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The significance of Ecosystem Services in sustaining people's livelihoods; a case study in Mara wetland, Musoma and Tarime District, Tanzania

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The findings, interpretations and conclusions expressed in this study do neither necessarily reflect the views of the UNESCO-IHE Institute for Water Education, nor of the individual members of the MSc committee, nor of their respective employers.

DEDICATION

This work is dedicated to my son Sebastian, my husband Shabu Maurus and my young sister Dorice Kema for their heartfelt love, care and support throughout my study. There is nothing I can give you in return but may God bless you abundantly.

Abstract

Mara river basin is a trans-boundary basin shared between Kenya and Tanzania. This research focused on Mara Wetland in the Musoma Rural and Tarime districts, Tanzania.

The aim of this study is to investigate the role of ecosystem services in sustaining people's livelihoods. This may help to understand which wetland functions need to be maintained to provide the required wetland ecosystem services. The results of this study may also be useful for raising awareness on the need for wise use of wetlands among the different stakeholders as well as under ecosystem managers and policy makers

For this study 270 households were interviewed (30 households from 9 villages) as well as 9 village leaders (one from each surveyed village) and other governmental officials (District Council Officer, Agricultural officer as well as Regional and District fisheries officers).

Results indicated that, the wetland provides both provisioning, cultural and regulating services, however only few interviewees recognized the use of regulating services. In terms of provisioning services; The Mara wetland provides numerous provisioning services, including food, energy, freshwater, poles, thatching grasses, papyrus, wood and clay soil. Cultural services provided are medicinal plants and area for research and education, recreation and tourism as well as for spiritual and religious activities. People in the study area identified food, energy, clothes, health services, income (cash), education, water and building materials as basic livelihood needs.

The vast majority of ecosystem services used from the wetland are the same for each village; however the extent of use depends on the effort needed to consume the service. This effort is mainly determined by the location of each village. For example easy access to larger trees increases the production of charcoal and a larger distance to law enforcement officers leads to a higher consumption of bush meat.

The study has demonstrated that majority of people are directly and completely depend on the services provided by Mara wetland for sustaining their livelihoods. All income needed to fulfil basic needs that the wetland cannot provide directly, such as education, is generated from services provided by the wetland. The only income identified in this study that is not related to wetland services are subsidies provided by the government for village leaders and school teachers.

People are well aware of their dependence on the wetland. This is illustrated by the concerns they expressed upon answering questions on the impact on their livelihoods if the wetland would disappear. For example respondents were worried about reduced provision of food, fish, grazing area for livestock, water for both livestock and human use and the expected absence of papyrus, fuel wood, wood for charcoal production, thatching grass, poles and clay soil.

A large variety of services provided by the Mara wetland are seen as essential for human survival. This implies that, according to the ecosystem functions and services framework by de Groot 2002, also a large variety of wetland ecosystem functions need to be maintained to enable the wetland to provide these services.

Keywords: Mara Wetland; livelihood; basic needs; wetland; ecosystem services and ecosystem functions

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List of acronyms

ELC: Environmental Literacy Council
ES: Ecosystem Services
ETFRN: European Tropical Forest Research Network
EU: European Union
FAO: Food and Agriculture Organization
IEA: International Energy Agency
IUCN: International Union for Conservation of Nature
LVCEEP: Lake Victoria Catchment Education Programme
MDGs: Millennium Development Goals
MEA: Millennium Ecosystem Assessment
MRBMI: Mara River Basin Management Initiative
O^3: Ozone
PCLG: Poverty and conservation in Tanzania. Poverty and Conservation Learning Group
PES: Payment for Environmental Services
USD: United States Dollar
USDA: United States Department of Agriculture
UV: Ultraviolet
WWF: World Wildlife Fund
WRI: Water Resources Institute
WMD: Water Management Department
JJ/WBGSP: Joint Japan/World Bank Graduate Program
IFAD: International Fund for Agricultural Development
SoK: South of Kenya
LVEMP: Lake Victoria Environmental Management Project
AARSE: International African Association of Remote Sensing of the Environment
IWRM: Integrated Water Resources Management
WARFSA: Water Research Fund for Southern Africa
GPS: Global Positioning System

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CHAPTER 1: INTRODUCTION

1.1. Background

An ecosystem is a community of organisms living in a particular environment and the physical elements in that environment with which they interact (ELC, 2008). The ecosystem structure is defined as the systematic physical organisation of the abiotic and biotic webs of that particular ecosystem whereas the properties that describe an ecosystem are its components (Tuner, 2000). The dynamics of transformation of matter or energy for the maintenance of the structure are the processes (Tuner, 2000).

Ecosystem functions are the result of the components, processes and structure of an ecosystem which includes production, cycling and biodiversity (De Groot *et al,* 2002, Tuner, 2000 and MEA, 2003).Where as ecosystem services are the benefits people obtain from using ecosystem functions, these includes provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits (De Groot *et al,* 2002 and MEA, 2003).

The functions and services analytical framework (Fig. 1.1) shows the interaction between the ecosystem and the human system, which is affected by direct and indirect drivers. As defined by MA a driver is any natural or human-induced factor that may cause a change in an ecosystem either directly or indirectly. A direct driver has an influence on ecosystem processes and can be identified and measured according to differing degrees in terms of accuracy; these drivers are chemical, physical, and biological, such as the introduction of alien invasive species, change in land cover and climate, air and water pollution, use of fertilizers, irrigation as well as harvesting. On the other hand an indirect driver affects one or more direct drivers, in which its influence can be determined through understanding of its effect imposed to direct drivers; these drivers are cultural and religious, demographic, socio-political, economic together with scientific and technological (MEA, 2003). The human system depends on the ecosystem to acquire various services that are important for their livelihoods and on return they affect the ecosystem through undertaking numerous activities that alter its condition and capacity to deliver services that are useful (MEA, 2003). The services provided by the ecosystem have values (direct, indirect and non use) which when translated into total economic value, contribute in decision-making processes.

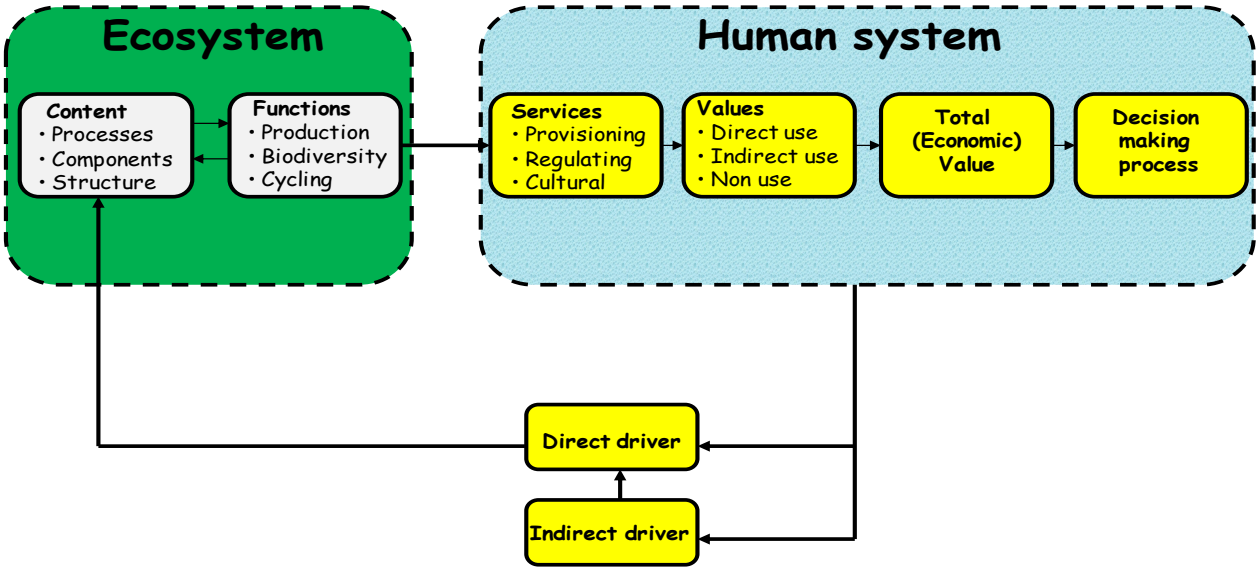

Fig. 1.1: Functions and services: Analytical framework

[*Source*: Hes *et al*, 2008]

Ecosystem functions are importance for example in agricultural production; pollination, biological control, disturbance prevention such as floods or drought, nutrient regulation and pure water supply are important for the effect to take place (Goulder & Kennedy, 1997). Thus there is a need to maintain them for the cultivation of plants for food and livestock to be successful (Wong *et al*, 2005).

The well being of every human population in the world is fundamentally and directly dependent on ecosystem services (European communities, 2008), according to the MEA 2003, human derive vast and uncounted benefits from the functioning of ecosystems, these benefits are in the form of services (generally grouped under the collective title of ecosystem services) such as food, wood, clean water, energy, flood protection and prevention of soil erosion, also these services are source of many life saving drugs as well as providing sinks for our wastes, including carbon (European communities, 2008).

In developing countries, majority of population depends on traditional energy sources, subsistence farming, generally free-ranging livestock and the products harvested from the surrounding natural resources as a source of income, thus offers the only option for survival (Petheram *et al*. 2006). The livelihood needs of local people demand for ecosystem services. For example the study on Impacts of land-use/cover changes on the hydrology of the Mara Basin shows that, the basin supports the economic livelihoods of pastoral people, farmers, fishers, some hunter-gatherers and other people relying directly or indirectly on tourism (Mati *et al*, 2008). In some areas tourist-related services provide important additional income for local communities (Thompson, 2002). For example the Mara–Serengeti ecosystem being a world famous wildlife sanctuary of great international importance; it is supporting a thriving tourism industry not only to its unique annual wildebeest migration but also to nomadic pastoralists

surrounded the area. In addition to that the pastoralists by themselves generate income by selling traditional art crafts (Mati *et al*, 2008).

The MDG's are an international challenge, but also a basis for establishing our linkage with the environmental and natural resources as key assets for our livelihoods (Barrow *et al,* 2007). Ecosystem services can be used in development as suggested by Sukhdev, 2008: European communities, 2008 fore example through the use of ecosystem services MDGs such as gender empowerment, eradicating extreme poverty and hunger as well as improving human health can be achieved especially in a poor country like Tanzania (Songorwa, 2007).

Ecosystem Services towards achievement of MDGs

As it has been stipulated prior to; ecosystem services can play a big role towards achievement of some of the MDGs, below are some findings towards their contribution;

Ecosystem services and eradicating extreme poverty and hunger

For many of the 1.1 billion people living in severe poverty, ecosystem services are a daily lifeline (WRI *et al*, 2005). Over half of the world's population continue to live on less than $2 dollars a day, with a billion on $1 or less (WRI *et al*, 2005) as over 1.6 billion people living in extreme poverty continue to depend on Ecosystem services for their livelihoods (World Bank 2004; WRI *et al*, 2005), therefore there is a connection between ecosystem services and poverty (Nkem *et al*, 2007). On average, income from small-scale agriculture and the collection of wild products such as non timber forest products together account for some two-thirds of the household incomes of families in poverty. Without income from ecosystem services, rural poverty would unquestionably be deeper and more widespread (WRI *et al*, 2005). For example, in one of the few studies about the relationship between poverty and ecosystem services in Uganda showed that, an overwhelming majority of papyrus harvesters in the Lake Bunyonyi wetlands sold raw papyrus or crafts made from papyrus to bridge income shortfalls for periodic high expenses such as school fees or end-of-the year festivities (McClean *et al*, 2003). Further, ecosystem services play a critical role as a source of natural fruits, protein from mushroom, bush meat to supplement children's and adult's diets (Barrow *et al*, 2007). Apart from that, the study in Ngitili has shown that in the drought of 2003 led many vulnerable households to desperation, but due to ecosystem services provided within the area they were used to ease the hunger as it has been evidenced by an old man in Shinyanga who collect 4 bundles of fuel wood and 3 poles from the ecosystem that he sold and was able to buy food (Monela *et al*, 2005).

Gender empowerment

The livelihoods of the majority of the poor (especially women) are highly dependent on ecosystem services because they are the ones to provide these services to the family. For example majority of women are involved in subsistence agriculture, fisheries (through buying fish in small quantities and then sell to get cash income for supporting their family), pastoral practices, and collection of energy, water supply and traditional medicines (herbs and tree barks) as their front line primary healthcare products (Nkem *et al*, 2007). Due to the close proximity to the ecosystem services women have quick and ready access to fuel wood and other services thus reduces the time taken to collect fuel wood by up to four hours and has freed up time for them to engage in other productive activities that can improve gender empowerment and equity (Monela *et al*, 2005), due to reduced walking distance the vulnerability of these group to danger (wild

animals) becomes minimal and on the other hand contributes to improved maternal health care (Monela *et al*, 2005).

Improving human health

The availability of a diverse range of edible products including fruit, vegetables and insects led to improved household nutrition. Over 22% of households in Shinyanga region have used the services provided from ecosystem as a source of food and fruits (Monela *et al*. 2005) and about 14% of households regularly use medicinal plants (Monela *et al*. 2005). Medicinal plants are used alongside, or in many cases instead of a formal health care system that may be too distant or costly to access (Monela *et al*, 2005). Further, easily availability of clean water reduces the incidence of water born diseases also the availability of medicinal plants help them to cure some water born diseases (Monela *et al*, 2005).

1.2. Problem description

Despite the role and importance they have for people, ecosystems are still under tremendous pressure worldwide, due to the fact that people demand more than ecosystem can provide or inefficient/over use of resources available due to poverty (De I'Umuganda, 2009). There are a number of factors contributing to this pressure; one being an increase in population which demand more than it was before (De I'Umuganda, 2009), second being an unrecognized value of these ecosystem services (European communities, 2008), All these result into unsustainable utilization of the natural resources and destruction of the ecosystems which provide important functions and services.

In general, ecosystem services support our daily economic activities, our quality of life as well as our social unity, nevertheless people are not well informed about the benefits that come from the ecosystem and the potential to lose those benefits (Daily, 1997) and if they are aware they tend to assume that ecosystems are endlessly regenerating (Costanza *et al*, 1997).

Worldwide people depend on ecosystem services for their livelihood. However, in Tanzania for example the most affected livelihoods include subsistence farming, animal husbandry, fishing and informal forestry (Wong *et al*, 2005).

Likewise the livelihoods of people in Mara wetland is being affected by pollution, soil erosion, deforestation, unsustainable utilization of wetlands, uncontrolled mining, unsuitable farming methods through the use of fertilizer, as well as degradation of rangelands from overgrazing (De L'Umuganda, 2009). For that reason the aim of this study is to determine the significant of ecosystem services in sustaining people's livelihoods; firstly, in order to determine the important ecosystem functions that need to be sustained. Thus make it capable to continue supplying services on which people depend for their livelihoods. Secondly, after having known its significance it would also enable people to engage themselves towards wise use of ecosystem services through the creation of awareness regarding ecosystems. According to Ramsar convention Secretariat, 2004 Wise use has been defined as *"their sustainable utilization for the benefit of mankind in a way compatible with the maintenance of the natural properties of the ecosystem"*. Furthermore, it may help in management integration through prioritisation in ongoing resources management activities.

1.3. Research Objectives

The overall objective of this study is to determine the significance of ecosystem services in sustaining people's livelihoods; a case study in Mara wetland, Musoma and Tarime district-Tanzania. For the achievement of this objective, the following specific objectives are accompanying the overall objective;

- To identify a list of ecosystem services provided within the area
- To find out where are these services located
- To find out what are the basic livelihood needs for the people
- To find out whether they depend on ecosystem services to sustain those livelihood needs
- To identify ecosystem functions that are required to supply services to the people in Musoma and Tarime district

1.4 Scope of the study

This thesis research work focused only in Mara wetland because the area provides ecosystem services that are not only potential to the people but also to animals. Since less has been done to the area and more specifically on its significance to the livelihoods of the people it was thus important to conduct research to make people aware on the potentiality of the area for their livelihoods.

The study was conducted in Musoma Rural and Tarime district. In which five villages out of 105 in Musoma Rural District together with four villages out of 157 in Tarime district were selected. The selection based on the locality of the village near to the wetland.

The selected villages were; Kirumi (S 01^{o} 33. 041, E 033^{o} 59. 049'), Lyamisanga (S 01^{o} 32. 037, E 034^{o} 03. 410'), Buswahili (S 01^{o} 37. 0643', E 034^{o} 09. 341'), Kongoto (S 01^{o} 36. 356', E 034^{o} 09. 341'), and Wegero (S 01^{o} 36. 662', E 034^{o} 13. 426') located in Musoma Rural district and other 4 villages namely; Kwibuse (S 01^{o} 30. 820', E 034^{o} 01. 591'), Marasibora (S 01^{o} 28. 948', E 034^{o} 08. 908'), Bisarwi (S 01^{o} 26. 690', E 034^{o} 16. 299'), and Kembwi (S 01^{o} 26. 945', E 034^{o} 17. 714') were located in Tarime District.

CHAPTER 2: LITERATURE REVIEW

2.1. The value of ecosystem services

"There are two ways that something can be valuable: instrumentally or intrinsically. Instrumental (or utilitarian) means that something has value because it is useful to something else. Intrinsic means that something has value in and of itself, not because something else deems it valuable" (Hawkins, 2003). "In environmental philosophy, these two values can be ascribed from three different viewpoints: ecocentric, biocentric, or anthropocentric. In an ecocentric viewpoint, ecosystem processes have intrinsic value while individual species have instrumental value. Biocentrists hold that animals and plant have intrinsic value while non-living nature has the instrumental value. With anthropocentrism, only humans have intrinsic value, while everything else (i.e. nature) has instrumental value" (Meffe and Carroll, 1997).

Economists divide values into two main categories: use and non-use. Use values are derived from physical involvement with some aspect of an ecosystem. One type of use value is direct, such as logging, fishing, recreation, and tourism, while another is indirect (Hawkins, 2003), these services are used as intermediate inputs for production of final services to humans for example for food production water, pollination, soil nutrients and biological control services are required. Similarly in order to attain clean air and water; waste assimilation, water purification and other regulating services that are responsible are needed to reduce the health risks (MEA, 2003).

Direct use is further divided into consumptive (logging, fishing) and non-consumptive (recreation, tourism) values (Hawkins, 2003). Regulation and habitat functions, such as flood control, climate regulation, and waste assimilation would fall into this category (Goulder and Kennedy, 1997). Non-use values do not involve physical interaction. This includes existence, bequest, and option values. Existence value (sometimes called passive use) is derived from the satisfaction of knowing that a certain species or ecosystem exists, even if it will never be seen or used. Bequest value is satisfaction from being able to pass on environmental benefits to future generations (Greenley *et al*, 1981. An example is the preservation of tropical rainforests because we may be able to find new medicines (Goulder and Kennedy 1997).

Furthermore, ecosystem services are traditionally considered free to society. The human economy depends upon the services performed "for free" by ecosystems; these ecosystem services supplied annually are worth many trillions of dollars (Daily *et al*, 1997). These services do not normally appear in corporate or national accounting systems, but they far out weigh direct values when they are computed (McNeely, 2005).

The critical contributions of ecosystem services are overlooked in public, corporate and individual decision making, for example, everyone enjoys the clean air, clean water, and flood prevention provided ecosystems. In 1997, Costanza *et al* estimated the worldwide value of all ecosystem services at USD 33 trillion per year, they also estimated that coastal ecosystems provide services worth over USD 4,000 per ha per year, while the annual values per ha of tropical forests are placed at USD 3,000, USD 15, 000 for wetlands and USD 8,500 for lake and rivers, though there were many uncertainties in developing this estimate and the calculation itself generated much criticism.

In the year 2000, USDA Forest Service economists estimated the minimum value of water from National Forest System lands to be USD 3.7 billion per year. Studies continue to evaluate the economic value of ecosystem services; at present, their true worth is unknown (Eaton and Sarch, 1997).

Tourism, for instance which is also a part of ecosystem service (recreational service), is undoubtedly the most well-know economic value of Protected areas, providing source of cash income to numerous stakeholders at local, national and international level (McNeely, 2005). It is possibly the world's largest industry; generating more than USD 4 trillion per year and providing employment for nearly 250 million people worldwide (McNeely, 2005). In Kenya for example, tourism is one of the largest export industries, earning over USD 400 millions per year, and provides thousands of jobs because of the tourists visiting Kenya's wonderful coast, and wildlife parks (McNeely, 2005).

2.2 People dependence on wetland ecosystems

Wetlands provide a host of ecosystem services for people and are often considered "jewels" by people who rely on and treasure those ecosystems (Gardner *et al*, 2009). In many parts, wetland services are the sole source for livelihoods and the main safety net for the poorest households (WMD *et al*, 2009). Some groups of people, particularly those living near wetlands, are highly dependent on these services (MA, 2005) in supporting their live, for development and cultural inheritance (Stuip *et al*, 2002). For example in Basse Vallée de l'Ouémé, Lagune de Porto-Novo, Lac Nokoué, Benin the site supports approximately 24,000 professional fishers and 13,000 seasonal fishers which in turn provides related jobs for about 200,000 people (Gardner *et al*, 2009). In Okavango delta system however, it provides tourism related employment opportunities such as the sell of craft and curios, spot and safari hunting, boat transportation and on top of that it provides reeds, thatching grass and fish (Gardner *et al*, 2009). In Uganda as well wetlands supply direct or subsistence employment for 2.7 million people, almost 10 percent of the population (WMD *et al*, 2009). Moreover, people also depend on wetlands for cultural activities for example in Muni lagoon, Ghana the site is culturally important because people use the forest adjacent to the lagoon "as the hunting ground during their annual 'Aboakyir festival' in Wenneba" (Gardner *et al*, 2009). Similarly in Sakumo lagoon in Ghana, the wetland has been used by school groups through visiting the area which results in better appreciation for the value of wetland and also universities have been able to conduct researches (Gardner *et al*, 2009). Furthermore, in Port Launay coastal wetlands in Seychelles, schoolchildren have been using the area for environmental awareness purposes, whereas in Ichkeul wetland in Tunisia schools and universities hold field lectures at the area (Gardner et al, 2009). In Lake Naivasha, Kenya as well people have been using the wetland for water for domestic use and livestock, subsistence and commercial fishing, and grazing during dry season; they also used the wetland to generate income through horticulture activity by exporting cut flowers primarily to the Netherlands and Great Britain. The lives of ordinary Kenyans confirm the importance of ecosystems. Indeed, they obtain income often directly from utilization of ecosystem services (WRI *et al*, 2005). They also depend on ecosystems to obtain other critical elements of their lives such as drinking water, fuel wood, building materials, clothes, tools, and medicines (WRI *et al*, 2005) and are also an important source of cash income, especially in emergencies (WMD *et al*, 2009) because of lack of affordable alternatives (WMD *et al*, 2009). According to Stuip *et al*, 2002 wetlands are

capable of providing alternative sources of income for people through leisure pursuits such as recreational fishing, hunting, bird watching and boating, which can generate money from visitors and provide sustainable development opportunities. High dependence of people on ecosystem services combined with few assets and capabilities makes poor people particularly vulnerable to ecosystem degradation (WMD *et al*, 2009; MA, 2005).

2.3 The role of ecosystem services in reducing people's vulnerability

Diverse of species, food and landscapes serve as 'saving bank' and 'buffer' to enable people to cope with changes during unfavorable time (Folke & Fabricius, 2005). The diversity of land and crop types used by different communities living in the same region reduces people's vulnerability by providing livelihood options to fall back on, in case crops or landscapes are negatively affected by catastrophes (Folke & Fabricius, 2005). For example at Qongqota in the Eastern Cape, South Africa, communities maintained natural fountains because they are essential for their long-term survival, and people rely on them when water pumps break (Folke & Fabricius, 2005). Further, the fuel wood from the ecosystem are essential for cooking food, especially during economic recessions when workers who send remittances home are made redundant, or when the prices of alternative fuels such as paraffin rise due to currency fluctuations or global fossil fuel shortages. In many cases, biomedicines are used in emergencies, or to supplement conventional medicines (Folke & Fabricius, 2005). Apart from that, wild fruit provides crucial vitamins and minerals at critical times of the year and at critical stages in infants' physical development. However, bush meat and fish supplement people's protein intakes and are also sold to supplement their incomes. Nevertheless, people or animals have been able to overcome severe food, water, or energy shortages from key landscapes such as wetlands, high pastures, sacred forests and groves, and sacred pools through provision of infrequently used resources (Folke & Fabricius, 2005). Ecosystem creates employment and income through sales of ecosystem products and creates jobs from tourism and related economic activities. This further reduces people's vulnerability by increasing their livelihood options (Folke & Fabricius, 2005).

2.4. Ecosystem Services Reliance

More than 1.3 billion people rely on fisheries, forests, and agriculture for employment close to half of all jobs worldwide (FAO, 2004) and more than 2 billion people rely on fuel derived from biomass for their main energy source (IEA, 2003), income and employment in many rural areas (Angeles *et al*, 2004). They also provide construction material, suitable area for farming, fishing, and to graze livestock in which people rely in sustaining their lives and livelihoods (WMD *et al*, 2009). They also provide fish which is the main source of protein for one billion people and accounts for at least 15% of animal protein in the diets of a further two billion (Ramsar, 2009). This reliance of livelihoods on ecosystem is nowhere more important than among the rural poor (MA, 2005). In Africa, more than seven in ten poor people live in rural regions, with most engaged in ecosystem dependent activities, such as small-scale farming, livestock production, fishing, hunting, artisan mining, and logging (IFAD, 2001), livestock rearing, collecting of fuel wood, herbs, or other ecosystem products (WRI *et al*, 2005). These ecosystem services may be sold for cash or used directly for food, heat, building materials, or innumerable other household needs (WRI *et al*, 2005). On top of that ecosystems are used in performing certain rituals as customary for people in respect of traditional rulers, particularly when they need rains or individual pursuits (Monela *et al*, 2005).

According to Bogers, 2007 fishermen on top of the income they generate from selling fish, they also obtain an important source of protein from fish consumption and most of fish types found in the basin are; lungfish (Kamongo), larger size tilapias (Sato), smaller size tilapia (Foeroe), catfish (Mumi) and the Nile perch (Sangara). In addition to that they also use both firewood and charcoal as a source of energy for various uses such as cooking. Furthermore, they make bricks using clay soil for constructing their houses and obtain income too. Apart from that these people generates part of their income by either making mat from using papyrus vegetation or through transportation of mat to near by villages or city.

2.5 Payment for Ecosystem Services (PES)

The importance of ecosystem services for human well being was succinctly highlighted by the Millennium Ecosystem Assessment 2005 attracting both public interest and stimulating market incentives and investment in payment for ecosystem services (PES) (Nkem *et al*, 2007). In the context of watershed management for example in the MRB, PES is a market scheme whereby beneficiaries or users of that watershed services will pay a fair compensation to those upstream parties who provide such services and this compensation may be in a form of cash or kind (McClain & Bhat, 2008). Services here are considered to be positive attributes being generated by keeping the natural components of the watershed in a certain condition or enhancing their existing potential (McClain & Bhat, 2008). Markets for ecosystem services are based on the same premise as in traditional market system, where by people regularly come together to buy and sell services : In ecosystem services' Sellers' could be private farmers, households and/or public and private agencies, landowners that provide clean air, clean water, wildlife habitat, and other services through sustainable management of their forests, wetlands, grasslands, planting trees and pasture grasses and maintaining riparian buffer zones. 'Buyers' of these services are economic entities who benefit from the service through increased and/or uniform water flow, improved water quality, increased production of consumable services such as food, fish, mining products, expanded tourism (McClain & Bhat, 2008).

The Mara River is the only perennial source of surface water available for development, and there are increasing water demands for farm irrigation, burgeoning urban centres, and as expanding tourism industry. But the Mara River provides more than water; it also provides many additional services that the people of the region depend upon; this includes food, important plants, and fertile soils.

The basin hosts two of East Africa most iconic reserves, Masai Mara National Reserve and Serengeti National Park. Thus biodiversity is high priority in the basin as it provides important services to wildlife. For example The Mara-Serengeti ecosystem contains the most diverse combination of grazing mammals in the world by holding about 2 million wildebeest, zebras and gazelles (Urama *et al*, 2008), and it is critical in the unique annual wildebeest migration (Mati *et al*, 2005; Machiwa, 2002; Dwasi, 2002; IUCN, 2000; Aboud *et al*, 2002).

2.6 Major Economic activities in Mara River Basin

The Mara River Basin provides economic support to the livelihoods of pastoral people, fisherman, small scale farmers, and some hunter-gatherers who live in forested areas and other people relying directly or indirectly on tourism (Aboud *et al*, 2002; Mati *et al*, 2005). However, the largest proportion of the population in the basin, accounting for about 62% of the households

(aerial coverage), are engaged in small scale farms (Aboud *et al*, 2002). Where by livestock husbandry, including pastoralism being the second most important economic activity. On the other hand people in the highlands use forest resources such as timber; charcoal burning as an important source of livelihood.

2.7. Major Ecosystem threats in Mara Basin

Even though the Mara Basin is among the more pristine of the rivers draining into Lake Victoria, yet there are major threats to the formerly serene ecosystem this includes accelerated reduction in vegetation cover in the upper catchments resulted from clearing and conversion of forests and savannah grasslands into agricultural lands (IUCN 2000; Machiwa 2002; Dwasi, 2002), while grazing resources have decreased. Consequently land use change has caused land degradation, which impacts the river flows and the ecosystem as well (Aboud *et al*. 2002; Mati *et al*. 2005). In addition to that, increased agricultural activities in the Mara River Basin over the last 50 years have resulted in the opening of large forest plantations for the cultivation of seasonal crops, so natural perennial vegetation has been reduced (Mati *et al*, 2008). This situation has been accelerated by high immigration rates and a rapid population growth rate of about 7.5 % (FOC, 2000) which was driven by high, reliable, well distributed rainfall and the fertile soils in the basin which was favorable for agriculture, livestock and wildlife activities.

2.8. Land use change in Mara River Basin

According to (Mutie *et al*, 2006) land use change has been observed between 1973 and 2000 by a decrease in closed forests of 31% due to clearing of forests for timber, charcoal burning, settlement and tea plantation (which increased by 82%). Moreover, the rangeland which includes shrub land, grassland and savannah which was mostly used for livestock grazing and/or wildlife reserves has decreased by 35% due to an expansion of agriculture (which has increased by 55%) (Fig. 2.1, 2.2 and 2.3).

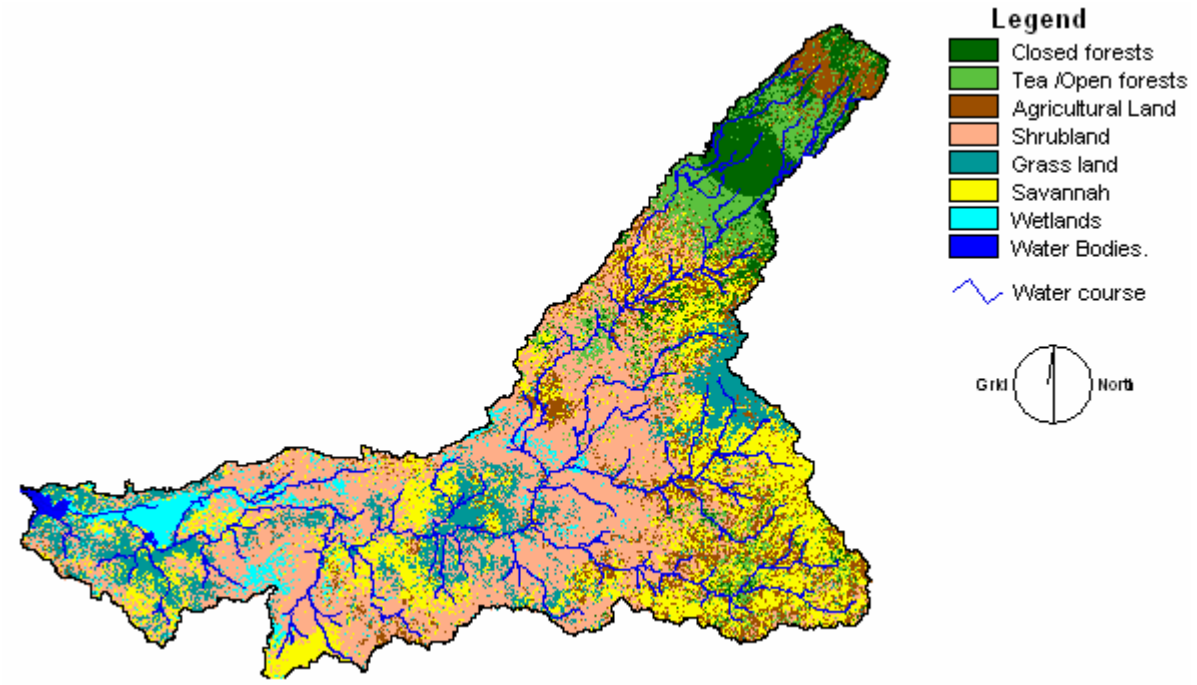

Fig: 2.1 Land use/cover in the Mara basin in 1986 (from Landsat TM)

[*Source*: Mati *et al*, 2008]

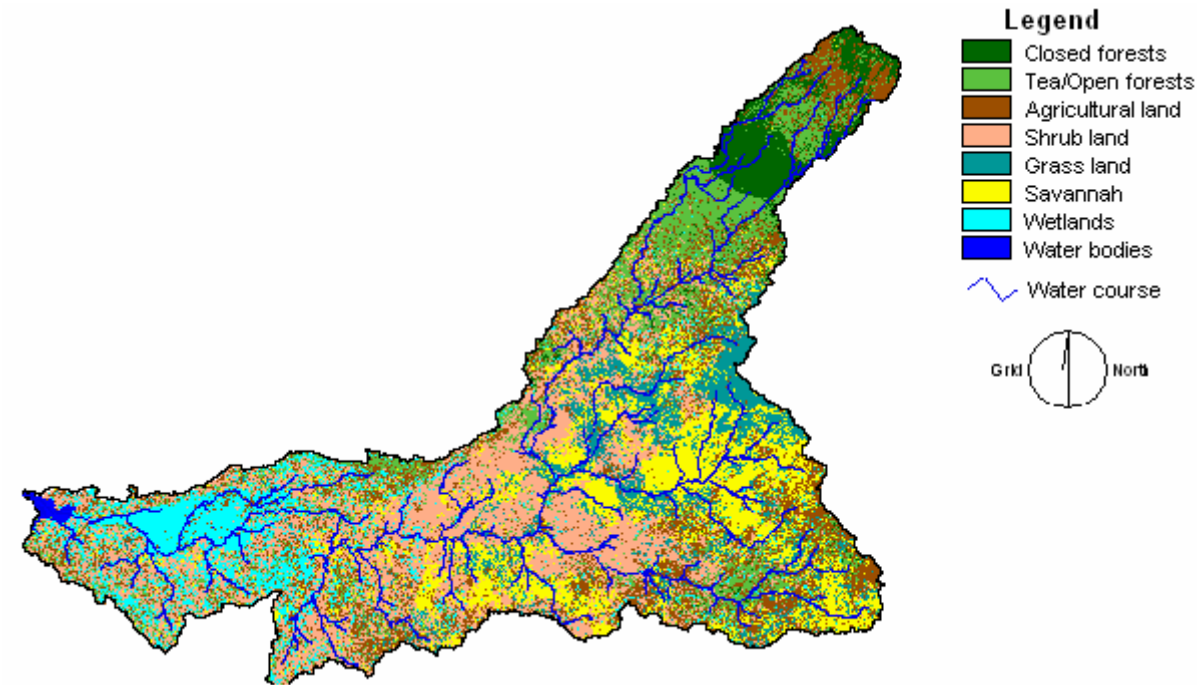

Fig. 2.2 Land use/cover in the Mara basin in 1986 (from Landsat TM)

[*Source*: Mati *et al*, 2008]

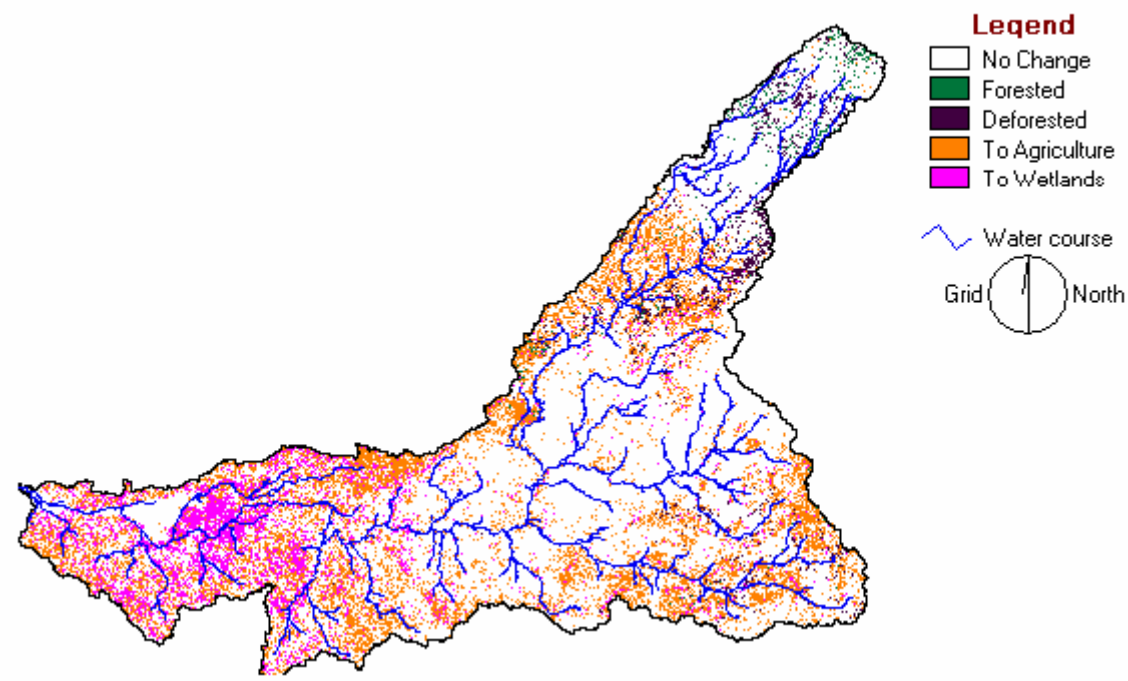

Fig: 2.3 Land use/cover in the Mara basin in 1986 to 2000 (from Landsat TM)

[*Source*: Mati *et al*, 2008]

As more land is being opened for crop production; pastoralists are finding it increasingly difficult to support their families and are highly vulnerable to drought. For instance, in 2000, pastoralists lost 35% of their cattle due to drought (Ottichilo *et al*, 2001; Reid *et al*. 2003). The locally driven degradation has increased the vulnerability of thousands of families who have no alternative income (Thompson, 2002). Consequently, due to land use change pastoral people living in the Mara ecosystem have less livestock per person than they did for the past 20 years and about half of them survive today on an income of less than USD 1 per day per person. Overgrazing on the river banks may lead to increased erosion and sedimentation (Obando *et al*, 2006). So, if the trend of change in land use/cover continues like this, it is probable that the Mara will support very less wildlife and poorer pastoral people 20 years from now if more pressure continues on the system (Reid *et al*, 2003).

Mara wetland has experienced significant changes. For example in 1960s torrential rains resulted floods which stayed for almost a year and deposited a large amount of fertile sediments (Flohn, 1987). While in mid-1970s, resulted in increased high flows especially during the long rains months (April and May), and low flows (January to March). The local people made it clear that hippos used to swim certain sections of the river, but these days, the water can be only knee-high during the dry season, which forces the animals to migrate. All of these are due to land degradation upstream which has adversely affected the water resources of the Mara basin. In

consequence it is turning into low economic growth, lost development opportunities, rural poverty and upstream-downstream conflicts in the Basin (Mati *et al*, 2005).

The ecosystem functions and services developed by De Groot *et al*, 2002 has been accepted to be used, thus its classification will be used to link the ecosystem services provided within the Mara wetland area to the corresponding ecosystem function from these list (Table 2.1) in order to obtain important ecosystem functions that has to be given priority for the continual provision of those services that are important in sustaining people's livelihood.

Table 2.1: Ecosystem functions, components, processes, structure and services examples

No.	Ecosystem Functions	Ecosystem processes,components & structures	Ecosystem Services (Examples)
1	Gas regulation	Role of ecosystems in bio-geochemical cycles (e.g. CO^2/O^2 balance, ozone layer, etc.)	1.1 UVb-protection by O3 (preventing disease). 1.2 Maintenance of (good) air quality. 1.3 Influence on climate (see also function 2.)
2	Climate regulation	Influence of land cover and biol. mediated processes (e.g. DMS-production) on climate	Maintenance of a favorable climate (temp., precipitation, etc) for, for example, human habitation, health, cultivation
3	Disturbance prevention	Influence of ecosystem structure on dampening env. disturbances	3.1 Storm protection (e.g. by coral reefs). 3.2 Flood prevention (e.g. by wetlands and forests
4	Water regulation	Role of land cover in regulating runoff & river discharges	4.1 Drainage and natural irrigation. 4.2 Medium for transport
5	Water supply	Filtering, retention and storage of fresh water (e.g. in aquifers)	Provision of water for consumptive use (e.g.drinking, irrigation and industrial use)
6	Soil retention	Role of vegetation root matrix and soil biota in soil retention	6.1 Maintenance of arable land. 6.2 Prevention of damage from erosion/siltation
7	Soil formation	Weathering of rock, accumulation of organic matter	7.1 Maintenance of productivity on arable land.
8	Nutrient regulation	Role of biota in storage and re-cycling of nutrients (eg. N,P&S)	Maintenance of healthy soils and productive ecosystems
9	Waste treatment	Role of vegetation & biota in removal or breakdown of xenic nutrients and compounds	9.1 Pollution control/detoxification. 9.2 Filtering of dust particles. 9.3 Abatement of noise pollution
10	Pollination	Role of biota in movement of floral gametes	10.1 Pollination of wild plant species. 10.2 Pollination of crops
11	Biological control	Population control through trophic-dynamic relations	11.1 Control of pests and diseases. 11.2 Reduction of herbivory (crop damage)
12	Refugium function	Suitable living space for wild plants and animals	Maintenance of commercially harvested species
13	Nursery function	Suitable reproduction habitat	13.1 Hunting, gathering of fish, game, fruits, etc 13.2 Small-scale subsistence farming & aquaculture
14	Food	Conversion of solar energy into edible plants and animals	14.1 Building & Manufacturing (e.g. lumber, skins). 14.2 Fuel and energy (e.g. fuel wood, organic matter). 14.3 Fodder and fertilizer (e.g. krill, leaves, litter).
15	Raw materials	Conversion of solar energy into biomass for human construction and other uses	15.1 Improve crop resistance to pathogens & pests. 15.2 Other applications (e.g. health care)
16	Genetic resources	Genetic material and evolution in wild plants and animals	16.1 Drugs and pharmaceuticals. 16.2 Chemical models & tools. 16.3 Test- and essay organisms
17	Medicinal resources	Variety in (bio)chemical substances in, and other medicinal uses of, natural biota	Resources for fashion, handicraft, jewelry, pets, worship, decoration & souvenirs (e.g. furs,
18	Ornamental resources	Variety of biota in natural ecosystems with (potential) ornamental use	feathers, ivory, orchids, butterflies, aquarium fish, shells, etc.)
19	Aesthetic information	Attractive landscape features	Enjoyment of scenery (scenic roads, housing, etc
20	Recreation	Variety in landscapes with (potential) recreational uses	Travel to natural ecosystems for eco-tourism, outdoor sports, etc.
21	Cultural and artistic information	Variety in natural features with cultural and artistic value	Use of nature as motive in books, film, painting,
22	Spiritual and historic information	Variety in natural features with spiritual and information historic value	Use of nature for religious or historic purposes (i.e. heritage value of natural ecosystems and features)
23	Science and education	Variety in nature with scientific and educational	Use of natural systems for school excursions, Use of nature for scientific research value etc.

[*Source:* adopted from De Groot *et al*, 2002].

CHAPTER 3: DESCRIPTION OF STUDY AREA

3.1 Study area

This thesis research was conducted in the Mara River Basin which is a Trans-boundary basin shared between Tanzania and Kenya, and is also part of the large Nile Basin that is shared by nine countries. The basin is being formed by several rivers and springs which includes five principal tributaries namely; Nyangores, Amala, Sand, Tarek, and Borogonja River. The Mara River Basin has been divided into four distinct physical and/or land-use sections: The forested Mau Escarpment being the first, followed by a section characterized by large scale agricultural farms (second). Some of the large scale farms are irrigated by using the water from Mara River. The third section being the open savannah grassland protected by Serengeti National Park in Tanzanian side and in Kenya it is protected by Maasai Mara Reserve. Lastly, the fourth section comprises the flood plain which is located in Tanzania where the Mara River discharges into Lake Victoria (Abuyu, 2010) (Fig 3.1).

Map of Africa

Map of East Africa

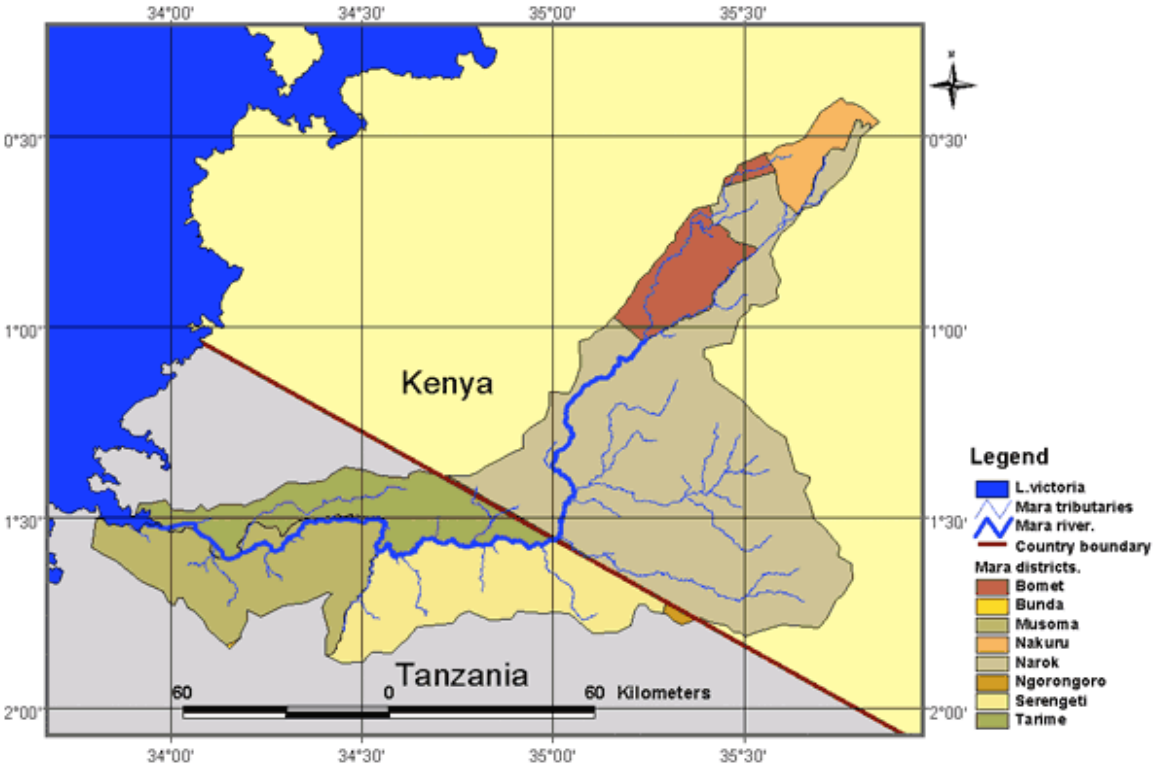

Fig. 3.1: Location of Mara River Basin in Kenya and Tanzania

[Source: Mutie *et al*, 2006]

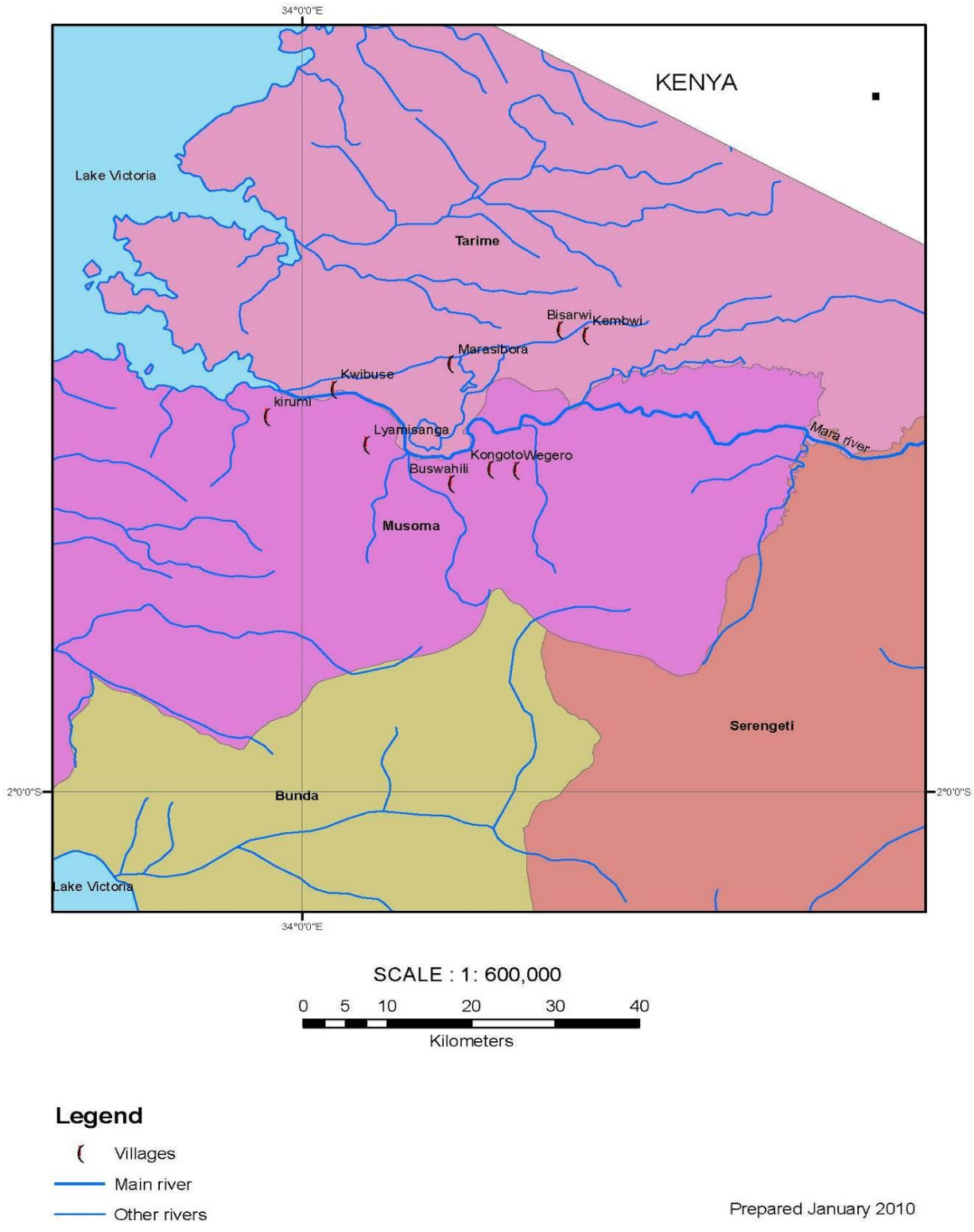

Fig 3.2: Mara River with the nine surveyed villages.

[*Source:* Field survey, 2010]

3.2 Location

A trans-boundary Mara basin covers an area of 13,750 km^2. It is located roughly between longitudes $33^o47'$ E and $35^o47'$E and latitudes $0^o38'$ S and $1^o52'$ S. The upper 65% of the area (8,941 km^2) is in Kenya, while the remaining lower portion is in Tanzania (Mutie *et al,* 2006). The river originates from the Mau Escarpment and flows for about 395 km from its origin and drains into Lake Victoria (Kairu, 2008). In the Tanzanian part, the River basin falls under the Mara regional administrative unit. The Mara region is bordering Kenya to the north and flanked by Lake Victoria in the west. In the Serengeti National Park, which is covering both the southern and eastern borders of the Mara region, human activity is restricted. In the Mara region the Mara River Basin is located in three different districts: Musoma, Tarime and Serengeti district (Bunda is the fourth district in the Mara region, but only covers a very small part the Mara River Basin). The districts border between Tarime and Musoma/Serengeti districts follows approximately the Mara River and the northern shores of the wetlands. The border between Serengeti and Musoma district is located between Wegero and Maji Moto (Bogers, 2007). Fig. 3.2 shows the location of each study village.

3.3 Climate and vegetation

The amount of precipitation varies according to altitudes. The Mau Escarpment receives most rainfall with a mean annual rainfall between 1,000 and 1,750 mm. The trans-boundary middle savannah grasslands receive an average between 900 and 1,000 mm, and the Kenyan lower Loita hills and the area around Lake Victoria receives about 700 and 850 mm of rainfall per year. The region has rainfall variability in terms of both space and time. The rainfall seasons are bi-modal, with the long rainfall starting in mid-March to June with a peak in April, while the short rains occurs between September and December (Kairu, 2008). The mean temperature is around 25^oC (Mutie, 2006).

Land uses

Forests: Eastern and South western Mau, Transmara, Ol-pusimoru; Conservation areas: Serengeti National Park in Tanzania and Maasai- Mara National Reserve in Kenya; Large scale agriculture: tea, maize, cotton, rice, wheat, and sugarcane; Rain fed agriculture: vegetables, beans maize, other cereal crops, root crops, tea, coffee and fruits; Livestock: Sheep, goat, poultry and cattle; Industrial: Logging, gold mining, tourism, urban business and trade; Aquaculture: tilapia (Kairu, 2008)

Soil type

The soil type in the region is formed by a combination of weathering of granite rocks and volcanic influences. There exist a large variety of soils in the region such as red sandy soils, light sandy loams, grey and black clay and black cotton soils (Bogers, 2007). The most commonly grown crops are maize, cassava and sorghum. The important cash crops are coffee, groundnuts, and tobacco (Bogers, 2007)

3.4 Topography and drainage

The altitudes in the basin range from 2,932 m above sea level around the sources in the Mau Escarpment to 1,134 m above see level around Lake Victoria. The geology and soil type in the River Basin offers vast opportunity for the cultivation of crops.

3.5 Demographic and economic situation

The study covered nine villages in which five villages (Kirumi, Lyamisanga, Buswahili, Kongoto and Wegero are located in Musoma Rural District and the other four villages (Kwibuse, Marasibora, Bisarwi and Kembwi are located in Tarime District. In each village the number of people, households and household average size has been indicated (Table 3.1).

Table 3.1: Shows number of people, household number and household average size

Village Name	Number of households*	No. of people in the village*	Gender		Household average size
			Male	Female	
Kirumi	431	2809	1370	1439	6.5
Lyamisanga	641	5874	2087	3004	9.2
Buswahili	315	2465	1154	1314	7.8
Kongoto	255	1578	789	789	6.2
Wegero	529	4030	1755	2275	7.6
Kwibuse	492	3017	1405	1612	6.1
Marasibora	353	2504	1165	1339	7.1
Bisarwi	525	3186	1596	1590	6.1
Kembwi	286	1690	872	818	5.9

**Number of households and people in the village according to survey, 2009/2010*
[*Source*: Field survey, 2010]

The main activities for income generation in the surveyed villages are among others livestock keeping, farming, bricks making and mat making while very few people (almost insignificant) have been employed to either the governmental or industrial sector. Fuel wood is the main source of energy mostly being used for cooking. Majority of people use water from Mara wetland for various uses such as domestic, irrigation and animal husbandry. Furthermore, in terms of health related issues; dispensary is only in Lyamisanga and Kongoto village. In most cases people travel far distance to urban areas for health services and/or use medicinal plants to cure various diseases. Kirumi village is located near (Musoma - Tarime high way road) which is concrete, and the opposite is true for other villages. In each village there is at least one primary school and relatively better connection to telephone facilities. Generally, from the field observation, survey as well; people in the study villages have low living standard of life.

CHAPTER 4: METHODOLOGY AND APPROACH

4.1 Methodological approach

This thesis research work started with an intensive and comprehensive literature review on the significant of ecosystem services to the people's livelihoods so as to come up with relevant information about the topic and thus a better understanding of it. Then a proposal was developed accompanied with literature review. This process took place form end of September until end of October which resulted into a thesis proposal, a checklist of ecosystem services and structured questionnaires. Then field work started in which the questionnaires were pre-tested based on the feedback from pre-testing of questionnaires, some modification was made and the study site was selected. Data acquisition was made through interviews, questionnaires and field observation (checklist of ecosystem services). Data processing and analysis followed after data organization and entry into a Microsoft excel software. Lastly, communication of the findings to the relevant people and organizations draws curtain on this methodological approach (Fig.4.1).

Research framework

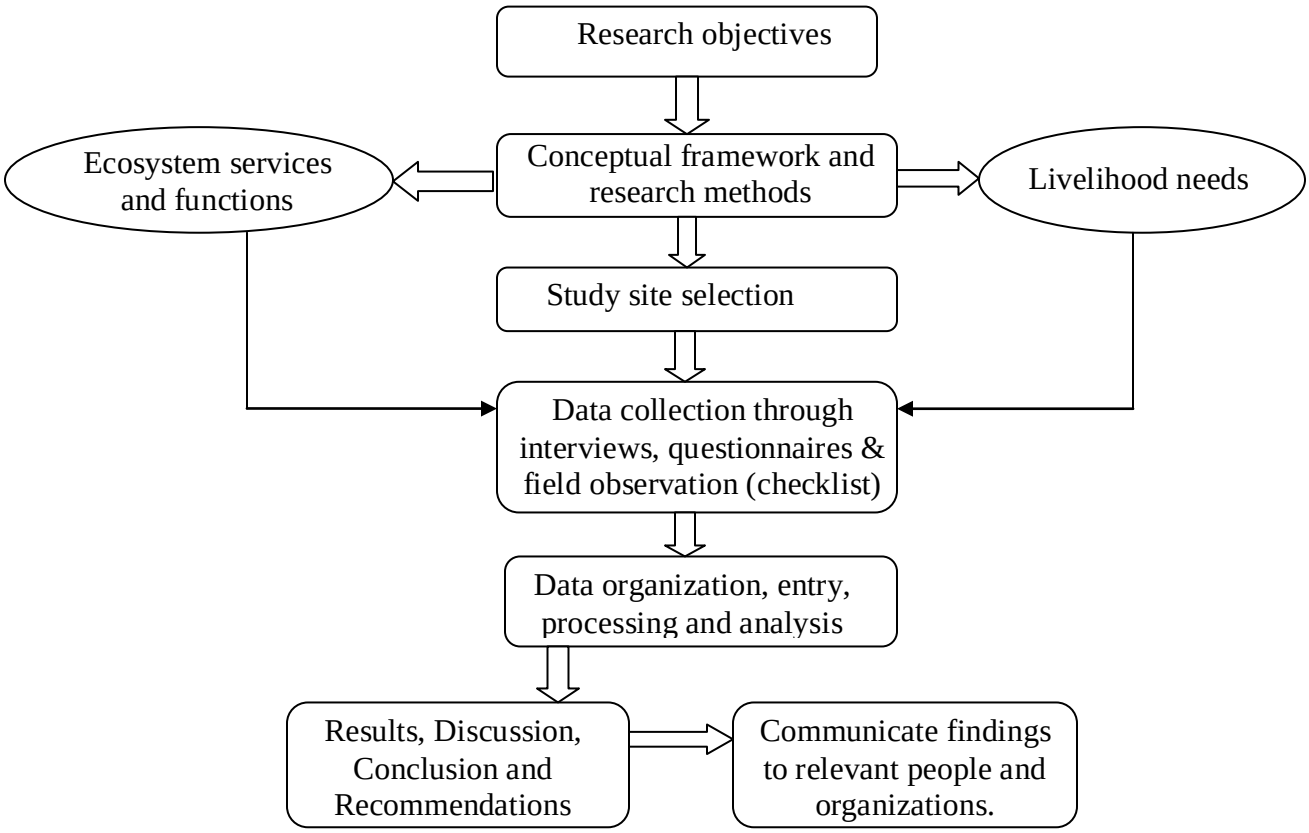

Fig. 4.1: Research framework at Mara River Basin Ecosystem.

4.2 Data collection method

Different data collection and sources were used in this study. In order to compare results and make the outcome reliable, both primary and secondary data was collected. Based on primary data, research methods such as survey based on interviews, questionnaires as well as field observation was employed.

4.2.1 Questionnaire survey:

The questionnaire was modified after pre-testing them to experts including World Wide Fund for Nature (WWF) and Lake Victoria Catchment Education Programme (LVCEEP) staffs. The questionnaire survey started few minutes after a meeting because every participant was allowed to go back to his/her house, and then 30 randomly selected households in each village among the 9 study villages were visited and interviewed. The interview was face to face, involved a researcher and one household respondent only. (Picture 4.1) The responses to questions were immediately recorded on a respective questionnaire page. However flexibility during the interview had been exercised to give an opportunity to interviewees to freely share their own perception and knowledge, in same cases an interpreter was used so as to break a communication barrier between a researcher/interviewer and interviewee. Besides some yes or no questions, there was an open question which was later classified. The information was collected on demographic variables such as age, number of children and relatives, people's knowledge on ecosystem services based on services provided within the area (Mara wetland) and its location. Moreover, the significance of the ecosystem services in sustaining their livelihood needs. The questionnaires were administered to a randomly selected household in the 9 study villages, namely Kirumi, Lyamisanga, Buswahili, Kongoto, Wegero, Kwibuse, Marasibora, Bisarwi and Kembwi. Based on the 2002 Tanzania population and housing census; see percentage of interviewed households in table 4.1.

Table 4.1: Percentage of interviewed household in each village

Village name	No. of households in the village	No. of interviewed households	% of household interviewed
Kirumi	431	30	7
Lyamisanga	641	30	5
Buswahili	315	30	10
Kongoto	255	30	12
Wegero	529	30	6
Kwibuse	492	30	6
Marasibora	353	30	8
Bisarwi	525	30	6
Kembwi	286	30	10
Total	**3,827**	**270**	**7.1**

Picture 4.1: Household's interview

4.2.2 Field observation:

In order to identify ecosystem services provided within the area, a checklist based on the list of services developed by De Groot *et al* (2002) and modified according to the study context was used. The check list encompasses the following services of the ecosystem (i) Provisioning services, such as energy, freshwater, food, wood, thatching grass (ii) Regulating services such as local climate, diseases, water regulation, water purification and (iii) Cultural services such as medicinal plants, religious, spiritual, recreational and tourism, research and education. The selection of the above mentioned services was based on the knowledge of the study area from other studies in the literature and on top of that other ecosystem services have been excluded because it requires formal knowledge for the respondent to provide a reasonable answer to the question, as based on their literacy it could have been difficult for them to say something. Apart from that it was not wise to consider a list of all ecosystem services as provided by De Groot because based on the nature of data collection (questionnaires) it would have been not possible to interview a lot of questions to one household otherwise they would have been bored and being irrational to questions. In each village a chairperson had been contacted, interviewed and requested to organize a short and brief meeting with people, where an introduction was made and asked them to plot a service map on the ground indicating location of each service available in their area. Furthermore, the map was sketched on a paper for follow-up during field observation; for each ecosystem service listed a GPS coordinate point has been taken as per ecosystem services location. Finally, a service map has been produced.

4.2.3 Governmental official's interview:

In order to have comprehensive information regarding the Mara River Basin Ecosystem Services, interview were conducted. There were a number of 13 interviews which includes 9 village leaders one from each study village, 1 district agricultural officer and 2 fisheries officers one being a district fisheries officer while another was a regional fisheries officer. Then the information was recorded on a particular question within a questionnaire.

CHAPTER 5: RESULTS

5.1 Households general information

Table 5.1: Households general information

Item	Category	Number of households								
		Village name								
		Kirumi	Lyamisanga	Buswahili	Kongoto	Wegero	Kwibuse	Marasibora	Bisarwi	Kembwi
Age	0-18	1	0	0	0	0	0	0	0	0
	19-36	8	14	12	11	10	11	11	12	10
	37-54	14	13	6	13	12	11	14	10	14
	55-72	6	2	7	5	7	7	3	7	5
	>=73	1	1	5	1	1	1	2	1	1
Gender	Female	11	11	14	11	12	12	13	14	10
	Male	19	19	16	19	18	18	17	16	20
Marital status	Single	1	2	1	1	0	0	0	0	0
	Married	23	24	24	27	27	27	29	29	28
	Divorced	2	2	1	1	2	2	1	1	1
	Widow	4	2	4	1	1	1	0	0	1
Education level	No formal education	9	6	7	4	3	5	6	5	3
	Primary	20	23	21	24	24	22	23	24	23
	Secondary	1	1	2	2	2	3	1	1	4
	College/University	0	0	0	0	0	0	0	0	0
Number of children	0	2	2	1	1	0	0	0	0	0
	1 to 5	12	12	15	13	16	14	17	11	8
	6 to 10	15	15	11	13	14	16	10	14	17
	11 to 15	1	1	1	2	0	0	3	5	5
	>=16	0	0	2	1	0	0	0	0	0
Number of relatives	0	3	2	8	4	4	2	2	2	3
	1 to 5	20	25	13	15	14	16	14	15	15
	6 to 10	5	2	8	8	7	6	10	6	6
	11 to 15	2	1	1	3	5	6	4	7	6
	>=16	0	0	0	0	0	0	0	0	0
Duration of stay (village)	<1	0	0	0	0	0	0	0	0	0
	1 to 5	1	0	0	1	1	0	0	0	0
	6 to 10	3	2	0	3	4	1	1	2	2
	>10	26	28	30	26	25	29	29	28	28

5.1.1 Age

The table 5.1 above shows general information about interviewed households in the 9 study villages. The result shows that, the most dominant age group is between 37-54 years in Kirumi, Kongoto, Wegero, Marasibora, and Kembwi village, while in Lyamisanga, Buswahili, and Bisarwi the most dominant age group is between 19-36 years and in Kwibuse village the both 19-36 and 37-54 are the dominant age groups.

5.1.2 Gender

The result shows that in each village male respondents in the household were higher (16-20) compared to female (10-14). This may be due to the culture and traditional attitude of people in the study area, because normally male are the household's head thus the main speakers of their families, since the questionnaires targeted only one member of the household many responses came from men who represents all household members.

5.1.3 Marital status

The result revels that, of all the interviewed households majority are married with a range from 24-29, while the lowest (1-2) being individual households who were single.

5.1.4 Education level

Among the 270 interviewed households, the majority (21-24) had primary education, while 3-9 had no formal education, and only 1-4 reached secondary education and none had college or university education.

5.1.5 Number of children

The result shows that, majority of households have a number of children range from 6 to 10 with a number of households range from 10-17, whereas households with a number of children from 16 and above are found only at Buswahili and Kongoto village.

5.1.6 Number of relatives

Many households have a number of relatives range from 1 to 5 with a household number between 13 and 25, very few (2-8) households who have no relatives at all. While none of the households had a number of relatives from 16 and above.

5.1.7 Duration of stay

In the study villages majority of the households stayed in their respective villages for more than 10 years with a number of households range from 25-30. While none of them stayed for less than a year, and only few (1) households at Kirumi, Kongoto and Wegero village stayed for 1 to 5 years.

5.2 Ecosystem services provided within Mara wetland

Mara wetland provides a wide range of ecosystem services such as provisioning, cultural, regulating and supporting services. However this study has mainly focused on the first three services due to time limit for research work, because it is not possible to include everything within a short time period.

The identification of Ecosystem services provided within the area was through interviews, field observations and literature review. However, from fig. 5.1 below it shows that the number of households indicated that the area provides provisioning and cultural services were high range from 21 - 29 and 14 to 30 respectively, while on regulating services few households (12 - 14) indicated it to be provided within the area.

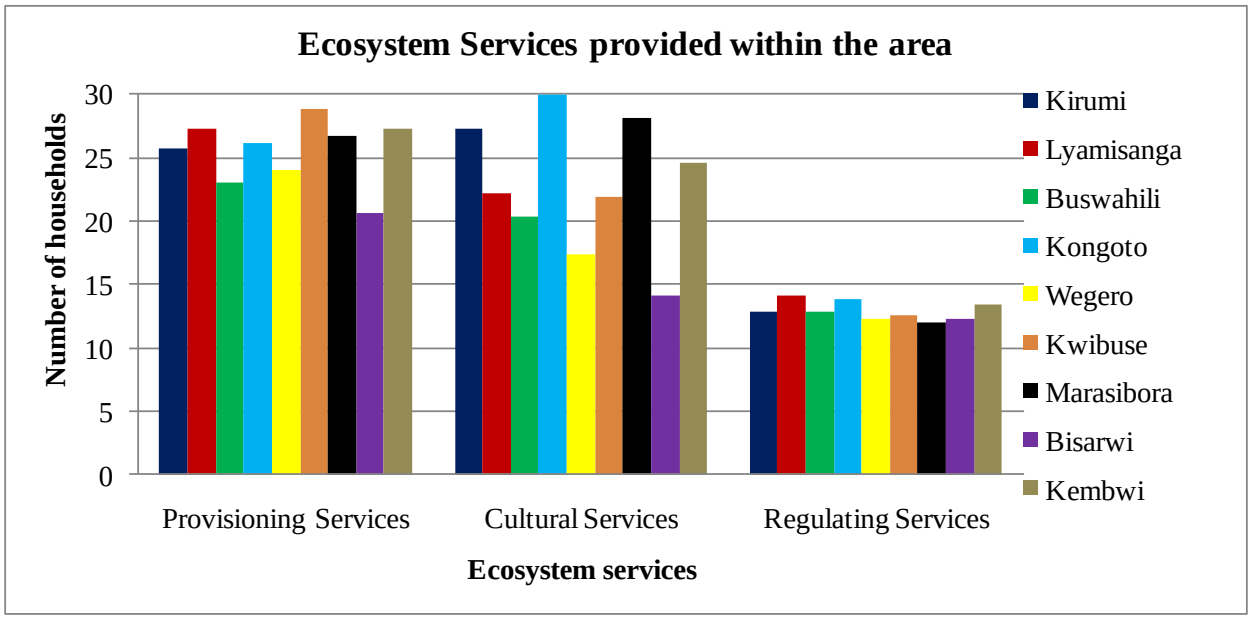

Fig. 5.1: Ecosystem Services provided within Mara River Basin Ecosystem

5.2.1 Provisioning services

The main identified provisioning services from the Mara wetland according to the survey were food (wild food, crops-cultivation area and livestock-grazing area), energy, freshwater, poles, thatching grasses, wood, clay soil and papyrus.

5.2.2 Cultural services

Likewise the following have been identified by households to be the cultural services provided within the area: - medicinal plants, recreational and tourism, education and research together with spiritual and religious services.

5.2.3 Regulating services

Moreover the area provides regulating services such as water purification, soil erosion protection, local climate regulation, disease prevention and water regulation.

5.2.1.1 Food provided within the wetland area

The result reveals that Mara wetland provides suitable area for; crops cultivation, fish catch, bush meat hunting, mushroom gathering, wild fruits collection and livestock grazing area see fig. 5.2 below

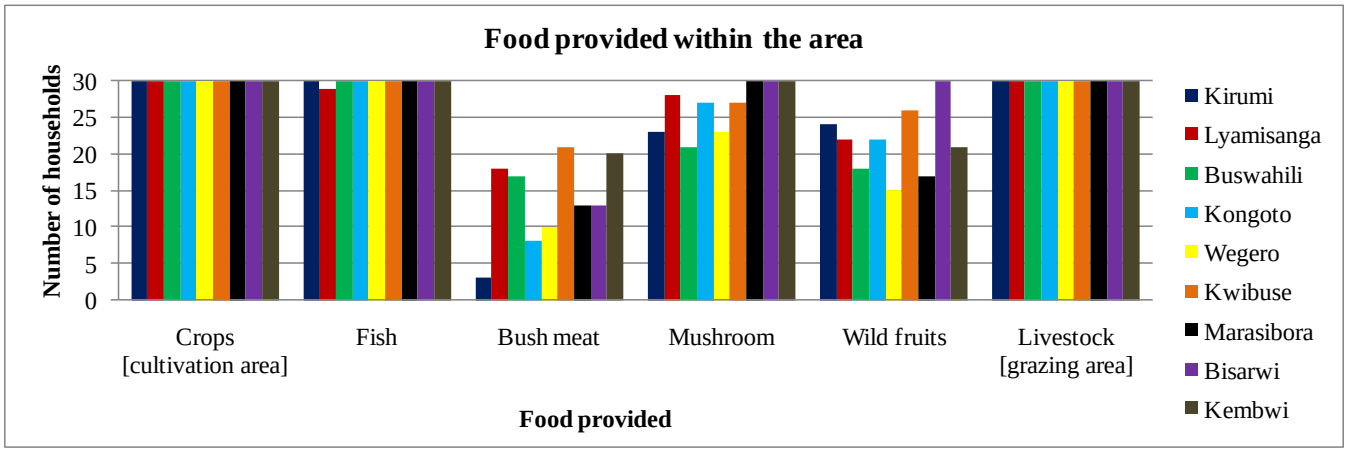

Fig.5.2: Food provided within the wetland area

Suitable area for crops cultivation

The wetland provides suitable conditions for crops cultivation. It has been found that among the interviewed households in the study area; 232 households have been engaged in farming activities. The main crops cultivated within the wetland area are maize, cassava and sorghum. However, the result shows that almost all the interviewed households cultivate maize. Other crops mentioned to be cultivated within the wetland area are millet, green vegetables, ground nuts, rice and sweat potatoes.

Consequently, due to suitable agricultural area provided, the result has revealed that the reliance of crops cultivation on rainfall as well as irrigation has a common trend for all villages, and that household's crop growth reliance on irrigation is low ranges from 2 to 9 which is due to labour intensive (as they have to use buckets) and difficultness in penetrating to papyrus vegetations in some places in order to fetch some water while it was not the case for rainfall because the number of households attributed to this was high ranges from 11 to 28 see fig.5.3.

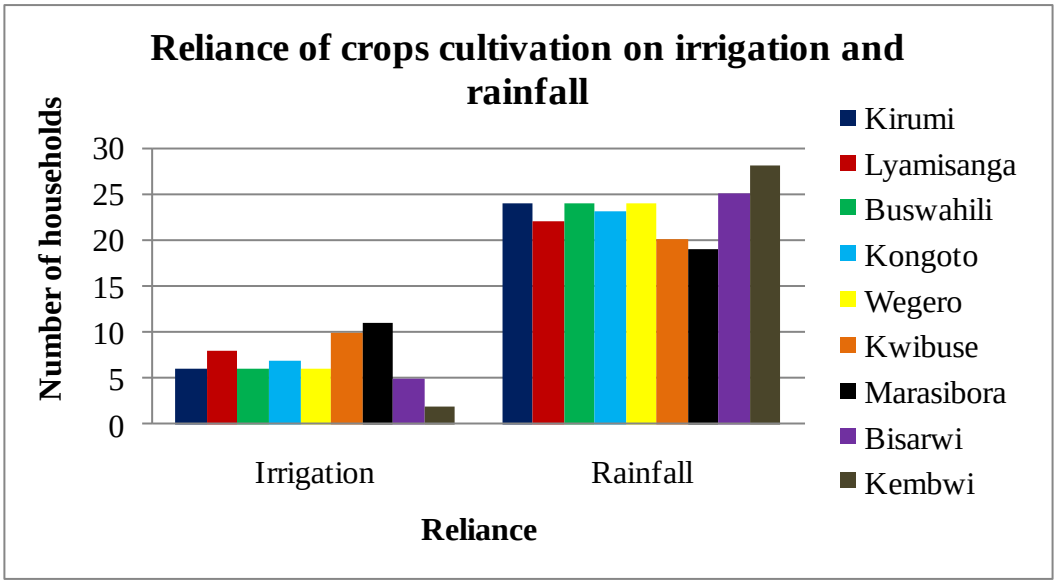

Fig.5.3: Crop cultivation reliance on rainfall and irrigation

Moreover, it has been found out that none of the households in both villages cultivate crops for commercial purposes and only few households range from 4 to 6 cultivate crops for local consumption with an exceptional from Lyamisanga where none of households cultivates crops for local consumption. Nonetheless, in fig.5.4 it has also been indicated that households in both villages cultivate crops for both local consumption and commercial purpose as well. Though in Lyamisanga village all 30 households cultivate crops for both local consumption and commercial purposes this is due to high number of people (5874) in the village (see also table 5.5) such that their is enough labour to cultivate large area as a result they are sure to obtain surplus for commercial purpose.

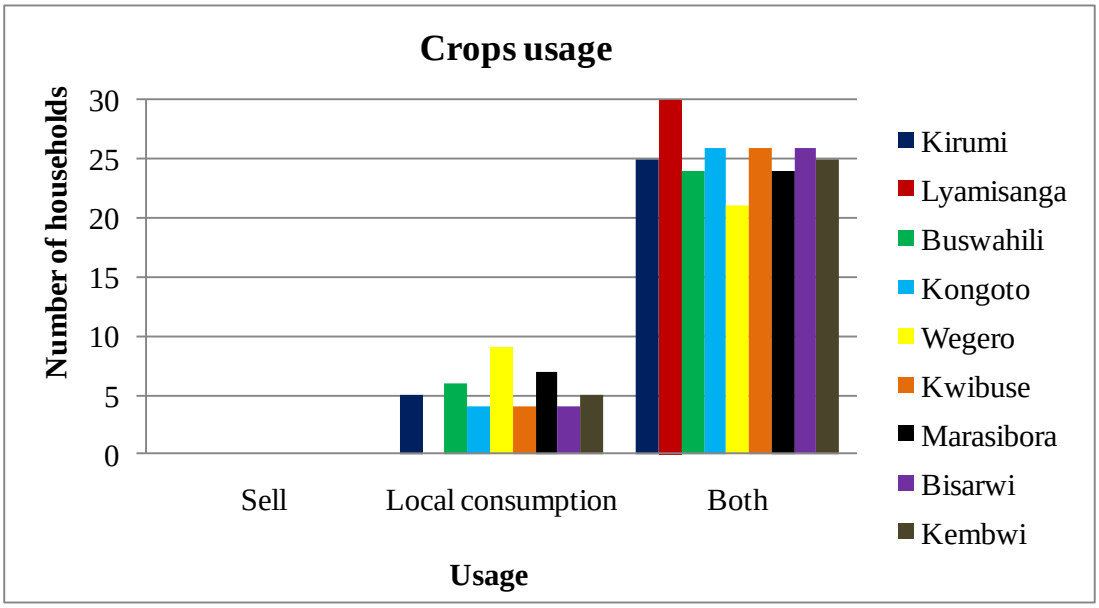

Fig.5.4: The use of cultivated crops

Farm land allocation

From the interview with agricultural officer with regard to farm land allocation, it has been revealed that village leaders are responsible to distribute the area based on household family size and then everyone is responsible to take care of his/her area by making a clear boundary; also the area can be inherited from grand parents.

Unluckily, regarding the number of households involved in farming activities, there is no actual data, however it has been stated that generally every house is engaged in farming activities for subsistence use in order to sustain their life.

Fish

In terms of fish, it has been depicted (Fig.5.2) by all interviewed households that the area provides fish, because the trend for all households was more or less the same for the surveyed villages.

Of all households interviewed 71 are involved in fishing activities, whereby majority of households belong to Lyamisanga (12), Kongoto (12), Kirumi (11) and few households range from 3-9 are from Kwibuse, Wegero, Buswahili, Bisarwi, Kembwi and Marasibora (Fig.5.5). Among them 66 are male while female are only 5. This may be related to physical requirements of fishing as an activity by itself and also it can be attributed with traditional beliefs that discourage women from fishing. Most of this activity is being conducted in the Mara wetland, however, it has been stated that during rain season water level increases such that it approaches to their home and this water comes with a lot of fishes, thus a number of households involved in fishing activity increases.

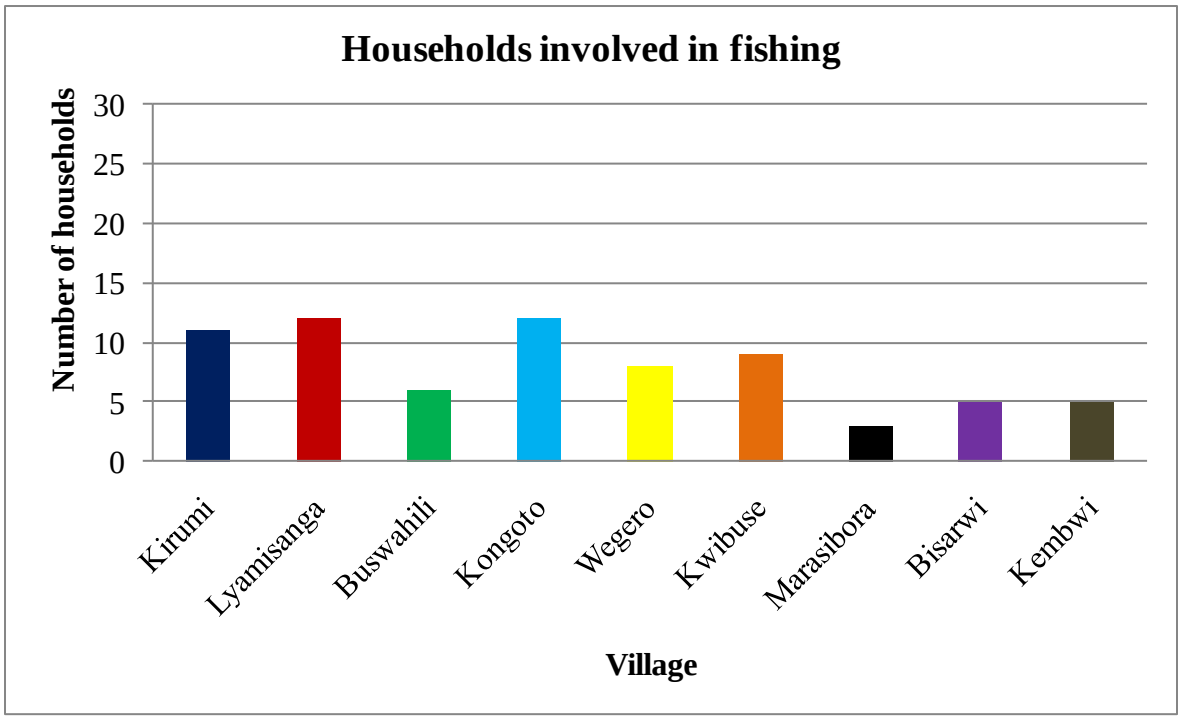

Fig.5.5: Households involved in fishing activity

Types of fishes being harvested by people in the study area are among others Lung fish "Kamongo"/"Kambale mamba" *Protopterus aethiopicus,* Cat fish "Kambale Mumi" *Clarias mossambicus*, Small sized tilapia "Sato wadogo" *Oreochromis esculentus* , Haprochromine "Fulu" *Haplochromis spp*., Large sized tilapia "Sato wakubwa" *Oreochromis niloticus*, Butter fish "Nembe" (*schilbe mystus*) and Nile perch "Sangara" *Lates niloticus*. Moreover, the result reveals that majority of households in Lyamisanga (12) and Kongoto (12) harvests lung fish more while in Marasibora only few (3) households harvest lungfish.

On the other hand, the result shown that large sized tilapia are being harvested more in Kirumi and Kongoto village (9) this may be due to the type of fishing gears used because they might be

selective only to this type of fish. However in Buswahili it was less, and none of household in Wegero, Marasibora, Kembwi and Bisarwi harvests this fish type. Small sized tilapia are being harvested more in Lyamisanga and Kongoto (8) and less in Bisarwi (1) village, while none of households in Marasibora and Wegero harvests this type of fish. But for cat fish the large number of households indicates the most harvesting of this fish is in Lyamisanga (10) and the least in Marasibora (3). Likewise, the result for the harvest of Nile perch shows low number of households which ranges from 1 to 4, while Kongoto, Wegero, Marasibora as well Bisarwi households does not harvest this type of fish. For the case of Haprochromine fish, the results followed the same pattern except in Kongoto village where 11 households do harvest this type of fish; the area may be a suitable habitat for them. In Marasibora, Kembwi and Bisarwi still none of the household harvested Haprochromine fish. Yet, for butterfish the highest and least number of households harvesting this type of fish being 7 and 1 in Kirumi and Kwibuse respectively (Picture 5.2 and fig. 5.6) despite the fact that none of households in Kongoto, Wegero, Marasibora, and Kembwi harvests this type of fish.

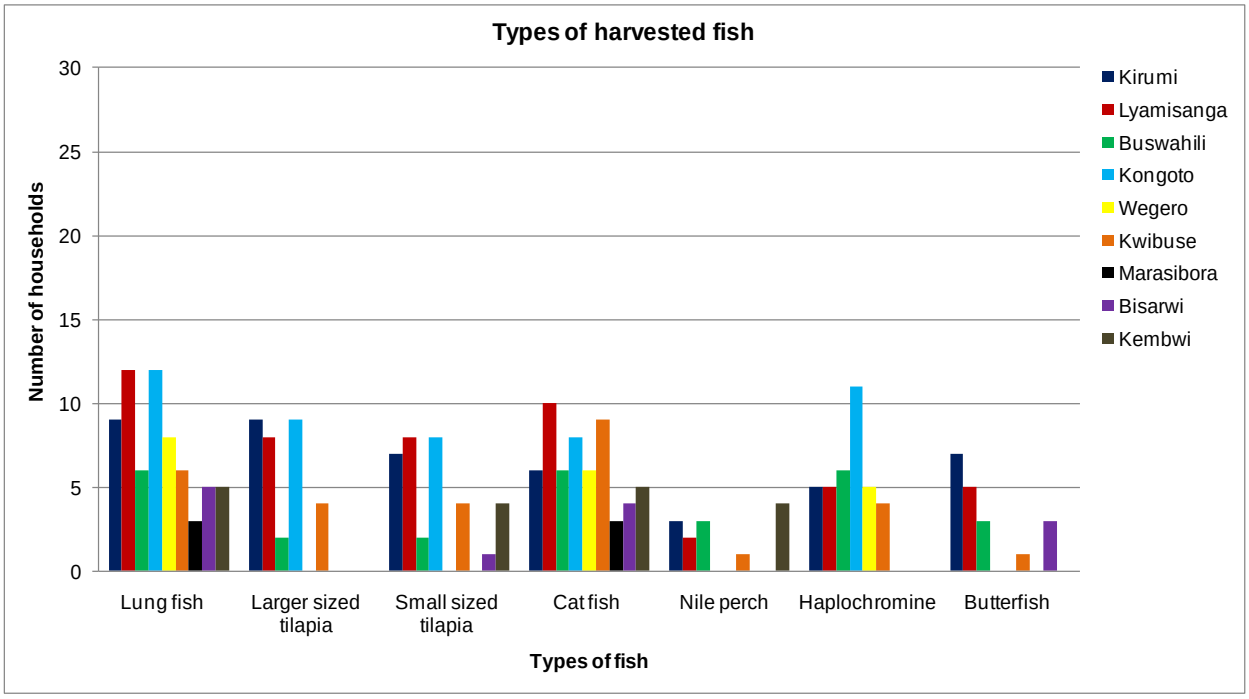

Fig. 5.6: Types of fish being harvested

From fig.5.7 it has been observed that neither of the households harvested fish for commercial purposes only, whilst none of the households in Marasibora and very few households from all other villages apart from Marasibora (1-6) harvested fish for subsistence use only and relatively high number (3-8) of households harvested fish for both subsistence and commercial purposes.

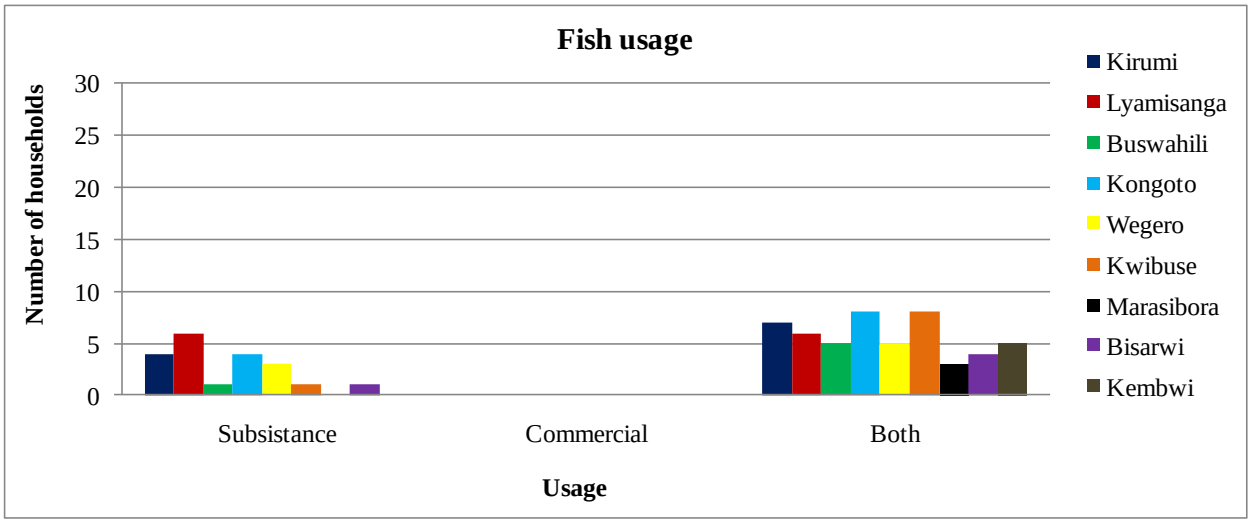

Fig. 5.7: Use of harvested fish

Tilapia "Sato" *Oreochromis niloticus*

Nile perch "Sangara" *Lates niloticus*

Haprochromine "Fulu" *Haplochromis spp*.

Butter fish "Nembe" (*schilbe mystus*)

Lungfish "Gogogo"

Catfish "Kambale Mumi" *Clarias mossambicus*

Lung fish "Kamongo" or "Kambale mamba" *Protopterus aethiopicus*

Picture 5.2: Types of fishes harvested from Mara wetland.

Fishing regulations

Based on the interview with fisheries officers it has been found that, the authority normally deal with large scale fishing, because they have considered fishing in wetlands such as Mara wetland as a small scale because people are fishing for local consumption only. However there are some regulations to be followed by these small scale fishermen, failure to obey to these regulations one is considered to illegal fishing. Below are the small scales fishing regulations;

Everyone is free to fish (no need of fishing licence) except that they are not allowed to fish by using a minimum gill net mesh size limit for Nile perch and tilapia of 5", Minimum mesh size for gill nets targeting sardines is 10 mm, water splashing fishing, use of monofilament nets (plastic nets), fishing by diving and capture fish, as well as poison because Mara wetland has been considered as fish breeding area where as for those fishermen conducting their activities in large water bodies such as Lake Victoria are being considered as large scale fishermen. Thus, they have to comply with the following; 1. They need to have a fishing licence. 2. Registration of fishing boats and gears 3. they have to obey legal fishing rules and regulations such as; (i) Minimum gill net mesh size limit for Nile perch and tilapia of 5" (ii) Minimum mesh size for gill nets targeting sardines is 10 mm (iii) Slot size of Nile perch for capture, processing and trading is from 50 to 85 centimetres (iv) Minimum size of Nile tilapia for capture, processing and trading is 25 centimetres (v) The following gears and methods are prohibited for use: trawling, beach

seines, monofilament nets, cast nets, drift nets, "tycoon", use of chemicals and explosives (vi) Vertical joining of nets is illegal (vii) Gill nets with more than 26 meshes deep are prohibited.

Unfortunately, there is no information regarding the number of households in either of the villages or districts who are involved in a small scale fishing activities because nothing has been done to capture such information. They normally deal with patrols just to see if there are illegal fishing activities in the within the wetland.

Wild food

Wild food collection is the most commonly used provisioning service. The result reveals that all the interviewed households utilize wild food such as bush meat, mushroom and fruits (Fig.5.8).

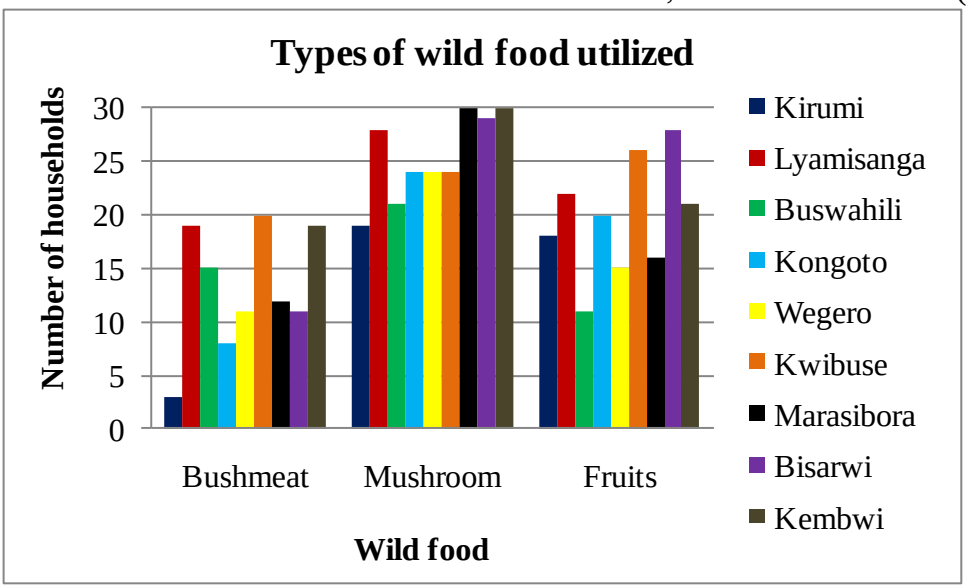

Fig. 5.8: Type of wild food being utilised by households.

Bush meat

On the other hand, since hunting is illegal, most households were unwilling to disclose information. Therefore the result for the provision of this service was generally low with a range from 3 in Kirumi to 21 in Kwibuse (Fig.5.2). Furthermore the result shows that in general few households (3-20) responded positively with regard to utilization of bush meat, this has been attributed to law enforcement for example in Kirumi the village is located near to the high way (Musoma - Tarime) hence it can be easily accessible by law enforcers (frequent patrols). It seems households utilizes more that this but since hunting for bush meat is illegal the results could not reflect the truth to all of the villages. However, in Kwibuse due to larger distance from Musoma town and unpaved road problems law enforcers may not be able to conduct patrols as frequent as in Kirumi village. Among the names of animals being hunted within the area are hippopotamus, crocodiles, warthog, wildebeest and buffalo. Based on the field observation, these people benefits a lot on bush meat but since it is not allowed to hunt wild animals, only few households were positive about this with a reason that "*Most of these animals are being killed once they approach the village area during night time because if we leave them they might cause harm to us*".

Mushroom

As depicted in fig.5.2, the result for the provision of this service to households inhabiting the area had similar trend with the number of households range from 21 to 30. This is due to households being aware of the mushroom availability. Likewise, fig. 5.8 shows more or less similar trend for households utilizing mushroom in all surveyed villages. This activity is mainly being conducted during rain season where women go around Mara wetland for mushroom gathering.

Wild fruits

The area provides wild fruits (Picture 5.3); among the fruits mentioned in their native language are; -man'go, masurusuji, magutu bhuraya, mawi, mataranguge, emisege, nkamatwetwe, ombhusangura, obhukoma and ombhusarwe. Fig. 5.2 shows that the provision of wild fruits within the area has similar trend from households in all surveyed villages (15-26), though in Bisarwi all 30 households said it has been utilized within the area this might be due to high abundance of wild fruits or it could be due to lack of opportunity to grow crops thus the searching effort for the fruits is significant.

As well fig.5.8, indicates that the trend for the utilization of wild fruits by households in the surveyed villages obeyed more or less same trend with an exception from Buswahili where the number of households utilizing wild fruits was low (11) due to low availability on the provisioning of these service. The majority said that these fruit are gathered in an opportunistic way as people walk in the forest during livestock grazing, or on the way to their farms and some normally go to search for fruits.

Picture 5.3: Wild fruits collected within the wetland

Livestock grazing area

From the study it has been found out that livestock are being kept on traditional ways[1] and that the wetland provides suitable area for grazing (Fig.5.2), thus they depend 100% on natural food such as green pastures for survival (Picture 5.4). This has been evidenced by 30 interviewed households in each study villages.

Picture 5.4: Ahead of livestock grazing within the Mara wetland area

From the results, it has been evidenced that 257 interviewed households are involved in livestock keeping. However, the result shows a slight increase in number of households keeping livestock when moving from village one (Kirumi) to last village (Kembwi) for all other types of livestock except for households keeping ducks, goat and sheep where Bisarwi village behaved differently (low number) as per field observation the area at the wetland proximity was somehow dry thus the pastures were also dry and Marasibora village (slightly high number) this may be due to the good palatability of green pastures around the area as per field observation compared to other villages. On the other hand, the trend for households keeping cow and donkey was more or less the same with the exception for Kwibuse village 4 (low number) on households keeping donkey (fig.5.9).

[1]In the morning the herd of livestock which includes cow, donkey, sheep, and goat are being taken to feed on green pastures and drink water available within the ecosystem preferably within the wetland area according to the survey and field observation.

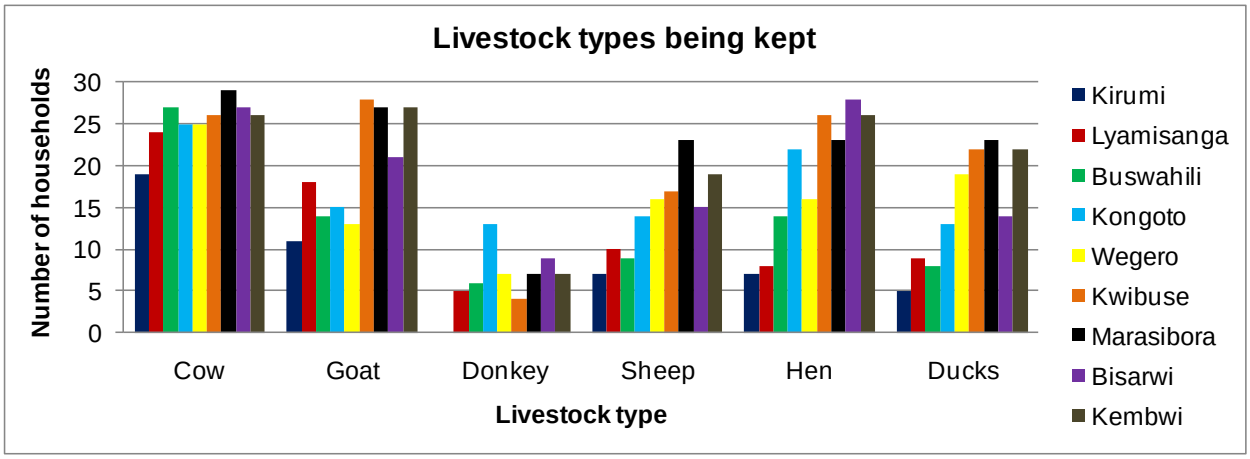

Fig. 5.9: Livestock type being kept

Beekeeping

Most of beehives have been made from locally available material such as hollowed-out tree trunks or clay pots (Picture 5.5) except in few villages where they have modern beehives donated by WWF Project. It has been found that beekeeping activity is not widely practised regardless of high abundance of bees as it has been stated by most of beekeepers. The trend for households keeping bees seems to decrease (Fig.5.10) moving from Kongoto (8) to Kembwi (1) village. However in Buswahili village only one household has been involved in beekeeping and none of the households keeping bees in Kirumi. This is due to the reason that bees products do not have enough market hence people are not interested.

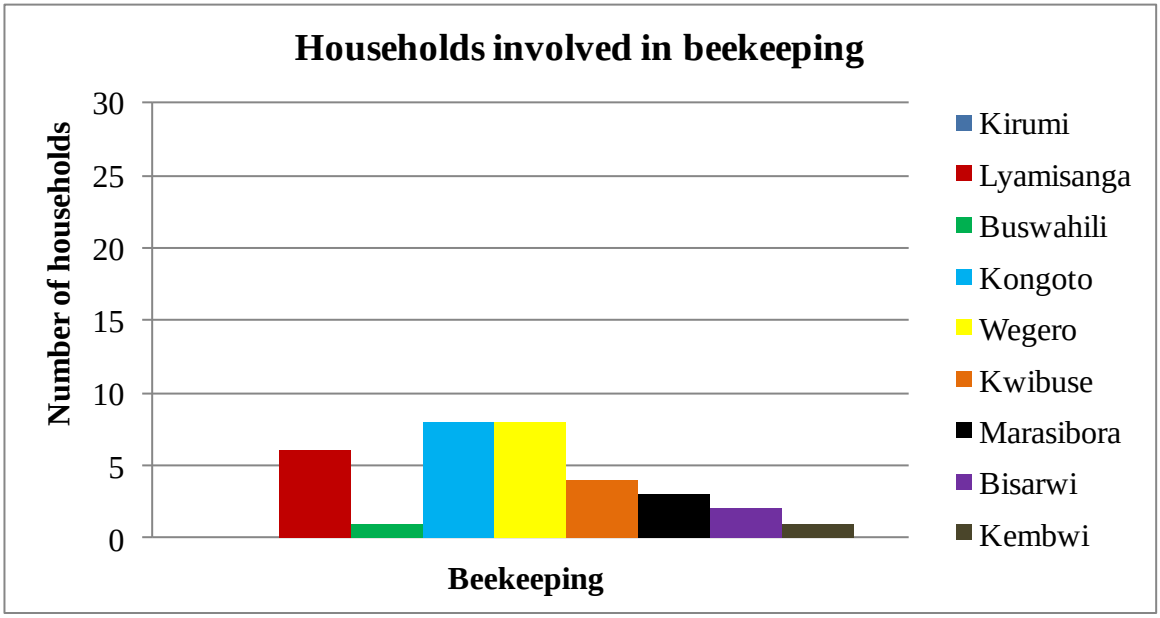

Fig. 5.10: Households involved in beekeeping.

In terms of bee products usage, the result reveals that (Fig. 5.11) few households in Kongoto, Bisarwi and Buswahili village use bee products for local consumption while on the other hand

few households in Lyamisanga and Kwibuse use it for commercial purposes in order to get some cash income. While households in Marasibora and Wegero use the products for both purposes.

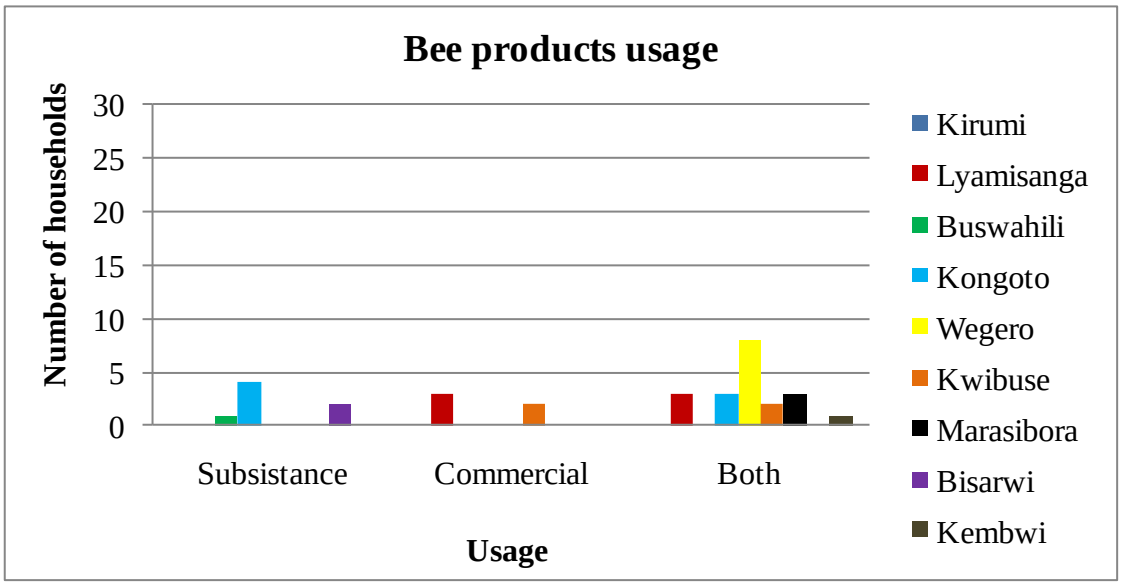

Fig. 5.11: Bee products use

(a) Bee hive made from clay soil

(b) Bee hive made from hollowed-out tree

Picture 5.6: (a) & (b) Bee hive made of materials from the ecosystem services

Energy provided within the area

The results from the survey shows that the area provides energy, nevertheless, fuel wood seem to be provided more within the area compared to charcoal because few households (8-30) articulated its provision within the area (Table 5.2). It has further being found that in Bisarwi, Marasibora, Wegero, Buswahili and Lyamisanga, few households indicated that the area provides energy, however this may be due to; fore example in Bisarwi low availability because suitable trees for charcoal are located far from the households location. While in Marasibora it may be due to low availability of big tree around the area especially for charcoal. In Wegero, Lyamisanga and Buswahili it is due to law enforcement; because regardless of high availability of many trees in Wegero still few people agreed to the provision of charcoal; this may be due to

law enforcement because near the wetland (where there are big trees) there is a group of cattle being kept by rich people from Musoma urban, hence households might be afraid to reflect the truth as the information might spread and threaten their life (by being jailed or penalised). Similarly, in Buswahili most of the time law enforcers (Forestry Officers) conduct patrols and they have informers at nearby centre, thus they might be afraid to reflect the truth about the provision of the charcoal within the area. Equally, in Lyamisanga this activity is being done within the wetland area near a crocodile hunting camp, thus during regular inspections of legal hunting documents by wildlife officers, they might be afraid of being caught. In contrary to Kongoto, Kwibuse, Kembwi where the number of households agreed to the provisioning of charcoal was high, this may be due to the reason that most of these activities are being conducted on forested hills, therefore it becomes very difficult for law enforcers to locate them unless they get information from informers (within their village-who knows the area well).

Table 5.2: The energy provided within the area.

	Energy provided within the area	
	Charcoal	Fuel wood
Kirumi	17	30
Lyamisanga	21	30
Buswahili	19	30
Kongoto	30	30
Wegero	13	30
Kwibuse	30	30
Marasibora	12	30
Bisarwi	8	30
Kembwi	30	30

[*Source:* Field survey, 2010]

This study is focused only on charcoal and fuel wood because these are the major types of energy being used by people due to affordability and easily availability as majority of them collects energy within the wetland area.

Picture 5.7 (a): Charcoal burning

Picture 5.7 (b): Fuel wood collection

Picture 5.7: (a) and (b) Energy collection within Mara wetland

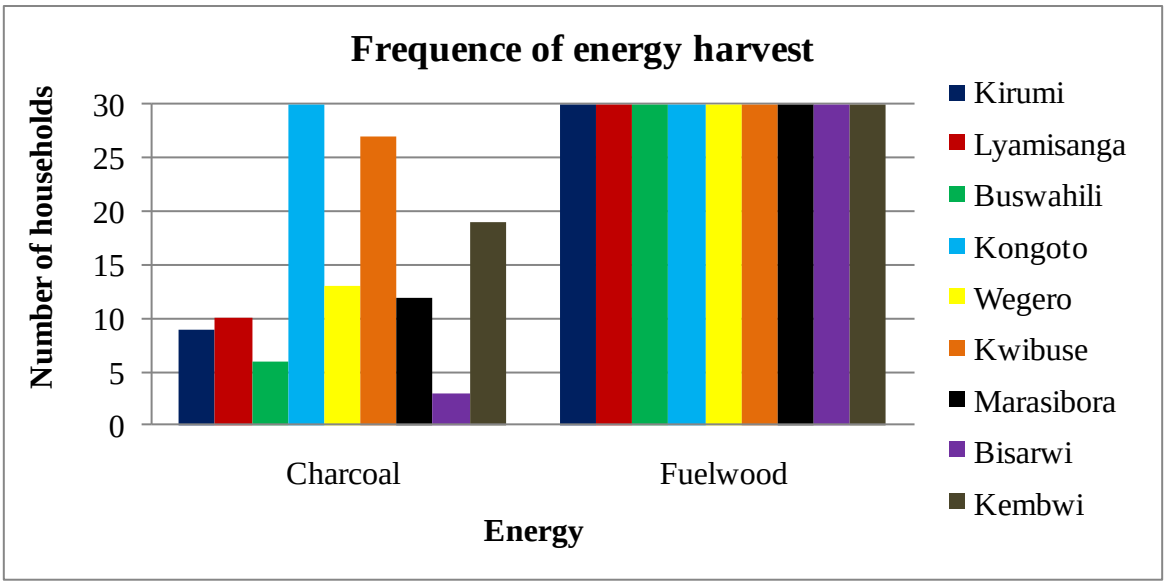

Fig. 5.12: Frequency of energy harvest

Consequently, the result shows that households in the surveyed villages relies on fuel wood for their daily energy use compared to charcoal due to less or no need to process as it is the case for charcoal. This has been evident in fig. 5.12 because all households in the study villages frequently harvest fuel wood for energy use, with an exception in Kongoto and Kwibuse village where a good number of households (30 and 27) respectively harvests frequently both charcoal and fuel wood for energy use compare to other villages.

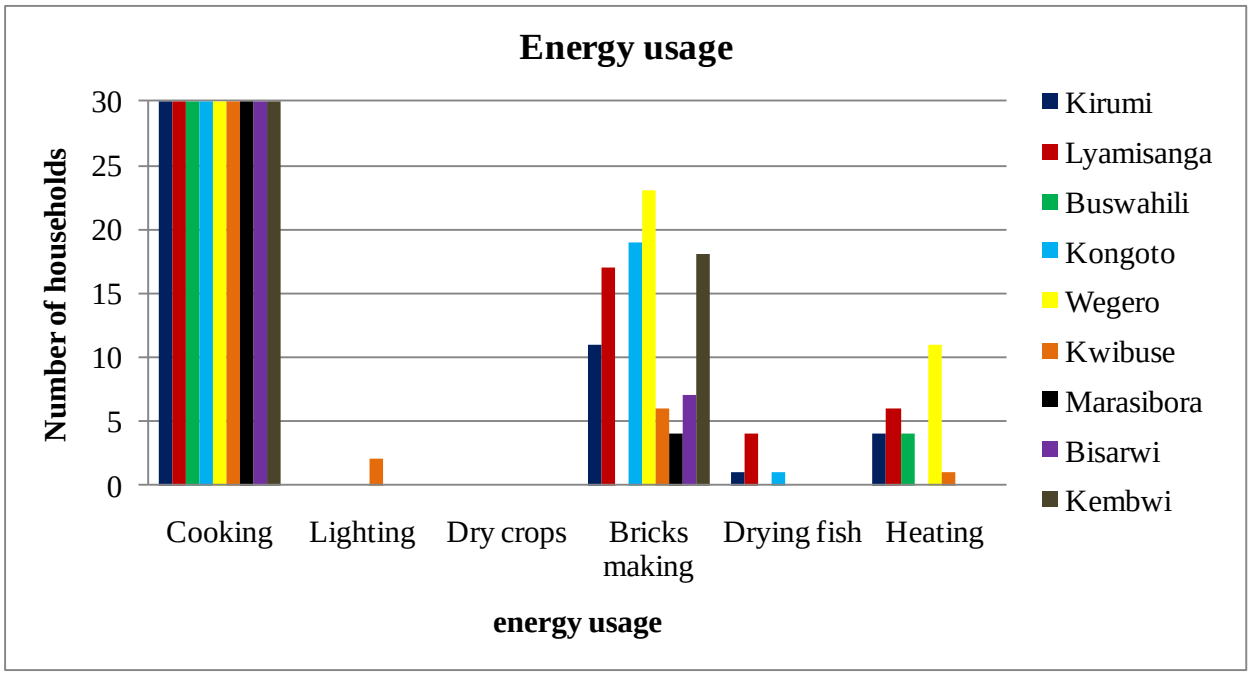

Fig. 5.13: Households indicating energy usage

The result also shows that, majority of households uses energy for cooking, followed by bricks making (burning) with an exception from Buswahili village where none of households uses energy for bricks burning due to unsupported soil type (high availability of sandy). Furthermore it has been found that few household uses energy for heating, drying fish, lighting and none uses energy for drying crops (Fig. 5.13).

Picture 5.8 (a): Local cooking

Picture 5.8 (b): Bricks burning near the wetland

Picture 5.8 (a) and (b) Energy use

Other provisioning services

Similarly, as per table 5.3 below, the result reveals that, the wetland provides services such as freshwater, thatching grass, poles from sisal plant - *Agave sisalana*, papyrus, clay soil and wood. However it has been observed that in Bisarwi the provision of poles is less with only 5 households mentioned its provision; this is due to less availability of poles to this area. Equally in Buswahili village only 5 households indicated that the area provides clay soil this is due to high availability of sandy soil. On the other hand, in Kembwi village only 12 households stated that the area does provide papyrus, as it has been explained by some of the households; the wind has been transporting the papyrus (freely floating) downward and leave few rooted papyrus. Furthermore, in terms of provision of wood within the area, it has been found that other villages has similar trend except in Buswahili, Kongoto and Wegero where only 9, 9 and 4 households respectively were positive about the provision of this service. Since logging for commercial purposes is illegal the reason to this may be due to law enforcement as livestock keepers from Musoma Urban have to pass through Buswahili and Kongoto to Wegero, these people are rich and some of them are aware about the importance of the environment therefore the information might be taken to law enforcers, thus makes them afraid to log for wood. Similarly, in Buswahili law enforcement probably plays a great role as most of the time law enforcers (Forestry Officers) conduct patrols and they have informers at nearby centre, thus they might be afraid to reflect the truth about the provision of the wood within the area.

Table 5.3: Other provisioning services provided within the area.

	Other provisioning services provided within the area					
	Freshwater	Poles	Thatching grass	Papyrus	Clay	Wood
Kirumi	30	30	30	30	25	28
Lyamisanga	30	30	30	30	30	25
Buswahili	30	25	30	30	5	9
Kongoto	30	30	30	30	30	9
Wegero	30	30	30	30	30	4
Kwibuse	30	30	30	30	30	30
Marasibora	30	30	30	30	30	30
Bisarwi	30	5	30	30	30	30
Kembwi	30	30	30	12	28	30

[*Source*: Field survey, 2010]

Building materials

One of the main benefits people inhabiting the Mara wetland area derive from the ecosystem is the ability to collect materials for building their homes (Picture 5.9 and 5.10). It has been found that majority of households in the study villages live in traditionally built houses made of building materials such as clay soil, poles, thatching grass and tree branches gathered around the area. The result reveals that 18-30 households in the surveyed villages have constructed their houses by using bricks made of clay soil. On the other side from the survey it has been revealed that only 2 households in the two villages (Buswahili and Wegero) used cement as wall material. Likewise few households (4-11) in Buswahili, Lyamisanga, Wegero, Bisarwi and Kirumi used

tree branches for house construction and none of households in Kongoto, Kwibuse, Marasibora and Kembwi used tree branches at all (Fig. 5.14).

Picture 5.9: Clay soil near the wetland

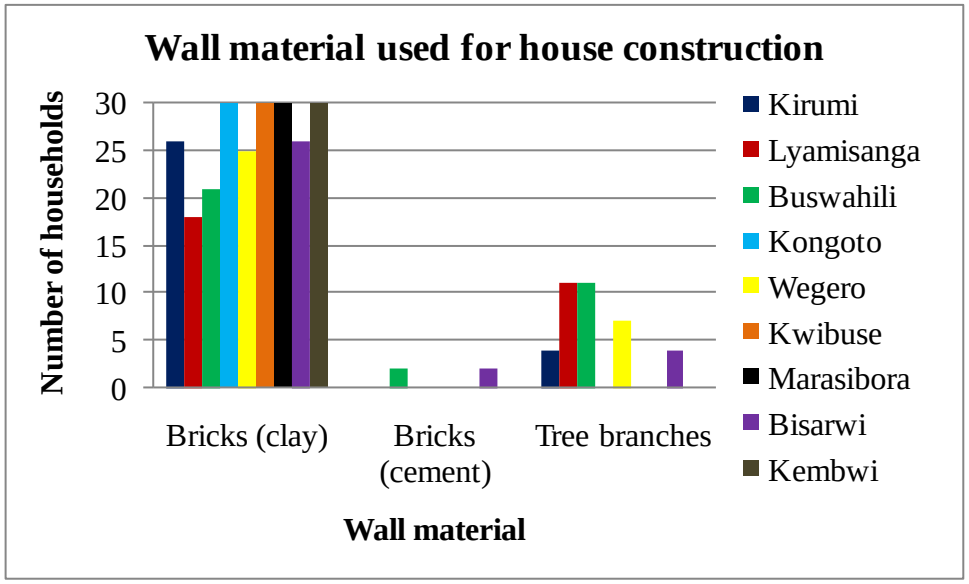

Fig. 5.14: Wall materials used for house construction

In terms of roofing materials the trend seem to be common for all villages in terms of thatching grass and poles. However, all respondents in Lyamisanga use thatching grass. On top of that none of the interviewed households in Lyamisanga used aluminium sheet as a roof material. Apart from that it has been found that the trend for household use of poles and thatching grass as roofing material followed similar trend with a number of households range from 23 to 30. Surprisingly, in Bisarwi village though the provision of this material seems to be low (5) see table 5.3 yet the use of poles was high (28). Moreover, in case of wood only few households in Buswahili (7), Wegero (5), Kwibuse (4), Bisarwi (2), and Marasibora (1) used wood as roofing material (Fig.5.15).

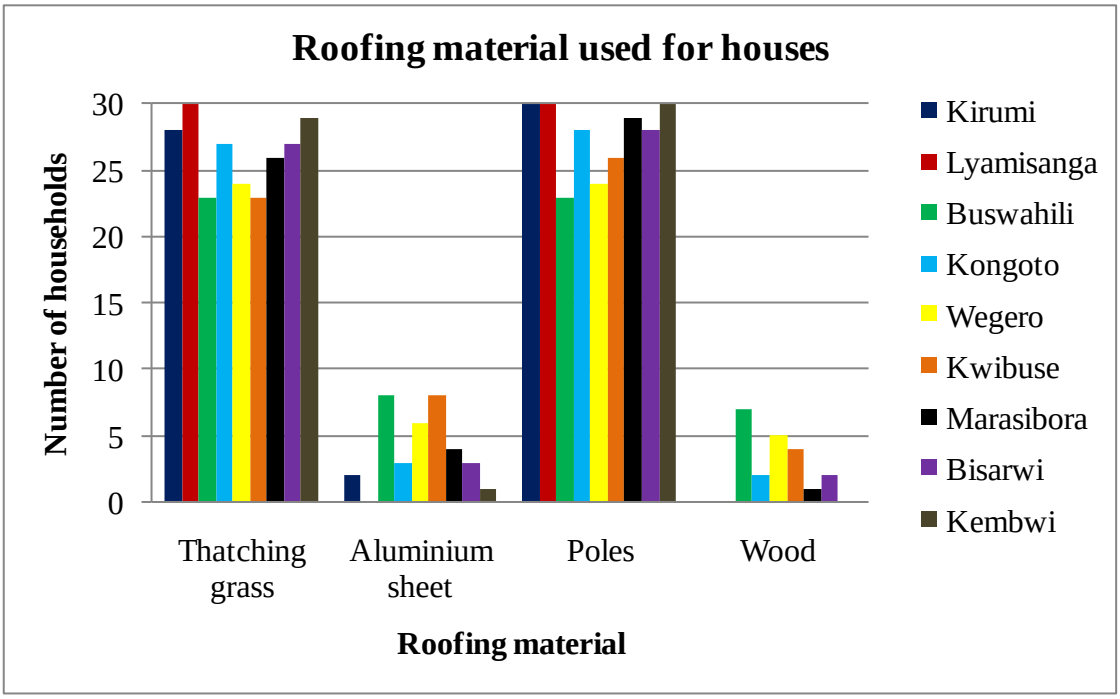

Fig. 5.15: Roofing material used for houses construction

Picture 5.10 (a): A hip of thatching grass near the wetland

Picture 5.10 (b): A house

Picture 5.10 (c): A church

Picture 5.10 (d): A man collecting poles

Picture 5.10 (e): A house roofed with poles

Picture 5.10: (a), (b), (c), (d) and (e) Roofing materials obtained from the ecosystem services

Papyrus

As per table 5.3 the results for the provision of papyrus within the wetland area has a common trend for households from all other villages with an exceptional from Kembwi village in which only 12 households were positive about its provision, it was however explained by households that most of the time papyrus (freely floating) are being transported downward by wind in addition to this during field observation only few rooted papyrus were seen.

The result revels that 122 households are involved in papyrus activities by either making products (Picture 5.11 and 5.12) or by transporting ready made products such as mats. Of which about 66 are female while male are 55. The result reveals that all households in the study villages are engaging themselves in papyrus activities through mat making with an exceptional from Bisarwi village in which households does not harvest papyrus at all probably the reason is that, they do not prefer this activity of making mats since it is tiresome, or the income they generate from other ecosystem services satisfies their livelihood needs. However, in other villages the trend looks alike except from Buswahili village where the number of households was only 6 (Fig. 5.16) this could be due to the fact that although papyrus provision is high (see also table 5.3) as stated during the survey it could be located far distance thus only few households are willing to go and get it.

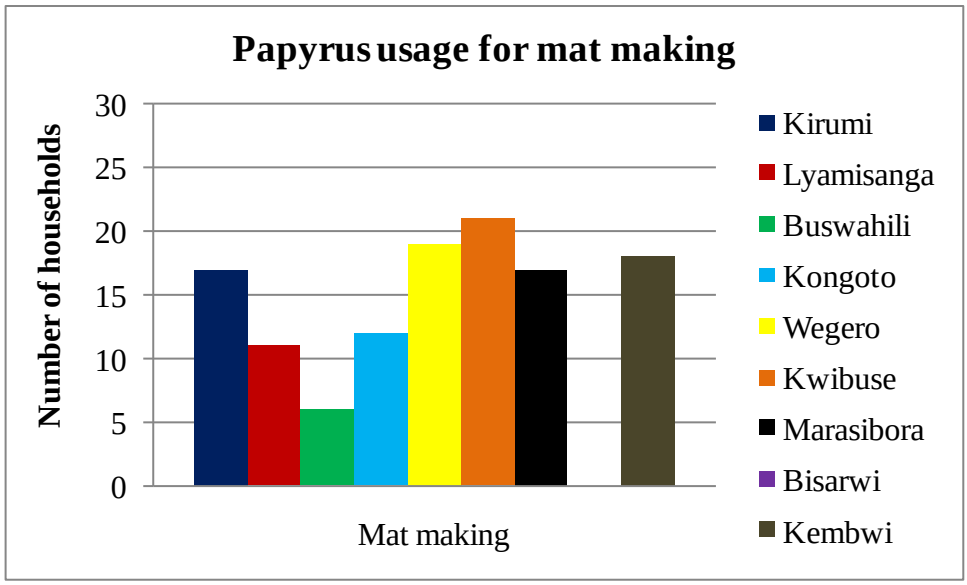

Fig. 5.16: Use of papyrus for mat-making

Picture 5.11: Papyrus

Picture 5.12: A woman making mat

Water

Similarly, as per table 5.3, the 30 interviewed households in all study villages have indicated that the wetland provides water within the area.

From the survey it was found that majority of households use water from the wetland for various uses such as domestic use, irrigation and animal husbandry fig. 5.17. It has been depicted that few households in Marasibora (12) and Kwibuse (14) uses the water for domestic use this is due to the fact that, majority of them use artificial water well pumps provided by WWF Project. On the other hand generally few household uses water from the wetland for irrigation purposes with the range from 1 in Lyamisanga and Kongoto to 18 in Marasibora. However, the large number of households in Marasibora compared to other villages in terms of water use for irrigation has been

due to the fact that more people are involved in growing green vegetables which have to be watered more. Above all, most of them specified that water extraction from Mara wetland need a lot of effort as they have to go through the mud and papyrus vegetations to find open water, therefore only few can afford to extract the water since they do not have machines most of the time they use buckets which is tiresome. On the other hand water use for animal husbandly had similar trend for households for all interviewed villages.

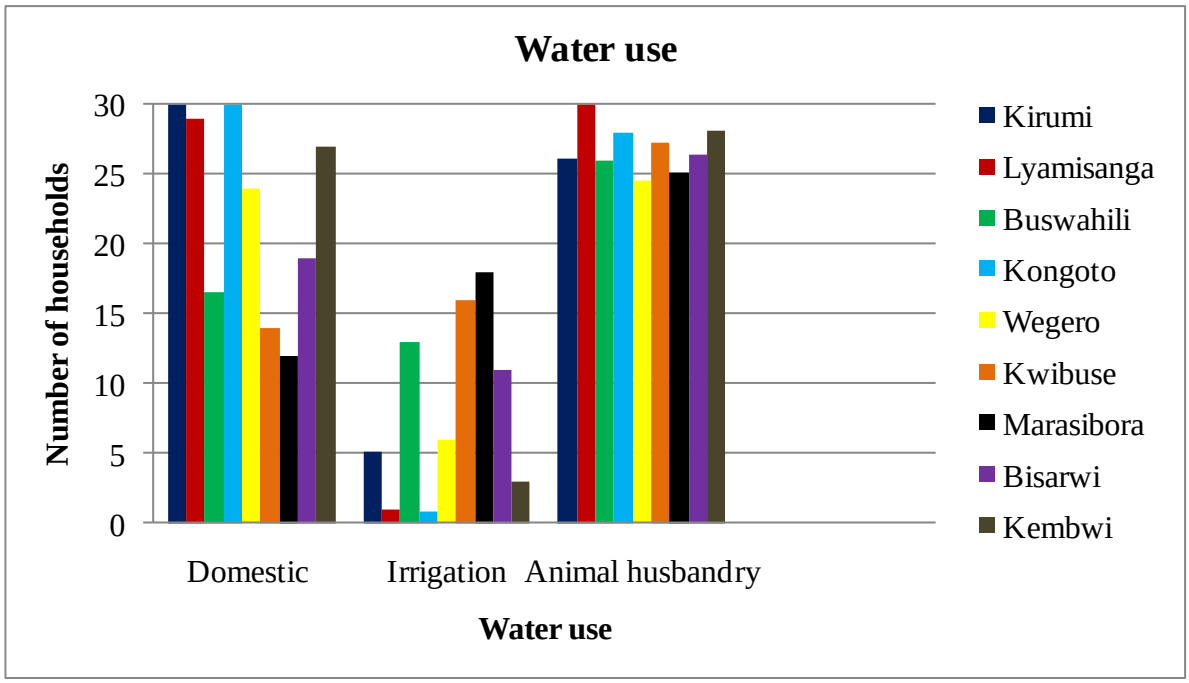

Fig. 5.17: Water uses from Mara wetland

Cultural services

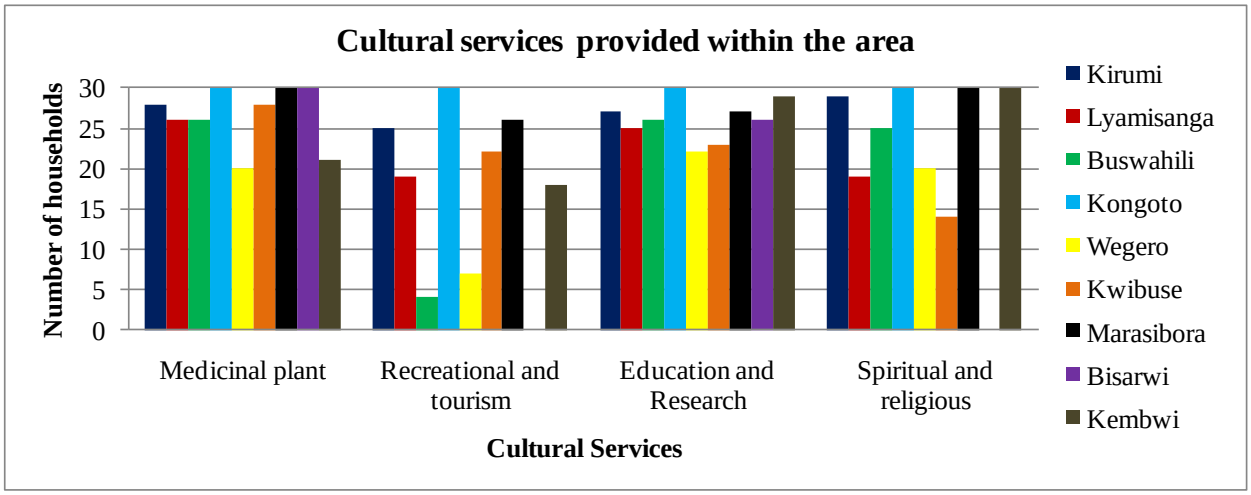

Fig. 5.18: Provision of cultural services within the area.

Medicinal plants

In fig. 5.18 it has been pointed out that, the trend for the provision of medicinal plants from all villages is quite similar with an exception from Buswahili and Kongoto village where only 4 and 7 households respectively were positive about its provision. This is due to availability of a dispensary within the village where some diseases are being cured (Kongoto), while in Buswahili it may be due to "confidentiality".

The trend seem to be the same for all households in all study villages in terms of medicinal plant use with a number of households range from 18 to 28 see fig. 5.19 In most cases, they have been using roots, barks, leaves, fruits and steam (Picture 5.13) as a decoction for healing different diseases, most commonly: stomach-ache, intestinal diseases, flu, wounds, malaria, dizziness, babies' illness, pregnant women, nausea, fever, snake poison, and asthma.

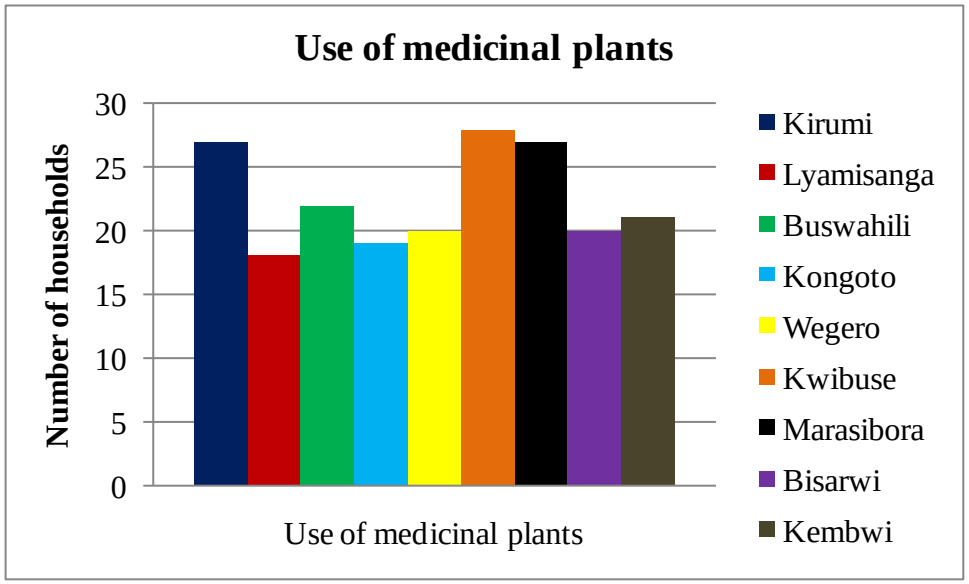

Fig. 5.19: Medicinal plant use

It has been highlighted by most of them that the reasons for the use of these medicinal plants being due to (Table 5.4) lack of money to pay for health services and other charges for example transport in extreme situations, hospitals being far from their village (only Lyamisanga and Kongoto had a dispensary) and another reason is due to strong belief regarding the traditional herbs.

Table 5.4: Reasons for use of medicinal plants

	Reasons for use of medicinal plants		
	Strong belief	Hospitals are far	Lack of money
Kirumi	5	8	14
Lyamisanga	13	0	5
Buswahili	12	5	5
Kongoto	10	0	9
Wegero	6	5	10
Kwibuse	12	9	7
Marasibora	5	16	6
Bisarwi	9	7	4
Kembwi	5	13	4

[*Source*: field survey, 2010]

From table 5.4 it has been evident that in Lyamisanga, Buswahili, Kongoto, and Kwibuse the main reason for households use of medicinal plant is due to strong belief that they have strength in curing various diseases within a very short time, while in Marasibora and Kembwi the use was due to lack of hospitals within their village, for this reason they have to go far thus it is easy for them to locate appropriate plant and once the disease prevail they just go to take and use it as required. On the other hand, households in Kirumi and Wegero village said that they normally use medicinal plants due to lack of money because most of the people are poor and that they can not afford to pay for hospital fees as well as modern medicine.

Picture 5.13: (a) Plant bark

Picture 5.13: (b) Plant leaves

Picture 5.13: (c) Plant fruits

Picture 5.13: (d) Plant steam

Picture 5.13: (d) Plant root

Picture 5.13: (a), (b), (c), (d) and (e): Medicinal plant parts utilized.

Recreational and tourism

The result reveals that the trend for the provision of recreational and tourism services for all villages were more or less the same with a range from 18 to 30 except in Buswahili (4) and Wegero (7) village where the provision of this service seem to be low see fig.5.18 and picture 5.14, based on field observation in Buswahili it is due to the fact that the inlet to the wetland is not just one, therefore some of the households might have no chance to see them, do not have a guide towards this village area, or many considers whites/foreigners as tourists and not themselves. As for Wegero; the distance towards the wetland is too far such that some of them can not afford to go, also it may be due to intact of trees within the area (car can not pass easily). However in Bisarwi none of them said the area provides recreational and tourism services probably this is due to poor road (unpaved). While in Kongoto village the situation is quite different as majority of the households (30) highlighted that the area provides beautiful and suitable places for recreational and tourism, this may be due to population size (1578), thus it is easier for the information to spread to almost every inhabitant once tourists visit the area, as compared to Buswahili and Wegero with a population of 2465 and 4030 respectively. Another reason may be due to distance from one house to another, because in Kongoto there is relatively short distance between houses compared to other villages (Buswahili and Wegero) thus the interaction and information exchange among themselves becomes significant.

Picture 5.14 (a) Birds (Crown crane)

Picture 5.14 (b) Birds

Picture 5.14: (d) Tortoise

Picture 5.14: (d) Beautiful and unique

Picture 5.14: (a), (b), (c) and (d) Some of the recreational and tourism attractions

[*Source*: Field survey, 2010]

Education and research

Majority of households (25 to 30) indicated that the area is suitable for research and education (Fig. 5.20). On the other hand, though the area is potential for education purposes, yet it has been observed that none of the primary schools in all study villages utilize it is potential. Its potential for research has been evidenced by a statement from majority of them that "Many researchers have been visiting the area for various findings however none has given a feedback".

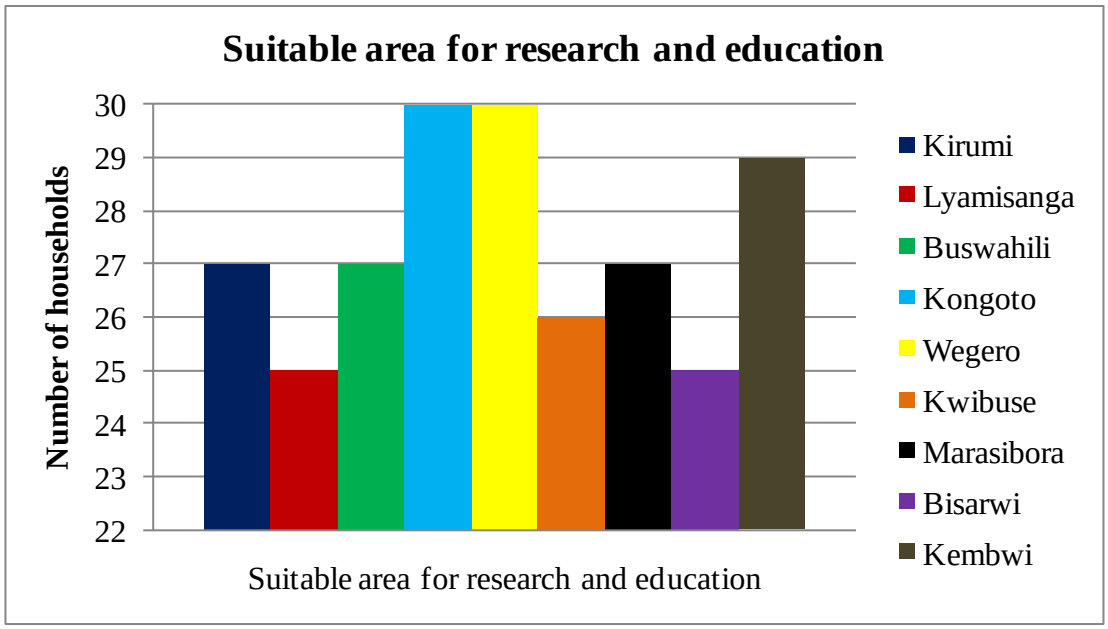

Fig. 5.20: Suitable areas for research and education.

Spiritual and religious

From the survey it has been found that the area provides respectful places for spiritual and religious purposes with the number of households articulated to this being 14 to 30 see fig. 5.18, nevertheless in Bisarwi village none of the households indicated about the provision of this service within the area; this may be due to abandonment of traditional culture.

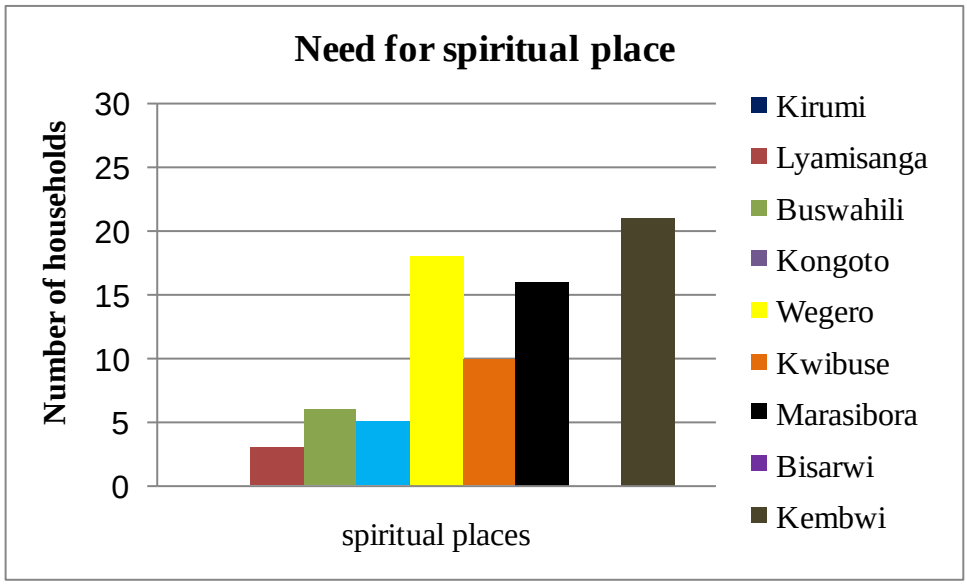

Fig. 5.21: Need for spiritual place

During the survey it has been observed that households in Kirumi and Bisarwi village do not need a place for spiritual purposes rather they have churches at village centre for prayers, while households in all other villages need a place for communion with their ancestors (Fig. 5.21). It

has further being identified that most of the spiritual activities are being conducted on big trees available within the wetland area.

Regulating services

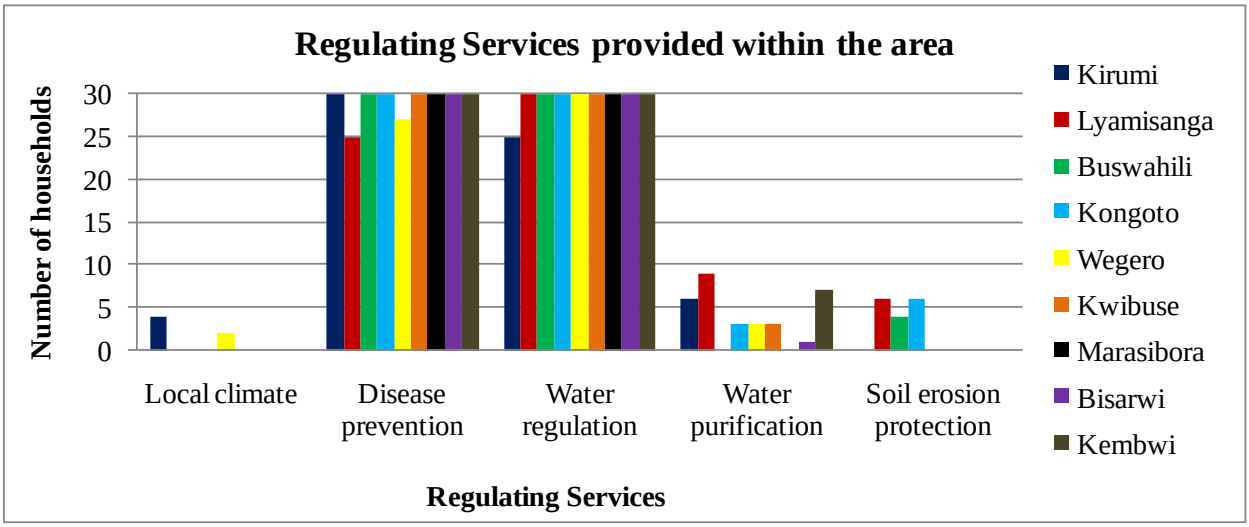

Fig. 5.22: Regulating Services provided within the area.

Water purification

Furthermore, in fig.5.22 it has been observed that in Buswahili and Marasibora none of the households designate on the provision of this service within the area, while in Kirumi, Kwibuse, Lyamisanga, Kongoto, Wegero, Bisarwi, Kembwi the number of households agreed to the provision of this service ranged between 1-9 which is still low. The reason could be due to lack of awareness on these services by people, or normally the water appears dirty as this has also been evidenced through field observation see also Picture 5.15 below.

Picture 5.15: Water appearance within the papyrus wetland.

It has further been found that majority of households (19-30) stated that the water appearance was dirty, while in terms of clean water appearance none of the households in Buswahili and Marasibora represented this and very few households (1-11) from the rest of the villages were positive about this (fig. 5.23).

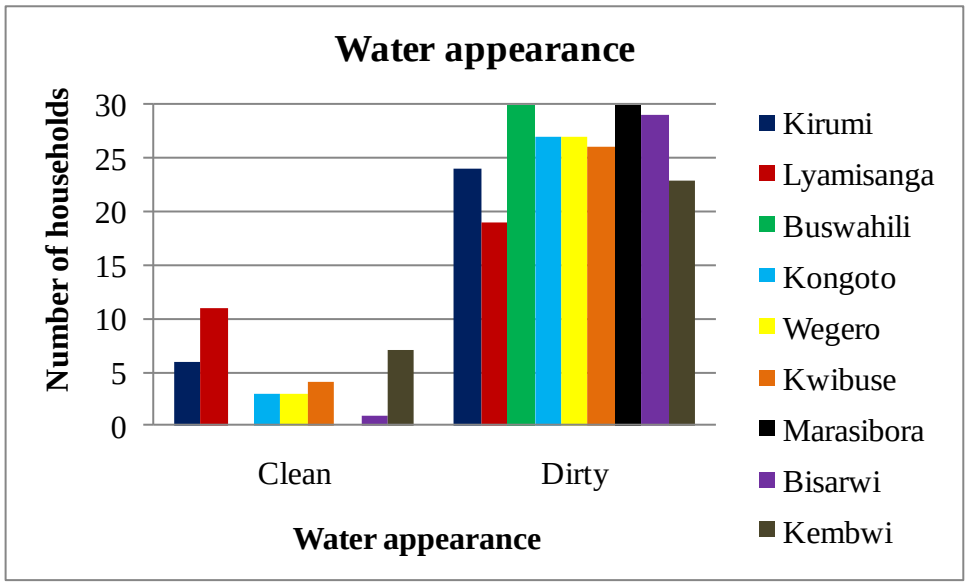

Fig. 5.23: Water quality in terms of physical appearance

Soil erosion protection

It has been found out that the provision of soil erosion protection within the area is low; this has been clearly shown from the field observation as well as survey where only 6 households in Lyamisanga and Kongoto and 4 households in Buswahili reflected that the area does provide soil erosion protection. Interestingly, households from other villages indicated that the service is not provided within the area; this may be due to lack of awareness generally on regulating services since it does not provide tangible benefits just like for provisioning and cultural services. And if they are aware of these services then, it would have been attributed to serious soil erosion problem within the area, as per field observation fig. 5.22.

Local climate regulation

Equally with regard to regulating services fig. 5.22 indicates that only few households 4 and 2 in Kirumi and Wegero respectively asserted that the area provides local climate regulation service; this could be agued based on the awareness on these services according to different exposure and/or access to environmental related issues such as broadcasts.

Furthermore, with regard to climate condition especially during dry season it has been made it clear by majority of households that, the condition is not suitable because of too much sun, intolerable heat and very dry wind with lots of dusts. Majority of them has attributed this to deforestation which is resulted from uncontrolled cutting of trees for charcoal.

Disease prevention

The trend for provision of diseases prevention within the area shows more or less similar pattern in the surveyed villages (fig. 5.22); this may be due to households being capable to obtain medicinal plants that prevents occurrence of diseases.

Water regulation

In line with the diseases prevention, water regulation has been provided within the area, as majority of the households evidenced it (fig. 5.22). This may be due to availability of rainfall within the area.

Income

The results from the survey shows that households are involved in activities such as livestock keeping, farming, bricks making, mats making, beekeeping, fishing, charcoal, fuel wood, food vending, tourism, others (such as wages, small businesses; namely shops, tailoring, stonework and kiosks) and employment for income generation. However it has been found that majority of them earn cash income from livestock keeping (23-30), farming (22-30), mat making or transport of ready made products (5-20) with the exceptional of Bisarwi village where none of the households are engaged in this activity where as 2 to 18 households are generates cash income from bricks making. With regard to other activities only few households generate some income for example 3-10 generates some income from fishing, 0 - 8 (Beekeeping), 1-7 (charcoal), 2-6 (fuel wood), 0-3 (food vending), (0-5) others and only one from tourism activities (Fig. 5.24 and 5.25).

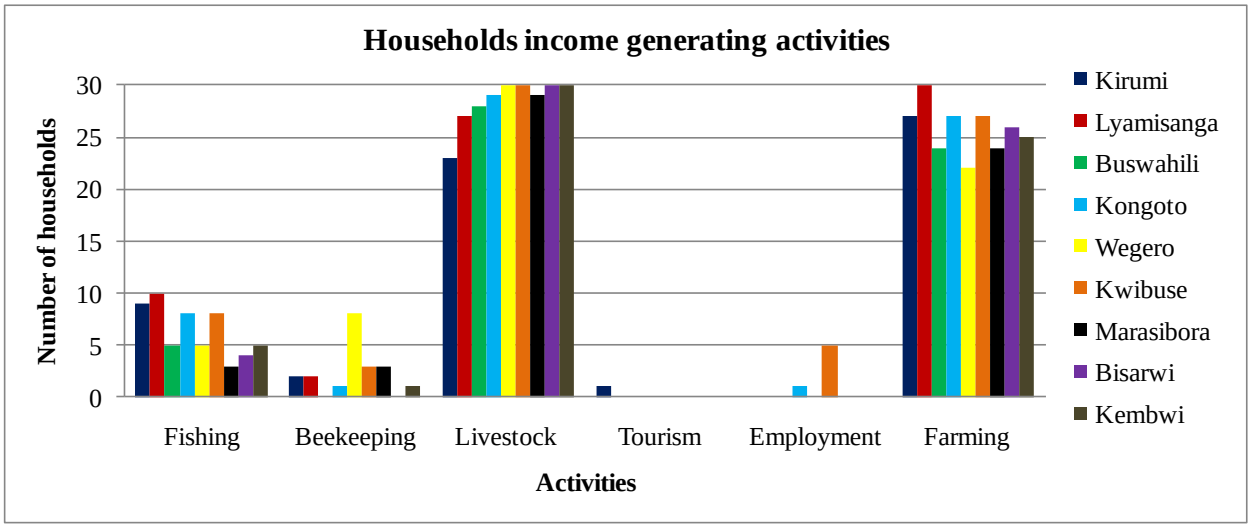

Fig. 5.24: Households income generating activities

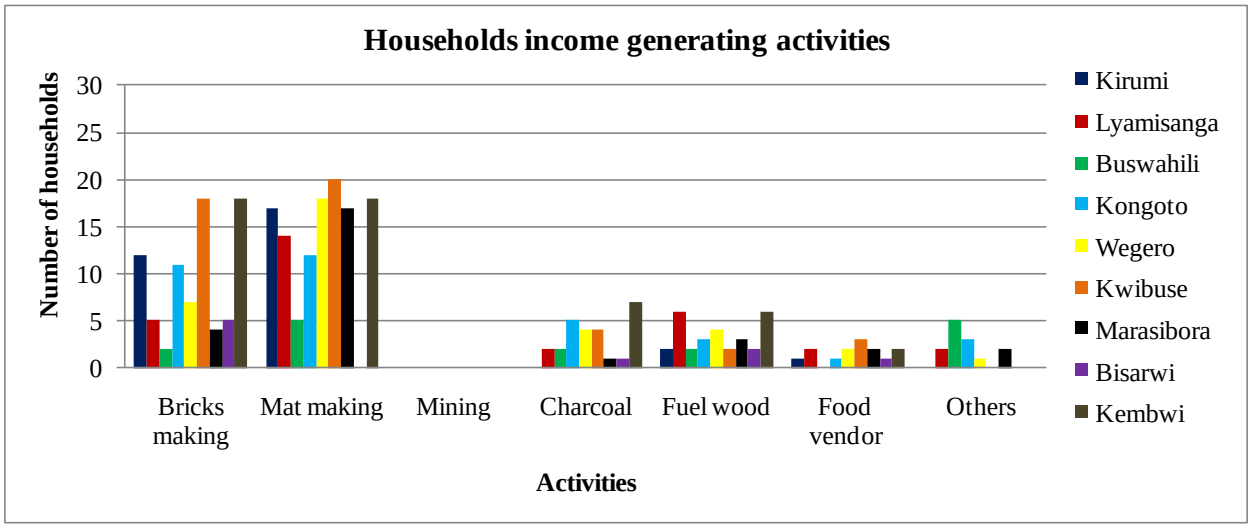

Fig. 5.25: Income generating activities

Picture 5.16: (a) A woman selling cooked food to fishermen near the wetland area

Picture 5.16: (b) A woman selling tomatoes, onions [Wetland products]

Picture 5.16: (c) Fuel wood for sale

Picture 5.16: (d) Charcoal for sale

Picture 5.16: (a), (b), (c) and (d) Income generating activities from ecosystem services

Contribution of income generated from ecosystem services to livelihood (Expenses)

The result shows that majority of households uses the money to pay for school fees (22-30), buy some food (29-30), clothes (29-30), pay for health services (15-29), agricultural activities (9-23), for buying livestock (11-29) and house construction (4-23) while few households uses the money to pay for bride price (2-7) and buy some local beer (1-5) see fig. 5.26.

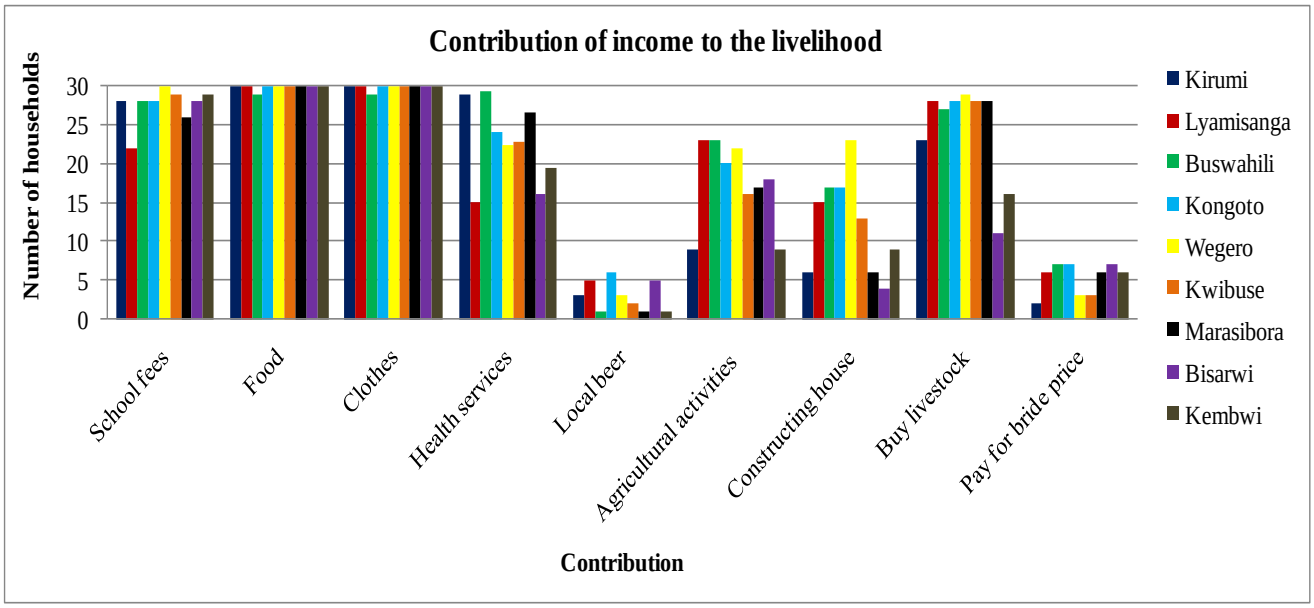

Fig. 5.26: Contribution of income generated from ecosystem services to the livelihood

5.3 Location of ecosystem services within the area

Based on the ground map plotted by households in each surveyed village; the result shows that most of the ecosystem services are located near the wetland (fig. 5.27) and that the extent of use depends on the location of the village.

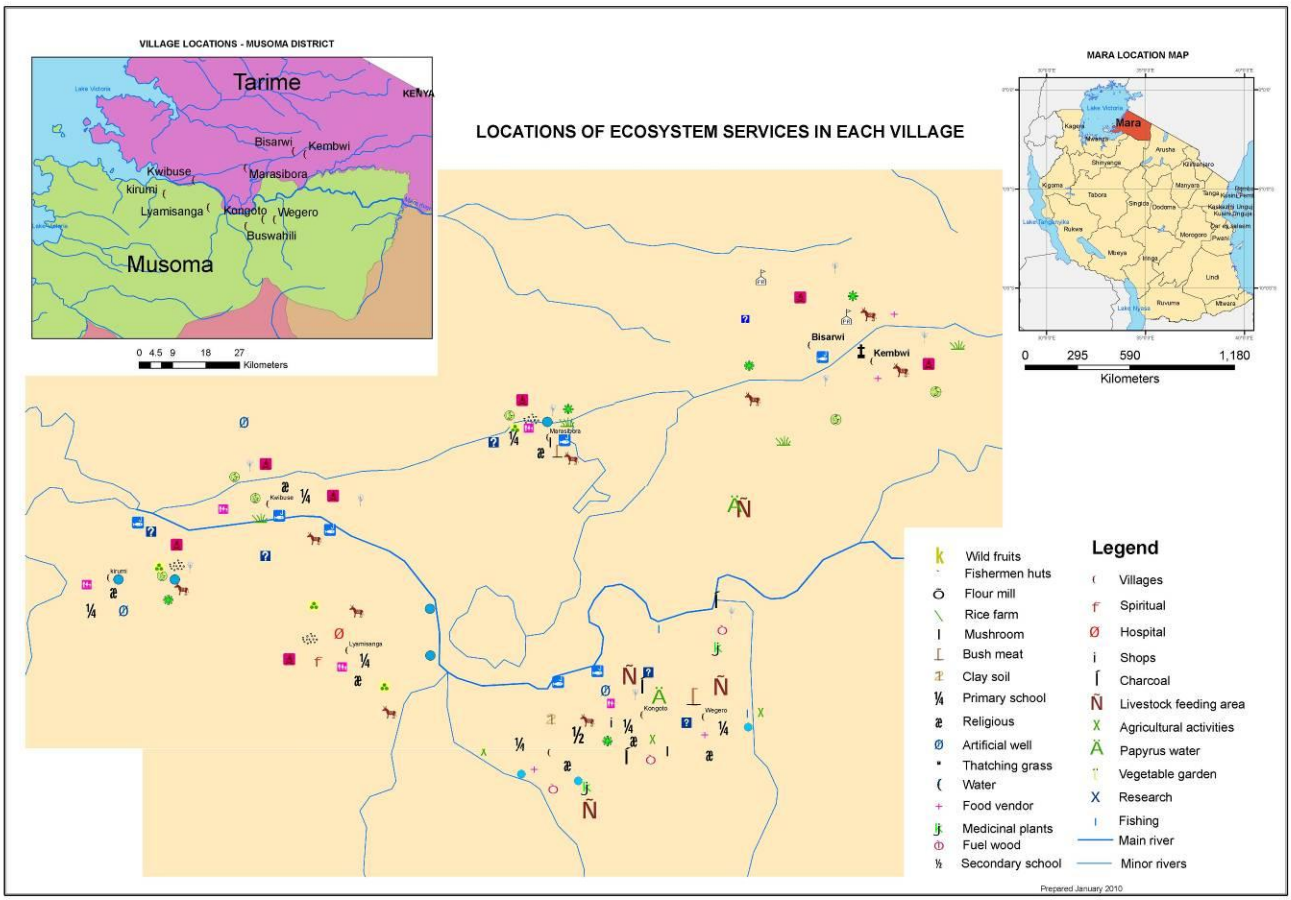

Fig. 5.27: Locations of ecosystem services within the area

5.4 Basic needs for livelihood

The result indicates that the basic livelihood needs for the households in the surveyed villages are;-

- Food
- Energy
- Clothes
- Freshwater
- Health services
- Building materials
- Education and
- Income

5.5 Dependence on ecosystem services in sustaining livelihood needs

From the interview with governmental officials (District Council Officer, Regional and District Fisheries Officer, Agricultural Officer and Village Leaders from the surveyed villages, it has been revealed that Mara wetland provides a lot of services to its inhabitants same as it has been mentioned by households during the survey. However, it has been indicated that majority of households depend mainly on the ecosystem services provided within the area in sustaining their livelihood needs due to the fact that neither of them receives the money from outside (salary) apart from school teachers and village leaders (Table 5.5).

Table 5.5: People dependence on Ecosystem Services

Village Name	No. of people in the village*	% of people who depends directly on Ecosystem Services	No. of people who depends directly on Ecosystem Services
Kirumi	2809	0.90	2528
Lyamisanga	5874	0.90	5287
Buswahili	2465	0.95	2342
Kongoto	1578	0.80	1262
Wegero	4030	0.90	3627
Kwibuse	3017	0.95	2866
Marasibora	2504	0.95	2379
Bisarwi	3186	0.95	3027
Kembwi	1690	0.98	1656

*Number of people in the village according to survey, 2010
[*Source*: field survey, 2010]

5.6 Most important services

There is a wide range of ecosystem services provided within the area, however when the interviewed households were given an opportunity to identify the most important services that they do not wish to loose, majority of them focused only on provisioning services, in which food, energy and freshwater has been identified as the very most important services they do not wish to loose (Fig. 5.28), this was followed by thatching grass which was ranked high (28) in Kembwi and low (9) in Buswahili village. Similarly poles were ranked after thatching grass with the high (22) number of households in Kwibuse and low (9) number of households again in Buswahili. Surprisingly, papyrus had been ranked after poles and that none of the households in Bisarwi, only few (3) in Buswahili and high (20) number of households in Kembwi. The last ecosystem service to be ranked was clay soil where none of the households in Buswahili, 1 in Kirumi and 16 in Wegero village identified it as an important service that they do not wish to loose. Interestingly, wood had not been identified to be an important service to them.

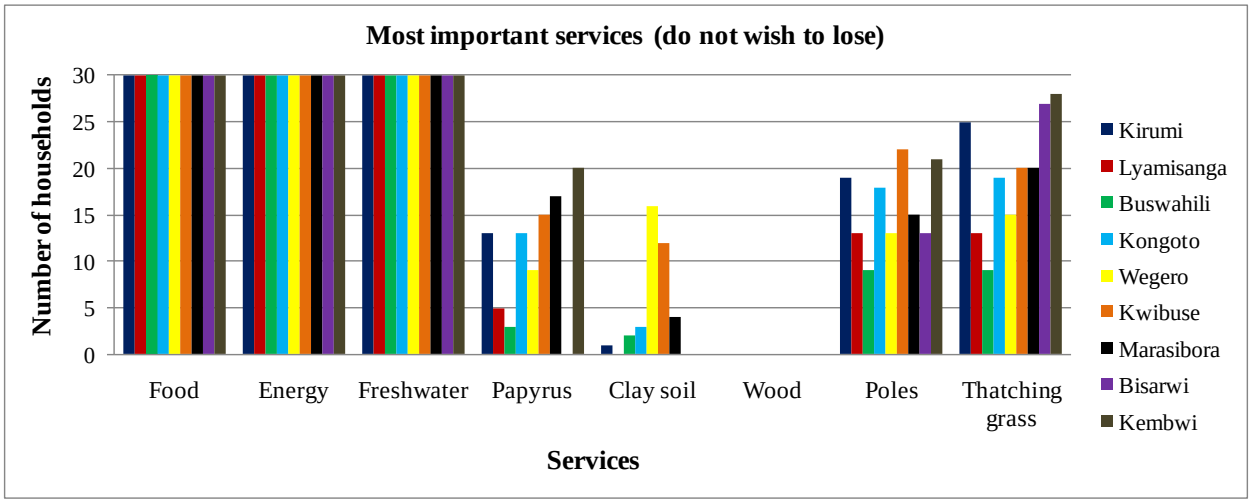

Fig. 5.28: Most important services

Effects if the wetland disappears

The major concern by most of interviewed households was crop cultivation because in the study village the result shows every household is involved in farming activities either for subsistence or commercial purposes, which is an important resource of food and income to them. This is probably due to the reason that wetland provides wet area which is suitable condition for crops cultivation. Therefore, once the wetland disappears agricultural farms will decrease in terms of size, besides crop yield will also decrease and make them not possible to get surplus which they normally sell in order to generate income which is then used for their survival and other livelihood needs.

Another concern was papyrus harvest, because around 45% of households interviewed harvests papyrus from the wetland and on top of that they generate income in two different ways: some of them harvests raw materials and make mats whereas others transports and sell ready made mats to nearby cities and towns. Apart from generating some income they also use this mats for domestic use such as drying crops, seating, sleeping, wall decoration. Therefore their main concern is that once the wetland disappears they will not be able to get any of these benefits any more and that life will be very difficult.

Apart from that, they also claimed about livestock grazing area because these animals are being kept traditionally therefore they depend on the available green and palatable pasture near the wetland, for that case if the wetland disappears livestock grazing area will be affected and thus the survival of livestock.

Freshwater, though the wetland provides unclean water as it has been declared by most of them yet approximately all households interviewed relies on it especially during rain season, because as it has been asserted by a large number of them including old people the wetland never gets dry throughout the year including dry season, therefore it becomes their only source of water for all activities such as domestic use, irrigation, animal husbandry. This is because the majority of artificial and natural water well gets dry. Based on the above importance of the wetland to the livelihood of people in the study villages these people will be affected at large with regard to water scarcity.

Fish, the wetland provides suitable place for aquatic mammal's fish inclusive. With regard to interviewed households, the result reveals that most of people obtain fish either by buying from fishermen or by fishing themselves, these fishes are being used as a source of protein (food) and for fishermen who harvests fish in excess they usually sell and generate some income which is then used to cover other services that supports their livelihood needs such as food, school fees, health services. Therefore it has been highlighted by the majority there will be no more fish for food as well as income.

5.7 Ecosystem functions provided within the area

The area provides a lot of ecosystem function namely; Gas regulation, climate regulation, water regulation, water supply, soil formation, nutrient regulation, pollination, biological control, refugium function, nursery function, food, raw materials, medicinal resources, aesthetic information, recreation, cultural and artistic information, spiritual and historic information, as well as scientific and education.

CHAPTER 6: DISCUSSION

6.1 Method of data collection

In this thesis work the major approach for data collection adopted were survey questionnaires, field observation and literature review. However based on the nature of the method for data collection, some people were resistant for the first time, thus more time was required for clarification that the research work has no negative impact on their life since majority of them depends fully on the wetland thus they were worried that the wetland will be privatized, and let them move away from the area and in some cases it was forced to leave contacts so that if anything happens they know the source. Therefore based on the nature of people in the study area it was not possible to collect any information without being accompanied by a village leader although he somehow influenced the results because it was not possible for an interviewee to disagree being interviewed. Nevertheless, during field work flexibility was entertained when ever there was a loop for potential information. In order to find more information on the significance of the wetland however there is a need for use of semi structured questionnaires without writing anywhere and become part of them through staying within the village for at least 6 months, for which the first 3 months may be used to make a trust to people so that they can be freely to disclose any information requested thus attainment of quality information that reflects the truth on the real study area. Since it has been found that there is some useful information it is hard for them to disclose to a passer-by. Then the other 3 month may be used for the actual commencement of data collection. Upon additional of time for research more data on fishing activities and hunting for bush meat will have to be collected as it seems their are useful but hidden information.

6.2 Ecosystem services provided within the area

From the study it has been found out that among others the Mara wetland provides a vast of ecosystem services essential for peoples livelihood needs. These services have been categories into three; namely provisioning services which includes food (bush meat, wild fruits, mushroom, fish, livestock-grazing area, crops- cultivation area), building materials as well as energy (ii) Cultural services which includes medicinal plants, recreational and tourism area, spiritual and religious together with research and education (iii) Regulating services which includes; water purification, water regulation, diseases prevention and local climate regulation. However, it has been found that among the three services provided within the area, people acknowledged and seem to understand more the cultural and provisioning services rather than regulating services this may be due to lack of awareness on regulating services since the benefits it provides some of them are not tangible and thus difficult to understand.

6.3 Location of ecosystem services

Based on the survey and field observation, the Global Positioning System (GPS) coordinate points were taken and used for plotting ecosystem services locations map for a respective village with reference to the wetland. It has been found that the larger number of ecosystem services are located at the wetland proximity and that these services are almost the same to each village; however the extent of use depends on the location of each village and the effort to consume those services. For example in Buswahili village although the provision of papyrus within the wetland

is high yet only few households managed to harvest them due to far distant location of this services to this village. Likewise in Bisarwi, the provision of poles within the area is very low due to distant location of the service however due to the effort used by the households majority of them have been able to use the service as the building material for their houses. Further due to the larger distance of the village to law enforcement officers; households in Kwibuse village; for example have been able to consume more of bush meat than in Kirumi village. Moreover, the easily access to big trees in forested area in Kongoto, Kembwi and Kwibuse have enabled people in the area to produce more charcoal.

6.4 Basic livelihood needs for the people

From the survey the basic needs for the people were identified to be; food, energy, clothes, health services, building materials, water, education as well as income. According to Adekola *et al*, 2008 in the study in Ga-Mampa valley wetland in South Africa, food, energy, water and building materials had been identified as the basic needs for the people for which in this study education, clothes, health services as well as income has been an additional basic needs identified by the people.

6.5 Dependence of people on ecosystem services in sustaining their livelihood need

Majority of households in the study area are poor and neither of them have been getting some income from outside, thus a large percent 98 of them depends directly on the ecosystem services in sustaining their livelihood needs (Table 5.5).

Food

Agriculture provides an important source of subsistence as well as cash income for food for rural households (WRI *et al*, 2005). Since these people are poor they can not afford to buy milled flour from shops, instead they utilize the suitable agricultural area provided within the wetland to cultivate various types of crops; maize is the most widely grown cereal crop (WRI *et al*, 2005) which serves as staple food for them. For farmers in western Kenya, for instance, the family harvest of maize, beans, tea, or other typical crops will reflect the level of rainfall or access to irrigation; the fertility of the soil and access to fertilizer; the genetic profile of their seed (WRI *et al*, 2005). Generally agriculture has been either a major source of food and/or income to the majority of households in the surveyed villages.

Apart from that during rain season they also go around the wetland for mushroom gathering, which is used as a source of food as well as income. (Falconer and Anord, 1992) found that mushrooms are favourites in many cultures, where they are added to sources and relishes for flavouring; often they are consumed as meat substitutes and that they are the good source of protein and minerals.

Although hunting for bush meat is illegal, it has been found that, people inhabiting the area utilizes bush meat for both subsistence (food-as a source of protein) and commercial to generate some cash income. Subsistence hunting and gathering of bush meat is estimated to account for 90ax of bush meat off take on the African continent and for many communities it increasingly constitutes a major informal industry critical to livelihoods (Biggs *et al*, 2004). According to Jaarsveld *et al*, 2005 wild plants and animals "bush meat" play a critical role in food security and

nutrition across southern Africa, in arid and semi-arid areas, particularly during times of drought or food insecurity.

Furthermore the freely provided wild fruits within the wetland area have been used by households as food supplement, full meal or refreshments to relieve hunger when people are on their farms or during livestock grazing before the actual meal are ready. It has been specified that these fruits are being eaten when raw. According to WRI *et al*, 2005 gathering of nuts, fruits, and tubers in Kenya's forests and savannas remain important to many, as has been true for thousands of years. These wild resources become particularly critical in times of drought, stress, and hunger whenever other resources become unreliable.

Due to high abundance of bees within the wetland and provision of beehives materials households have been able to obtain honey which is being used for both local consumption such as food supplement, medicine, substitute for sugar and commercial purpose for generating cash income.

Fishing provides food and a way to earn cash income for many people living near major bodies of water, particularly Lake Victoria (WRI *et al*, 2005). The fishery of the Lower Mekong basin (shared by Cambodia, Laos and Vietnam) is vitally important to the livelihoods of the basin's 55 million people, many of whom derive an income from catching, processing or selling fish, which constitutes the main source of animal protein in the region (Ramsar, 2009). It has been identified that, households obtain fish from the wetland which serves as food for protein source and cash income. Likewise, fisher folk from Lake Victoria depend on ecosystem services on the health of fish stocks and the availability of fuel wood to smoke their catch (WRI *et al*, 2005).

Accordingly, these animals after having provided grazing area and water from the wetland, in turn they provide a support to household's livelihood through provision of protein and micronutrients especially for children (WRI *et al*, 2005; IFAD *et al*, 2004) once they consume meat at their family, not only that but also fresh milk from cows, eggs from chicken and ducks. They also play a particularly vital role as a food source in the semi-arid and arid lands that cover more than 80 percent (SoK, 2003) of Kenya, where it is difficult or impossible to grow most crops (WRI *et al*, 2005). Accordingly, the life of a livestock herder in the north (Kenya) shows a similar dependence on access to ecosystem services, including good pastures, healthy animals of good genetic stock, and reliable watering points for livestock (WRI *et al*, 2005).

Other services being derived from livestock which are of beneficial to people's livelihood needs apart from food are livestock dung serves as manure which is used on self farm as fertilizer, and to some extent as a substitute to cement especially on houses made of tree branches, in addition it also serve as crops drying place (through spreading it on a bare land and let it dry), they are also used for transportation (carry luggage), during farming activities, pay as a bride price, according to IFAD *et al*, 2004 livestock often play a central role in cultural traditions such as weddings and funerals. From the study it has been found that livestock are also used for income generation once sold as live animal, smoked or fresh chopped meat and in some cases through renting see Picture 5.17 below.

Picture 5.17: (c) Donkey carrying luggage

Picture 5.17: (c) Cow carrying thatching

Picture 5.17: (c) Fresh chopped meat sell

Picture 5.17: (c) Smoked meat sell

Picture 5.17: (c) Animal dung used as a surface area for drying crops

Picture 5.17: (c) Livestock during farming activity at the wetland proximity

Energy

From the survey it has been found that people can not afford to pay for electricity or gas cooker, hence they fully depend on the energy provided within the wetland area which in most case it is charcoal and fuel wood. Furthermore it has been revealed that this energy is mainly being used for cooking and breaks burning and in few cases for heating and drying fish for preservation. Fuel wood is the main energy source in most Third world rural communities (Falconer and Arnold, 1992), and is likely to remain an important energy source in Africa in the coming decades (Arnold *et al*, 2003). All cooking and most food processing are dependent on fuel wood (Falconer and Arnold, 1992). The study in the economic importance of wild resources in Hadejia-Nguru Wetlands, Nigeria revelled that a large amount of the firewood collected in the Wetlands is destined for subsistence use, as it is the primary source of energy for most households (Eaton and Sarch, 1997). Both women and men engage in fuel wood harvesting. Women collect wood for their own use, as well as possibly for sale within the village, while men gather fuel wood primarily to generate income (Eaton and Sarch, 1997).

Building materials

Majority of households used the freely available materials such as poles, thatching grass and clay soil not only because they are available within the area but also due to low income level because they can not afford to buy other materials such as aluminium sheet, wood and cement. In a study of Yala swamp in Kenya (Schuyt, 2005) it was found that 86% of the population relied on the wetland for the provision of building materials such as clay, sand, wood and papyrus.

Freshwater

The wetland provides freshwater which is vital for human survival and sanitation (Jaarsveld *et al*, 2005). Freshwater is a vital input for the production of food (e.g., fish, irrigated crops, and livestock), timber, fiber, and fuel. Of course, freshwater itself is a product for consumption (WRI *et al*, 2005) such as domestic use, irrigation and animal husbandry, because the wetland supplies adequate water throughout the year including during dry season when all other water sources are almost dry. Adequate access to water also means that the considerable amount of time women and children spend fetching water can be spent on more productive tasks that improve livelihoods and economic productivity, a key component of poverty alleviation. (Jaarsveld *et al*, 2005). Wetlands have a high potential for a diversity of livelihood activities (Kangalawe and Liwenga, 2004). According to Schuyt, 2005 water which is used for drinking, cooking, washing has a dependence ratio of 100% among the people.

Education

Education is among the basic needs for people inhabiting the area; however it can not be acquired without provision of school fees, uniforms and all other school contributions (security guard, desks contribution). Nevertheless, this has been possible for them due to the services provided within the area thus enabled them to generate cash income which was then used to pay for their children and/or relatives.

Clothes

Equally, it has been found that due to income generation from utilization of ecosystem services people have been able to use the money for buying clothes for themselves and their family.

Health services

Due to the fact that there are no dispensaries in all villages except in Lyamisanga and Kongoto village as well as low income level people have been utilizing medicinal plants mostly roots, barks, leaves, fruits and steam provided within the area as a decoction for healing different diseases, most commonly: stomach-ache, intestinal diseases, flu, wounds, malaria, dizziness, babies illness, pregnant women, nausea, fever, snake poison, and asthma. According to Monela *et al*, 2005 people benefit from the cheaper availability of herbs for the ailment that they can administer on their own. However in few cases where the disease becomes serious they normally go to professional doctors in hospitals located at town, thus they are required to pay for transportation and all other hospital charges such as admission fees, doctor's consultation fees, medicine and all other charges. At this point, they normally use the income generated from ecosystem services.

Income

Majority of households reflected that the income generated from activities such as livestock keeping, farming, mat making, bricks making, fishing, fuel wood, charcoal, food vending, beekeeping has been used to support other services that requires exchange of money. For example the money obtained is then used to take their children or relatives to school and that the money was not only used to pay for school fees but also school uniforms and other school contributions such as desks, security guard, examination, to buy food items like salt, sugar, cooking oil, in small quantity on daily bases depending on the amount of money the get, furthermore it has been indicated that majority of households use the money to buy clothes, to cover health services costs, buy livestock, agricultural activities such as pay for manual labour or livestock. Apart from that other household said that they use the money for house constructions through paying local house constructors, buying building materials like aluminium sheet, cement. Furthermore, it has been found that some households use the money for paying bride price to the bride's family and also the money is used for social matters such as drinking local beer with friends. According to Monela *et al*, 2005 the income generated from the ecosystem services can be used to purchase new farm equipment, hire agricultural labour, build classrooms, village offices, and healthcare centres (Monela *et al*, 2005).

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

In general, the Mara wetland provides a variety of services including provisioning, cultural and regulating services. However people in the surveyed villages seem to acknowledge and understand the cultural and provisioning services better than the regulating services.

The vast majority of ecosystem services used from the wetland are the same for each village; however the extent of use depends on the effort needed to consume the service. This effort is mainly determined by the location of each village. For example easy access to larger trees increases the production of charcoal and a larger distance to law enforcement officers leads to a higher consumption of bush meat.

This study has demonstrated that majority of people inhabiting the area directly and completely depends on the goods and services provided by Mara wetland for sustaining their livelihoods. All income needed to fulfil basic needs that the wetland cannot provide directly, such as education, is generated from services provided by the wetland. The only income identified in this study that is not related to wetland services are subsidies provided by the government for village leaders and school teachers.

The wetland has been able to sustain people's livelihoods not only through provision of food such as crops- in terms of suitable soil for agriculture and wild fruits but also provides protein source through the use of bush meat, fish and livestock. The wetland has also provided water for domestic use, irrigation and animal husbandry. Apart from that people have been able to obtain source of energy through the use of fuel wood and charcoal. Further, since people in the study area are poor majority of them can not be able to buy other building materials apart from using the freely available materials such as poles, thatching grass, clay soil and wood. Likewise the wetland has provided medicinal plants that have been used to cure and/or prevent some diseases. On top of that through the provision of papyrus, suitable area for farming, livestock grazing area, clay soil, fishing area and energy people have been able to generate some cash income that has been used to cover other basic needs such as paying for health services, school fees for their children and/or relatives, buying of other food that are not possible to get directly from the area, clothes and construction of houses.

People are well aware of their dependence on the wetland. This is illustrated by the concerns they expressed upon answering questions on the impact on their livelihoods if the wetland would disappear. For example respondents were worried about food provision due to unfavourable conditions for crop cultivation, reduced availability of fish and less grazing area for livestock. They also expressed concerns on water availability for both livestock and human use and the expected absence of papyrus, fuel wood, wood for charcoal production, thatching grass, poles and clay soil.

A large variety of services provided by the Mara wetland are seen as essential for human survival. This implies that, according to the ecosystem functions and services framework by De Groot (De Groot *et al*, 2002), also a large variety of wetland ecosystem functions need to be maintained to enable the wetland to provide these services.

7.2 Recommendations

Due to the significance of the wetland in sustaining people's livelihood needs, there is a need to create awareness on the importance of conservation to the area not only to people around the area but also to policy and decision makers.

More research should be done on the link between ecosystem services and functions and the effect of the drivers on the ecosystem; in order to allow the continuous supply of the services in which people depend in sustaining their livelihood needs.

More time (about 6 month) should be given for the field work such that the first 3 months should be for building trust to the people inhabiting the area and the remaining 3 month are enough for the commencement of data collection, thus attaining quality data that reflect the real situation within the study area, for example the data for the utilization of bush meat might have been higher compared to the one have been acquired.

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Households Questionnaires

Dear respondent

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

Household No…….. Respondent No……..

Part A. General Information

1. Personal details;
   a) Sex: Male..... Female.....
   b) Age: .....
   c) Marital status:
      i. Single iii. Divorced
      ii. Married iv. Widow

How many children do you have? .....

How many relatives do you have? .....

   d) Level of education:
      i. Primary school iii. College/University
      ii. Secondary/Advance level iv. No formal education

For how long has your family been living in Musoma district?
   i. Less than 1 year iii. 5-10 years
   ii. 1-5 years iv. More than 10 years

Part B. Data collection based on objectives

1. What are the ecosystem services provided within the area? Please tick.
   i. Provisioning services
      Food
         [ ] Crops
         [ ] Fish
         [ ] Bush meat
         [ ] Mushroom
         [ ] Wild fruits
         [ ] Livestock
      Energy
         [ ] Charcoal
         [ ] Fuel wood
      [ ] Freshwater
      [ ] Poles
      [ ] Thatching grasses
      [ ] Papyrus

[ ] Clay soil
[ ] Wood

ii. Cultural services
[ ] Medicinal plants
[ ] Recreational and tourism
[ ] Education and research
[ ] Spiritual and religious

iii. Regulating services
[ ] Local climate
[ ] Diseases prevention
[ ] Water regulation
[ ] Water purification
[ ] Soil erosion protection
Others please mention.....

2. What are the basic needs for your livelihood? Please tick.
[ ] Food
[ ] Fresh water
[ ] Energy
[ ] Health services
[ ] Clothes
[ ] Building materials
[ ] Education
[ ] Income
Others please specify.....

3. Ecosystem services and livelihood

Which type of crops do you cultivate?

i. Maize
ii. Rice
iii. Groundnut
iv. Cassava
v. Sorghum
vi. Others; please specify.....

Does your crop depend on:-
a) Irrigation
b) Rainfall
c) Both a and b

How do you use it for?
a) Sell (Cash Crops)
b) Local consumption (subsistence crops)
c) Both a & b

Livestock

Which livestock do you have?

What is the number of livestock you do have?
(i) 1-10
(ii) 10-50

(iii) >50

How do you use these animals for?

a) Food
b) Farming activities
c) Carry luggage
d) All of the above
e) Others please specify.....

Livestock	Number	Uses
Cow		
Goat		
Dunkey		
Sheep		
Pigs		
Hen		
Ducks		

Which kind of food do you use to feed your livestock?

a) Natural food (e.g. pasture) b) Artificial food

Fish

Do you harvest fish? Yes/ No

If the answer is yes, where do you normally harvest?

i. River
ii. Wetland
iii. Lake
iv. Others please specify.....

How do you use harvested fish for?

i. Subsistence use (Food)
ii. Commercial use (income)
iii. All of the above

Which type of fish do you harvest?

Beekeeping

Is beekeeping one of your activities? Yes/No

If the answer is yes, how do you do with the honey?

a) Subsistence use (food)
b) Commercial use

Do you sometimes obtain wild food from the forest area? Yes/No

If the answer is yes, which type of wild food?

a) Bush meat
b) Mushroom
c) Fruits

d) Others please specify.....

Fresh water

Where do you normally get fresh water?

i. Mara river
ii. Wetlands
iii. Lake
iv. Others please specify

How do you use the water?

a) Domestic use
b) Irrigation
c) Animals husbandry
d) All of the above

What is the quality of the water?

Energy

Which type of energy do you use?

i. Charcoal
ii. Fuel wood

Where do you get it from?

i. Forest area
ii. Others please specify.....

What is its use?

i. Cooking
ii. Lighting
iii. Drying crops
iv. Brick making
v. Drying fish
vi. Heating
vii. Others please mention.....

Clay soil

Where do you get clay soil? Please mention.....

What is its importance (use)?

a) Bricks making
b) Pots (cooking & drinking water)
c) Sculpture

Papyrus

Where do you harvest papyrus? .....

What is its use/importance? Please mention

a).....
b).....
c).....
d).....

Poles, thatching grasses

Is this house yours? Yes/No

If yes, what have you used to construct the house wall?

i. Bricks (Clay soil)
ii. Bricks (Cement)
iii. Others please specify.....

What have you used as a roof for your house?

i. Thatching grasses
ii. Aluminium sheet
iii. Poles/wood

Tourism & recreation

Do you make some handcraft products for selling to tourists? Yes/No

If the answer is yes, which products do you make?

a) Beads
b) Sculpture
c) Traditional clothes
d) Baskets
e) Traditional shoes
f) others please specify.....

Medicinal Plants

Do you sometimes use medicinal plants to cure some diseases? Yes/No

If the answer is yes, what kind of diseases do you normally treat? Please mention.....

Why do you use medicinal plants to cure some diseases?

a) Strong belief on them
b) Cannot afford to go to hospitals

If the answer is (b), why?

[ ] Hospitals are very far
[ ] Lack of money to pay for fees
[ ] Others please specify.....

Spiritual & religious

Do you have a special place which is mainly used for spiritual or religious purposes? Yes/No
If the answer is yes, where is the place? Please mention.....

Research

Do scientists come to the area for research purposes? Yes/No

How do you see the climate condition in your area during dry season?

What do you think is the reason for that?

Income

Which activities do you depend on for earning some income? Please tick.

[ ] Fishing
[ ] Beekeeping
[ ] Livestock (Farming activities)
[ ] Tourism (recreation & ecotourism)
[ ] Employment
[ ] Farming (cash crops)
[ ] Bricks making
[ ] Mat making/transport
[ ] Mining
[ ] Energy
- Charcoal
- Fuel wood

[ ] Food vendor (seller)

How do you spend your money? Please tick.

[ ] Pay for school fees
[ ] Buy some food
[ ] Buy some clothes
[ ] Pay for health services
Others please specify.....

What are the most important services that you do not wish to lose them for your livelihood need? Please mention them.....

If it happens that the wetland disappears, how are you going to be affected in terms of livelihoods?

If it happens that the river dries-up, how are you going to be affected in terms of livelihoods?

District council officer

Dear Respondent,

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

1. What are the ecosystem services provided within the area? Please tick.

i. Provisioning services

Food

[ ] Crops
[ ] Fish
[ ] Bush meat
[ ] Mushroom
[ ] Wild fruits
[ ] Livestock

Energy

[ ] Charcoal
[ ] Fuel wood

[ ] Freshwater
[ ] Poles
[ ] Thatching grasses
[ ] Papyrus
[ ] Clay soil
[ ] Wood

ii. Cultural services

[ ] Medicinal plants
[ ] Recreational and tourism
[ ] Education and research
[ ] Spiritual and religious

iii. Regulating services

[ ] Local climate
[ ] Diseases prevention
[ ] Water regulation
[ ] Water purification
[ ] Soil erosion protection
Others please mention.....

2. What are the basic needs for people's livelihood in this district? Please tick.

[ ] Food
[ ] Fresh water
[ ] Energy
[ ] Health services
[ ] Clothes
[ ] Building materials

[ ] Education
[ ] Income
Others please specify.....

3. Ecosystem services and livelihood

Which type of crops do they cultivate?

i. Maize
ii. Rice
iii. Groundnut
iv. Cassava
v. Sorghum
vi. Others; please specify.....

Do those crops depend on:-

a) Irrigation
b) Rainfall
c) Both a and b

How do they use them for?

a) Sell (Cash Crops)
b) Local consumption (subsistence crops)
c) Both a & b

Livestock

Which livestock do they have?

How do they use these animals for?

a) Food
b) Farming activities
c) Carry luggage
d) All of the above
e) Others please specify.....

Livestock	Number	Uses
Cow		
Goat		
Dunkey		
Sheep		
Pigs		
Hen		
Ducks		

Which kind of food do they use to feed their livestock?

a) Natural food (e.g. pasture)
b) Artificial food

Fish

Do they engage in fishing activities? Yes/ No

If the answer is yes, where do they normally harvest fish?

i. River

ii. Wetland
iii. Lake
iv. Others please specify.....

How do they use harvested fish for?
i. Subsistence use (Food)
ii. Commercial use (income)
iii. All of the above

Which type of fish do they harvest?

Beekeeping

Is beekeeping one of activities in this district? Yes/No

If the answer is yes, how do they do with the honey?
a) Subsistence use (food)
b) Commercial use

Do they sometimes obtain wild food from the forest area? Yes/No

If the answer is yes, which type of wild food?
a) Bush meat
b) Mushroom
c) Fruits
d) Others please specify.....

Fresh water

Where do they normally get fresh water?
i. Mara river
ii. Wetlands
iii. Lake
iv. Others please specify

How do they use the water?
a) Domestic use
b) Irrigation
c) Animals husbandry
d) All of the above

How do you see the quality of the water?

Energy

Which type of energy do they use the most?
i. Charcoal
ii. Fuel wood

Where do they get it from?
i. Forest area
ii. Others please specify.....

What is its use?

i. Cooking
ii. Lighting
iii. Drying crops
iv. Brick making
v. Drying fish
vi. Heating
vii. Others please mention.....

Clay soil

Where do they get clay soil? Please mention.....

What is its importance (use)?

a) Bricks making
b) Pots (cooking & drinking water)
c) Sculpture

Papyrus

Where do they harvest papyrus? .....

What is its use/importance? Please mention

a).....
b).....
c).....
d).....

Poles, thatching grasses

What materials does people in this district use for constructing their houses?

a) Bricks (Clay soil)
b) Bricks (Cement)
c) Poles
d) Thatching grasses
e) Others please specify.....

Tourism & recreation

Do they make some handcraft products for selling to tourists? Yes/No

If the answer is yes, which products do you make?

a) Beads
b) Sculpture
c) Traditional clothes
d) Baskets
e) Traditional shoes
f) others please specify.....

Medicinal Plants

Do they sometimes use medicinal plants to cure some diseases? Yes/No

If the answer is yes, what kind of diseases do they normally treat? Please mention.....

Why do they use medicinal plants to cure some diseases?

a) Strong belief on them
b) Cannot afford to go to hospitals

If the answer is (b); why?

[ ] Hospitals are very far
[ ] Lack of money to pay for fees
[ ] Others please specify.....

Spiritual & religious

Do they have a special place which is mainly used for spiritual or religious purposes? Yes/No
If the answer is yes, where is the place? Please mention.....

Education and research
Do scientists come to the area for research purposes? Yes/No

How do you see the climate condition in this area during dry season?

What do you think is the reason for that?

Income

Which activities do they depend on for earning some income? Please tick.

[ ] Fishing
[ ] Beekeeping
[ ] Livestock (Farming activities)
[ ] Tourism (recreation & ecotourism)
[ ] Employment
[ ] Farming (cash crops)
[ ] Bricks making
[ ] Mat making/transport
[ ] Mining
[ ] Energy
- Charcoal
- Fuel wood

[ ] Food vendor (seller)

What are the most priority services in the livelihood needs of people in this district?
Please mention them.....

If it happens that the wetland disappears, how are they going to be affected in terms of livelihoods?

If it happens that the river dries-up, how are they going to be affected in terms of livelihoods?

What is the number of people in this district?

How many people in this district depend directly on ecosystem services (who have no alternative source of income)?

How many people lives outside this district and come to utilize the services provided within the area?

Village leader

Dear Respondent,

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

1. What are the ecosystem services provided within the area? Please tick.

i. Provisioning services

Food

[ ] Crops
[ ] Fish
[ ] Bush meat
[ ] Mushroom
[ ] Wild fruits
[ ] Livestock

Energy

[ ] Charcoal
[ ] Fuel wood

[ ] Freshwater
[ ] Poles
[ ] Thatching grasses
[ ] Papyrus
[ ] Clay soil
[ ] Wood

ii. Cultural services

[ ] Medicinal plants
[ ] Recreational and tourism
[ ] Education and research
[ ] Spiritual and religious

iii. Regulating services

[ ] Local climate
[ ] Diseases prevention
[ ] Water regulation
[ ] Water purification
[ ] Soil erosion protection
Others please mention.....

2. What are the basic needs for people's livelihood in this district? Please tick.

[ ] Food
[ ] Fresh water
[ ] Energy
[ ] Health services
[ ] Clothes
[ ] Building materials

[ ] Education
[ ] Income
Others please specify.....

3. Ecosystem services and livelihood

Which type of crops do they cultivate?

i. Maize
ii. Rice
iii. Groundnut
iv. Cassava
v. Sorghum
vi. Others; please specify.....

Do those crops depend on:-

a) Irrigation
b) Rainfall
c) Both a and b

How do they use them for?

a) Sell (Cash Crops)
b) Local consumption (subsistence crops)
c) Both a & b

Livestock

Which livestock do they have?

How do they use these animals for?

a) Food
b) Farming activities
c) Carry luggage
d) All of the above
e) Others please specify.....

Livestock	Number	Uses
Cow		
Goat		
Dunkey		
Sheep		
Pigs		
Hen		
Ducks		

Which kind of food do they use to feed their livestock?

a) Natural food (e.g. pasture)
b) Artificial food

Fish

Do they engage in fishing activities? Yes/ No

If the answer is yes, where do they normally harvest fish?

i. River
ii. Wetland
iii. Lake
iv. Others please specify.....

How do they use harvested fish for?

i. Subsistence use (Food)
ii. Commercial use (income)
iii. All of the above

Which type of fish do they harvest?

Beekeeping

Is beekeeping one of activities in this district? Yes/No

If the answer is yes, how do they do with the honey?

a) Subsistence use (food)
b) Commercial use

Do they sometimes obtain wild food from the forest area? Yes/No

If the answer is yes, which type of wild food?

a) Bush meat
b) Mushroom
c) Fruits
d) Others please specify.....

Fresh water

Where do they normally get fresh water?

i. Mara river
ii. Wetlands
iii. Lake
iv. Others please specify

How do they use the water?

a) Domestic use
b) Irrigation
c) Animals husbandry
d) All of the above

How do you see the quality of the water?

Energy

Which type of energy do they use the most?

i. Charcoal
ii. Fuel wood

Where do they get it from?

a. Forest area
b. Others please specify.....

What is its use?

i. Cooking
ii. Lighting
iii. Drying crops
iv. Brick making
v. drying fish
vi. Heating
vii. Others please mention.....

Clay soil

Where do they get clay soil? Please mention.....

What is its importance (use)?

a) Bricks making
b) Pots (cooking & drinking water)
c) Sculpture

Papyrus

Where do they harvest papyrus? .....

What is its use/importance? Please mention

a).....
b).....
c).....
d).....

Poles, thatching grasses

What materials does people in this district use for constructing their houses?

a) Bricks (Clay soil)
b) Bricks (Cement)
d) Poles
e) Thatching grasses
c) Others please specify.....

Tourism & recreation

Do they make some handcraft products for selling to tourists? Yes/No

If the answer is yes, which products do you make?

a) Beads
b) Sculpture
c) Traditional clothes
d) Baskets
e) Traditional shoes
f) others please specify.....

Medicinal Plants

Do they sometimes use medicinal plants to cure some diseases? Yes/No

If the answer is yes, what kind of diseases do they normally treat? Please mention.....

Why do they use medicinal plants to cure some diseases?

a) Strong belief on them
b) Cannot afford to go to hospitals

If the answer is (b), why?

[ ] Hospitals are very far
[ ] Lack of money to pay for fees
[ ] Others please specify.....

Spiritual & religious

Do they have a special place which is mainly used for spiritual or religious purposes? Yes/No
If the answer is yes, where is the place? Please mention.....

Education and research
Do scientists come to the area for research purposes? Yes/No

How do you see the climate condition in this area during dry season?

What do you think is the reason for that?

Income

Which activities do they depend on for earning some income? Please tick.

[ ] Fishing
[ ] Beekeeping
[ ] Livestock (Farming activities)
[ ] Tourism (recreation & ecotourism)
[ ] Employment
[ ] Farming (cash crops)
[ ] Bricks making
[ ] Mat making/transport
[ ] Mining
[ ] Energy
- Charcoal
- Fuel wood

[ ] Food vendor (seller)

What are the most priority services in the livelihood needs of people in this village?
Please mention them.....

If it happens that the wetland disappears, how are they going to be affected in terms of livelihoods?

If it happens that the river dries-up, how are they going to be affected in terms of livelihoods?

What is the number of people in this village?

How many people in this village depend directly on ecosystem services (who have no alternative source of income)?

Agricultural officer

Dear Respondent,

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

Ecosystem services and livelihood

Which type of crops do people in this area cultivate?

i. Maize
ii. Rice
iii. Groundnut
iv. Cassava
v. Sorghum
vi. Others; please specify.....

Do those crops depend on:-

a) Irrigation
b) Rainfall
c) Both a and b

How do they use them for?

a) Sell (Cash Crops)
b) Local consumption (subsistence crops)
c) Both a & b

If it happens that the wetland disappears, how are they going to be affected in terms of livelihoods?

If it happens that the river dries-up, how are they going to be affected in terms of livelihoods?

What is the number of people who are engaging in farming activities in this area?

How is the farm land allocation regulation?

Fisheries officer

Dear Respondent,

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

Ecosystem services and livelihood

Fish

Do people in this area engage in fishing activities? Yes/ No

If the answer is yes, where do they normally harvest fish?

i. River
i. Wetland
ii. Lake
iii. Others please specify.....

How do they use harvested fish for?

i. Subsistence use (Food)
ii. Commercial use (income)
iii. All of the above

Which type of fish do they harvest?

If it happens that the wetland disappears, how are they going to be affected in terms of livelihoods?

If it happens that the river dries-up, how are they going to be affected in terms of livelihoods?

What is the number of people who are engaging in fishing activities in this area?

What are the fishing regulations?

Head teacher and pupil

Dear Respondent,

My name is Wande Maduhu Kema, a student at UNESCO-IHE Institute for water Education in Delft-The Netherlands. I would like to request you to kindly take a few minutes to answer the following questions. Your honest response for the following questions is crucial for the validity of the study. If you feel uncomfortable or do not understand any question, please inform me and feel free to ask questions. Note that the information given is confidential and shall absolutely be used for the sake of a Master's thesis and ongoing project activities. The information given will also be stored only secretly so there will be no any reference to your household data.

Education

In your study programme, do you have time to go for excursion?

Where do you normally go?

What do you learn from there?

Thank you very much for your cooperation

*The End *