

1.7 What are the important types of land degradation[1] in the territory? …….

……

……

1.8 For each distinct type: What do you consider are the main causes...?

……

……..

1.9 What are the main impacts...?

……..

1.10 What are the changes in the last 10 years or so, in terms of type, extent and severity?

…….

…….

1.11 What indicators do the locals use to describe soil erosion / degradation (e.g. loss of fertility, salinity, soil loss, gully formation (active / under control), build-up of sand or shifting sand dunes, sediment load or pollutants in water resources etc.)? ……

……

……

1.12. What are the livestock management strategies and related problems in terms of degradation or related benefits in terms of sustainable land management? ……..……

……..……

1.13 Has the study area experienced i) drought, ii) flooding or any other extreme weather event (e.g. intense storms) in the last 10years? Is the frequency and severity normal or exceptional……

….

…….

……

1.14 What are the strategies and coping mechanisms adopted i) during drought or unusual dry years or ii) to reduce risk of flooding or iii) to reduce damage from

Wind/storms…….

……..

……

1.15. Are there any conflicts in relation to land and water uses in the area……

…….

……..

1.16 What are the main livelihood problems / difficulties (i.e. serious / long term);(less serious / short term) faced by rural households (food insecurity, poverty, access to resources, access to markets…….....

……
……
…….

1.17. Are there successful areas where land degradation control (i.e. Conservation, restoration and or improvement of land resources) has been achieved...

…….

If so(a) What were the main sustainable land management (SLM) practices or measures (policies, legislation, bye-laws etc.) to prevent land degradation that were implemented in specific land use systems / types?.....

……

(b)Were they aimed: i) to improve ……

(2) Restore the productive capacity of the land (e.g. soil fertility, use of water);

(3)) For conservation / protection of resources (soil, water, vegetation, wildlife, biodiversity)……

Indicate for each whether they are the result of an external intervention or a local / traditional practice……..

……..

1.18 If possible, identify any interventions that have gone beyond a focus on soil and water conservation and productivity in situ to address wider ecosystem services (e.g. water catchment / supply, carbon sequestration, reduced greenhouse gas emissions, pest and disease regulation, protection of biodiversity and aesthetic landscape values etc……

…….

…….

1.19What are the various organizations that determine the way land (including water and vegetation resources) is managed in the community?.....

…….

……

1.20 The main informal and formal systems of tenure and rights to access land resources (crop land, pasture land, forest and water) in the community?

(For each indicate how they influence land degradation, conservation or improvement)…….

……

……..

1.21 How do laws, rules and regulations concerning land resources affect the extent of land degradation and / or conservation? (Prompt for positive and negative effects)……..

……

……

1.22 What other major social divisions (apart from poverty / wealth) exist in the community (e.g. Religious or caste groupings, pastoralists or settled farmers, farmers practicing irrigation or rain fed cropping) that affect the differential access people have to resources and / or the ways in which they manage their land?……...

……

……

……

2. Green Water Credit scheme

2.1 Is water availability an issue in the area?

- ☐ yes
- ☐ No

If yes how...

……
……

……
……

2.2 What are the competing claims...?

……
……

……
……

2.3 Are there existing land and water rights?

- ☐ Yes
- ☐ No

If No, Explain……………………………………………………………………………………

2.4 Who has the right to modify them? …………………………………………………

………..

……

2.5Who has to compensate whom?………………………………………………………………………………………

……

……

2.6 Is there already an initiative for payment for watershed services?

- Yes
- No

By whom?……

……

……

2.6a what are the challenges faced by the current initiative……………..

.

‘’’

………………………………………………………………………………………………………

2.7 Is there demand for payment for ecosystem services?

- Yes
- No

2.8 Should Green water credit (GWC) be seen as an

- Incentive
- Reward
- investment

- compensation
- Punishment

2.9 What is the best mechanism for payment for ecosystem services?

- Credit
- Voucher
- Cash
- Payment in kind

2.10 What is the best institutional arrangement for management of Green water credits (GWC)

- Water users association
- Stakeholder from various institutions'.
- A farmer led institution
- Government officials

2.11 Can green water credits be used to promote alternative livelihoods at household level?

- Yes
- No

If yes

how?.....

.....

.....

.....

2.11a Can green water credit scheme be use to address poverty

- Yes
- No

If Yes

how?.....

.....

.....

.....

2.12 How can green water credit make a difference for the livelihood strategies of

Upstream

(stewards)……

……

……

……

……

……

Downstream

(Beneficiaries)……

……

……

……

……

……

2.13 How can green water credits be used for the sustainable management of lake Naivasha?.....

……

……

……

……..

……

……..

3. Recommendation

3.1. What can you recommend to improve the environmental conditions of the lake Naivasha Basin?

……
……
……
……

3.2. How do you cope with the present environmental conditions in your areas?

a) Frequent Water shortages
   ……
   ……
   ……
   ……
b) Badly degraded land…….....

……
……
……
……

c) Frequent water conflicts……...

……
……
……
……

……...

……
……
……

d) Others(specify)……
……
……
……

Appendix 1.2: LAND DEGRADATION FIELD ASSESSMENT FORMS FOR RIL PEDESTAL AND GULLY.

Field Form Rill

Site:

Date:

HH -Name:

Soil Type:

Appendix1.2: Field form for rill erosion measurement

Measurement	Width(cm)	Depth (CM)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
Sum of all measurements: Average		
Length of Rill		
Contributing catchment to rill		
Cross-sectional area(rectangle)		
Volume of soil lost		
Volume lost/m2		
Net soil loss in tons/ha		

By calculating the average cross-sectional area using the formula appropriate for the cross-sectional one can estimate the amount of soil loss.

Field form Pedestal

Site:

Date

HHNa

Appendix1.3: Field form for pedestal erosion measurement

Measurement locality	Maximum length of pedestal in locality (mm)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

12	
Sum of Measurements	
Average pedestal Height	
Net soil loss	

Amount of soil lost per unit area can be determined by Calculating t/ha equivalent of the net soil loss (represented by the average pedestal height).

Field form Gully

Site:

Date:

HH Name:

Length of gully

Catchment area 1km2

Appendix1.4: Field form for gully erosion measurement

Measurements	**Width of lip (w1) (m)**	**Width of base (w2) (m)**	**Depth (m)**
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
Sum of all measurements			
Average	Width (w1)	Width (w2)	Depth (d)

Av cross sect area			
Soil lost from gully			
Soil lost/m2 equivalent			
Soil lost tons/ha			

Calculating the average cross-sectional area of the given gully and add up to catchment area will give the total soil loss per unit area.

Site:

Date:

HH Name:

Length of gully

Catchment area

Appendix1.5: Field form for gully erosion measurement

Measurement number	Width of lip (m)	Depth m
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
Average W1		
Average Depth		
Average Cross Sectional Area		
Volume Of Soil Lost		
Volume Lost Per Square Meter		
Loss in Tons Per Hectare		