ASSESSMENT OF CURRENT NET BENEFIT OF WATER RESOURCE IN DIFFERENT LAND-USES AROUND THE KILOMBERO VALLEY RAMSAR SITE IN TANZANIA

BY

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES AND SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

Water scarcity is globally getting worse in the light of increase in demand for water use. Human and ecosystem health and economic development are affected by problems of water scarcity and water pollution. This study was carried out to assess the current net benefit of water resource in different land uses around the Kilombero Valley Ramsar Site in Tanzania. Specifically the study was conducted to identify different land uses related to water, to determine and estimate costs and benefits of different land uses related to water and to quantify the monetary value of water in different land uses. Household questionnaires, checklist for key informants, participant observation and PRA techniques were employed for data collection. The data relating to household characteristics and water related economic activities were analysed using SPSS (version 16) whereby the cost for production, inputs and returns were analysed and compared using Microsoft Excel. The residual imputation approach was used to estimate the values of water in different land uses. The findings revealed that the main land uses were irrigation and rainfed agriculture, livestock keeping, small scale business and vegetables production. This study also established that the net values of water for brick making, livestock and domestic use are very high averaging at around Tsh. 3 186.7 (US$ 1.7) Tsh. 1 721.7 (US$ 1.4) and Tsh. 1 282.5 (US$ 1.3) per m^3 of water consumed respectively. For irrigated crops such as paddy and non paddy crops the net values were estimated to Tsh. 273.6 (US$ 0.23) and Tsh. 87.7 (US$ 0.073) per m^3 of consumed water respectively. Results show that the return from agriculture is smaller compared to returns from other water uses. Nevertheless, since majority of households are depending on agriculture this study recommends that emphasis should be put on effective and efficient use of water to improve its productivity.

DECLARATION

I, **Emmanuel Musamba** do hereby declare to the Senate of Sokoine University of Agriculture that the dissertation presented here is my own original work and that it has neither been submitted nor is concurrently being submitted for a degree award in any other University.

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Prof. Yonika M. Ngaga   Date

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This work is dedicated to my beloved mother, Brigitha Akiny Obure and to my beloved father the late Boniphace Musamba Msimbete for their firm cares since my childhood because they have made me to be as I am. May the Almighty GOD bless them indefinitely, Amen!

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LIST OF ABBREVIATIONS AND ACRONYMS

BCR	Benefit Cost Ratio
BoT	Central Bank of Tanzania
CINI	Change- In-Net-Income
CVM	Contingent Valuation Method(s)
CWPs	Crop Water Productivities
CWRs	Crop Water Requirements
DALDO	District Agricultural and Livestock Officer
EMM	Estimated Marginal Means
FAO	Food and Agriculture Organisation of the United Nations
FV	Future Value
ha	hectare
IGAs	Income Generating Activities
IHSA	Immaculate Heart Sisters of Africa
Kg	Kilogramme
km	kilometre
KVRS	Kilombero Valley Ramsar Site
LUS	Land Use Systems
m^3	Cubic metre
MPV	Marginal Value Product(s)
MWTP	Marginal Willingness to Pay
NPV	Net Present Value
PO-PSM	President’s Office Public Service Management
PRA	Participatory Rural Appraisal
RIA	Residual Imputation Approach

SNAL	Sokoine National Agricultural Library
SMUWC	Sustainable Management of the Usangu Wetland and its Catchment
SPSS	Statistical Package for Social Science Programme
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forestry Research Institute
TAWIRI	Tanzania Wildlife Research Institute
Tsh	Tanzania Shillings
TVP	Total Value of Product
UN	United Nations
URT	United Republic of Tanzania
US$	United States Dollar
VMP	Value of Marginal Product(s)
WTA	Willingness-To-Accept
WTP	Willingness-To-Pay

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Water is a basic natural resource for socio-economic development activities such as industrial production, irrigated agriculture, livestock keeping, hydropower production, navigation, recreation and tourism (Kadigi, 2006; URT, 2002; Young, 2005). Its benefits (values) are determined by the degree of use, the sustainability of that use and the non-use (Turpie *et al.*, 2005; 2003; Young, 2005). Kilombero Valley among other uses, serves as a source of water for domestic uses, farming, livestock and for fishing (Kato, 2007; Masiyandima *et al.*, 2004; McCartney *et al.*, 2004). Freshwater is now scarce in many regions of the world and it can unite people that share a source of water or provoke conflicts among them as they compete for it (URT, 2002; World Bank, 2002). In many areas around the world conflicts have risen due to increase in water demand in its competing uses (World Bank, 2002).

According to Malan (2010) choice in water resource allocation involves its availability, costs and economic benefits accruing from water, and environmental impacts. Thus, the increase in water demands in its competing uses and watershed degradation are the driving forces for water scarcity which brought the critical need for the use of economics to assist in decision-making and water management. However, the problem of water scarcity is globally getting worse in the light of cities and populations growth and the needs for water increase in agriculture, industry and household use (Gleick *et al.*, 2001; Millennium Ecosystem Assessment, 2005). Water scarcity is a function of supply and demand. Its demand is increasing at an alarming rate in some regions, due to increase in population growth and increasing per capita use. Competition among agriculture, industry and cities for limited water supplies is already constraining development efforts in many countries. As populations expand and economies grow, the competition for limited supplies will be intensified and create conflicts among water users (Turpie *et al.*, 2005; Young, 2005). Despite water shortages, misuse of water is widespread. Human and ecosystem health is affected by problems of water scarcity and water pollution, and it slows down the economic and agricultural development (Falkenmark *et al.,* 1999; Kadigi, 2006).

The annual renewable water resources of Tanzania are 89 cubic kilometres or 2 700 cubic meters of water per person per year (URT, 2002). Based on projected population from estimated 33 million in year 2001 to about 59.8 million by year 2025, annual average available water per capita will be reduced by 45% to about 1 500 cubic meters per person per year which shows that the country will face a water stress situation, considering that below 1 700 cubic meters per person per year signifies water scarcity (URT, 2002). Currently, many people around the Kilombero Valley are benefiting from irrigated and non-irrigated agriculture through cultivation of paddy and non-paddy crops, livestock production and water for domestic consumption (Kangalawe and Liwenga, 2004; URT, 2002).

According to Young, (2005; 1996) it will be useful to group the types of water-related economic values into several classes because each one usually call for specialized evaluation and management approach. These classes are commodity benefits, aesthetic and recreational benefits, waste assimilation benefits and dis-benefits. Due to limited time and financial resources, this study concentrated on commodity benefits. These are the benefits derived from domestic consumption of water and those which are contributing to land productivity such as agriculture and livestock keeping. Ideally, water would be allocated among all users and uses over time and space so that the marginal benefit of an additional unit of water for any one use would be equal to the marginal benefit of an additional unit of water for any other use. To do this, it is necessary to know the value of water in different uses over time and space, and the costs imposed by externalities associated with those uses (Young, 2005; 1996).

1.2 Problem Statement and Justification

Water resource continues to be degraded at an alarming rate despite the enacting of legislation to prevent unsustainable use of water resource (Millennium Ecosystem Assessment, 2005). Its demand for different land uses (LUS) such as industrial production, crop and livestock production, hydropower production, recreation and tourism is increasing in the light of population increase despite its degradation (Briscoe, 1996; Gleick *et al*., 2001).

The quantity and quality of water in different LUS around the Kilombero Valley Ramsar Site (KVRS) is reduced by degradation of water sources (Baum, 1968; Kato, 2007). Therefore, water productivity in different LUS around the KVRS continues to be reduced due to degradation of water resource (Kato, 2007; Kangalawe and Liwenga, 2004; 2005) hence reducing the economic returns in different LUS (Aylward, 2000; Calder, 2000). Yet, water management remains at best inefficient, resulting in shortages and conflicts over allocation regimes (Kangalawe and Liwenga, 2004; Young, 2005).

The destruction of rivers, lakes, marshes and other wetlands is due to failure of modern society to deal with water as a finite resource (Duarte *et al.,* 2002; Ohlsson and Lundqvist, 1999). Briscoe (1996) suggested that, water allocation should favour LUS which yield maximum net benefits. However, the question of the net benefits of water varies from one area to another. There is no single economic value of water due to variability in the carefulness of use, efficiency and management of water resource in different areas of the world. Nonetheless, although there is no single economic value of water, it is of interest to evaluate the net benefits of water in different land uses because it is the one that reflects the welfare changes associated with some policy-induced changes in the attributes of the commodity (Young, 2005; 1996).

Since the carefulness of use and management of water resource depends on how beneficial water is to the user (Briscoe, 1996) then, information on the current net benefit of water in different LUS in monetary terms will significantly make beneficiaries to assume part of responsibility in sustaining the ecosystems. Some of the previous studies provide information on shortages, conflicts, allocation and competition over water resource (Baur *et al.,* 2000; Dinar, 2000; SMUWC, 2001). There is no study that has been conducted at KVRS to establish how much has been gained or lost by landholders in different LUS by using or not use water resource. Little information on net benefit of water in monetary terms is known in different LUS for most wetlands including KVRS despite its significance. Furthermore, the conflicting policies in land and water use (URT, 2002; 1998a; 1998b; 1997a; 1997b; 1997c) also call upon the need to determine the net benefit of water in its competing uses. Thus, this research provides enriched and useful information to which significantly fills this gap of knowledge and that could influence policy reforms and appropriate decision making for allocation of water in its competing uses.

1.3 OBJECTIVES

1.3.1 General objective

The overall objective of this study was to evaluate the current net benefit of water in different land uses around Kilombero Valley Ramsar Site and provide information that could be useful for environmental and land uses planning, water allocation and for sustaining the ecosystems conservation.

1.3.2 Specific objectives

(a) To identify different land uses related to water around the Kilombero Valley.

(b) To determine and estimate costs and benefits of different land uses related to water.

(c) To quantify the monetary value of water in different land uses.

1.4 Research Questions

(a) What are the existing land uses related to water around the Kilombero Valley?

(b) What are the costs and benefits of socio-economic activities related to water?

(c) What is the net value of water resource in different land uses?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

This chapter presents a review of literature related to land use management and water conservation, neo-classic economic perspective on water resources, challenges in water resource management, water quantity and quality, upstream-downstream relationship in water resource uses, water regulations, water policies and water management, water and food security, the concept of economic value of water, water prices and allocation, benefits and opportunity cost of water, techniques and approaches of economic valuation of water in different land uses, economic analysis and the role of monetary valuation of water resource.

2.1 Neo-classic Economic Perspective on Water Resources

Worldwide, water is considered and treated as a social and basic good where the social aspects are accentuated and given the most attention (Costanza *et al.*, 1997; Gleick *et al.*, 2001). The concept of water as an economic good comes from the understanding that water is a finite resource and its allocation should therefore consider its nature of being scarce and water should not be considered as free. According to economic efficiency principle, a resource should be allowed to flow to a sector/use generating the highest marginal value (Briscoe, 1996; Kadigi, 2006; Reisman, 1968).

Efficient management of water resource is indispensable due to the increase of water demand to accomplish various economic and ecological needs (Young, 2005). Therefore, there is a need for decision makers to be informed on the net value of water which can help to make optimal decisions in allocation and consumption. Reasonable prioritization among different current users, as well as between current and future users, is facilitated when the values of the alternatives are quantified (Dinar, 2000; Young, 2005; 1996). Conservation of water can be encouraged through economic incentives and a calculation of its value is necessary for relevant pricing of water (Briscoe, 1996).

The focus on economic efficiency as a primary objective in development and allocation of water resources is because of its importance as a social and economic good that having viable meaning in resolving conflicts and assessing the opportunity costs of pursuing alternative uses (Gleick *et al.,* 2001; Young, 2005). Although economically efficient allocation of irrigation water is rarely attained in practice, analysis of economic efficiency provides a useful point of reference for understanding causes of inefficient allocation and mechanisms for improving the overall economic performance of irrigated production (Briscoe, 1996; Stratos and Basil, 2005).

2.2 The Challenges in Water Resource Management

Water is a very essential natural resource for the world's economic growth (Millennium Ecosystem Assessment, 2005). According to Chaturvedi (2000); Kadigi *et al.* (2004) and URT (2002) various sources of ground and surface water (including Kilombero Valley) provide human with many goods and services, including the benefits accrued from domestic uses, irrigated agriculture, fishing opportunities, water cleansing, employment, nutrient cycling, climate regulation, recreation opportunities, water supply for livestock and wildlife. Nonetheless, water quality, quantity and availability are declining in most parts of the world (Dinar, 2000; UN, 2006; Young, 2005). This is attributed to increasing demands for water resource exerted by rapid human population growth which in most cases goes in line with the increasing socio-economic activities which require water such as agricultural production, energy production (biofuel and Hydroelectric power) and industrial processes (McCartney and van Koppen, 2004; URT, 2002). Decreasing availability, declining quality, and growing demand for water are creating significant challenges to manage and allocate water among its competing uses (Briscoe, 1996; UN, 2006; URT, 2002; Young, 2005).

The Millennium Ecosystem Assessment (2005) and UN (2006) report that, the complexity of whether water should be treated as an economic good or social good has posed challenges in managing the resource. It further asserts that, the application of integrated water management is fundamental to optimize the positive ecological, economic and social benefits which are the main pillars of sustainable development. The benefits from each water use should take into account, for instance the costs of service provision, and foregone benefits to users who do not have access to water (Ngaga, 2007; Young, 2005). Nevertheless, appropriate policies on rational use and management of water resource are inevitable to guarantee sustainable supply of water benefits. Policy formulation will require an understanding of the contribution of water to the economy and livelihood of the people benefiting from water (AFRODAD, 2007; Ngaga, 2007; Young, 2005).

Although nearly 70% of the Earth is covered with water, only 2.5% of this is fresh-water, and 70% of this freshwater is frozen in ice caps of Antarctica, Arctic and Greenland. The remaining 30% of this freshwater is available as soil moisture, or lies in deep underground aquifers as groundwater and as surface water (Gleick *et al.*, 2001; URT, 2002). Only one third of this water is the water found in lakes, rivers, reservoirs and those underground water sources that are shallow enough to be tapped at an affordable cost are allocated to various uses. This is the only amount that can regularly be renewed by rain and snowfall, and therefore available on a sustainable basis (Calder, 2000; URT, 2002). Moreover, Sharma *et al.* (2005) asserts that, degradation, inefficient management and misuse of water resources is attributed by lack or insufficient information on various aspects of water such as water value, quality, quantity in many developing countries including areas of Sub-Saharan Africa.

Knox and Meinzen-Dick (2001) and Musamba (2006) highlight the fact that local communities have an incentive to preserve resources because they are critically dependent on them for livelihood. They therefore have an interest in the use and maintenance of the resource over a long period of time. The extent to which local users depend on the resource for their livelihoods has a significant impact on the level of cooperation that can be expected in the management of the resource since local users who are critically dependent on the resource have the incentive to protect the resource (Dinar, 2000).

Water resources provide important commodity and environmental benefits to society. Any particular use of water is associated with opportunity costs, which are the benefits foregone from possible alternative uses of the resource (Young, 2005; 1996). Thus, planners, policy-makers and decision-makers are faced with the challenge of balancing, for instance, water demands from agricultural irrigation for food production with the desire to preserve wetlands for fish and wildlife habitat (efficient and rational water allocation) (AFRODAD, 2007; Kadigi, 2006; Young, 2005). Economics contribute towards improved allocations by informing decision-makers of the full social costs of water use and the full social benefits of the goods and services that water provides (Briscoe, 1996; Turpie *et al.*, 2005; World Bank, 2002; Young, 2005).

2.3 Water Quantity and Quality

Water, in its natural state, is an integral part of the environment whose quality and quantity determines how it can be used. The use of contaminated water sources pose health risks to the population as it can be clearly proved by the incidences of water borne diseases such as cholera and diarrhoea. Notwithstanding its importance to our lives and development, water is unevenly distributed in time, space, quantity and greatly varies in quality (Dinar, 2000; Sharma *et al.*, 2005; URT, 2002). However, water scarcity is perceived in various areas in the world due to unreliable rainfall, multiplicity of competing uses, degradation of water sources and catchments. The scarcity of water threatens energy production and environmental integrity, food security, and as a result there are water use conflicts between sectors of the economy (Kumar *et al.*, 2008; Palanisami *et al.*, 2006; URT, 2002).

The quality of freshwater at any point on the landscape reflects the combined effects of many processes along water pathways. Human activities on all spatial scales affect both water quality and quantity (McCartney *et al.,* 2004). Alteration of the landscape and associated vegetation has not only changed the water balance, but typically has altered processes that control water quality. Effects of human activities on a small scale are relevant to an entire drainage basin (Abdallah *et al.*, 1992; Falkenmark *et al.,* 1999; Turpie *et al.*, 2003).

Water quantity and quality have intimately linked with land and water productivity. Different uses and processes may affect water quantity and quality in one way or another, thus encumbering its allocation and productivity (Kangalawe and Liwenga, 2004). Calder (2000) and Gleick *et al.* (2001) assert that the quantity and quality of the surface water and groundwater available affect the functions provided by water resources. The quantity of water available in the short term is determined by volume of available surface water and groundwater. The rates of surface and groundwater recharge and discharge and rates of abstraction influence the quantity of water available in the long term. However, water quality is determined in the short term by pollution with natural and artificial contaminants (Abdallah, 1994; Abdallah *et al.,* 1992).

In determining the value of water resource, there are several issues to be considered such as spatial and temporal scale of water, and the persistence of the functions of a water resource which depend on the complexity and diversity of its structures and processes (Dinar, 2000; Gleick *et al.,* 2001). Water resources are dynamic in space and time. Change is the normal course of events, natural or human-induced disturbances create an interrelated mosaic of change. This influences water resource processes at large spatial scales (Abdallah, 1994; Abdallah *et al.,* 1992).

The limited supply of water suggests the importance of estimating the economic value of water to evaluate both structural and non-structural methods of enhancing returns to a scarce resource (Turpie, 2000; Young, 2005). The marginal value product measures the incremental gains from the resource use, and can be compared with incremental cost to determine economic feasibility. Estimates of water resource productivity also provide a useful method for examining the efficiencies of the existing resource allocation, and aid in formulating national and provincial resource development policies (Turpie *et al.,* 2003; Young, 2005). Estimating the value of water is thus imperative for providing useful information to irrigation managers and policy-makers. Contaminated and polluted water kills, and debilitates, reducing physical capacity, lowering productivity, stunting growth, and inhibiting learning. These water-related conditions reduce learning capacity, school performance and school attendance of children and increases the work days lost to sickness, lowers earnings, and shortens work lives of adults (Calder, 2000; Gleick *et al.*, 2001).

2.4 Upstream-downstream Relationship in Water Resource Uses

Land use practices have impacts on both the availability and quality of water resources. These impacts can either be positive or negative. The in-depth understanding of upstream-downstream relationship is imperative for the proper and effective management of water resources (Baur *et al.,* 2000; Falkenmark *et al.,* 1999; Ngaga *et al.,* 2005). The impact of land use on water resources clearly attributed to natural impacts or other anthropogenic impacts. Nevertheless, upstream-downstream relationship focusing on land uses established as the dominating factor determining water availability and quality downstream (Baur *et al.,* 2000; Falkenmark *et al.,* 1999; Sokile and Mwaluvanda, 2005). Dinar (2000) asserts that if costs for downstream users are small or occur in the distant future, downstream users are not likely to invest in upper watershed protection. He continues to illustrate that, the absence of a sufficient economic value for downstream users of upstream land use impacts, however, this does not imply that upstream watershed protection is not necessary.

It is intuitively appealing that the benefits of improved land management, or the costs associated with negative impacts of inadequate land use on the water resources, might not only be felt by water users who cause them, but also by others who live downstream and make use of the affected water resources (Calder, 2000; Kangalawe and Liwenga, 2004). In order to assess these costs and benefits, it is important to get a clear picture, from a landscape and economic perspective, of the extent that different land use practices affect hydrologic regime and water quality and at which scale the impacts are of importance (Aylward, 2000; Young, 2005).

Previous studies (Manez and Zeller, 2003; Ngaga, 2007; Turpie *et al.,* 2003; Baur *et al.*, 2000) show that the degradation of water quality in upstream parts of a watershed can have negative effects on users in downstream parts of the watershed and the degradation affects flow through the watershed. If water is used lavishly in one sector, or by one group of users, comparatively less water will be accessible for other users (Sharma *et al.*, 2005). Re-use is, of course, an option but it is not possible after consumptive use and the options are reduced if quality is affected (Lundqvist, 1999). Keller *et al.* (1996) asserts that, it is usually difficult to develop institutional mechanisms to manage water systems fully, as system boundaries rarely coincide with other administrative boundaries whether locally or internationally, and the range of authority required for effective system management is seldom vested on a single administrative unit. He suggested that, without some mechanism to allocate water reasonably among competing interests and to set, monitor, and enforce discharge standards, downstream users will increasingly be at risk.

2.5 Water Regulations, Policies and Water Management

The institutional arrangement that maximises efficient use of water in the face of growing demands for scarce and random supplies is the central policy issue in many areas around the world particularly developing countries (Dinar, 2000; UN, 2009; World Bank, 2002). Information on economic value of water enables decision makers to make informed choices on water development, allocation, conservation, and use when increasing demands for all uses are made in light of increased scarcity (Young, 2005). Theoretically correct and empirically accurate estimates of the economic value of water are necessary for rational allocation of scarce water across uses, users, spatially and temporally (Ward and Michelsen, 2002; Kadigi, 2006; Turpie, 2000).

Tanzania is aiming at achieving the *"high quality livelihood"*, by 2025 through *"good governance through the rule of law"* and to develop a "strong and competitive economy". The 2002 water policy recognizes that water is one of the most essential resources behind the achievement of these goals (URT, 2002). It further, put down emphasis on full cost recovery at the community level, the introduction of demand driven approach and the opening up for new actors to participate in the planning, investment, ownership and management of water supply infrastructure. Additionally, the 2002 water policy provides a number of guiding principles around social rights, economic approach, environmental protection and sustainability (URT, 2002). Therefore, the 2002 policy calls upon for the need to determine the value of water in order to facilitate its implementation and decision making for efficient water allocation among its competing uses.

Securing safe and reliable water and sanitation services for all is one of the leading challenges facing sustainable development. To tackle these challenges associated with water supply and allocation, good policy, strategies and management plans are inevitable (Dinar, 2000; UN, 2009). There is a need therefore to have sufficient information pertaining value of water resources in order to have comprehensive water policies, water management plans and strategies. However, proper management of existing water supplies entails sufficient quantities (efficient water allocation) of clean water to support both human needs and essential ecosystem functions (Briscoe, 1996; Sharma *et al.*, 2005).

There are increasing challenges of managing the trans-boundary watercourses and strengthening water resources management policy and legal and institutional frameworks. Inadequate regulations to monitor groundwater resources development has led to underutilization of the resources and in some places over exploitation and interference in the existing water sources. Fragmented planning, implemented following sector, regional or district interests, aggravates this situation even further (Keller *et al.,* 1996). Good governance will require careful consideration of the institutions in place to manage water supply and sanitation systems, including the role that might be played by the private sector. As the largest user of water, policies to encourage sustainable use by agriculture will be particularly important (Acharya and Barbier, 2000; URT, 2002; Young, 2005; Kumar *et al.*, 2008; Palanisami *et al.,* 2006; Semra, 2005).

Studies conducted in different areas around the world such as Mekong, Jordan basin, southern Caucasus, Incomati and Okavango to mention few revealed that, civil society has a very important role to play in influencing public and international decision making and policy on water management. Undoubtedly the role of international civil society has perhaps been more significant in some countries than that of indigenous civil society (AFRODAD, 2007; Dinar, 2000; Rosegrant *et al.,* 2000; URT, 2002).

Successful policy and effective legal frameworks are indispensable to develop, carry out and put into effect the rules and regulations that govern water use and protect the resource. Water policy functions within a milieu of local, national, regional and global policy and legal frameworks that must all support sound water management goals (URT, 2002; Keller *et al.,* 1996; Sharma *et al.,* 2005). Legitimate, transparent and participatory processes can effectively mobilize input for designing and implementing water resources policy and create a strong deterrent to corruption (UN, 2009; Dinar, 2000; AFRODAD, 2007). Although water is often described as a ‘gift of nature’, harnessing and managing it for the wide variety of human and ecological needs entail financial costs (Young, 2005; Duarte *et al.,* 2002; Calder, 2000). Policy-makers need to make political decisions on socially and environmentally acceptable trade-offs among different objectives and on who bears the costs of such compromise. Effective policy and legal frameworks are necessary to develop, implement and enforce rules and regulations for controlling water uses (World Bank, 2002; Duarte *et al.*, 2002).

Linking water-related issues to decisions made outside the water realm is vital. Unless water managers and experts in other fields communicate, plan, find joint solutions and work in a participatory manner with planners, policy makers and users a global water crisis will neither be averted, nor the sustainable development will be advanced. Moreover, the contribution of water in areas such as mining and waste management, the impact on water resources of consumption and production patterns and the linkages to broad development goals must be articulated and understood at the political, policy and decision-making levels (UN, 2009; Dinar, 2000). Therefore, to understand the contribution of water in different sectors such as mining, agriculture, industry to mention few, it is necessary to determine water value in its competing use.

2.6 Water and Food Security

In the second half of the 20th century, globe population had a twofold increase, agriculture doubled food production and developing countries increased per capita food consumption by 30 percent (FAO, 2005; UN, 2006). Conversely, while feeding the world and producing a diverse range of non-food crops such as cotton, rubber and industrial oils in an increasingly productive way, agriculture also substantiated its position as the largest user of water in the world. Many studies reveal that irrigation now claims about 70 percent of all freshwater appropriated for human use (Millennium Ecosystem Assessment, 2005; FAO, 2005; 1999; McCartney and van Koppen, 2004; UN, 2009). Presently, agriculture sector faces a multifaceted series of challenges such as producing more food of better quality while using less water per unit of output; provide rural people with resources and opportunities to live a healthy and productive life; apply clean technologies that ensure environmental sustainability; and contribute in a productive way to the local and national economy (Turpie, 2000; FAO, 2005; Kumar *et al.*, 2008; Palanisami *et al.*, 2006).

The growing need to manage water for agriculture in developing countries such as Tanzania has been mooted by several researchers due to its ability to reduce the incidence of poverty, and achieving food sufficiency (Kato, 2007; URT, 2002; Baum, 1968; Kangalawe and Liwenga, 2004; Chaturvedi, 2000). However, it should be known that a fundamental concept for addressing and implementing integrated land and water resources management is that a land management decision is a water-resource decision. Land alteration and associated changes in vegetation have not only changed the water balance, but typically have altered processes that control water quality and quantity, leading into food insecurity (Rockström and Gordon, 2001; Millennium Ecosystem Assessment, 2005).

Water is an essential factor in the production of any good. Improving agricultural productivity per drop of water is a key to provide foods for a growing population (FAO, 2005; UN, 2009). Nonetheless, improving the technology and management of irrigation systems can play an important role in improving agricultural production, producing more food with less water and preventing the overexploitation of both surface water and groundwater resources. Such interventions need to carefully consider their economic efficiency (Young, 2005; Kadigi *et al.*, 2004; Briscoe, 1996). It can therefore be argued that, water management can help to ensure food security, reduce poverty and conserve ecosystems (Turpie, 2000; UN, 2009; Briscoe, 1996; Sharma *et al.*, 2005).

2.7 The Concept of the Economic Value of Water

The total economic value of water comprises explicit use benefits as well as implicit non-use benefits (Stratos and Basil, 2005; Young, 2005). Use benefits are those that are accrued from the physical use of water resource such as water for irrigation agriculture, livestock production, forestry, fisheries and domestic use. Non-use benefits, on the other hand, refer to the benefits individuals may obtain from water resources without directly using it. That is, a user or a non-user might be willing to pay something to maintain water quality at a recreation site in a particular area, even though he/she will not use it, so that her/his children may have future use of the site or simply to ensure that the ecosystem at the site is maintained (Turpie *et al.,* 2003; Young, 1996; 2005; Stratos and Basil, 2005).

2.7.1 Relevance of information on the economic value of water

Rational decisions supporting water resource development, allocation, and use require establishing the value of water in its competing uses. When the market system works, water can be allocated to activities which yielding the greatest returns (Young, 2005). Due to the subjectivity of water supply to a steady stream of unexpected changes, high cost of capturing and holding water, it is typically expensive and impracticable to define, establish, and enforce property rights required by a water market system. Consequently, well-defined market institutions that could create prices that could serve to allocate water resources are typically lacking (Stratos and Basil, 2005). Predominantly, decisions with regard to water development, use, and allocation occur in the political domain and in other arenas outside the marketplace. Yet, there are many competing demands for taxpayer resources supporting water development and allocation and for the water itself; hence there is a compelling need for analysis in which the economic value of water proposals and plans can be compared to their costs (Duarte *et al.,* 2002; Dinar, 2000; Young, 1996).

2.8 Water Prices and Allocation

In practice, market forces rarely establish prices for water. Instead, prices are set by publicly-owned supply agencies or regulated private utilities. Water prices impact on efficiency, equity and environmental services. Countries are increasingly adopting the full cost principle, which employs market and nonmarket incentives to encourage all users of resources to pay for the full cost of their use. This principle is based on the presumption that all humans have right to a safe and healthy environment (Gleick *et al.*, 2001; Young, 2005).

Societies interested primarily in maximizing net social product as the goal for a pricing scheme advocate marginal cost pricing. When prices are set at marginal cost, rational consumers demand water as long as willingness to pay (demand) exceeds the incremental costs (Briscoe, 1996; Baur *et al.*, 2000). But application of marginal cost pricing encounters a number of obstacles. One problem is the variety of definitions of the appropriate marginal cost concept, particularly whether to use a short-run (variable cost) concept, or a long-run full-cost approach. A long debate ensued over the "short run marginal cost" pricing proposal stemming from welfare economists' work in the 1930s (Rockström and Gordon, 2001; Young, 1996; 2005). However, policy reforms is fundamental to create a favourable macroeconomic environment and water sector institutions and incentive structures to encourage efficiency use of water resource through various economic tools (including water pricing) among competing needs (Lundqvist, 1999; Turpie *et al.*, 2003; 2005; Gleick *et al.*, 2001; Briscoe, 1996).

2.8.1 Benefits and opportunity cost of water

The world has finite water resources, which are under increasing stress as the human population and water demand per capita increases. Since water is in limited supply it will have a positive opportunity cost. The opportunity cost represents the scarcity value of water, which means that one unit of water used in one sector reduces the water availability in other sectors by one unit (Young, 1996; Briscoe, 1996). Paradoxically, opportunity costs are passed to people who lose the chance to use water resource because it has been used somewhere else (Baur *et al.,* 2000; Dinar, 2000). These costs can be paid by taxpayers, by future users or by the economy of the country in general. The result is that consumers today keeps on using water until the benefits to them are the same as their private cost (Kumar *et al.*, 2008).

Young (2005) asserts that, there is an uncertainty element in the valuation of alternative uses of water now and in the future, but the risk is considerable that when opportunity cost is added to the private cost, it is greater than the benefit. In that case, water is being used inefficiently. Some previous studies (Ngaga, 2007; Young, 1996; Rosegrant *et al.*, 2000) suggest that, there is a need to identify and quantify costs and benefits associated with water use so that we can make a rational decision in using water efficiently or for any judgement of efficiency in allocation to be done. This will probably make a balance between the total social costs/benefits and total private costs/benefits.

2.9 Economic Valuation of Water in Land Uses

Economic valuation techniques reflect the extent to which the goods and services provided by water resources touch on the welfare of society either as direct determinants of individuals' well-being (e.g. as consumer goods) or via production processes (e.g. as intermediate goods). Water is essential for the creation of sustainable livelihoods (Turpie *et al.*, 2003; Young, 2005). Crop irrigation, livestock production, mining and industry depend on water. When markets are absent or not operate effectively, economic valuation of water resource allocation requires that some means of estimating resource value be found. The techniques of valuation often differ between producers' goods and consumers' goods (Young, 2005). The most extensive uses of water are for intermediate or producers' goods, which is for production of goods that are not final products. Water used for crop irrigation, industry, livestock production, or for hydroelectric power generation are examples of intermediate good uses.

2.9.1 Techniques/approaches for water valuation

There are numerous techniques for water valuation depending on the type of use and value under consideration and on the existence of competitive markets. Some of the techniques include residual imputation approach, change in net income method, hedonic pricing approach, contingent valuation methods and travel cost method to mention few. The detailed explanations of these techniques are given by Young (1996; 2005) and FAO (2004).

2.9.1.1 The residual imputation approach (RIA)

This is a method for measuring the value of an input used to produce intermediate goods. The RIA method is most commonly applied to shadow pricing irrigation water and other producers' goods. Broadly, it determines the contribution of each input to output in the production process. If appropriate prices can be assigned presumably by market forces to all production inputs but one, the remaining total value of product is imputed to the remaining or residual resource (Young, 1996; 2005).

2.9.1.2 Change in Net Income Method (CINI)

This is one of the approaches in *conventional market based approaches*. The Change in Net Income (CINI) method calculates the difference in net income in the situation with or without a certain project, for example an irrigation project (Young, 1996; 2005). It is also possible to estimate the effects different amounts of irrigation water would have on the income. Then the analyst has to make a number of assumptions on how the optimal mix of inputs would change, how crop species and volumes would change etc (Kadigi, 2006). The Change in Net Income is a simplified approach derived from the Residual Imputation Method and is commonly used to assess the benefits or value of water, when water is used as an intermediate good (i.e. when it is used as an input to produce another good such as crops in irrigation or electricity in hydropower generation). If the CINI method is used to value the irrigation water, livestock activities are not recommended to be included in the analysis. The reason for this is that livestock production could be possible in the absence of irrigation if feed was imported to the region (Young, 1996; 2005; Ward and Michelsen, 2002).

However, the value of water in this method is basically derived from change in revenue of the associated enterprise outputs. The approach stems from the principle of production theory which states that the value of an intermediate good is the net economic contribution of that good to the value of the final output. Some previous studies (Young, 1996; Kadigi, 2006; Kadigi *et al.,* 2004) have used this approach to value the use of water in irrigation.

Depending on the period of adjustment of economic decisions, which is considered and the associated costs, different values may be estimated (Young, 1996; Ward and Michelsen, 2002). For long-term decision permitting new investments, capital costs of assets (e.g. land, farm machinery and equipment, irrigation system etc) are subtracted while for short-term allocation decision merely operational and maintenance costs are computed. For a certain use of water in a specific site, long run values are therefore less than short run values because of the higher costs included in the former, together with depreciation. Thus, the value of water can be calculated from a private water user point of view (e.g. the farmer or the power plant as in Turpie *et al.,* 2003)

2.9.1.3 The hedonic pricing approach

The *Hedonic Pricing Approach* is a revealed preference method of valuation. The method uses surrogate markets for placing a value on environmental quality such as water quality. However, the hedonic pricing method is based on Lancaster’s characteristics theory of value, which states that any good can be described as a bundle of characteristics and the levels these take, and that the price of the good depends on these characteristics and their respective levels (Young, 1996). It also relies on the notion that the price of marketed goods can be decomposed into attributes and that an implicit price exists for each of these attributes (Kadigi, 2006).

The hedonic pricing method is grouped under the category of observed indirect or implicit or revealed preference approach (Young, 1996; Ward and Michelsen, 2002). It can be used to place monetary values on property attributes such as proximity to water intakes for irrigation, availability of canal or ground water, proximity to road, market and major population centres, productivity and fertility index or land rent and annual lease revenue (Kumar *et al.,* 2008; Kadigi, 2006). Young (1996) asserts that hedonic pricing method can be used to another class of situations in which markets can provide data which can be used to measure willingness to pay by consumer for water supply or environmental quality differences.

2.9.1.4 Contingent Valuation Method (CVM)

The contingent valuation method is under the category of *stated preference approaches*. It uses survey techniques to elicit people's willingness to pay (WTP) to obtain a particular good or willingness to accept (WTA) to give up the good. It can be applied for goods both which are and are not traded in regular marketplaces (Young, 1996). For goods, which are not traded in the market-place, like restoring the wetlands, environmental goods and services, a hypothetical market-place is created in which respondents are given the opportunity to buy the good. Since the elicited WTP values are contingent upon the particular hypothetical market described to the respondents, this approach came to be called the contingent valuation method (Kadigi, 2006; Young, 1996).

2.9.1.5 Travel Cost Method (TCM)

The travel cost method is used to estimate use values associated with ecosystems or sites (such as forests, wildlife, parks, wetlands, and beaches) that are used for recreation to which people travel for the purpose of making pleasure by hunting, fishing, hiking, or watching wildlife (FAO, 2004; Young, 1996; 2005). The basis of the TCM is that the *"price"* of access to the site is the function of time and travel cost expenses that people incur to visit a specific site. Consequently, peoples' WTP to visit the site can be estimated based on the number of trips that they make at different travel costs. However, this is analogous to estimating peoples' WTP for a marketed good based on the quantity demanded at different prices. The TCM encompasses a variety of models, ranging from the simple single-site TCM to regional and generalised models that include quality indices and account for substitute sites (Young, 1996; Kumar *et al.*, 2008).

The method can be used to estimate the economic benefits or costs resulting from changes in access costs for a recreational site, elimination of an existing recreational site, addition of a new recreational site and changes in environmental quality at a recreational site. There are however several limitations to TCM (FAO, 2004; Young, 2005). Defining and measuring the opportunity cost of time is complicated since there is no strong consensus on appropriate measure. Substitute sites are only taken into account in the random utility approach to TCM, which uses information on all possible sites that a visitor might choose their quality characteristics, and the travel costs to each site. Some studies (Kumar *et al.,* 2008; Kadigi, 2006; FAO, 2004; Young, 1996; 2005) suggest that, this approach yields information on the value of characteristics in addition to the value of the site as a whole. Thus, the method can only be used to value goods consumed in situ and, it cannot capture the non-use values of environmental resources.

2.9.2 Economic analysis

Economic analysis generally aims at improving the social well-being of society in terms of income or consumption by encouraging efficient use of resources (Young, 2005). The contents of the economic analysis of water include the choice of economic assessment index system, the calculation of the indexes and sensitivity analysis (Kashahu, 1996).

2.9.3 The role of monetary valuation of water

Many environmental resources are not traded in markets and so do not have market price. If the effects of human activity on the natural environment will be ignored, then the decisions made will not be in the best interest of society (Falkenmark *et al.,* 1999; Stratos and Basil, 2005). Though most environmental resources do not have a market price, this does not mean they do not have value. This is the difference between financial analysis which is concerned only with goods and services traded in markets and economic analysis which is concerned with society's well-being or welfare. If we are concerned with people's welfare, we must fully consider anthropogenic activities that negatively affect environment such as destruction of water catchments and their damage cost and this can be achieved by assigning economic value to environmental resources (including water) through economic valuation (Stratos and Basil, 2005).

Monetary values are readily observable for commodities regularly exchanged in the market place. Nonetheless, because many environmental resources such as irrigated water are not exchanged in markets they are not given market price. However, these resources have monetary value as long as people are willing to trade some of their income and wealth for them. Therefore, the monetary value of water which is the reflection of social welfare that could be gained or lost is critical for better management of water resource (Young, 1996; 2005; Stratos and Basil, 2005).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Overview

This chapter gives description about the study area including population size and ethnic groups, climate and economic activities. It also describes the methods employed in collecting both primary and secondary data and how the data were analysed.

3.1.1 Description of the study area

3.1.2 Location

The Kilombero Valley, part of the Rufiji Basin of southern Tanzania, is located in the Ulanga and Kilombero Districts, Morogoro Region and lies at the foot of the Great Escarpment of East Africa in the southern half of Tanzania, about 300 km from the coast (Jatzold and Baum, 1968). At the end of the Eastern Arc Mountain range, the Kilombero Valley forms a 6 650 km^2 lowland oasis.

The Kilombero Valley is situated in southern-central Tanzania (8°32’ S 36°29’ E) and lies adjacent to the Selous Game Reserve to the east, near Mikumi National Park, the Udzungwa Mountains National Park to the north and the Mahenge Mountains to the south. The Valley consists of a seasonally inundated floodplain that is fringed by tracts of miombo woodland, rising to old-block mountains with evergreen forest. It has potential areas for irrigation totaling to about 329 600 ha for surface water irrigation (Kato, 2007). This study was conducted in three villages around the valley namely Segamaganga, Lumemo and Njage (Fig.1).

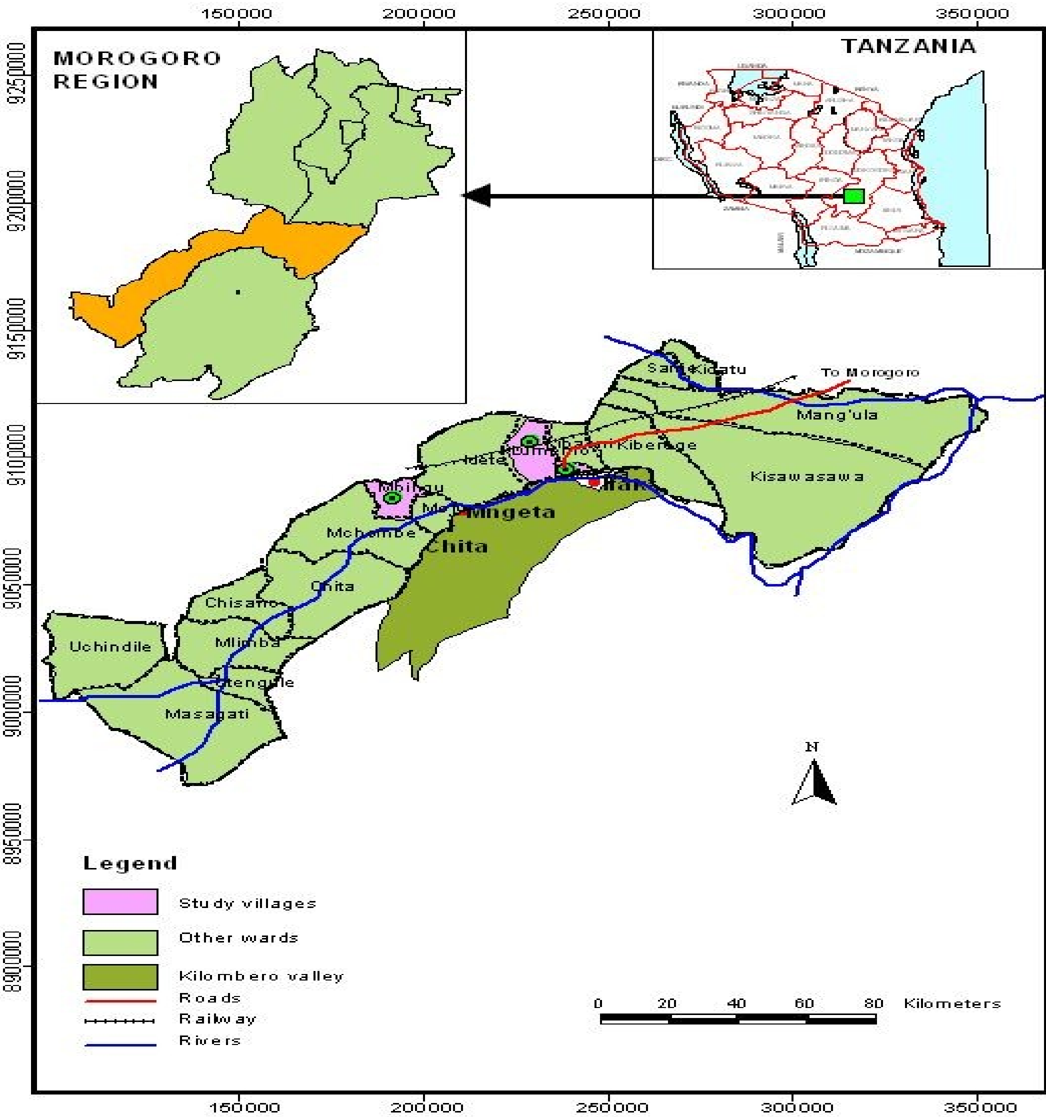

Figure 1: Map showing location of study villages in Kilombero District, Tanzania

3.1.3 Natural resources

High concentrations of large mammals, especially puku antelope *Kobus vardoni* (with nearly 75% of the world population), buffalo, elephant, hippotamus, and lion, are supported, and three endemic birds are known to exist. The Kilombero Valley is home to a wide variety of large mammals, most importantly the endangered puku antelope. The puku is an antelope of medium size that has a scattered distribution across Southern and Central Africa. In the past *pukus* were widely distributed across savannah grasslands and floodplains, while at present they are only found as isolated populations in wetland ecosystems in eight African countries, with the Kilombero Valley in Tanzania, having the largest viable population, estimated at approximately 42 000 animals (Jatzold and Baum, 1968; Kato, 2007).

The Kilombero Valley has a large stock of fish, being the fourth most important inland supply of fish in Tanzania after the Lakes Tangayika, Nyasa and Victoria. Two fish species (*Citharinus congicus* and *Alestes stuhlmanni*) are endemic to the site and downstream in the Rufiji River. Fish is an important food source for local communities, serving as their major source of protein. Fishing is a traditional practice of the Wandamba tribe, and the local government is now promoting it to enable other tribes to also profit from this source. The number of fishermen is therefore increasing, though for many it remains a seasonal activity due to the in-accessibility of the floodplain in the wet season (Kato, 2007; Baum, 1968; Kangalawe and Liwenga, 2004).

3.1.4 Agriculture

The Kilombero valley has potential areas for irrigation totaling to about 329,600 ha for surface water irrigation (Kato, 2007). Currently, the valley is a major rice production area (McCartney and van Koppen, 2004) supplying about 9% of all rice produced in Tanzania (Kangalawe and Liwenga, 2004).

3.1.5 Climate

The climate of Kilombero can be described as the tropical to sub-humid. It experiences dry seasons from July to August and hot dry seasons from September to November (Baum, 1968). The elevation of the inner valley is about 300 m above sea level, and the climate is hot and humid throughout the year (Jatzold and Baum, 1968; Kato, 2007).

3.1.6 Demography

The Kilombero district has a population of around 322 779 people (73 393 households), with growth rate of 2.5% per year and it is projected to have 516 447 people in year 2025 (URT, 2003). However, based on the documented information on the population and the growth rate of 2.5% (URT, 2003) the population in the year 2010 is estimated to be 392 275 people. This indicates the increase in demand for water to sustain the increased population in the study area. Furthermore, there are fast expanding human settlements along the fringes of the floodplain result in a higher utilization of the available resources, with land increasingly being used for rice paddy production and other cultivation (Kato, 2007).

3.1.7 Socio-economic activities

Majority of the villagers are subsistence farmers of vegetables, maize and rice. However there are large wood plantations in Kilombero and neighbouring Ulanga district. The Valley serves as a source of water for farming, livestock, fishing and for domestic uses (Kato, 2007).

3.2 Data Collection

Both primary and secondary data were collected for the accomplishment of this study. Primary data focused mainly on background of wetland agriculture practices, costs of inputs used for and benefits accrued from crop production, livestock production, and domestic use of water.

3.2.1 Reconnaissance survey

A preliminary survey was conducted to familiarize with the study area and to pre-test the questionnaires. For the purpose of pre-testing the research instruments, preliminary data were collected in Njage village to obtain general information about household characteristics, socio economic activities and domestic use of water, provision of water services and related activities. About ten households and four members of the village natural resource committee were interviewed and information gathered was used to modify research instruments so that it fitted to the actual conditions (Goldman and McDonald, 1987). Pre-testing of research instruments was done in order to check their validity and reliability.

3.2.2 Primary data collection

The data were collected in three villages namely; Segamaganga, Lumemo and Njage. A combination of techniques such as Participatory Rural Appraisal (PRA) methods, structured questionnaires (both closed and open-ended questionnaire) and participant observation were used in data collection. This combination of methods was used to complement each other because of limitations by one technique and allows cross checking and verification (Olsen, 2004).

3.2.2.1 Sampling procedure for the questionnaire survey

Multistage was employed in selecting the study sample whereby three wards around KVRS were purposively selected. The selection of these wards based on existing production systems, with the purpose of capturing a wide range of land uses and water benefits. However, using simple random sampling three villages one from each ward were selected. A sampling unit for this study was a household. Each household was randomly selected in all villages (Table 1). The sampling intensity for this study was 5% of households in each village. According to Bailey (1994) a random sample should at least constitute 5% of the total population to be a representative of that population.

Table 1: Distribution of respondents in the surveyed villages in Kilombero district, Tanzania

Village	Total number of households	Number of sampled households	Sample size (%)
Njage	725	37	5
Segamaganga	727	37	5
Lumemo	920	46	5
Total	**2372**	**120**	**5**

3.2.2.2 Questionnaire survey

Questionnaires were administered to a sample of 120 households involving pastoralists and irrigators for the purpose of collecting both quantitative and qualitative data (Table 1). Information collected focused mainly on socio-economic activities such as agricultural production and livestock keeping (average number of livestock, acreage, inputs-cost element, outputs, prices, quantities produced, sold and consumed domestically), domestic use of water, provision of water services and related activities. Also people were asked to state their willingness to pay (WTP) for improved water services. Information on willingness to pay for water services to the communities is a good reflector for water value than prices set by water authorities (Turpie *et al.*, 2003).

3.2.2.3 Key informants

This is the tool used to collect information from key informants. Village elders, village environmental committee members, village natural resource committee members, agriculture and livestock officer, Wildlife Officers and Forest Officers were the key informants for this study. According to Mettrick (1993) a key informant is an individual who is knowledgeable, accessible and willing to talk about the issues under the study.

3.2.2.4 Participatory rural appraisal

Participatory Rural Appraisal (PRA) was employed to learn about rural conditions in an intensive and interactive manner. The focus group discussions, direct observation and resource mapping were the main tools used in PRA. Focus group discussion was deliberately selected in order to explore information from people of different ages, sex and occupation. As a research tool, PRA serves the purpose of opening up discussions with villagers on a particular topic of interest (Kessy, 1998). To achieve the purpose, simple participatory methods were used. These are such as venn diagrams, time line, pair wise ranking, resource mapping and matrix scoring which were easily handled by the villagers with minimum level of education and hitherto provide useful information. Moreover, in this study PRA was used to identify different LUS in the study area. The main LUS identified are mainly crop production (both irrigation and rain-fed crop production), fishing and livestock production (Plate 1).

Plate 1: Main Land use systems in study villages, Kilombero district

3.2.2.5 Participant observations

This method was employed during data collection in order to link the discrete elements of data collected by other methods. According to Kajembe and Luoga (1996) this method as its name implies, is distinguished by the fact that the observer forms part of the situation which he or she is studying. In this study, the method enriches the understanding of the collected information. Additionally, the researcher gained the confidence on the persons being studied, so that his presence did not interfere with the natural course of events. Observing operations in the field gives an opportunity to discuss with the respondents what, how and why things are done and to check what you are told against what you see (Kessy, 1998). In this study, participant observation involved own assessment on various water related socio-economic activities, different land uses, farming practices, identification of agricultural crops, agriculture inputs and status of water quantity and quality around the Kilombero Valley. The observation enabled to highlight the inter linkage between socio-economic activities, costs and benefits, and environmental effect in relation to water use.

3.3 Secondary Data

Both qualitative and quantitative secondary data were collected from Kilombero district water authority, District Agricultural and Livestock Development offices and from the Kilombero Valley Ramsar Site Office. Sokoine National Agricultural Library (SNAL), University of Dar es Salaam, Tanzania Forestry Research Institute (TAFORI), Tanzania Wildlife Research Institute (TAWIRI), National Environmental Management Council, Ministry of Water (Water Policy) and Internet were the major sources of information. Water balance readings were collected from Rufiji River Basin Office. Furthermore, reports on related studies were gathered and relevant information collected to supplement primary data.

3.4 Data Analysis

Both quantitative and qualitative methods of data analysis were employed to analyse the data. Quantitative analysis was performed using Statistical Package for Social Sciences (SPSS version 16). Descriptive statistics, charts, frequencies tables and graphs were used to present the results. Ms Excel was employed to analyse and quantify benefits accrued from water. Different analytical tools were used to analyse benefits of water in different land uses. The main approaches used to capture the value of water were residual imputation approach (RIA), Change in Net Income Approach (CINI) and Contingent Valuation Methods (CVM).

3.4 Evaluation of Economic Benefits of Water

The analysis of water benefits in crop production and livestock production employed the Change in Net Income Approach (CINI) as given by the following equation (Stratos and Basil, 2005; Kadigi *et al.*, 2004; Young, 1996; 2005).

$$AW_V = \frac{(NVO_W - NVO_{WO})}{W} \quad [1]$$

$$NVO_X = (GVO_O - C_X) \quad [2]$$

Where;

AW_V = The average value of water

NVO_W = The net output value *with* irrigation or rainfall water in irrigated or rainfed agriculture respectively

NVO_{WO} = The net output value *without* irrigation or rainfall water in irrigated or rainfed agriculture respectively

W = Volume of water used

GVO_X = The gross output value, and

C_X = The total cost of production

Modelling of Crop Water Productivities (CWPs) was indispensable *prior* to the use CINI Approach. This was done by using FAO's CROPWAT model which is a computer programme used to calculate crop water requirements (CWRs) and irrigation requirements (IRs) from climatic and crop data (FAO, 2001). The climatic data were used in the model to calculate the reference crop evapotranspiration (ET_o). The ET_o together with rainfall, crop parameters were used in the simulation of CWRs. The gross margins and returns to labour were calculated for each land use system. The net output values were determined using equation 3 (Stratos and Basil, 2005; Young, 1996; 2005; Ward and Michelsen, 2002).

$$NVO = Y_c * P - C_{op} - C_L - C_{FL} - C_{HL} - C_W \qquad [3]$$

Where,

$\mathbf{Y}_C$ is the crop yield/product; **P** is the unit price of a product e.g. crop, $\mathbf{C}_{OP}$ entails all variable costs (in case of crop production e.g. seeds, fertilisers, pesticides, transport and packaging, financial costs associated with the purchase of variable inputs), $\mathbf{C}_L$ is the land rental price; $\mathbf{C}_{FL}$ is the cost of family labour, priced at the average hired labour wage, including field operation and management; $\mathbf{C}_{HL}$ is the cost of hired labour; and $\mathbf{C}_W$ is the irrigation fee (water use fee/cost).

The livestock production in this study mainly involves family labour as major input, mostly provided by young members of the family (Plate 2). The Labour was valued at Tsh. 15 000 per month, which is the wage reported to be commonly paid to hired herdsmen in the three villages. The adult cattle was estimated to use 20 litres of water per day per individual, though it was reported to range from 25 to 30 litres per day per adult cattle. This estimate is mainly based on estimates given by SMUWC (2001). According to SMUWC (2001) an African indigenous adult cattle with 250kg live-weight consumes about 20 litres of water per day during rainy season. The calculation of the value of water was then done using the CINI Approach.

Plate 2: Family labour by young member of the family in the study area, Kilombero district

For domestic water uses, the value was estimated by using the Contingent Valuation Methods (CVM). Households were asked individually on their willingness to pay for improved water supply. This involved the use of direct, open-ended question. The questionnaires were designed in the form of a bidding game with several options of combining open-ended and yes or no questions.

However, the residual imputation approach was also used in assessing water value. In this approach the incremental contribution of each input in the production process was determined. The appropriate prices were assigned by market forces to all inputs but one (water), the remainder of all total value of products was imputed to the residual input (Kadigi *et al.*, 2004; Young, 1996). The approach approximates the marginal value product (MPV) of a productive input, such as water, by subtracting all costs of production but one from the total value of output. The remaining (residual) value is assigned to the non-priced input (Young, 1996; 2005).

For deriving the residual value (water value) two principle postulates were considered. First, competitive equilibrium requires that the prices of all resources are equated to returns at the margin. Profit-maximizing producers were assumed to add productive inputs up until the point that value marginal products are equal to opportunity costs of the inputs. The second principle requires that the total value of product can be divided into shares, so that each resource is paid according to its marginal productivity and the total value of product is thereby completely exhausted.

For an agricultural production process in which a single product denoted Y is produced by four factors of production namely; capital (K), labour (L), other natural resources such as land (R) and irrigation water (W). The production function will be;

$$Y = f(K, L, R, W) \qquad [4]$$

$$\frac{\partial Y}{\partial K} = MP_K \qquad [5]$$

$$\frac{\partial Y}{\partial L} = MP_L \qquad [6]$$

$$\frac{\partial Y}{\partial R} = MP_R \qquad [7]$$

$$\frac{\partial Y}{\partial W} = MP_W \qquad [8]$$

$$VMP = \frac{\partial Y}{\partial x} P_X \quad [9]$$

If competitive factor and product markets can be assumed, prices may be treated as constants. Then considering the second postulates, it then follows that:

$$TVP_Y = \left[\left(VMP_K * Q_K\right) + \left(VMP_L * Q_L\right) + \left(VMP_R * Q_R\right) + \left(VMP_W * Q_W\right)\right] \quad [10]$$

Where TVP_y is total value of product Y; VMP is value marginal product of resource i; and Q is the quantity of resource i. Therefore, on the assumption that price (value) for all variables are known except P_w (value of water); then;

$$P_W = \frac{\left[TVP_Y - \left\{\left(P_K * Q_K\right) + \left(P_L * Q_L\right) + \left(P_R * Q_R\right)\right\}\right]}{Q_W} \quad [11]$$

The ‘‘residual imputation approach’’ has been widely used to estimate economic values of water, particularly in crop production (Kadigi *et al.,* 2004; Young, 1996; 2005). The method entails identification of the incremental contribution of each input to the value of total output. In this approach, both simple and more advanced analytical models can be used, but many researchers have centred their analysis on simplicity of the functional forms giving little attention to other factors (e.g., the nature of factor substitution, whether variable, constant or a unit). In essence, these may dictate the forms (e.g., constant elasticity, production function, variable elasticity production function and unitary elasticity production function). For ‘‘intermediate good uses’’ of water, models of the ‘‘profit-maximizing’’ firm can be used. A difficulty is that the residual return (after subtraction of the costs of all measured non-water inputs) is the return to water plus all unmeasured inputs, and hence will result in overstatement of the value of water. The approach is also extremely sensitive to small variations in assumptions concerning the nature of the production function or prices. Thus, it is most suitable for use in cases where the residual input contributes significantly to output.

3.4.1 Validity and reliability of information used for water valuation

Calculation of residual values requires considerable information and accuracy in allocating contributions among the range of resource inputs. According to Hill and Lewicki (2007) goodness of prediction of dependent variable (Y_i) by independent variables (X_i) or predictors is a function of reliability and validity of the gathered information (independent variables). The coefficient of determination (R^2) indicates the percentage of variation in dependent (Y_i) variable explained by the variation in independent variables (X_i) or predictors. Therefore, the greater the value of R^2 the good the model (independent variables) it is for predicting the dependent (Y_i) variable. Furthermore, the standard error is also a measure of accuracy of predictions using the regression model. The lower the value of standard error the more precise the prediction is by predictors (X_i) (Hill and Lewicki, 2007; Greene, 2000).

According to Young (1996; 2005) and Kadigi *et al.* (2004) the contribution of water in producing a unit product can be determined by considering the production function of a respective output (Y). The production of yield (Y) can be presented in a production function as $Y = f(K, L, R, W)$, [i.e. K-capital, L-labour, and other natural resources such as land (R) and irrigation water (W)] (refer equation 4 above). For the purpose of checking validity, reliability and significance of information used in determining the value of water, the contribution of water for producing output (Y) was predicted based on the aforementioned inputs. This was carried out so as to ascertain the contribution of each input on the marginal production of output (Y) and to reveal the relationship between various socio-economic activities, land use type and water uses in the study area.

The regression analysis to predict the output (Y) based on the aforesaid independent variables gave the R^2 of 80.4% which confirms that water contributes significantly (*p-value* = 0.00) to the output of various socio-economic activities and various land uses such as agriculture, agro-pastoralism at 5% level of significance. Hill and Lewicki (2007) and Greene (2000) assert that, the higher the value of *r* the higher the correlation between dependent variable (Y_i) and independent variables or predictors (X_i). In this study the correlation coefficient (r) of 0.90 was also observed which shows that the inputs and outputs are highly correlated (Table 2). These results indicate that the information used for water valuation was valid, reliable and significant at 5% level of significance.

Table 2: The model summary for prediction output based on capital, labour, land and water

Model	R	R Square[b]	Std. Error of the Estimate	Pearson's correlation coefficient	Sig.
1	.897[a]	.804	0.18	0.9	0.00

a. Predictors: K-capital, L-labour, R-land and W-water

b. For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression.

3.5 Economic Analysis

The Net Present Value (NPV), Future Value (FV), Benefit Cost Ratio (BCR) and sensitivity analysis for each LUS was done to assess and to compare the current net benefit of water in different LUS. The major purpose of sensitivity analysis was to know the elements that have important influence on the current net benefits of water in different LUS (Young, 1996; 2005). NPV is the total increased net value or profit of LUS in the entire calculation period. BCR is the ratio of benefits and costs of LUS in entire calculation period. The NPV and BCR were used to analyze the economic worth of different LUS. These parameters gives the profitability of LUS, thus, helps to compare the net benefits of water in different LUS using NPV and BCR (Aylward, 2000; Kashahu, 1996; Young, 1996; 2005). For this matter, the following formulas were used:

$$NPV = \sum_{t=o}^{n}\left[\frac{B_t}{(1+r)^t}\right] - \sum_{t=o}^{n}\left[\frac{C_t}{(1+r)^t}\right] \qquad [12]$$

$$FV = PV(1+r)^t \qquad [13]$$

Where,

NPV = Net present value of water in different LUS

FV = Future value of water in different LUS

B_t = Total revenue accrued at time t, (t = 1, 2 …n; years) for products in different LUS

C_t = Total costs in year t;

n = Number of years in the planning period

r = Guiding discounting rate in %

t = Time in (month/years).

3.5.1 The guiding discounting rate (r)

The discount rate has become one of the central concepts of finance. Some of its manifestations include familiar concepts such as opportunity cost, capital cost, borrowing rate, lending rate and the rate of return on stocks (Young, 1996; Arango *et al.*, 2002). It has great influence in computing NPV. The selection of proper rate is critical because it helps for making correct decision. In order to compute net present value, it is essential to discount future benefits and costs (Khan and Jain, 2004; Ologunde *et al.,* 2006; URT, 2006; Li and Rowe, 2007). This discounting reflects the time value of money. According to Khan and Jain (2004) Ologunde *et al.* (2006) and Arango *et al.* (2002) using proper discount rate depends on whether the benefits and costs are measured in real or nominal terms. To be consistent and free from inflation bias, the cash flows should match with discount rate. The relationship between discounting rate (r), real rate (K) and expected inflation rate (α) can be explained by *Fisher's effect* (Khan and Jain, 2004; Arango *et al.,* 2002; Ologunde *et al.,* 2006) as follows:

$$r = (1-K)\,(1-\alpha) - 1 \qquad [14]$$

If in period *t*, one Tanzanian shilling is invested in a bond which pays TZS $1+\rho_t$ in period t+1, then the nominal interest rate is ρ_t . Thus, the expected increase in real purchasing power from buying the bond is (Khan and Jain, 2004; Ologunde *et al.,* 2006):

$$1+i_t = \frac{E\left(\frac{1}{P_{t+1}}\right)(1+\rho_t)}{\frac{1}{P_t}} \qquad [15]$$

Where *Pt* is the current level of the price index, $E(P_{t+1})$ is the expectation of the price level in period *t+1*formed in period *t,* and i_t is the bond's expected rate of growth in purchasing power (its expected real return). TZS 1 has purchasing power $\frac{1}{P_t}$ in period *t.*

Let z_t be the expected rate of growth of purchasing power of TZS 1:

$$z_t = \frac{E\left(\frac{1}{P_{t+1}}\right) - \frac{1}{P_t}}{\frac{1}{P_t}} \qquad [16]$$

(Note that if the price level was expected to increase, *z* would be negative). Substituting this into equation 15 gives (Khan and Jain, 2004; Ologunde *et al.*, 2006):

$$(1+i_t)=(1+z_t)(1+\rho_t) \qquad [17]$$

Now,

$$1+z_t=\frac{E\left(\frac{1}{P_{t+1}}\right)}{\frac{1}{P_t}}\approx\frac{P_t}{E(P_{t+1})}=\frac{1}{(1+\pi_t)} \qquad [18]$$

Where π_t is the expected rate of inflation in period *t* (the expected percentage increase in the price index over the period).

The relationship, therefore, between the real interest rate *i* and the nominal interest rate is (Ologunde *et al.*, 2006):

$$(1+i)(1+\pi)=(1+\rho) \qquad [19]$$

This gives:

$$i=\frac{(\rho-\pi)}{(1+\pi)} \qquad [20]$$

Therefore, NPV in this study was calculated using the guiding discounting rate of 12% as recommended by World Bank. This was done while taking into account the effect of current average bank interest rate ranging from 14.2% to 18% (BoT, 2010) and average inflation rate of 9.6% in Tanzania (BoT, 2010).

3.6 Limitations of the Study

This sub-section gives discussion on limitations of the study in evaluating the net benefit of water and how these limitations were handled. It also gives highlights on limitations during field work.

3.6.1 Problems associated with non-market valuation of water

A number of additional economic and physical characteristics give distinctive problems in water valuation. The important point to know is that there is no single economic value of water. What is being measured is the welfare changes associated with some policy-induced change in the attributes of the commodity (Young, 1996; 2005). All methods for valuation of water particularly the Change in Net Income method, hinge on observing responses of crop yields to various water applications. Water productivity may vary according to soil fertility, soil type, farmer (experience, management ability, attitude towards risk and financial constraints); weather conditions of the year and level of other inputs. Therefore, these variables (soil fertility, soil type, farmer weather conditions of the year and level of other inputs) may cause variation in yields and prices which may lead to inaccurate estimates of crop water uses thus incorrect economic value of water. An agronomic model, CROPWAT was used in this study to allow the calculation of water requirements over a period of time in absence of field observations of yield response to various levels of water application.

3.6.2 Challenges of the study in data collection

A researcher faced some challenges during data collection. Some of the respondents were not sure with their answers due to lack of information keeping concerning their businesses and they had to think relatively long before responding to the question. Some respondents were not ready to respond to some of the survey questions for fear that once they respond that information will be known to Government. For example some of respondents were not ready to give exact number of their livestock fearing that they will be taxed more. However, these limitations were solved by asking the same questions in different ways to check and to compare the given answers. The problems of under reporting the number of livestock and agricultural information were handled by comparing the answers with the reports from Kilombero District Agricultural and Livestock Officer (DALDO).

3.6.3 Practical problems to value irrigation water

The following problems were encountered in establishing the values for irrigation water. In developing countries, a large part of yields in farming systems is usually used for household consumption. The economic value of the total output embraces the values of marketed output and the one for home consumption. When no market persists for these products then the choice of appropriate price for the household consumption is an issue. During the study household consumption was valued at current prices in the village or nearby markets. The great variation in yields, price and water from season to season may lead to inaccuracy estimates of water value. However, these were taken into account by comparing the gathered information with secondary data from DALDO's office just to complement primary data.

3.6.4 Practical problems to value water in agro-pastoral farming systems

Agricultural water use has a role in maintaining complex agro-ecological systems and isolating just a single aspect is fraught with difficulties. Providing an accurate and comparable estimate of the economic value of water is especially difficult where different water uses are interdependent. In agro-pastoral farming systems, exact figures of the economic value of water can hardly be given due to the synthesis between different water using activities. For instance cattle, sheep and small ruminants consume a considerable amount of water through the water embedded in fodder, but simply account this embedded water as livestock water consumption misses the point that livestock may graze on crop residues that would otherwise lost. In fact livestock grazing on crop residues might contribute to crop production. Therefore capturing these inter-linkages is normally difficult and the assessment of the value of water for livestock in this study has considered only the water that is used by livestock as drinking water.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents and discuss findings of the study on water related socio-economic activities in different land uses in the study villages, value and economic benefits of water and local community participation in conservation activities.

4.1 Socio-economic Characteristics of the Respondents

4.1.1 Sex and age distribution

The results show that 75% of the respondents were males and 25% were females (Table 3). These results do not imply that only males are involved in production activities rather it indicates that most of households in the study area are headed by men. However, it also implies that, women were busy taking care of their children at home and performing other domestic activities. The results may probably indicate that women were not free to talk to any guest and give out information related to their families. This is typical for most African societies where the majority of household are male headed (Magembe, 2007). According to Njuki *et al.* (2004) and Kanji *et al.* (2007) women bear most of the household activities but they are inadequately represented in decision making in many families headed by men. Nonetheless, in some ethnic groups women are not allowed to give information to any guest unless allowed by the head of the household which in most cases are men in "*patrineal*" system (Butegwa and Awori, 2009; UN, 2009).

This study revealed that 37.5% of the respondents were between 44-56 years of age, followed by the age groups of 31-43 years (32.5%), 18-30 years (21.7%) and then age group of above 56 years (8.3%) (Table 3). These results indicate that majority of youths (54.2%) of 18-43 years old and aged (37.5%) people of 44-56 years old were all engaged in most economic activities such as crop production and livestock production while small

(8.3%) proportion of old age people are engaged in economic activities in the study area (Table 3). This may be due to the fact that at old age people are not energetic enough to undertake field works. However, a higher percentage (91.7%) of the respondents were between the age of 18 to 56 years which in most cases is the age of people who are energetic enough to participate in production activities.

Table 3: Distribution of the respondents by age group and sex, study villages

Variable	Frequency of respondents	Percentage
Sex		
Male	90	75
Female	30	25
Total	**120**	**100**
Age group (years)		
18 to 30 years	26	21.7
31 to 43 years	39	32.5
44 to 56	45	37.5
Above 56	10	8.3
Total	**120**	**100.0**

Moreover, this gives an insight that the contribution of this group in water related economic activities to provide labour input in production is high. This observation indicates that large population in the study villages are able to participate in production activities such as crop production, livestock production and other economic activities hence increase in the demand for water in economic production activities. United Nations (2009) asserts that youth have high potentials in poverty alleviation and in the labour market. Thus, they are supposed to play a big role especially in combating poverty and hunger.

4.1.2 Education level of the respondents

Majority (43.3%) of the surveyed population had attained primary education while 35.1% and 12.5% had attained secondary and higher education respectively (Table 4 and Figure 2). These results can be compared with those of 2008, whereby 41.6%; 33% and 9% of the population in the study area had respectively attained primary education, secondary and higher education (Butegwa and Awori, 2009). The increment might be due to increase in ward secondary schools in the study area and in the country as whole.

However, findings show that 2.5%, 3.3%, 3.3% of respondents in the age groups of 18 to 30 years, 31 to 43 years and 44 to 56 years respectively have not attained any form of education. About 10%, 12.5%, 15.8% and 5% in the age groups of 18 to 30 years, 31 to 43 years, 44 to 56 years and above 56 years respectively have attained primary education. About 6.7%, 12.5%, 12.5% and 3.4% of the respondents in the age groups of 18 to 30 years, 31 to 43 years, 44 to 56 years, and above 56 years have attained secondary education in that order. Only few (2.5%, 4.2%, 5% and 0.8%) of the respondents in the age groups of 18 to 30 years, 31 to 43 years, 44 to 56 years, and above 56 years have attained higher education respectively (Table 4). From these results (Table 4 and Fig. 2) it can be established that, most people in the surveyed villages have attained formal education as explained above. This indicates that they can be trained to participate more effectively in water management and conservation.

Education is an important factor for making various decisions in life and it facilitates active and effective participation of stakeholders in natural resource management (including water resource) and in planning process. According to Kalineza *et al.* (2002) a knowledgeable population is more likely to adopt new innovations compared to unknowledgeable population. Furthermore, Education is argued to be one of the strongest determinants of household income and has a big bearing on household decisions made by household head (World Resources Institute, 1996; World Bank, 2002).

Table 4: Distribution of the respondents by age group and level of education

Household age distribution	**Level of Education**				
	No Education	**Primary Education**	**Secondary Education**	**Higher Education**	
	Percentage				**Total**
18 to 30 years	2.5	10	6.7	2.5	**21.7**
31 to 43 years	3.3	12.5	12.5	4.2	**32.5**
44 to 56	3.3	15.8	12.5	5	**36.6**
Above 56	0	5	3.4	0.8	**9.2**
Total	**9.1**	**43.3**	**35.1**	**12.5**	**100**

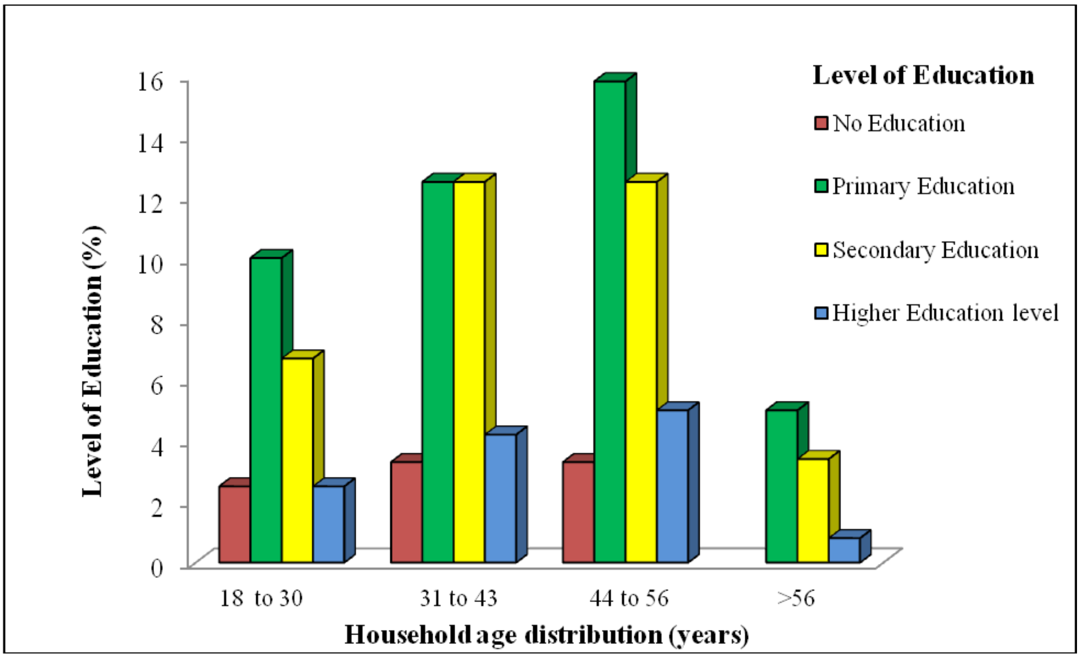

Figure 2: Distribution of the respondents by age group and level of education in study villages

4.1.3 Main sources of income

The results of the study have revealed that, 41.7% of the respondents depended on selling crops as the main source of income, 26.7% of the respondents depended on selling livestock products, while 15% were depended on both crop production and livestock keeping as the source of income (Table 5). Only 6.7% of the respondents depended on small scale businesses and 5.9% of the respondents depended on both crop production and making bricks as the income source. Furthermore, the results show that, few of the respondents (4.9%) were employed and 1.6% of the respondents depend on both employment and crop production (Table 5).

Table 5: Responses on Source of Income of respondents in the study villages, Kilombero District

Name of Village	Source of Income						
	Sales of crop products	Sales of livestock products	Sales of crops and sales of bricks	Sales of both crops and livestock products	Small scale businesses IGAs	Employed (Salary)	Employee and sales of crop products
	Percentage						
Njage	25.8	0	1.7	0	0	3.3	0
Segamaganga	0	25	0	4.2	0	0.8	0.8
Lumemo	15.8	1.7	4.2	10.8	6.7	0.8	0.8
Total	**41.7**	**26.7**	**5.8**	**15**	**6. 7**	**4.9**	**1.7**

Previous studies (Baum, 1968; Abdallah *et al.*, 1992; Falkenmark *et al.*, 1999; Aylward, 2000; Calder, 2000; AFRODAD, 2007) proved that, there is a direct relationship between people's income and the use of natural resource such as water and land. The wise use of water and land resources is important in order to maintain and support the economy through crop production, livestock production and industrial processes (Acharya and Barbier, 2000). Correspondingly, most (83%) of the respondents in the surveyed villages depended on selling crop and livestock products (crop production and livestock production) for their income (Table 5), which indicate and emphasize that water is necessary for sustaining these economic activities and the social welfare of the local people in the study area. Moreover, the findings imply that water is a critical factor for local people's income due to the fact that about 88.4% of the respondents depended on brick making, selling crop products and livestock products (Table 5). Previous studies (Acharya and Barbier, 2000; Dinar, 2000; Young, 2005; Kadigi *et al.*, 2004) around the world have shown that water (surface and ground water) is a vital input in various production sectors and it is has potentials for supporting income generating activities to local people around the world.

However, small proportion (3.3%), of the respondents was employees thus their income is through monthly salary in Njage village. The findings show that there were few employees in the surveyed village. The implication of the results is that, many people are self employed (engaging themselves in crop production, livestock keeping and small scale business) and few of them depend on employment. This can be attributed to the fact that in the surveyed villages, majority (88.3%) of people are owning land thus they can easily use it for various socio-economic activities (Tables 5 and 6). Moreover, poor and insufficient social services such as hospitals, infrastructure and electricity to motivate private investors to invest in the study area and create employment to local people, might probably account for small proportion of the observed few employees in the study area. According to Chaturvedi (2000) insufficient and poor social services such as infrastructures, health services and transport in rural areas is still a challenge in most developing countries (including Tanzania).

Kato (2007) and URT (2004) argued that, in the Kilombero Valley, where most people have cultivated paddy rice as a staple food, rice cultivation expanded rapidly, as it was the only income generator after economic liberalisation. They further mention the valley as a major rice production area, supplying about 9% of all rice produced in Tanzania. Therefore, the findings of this study show that about 25.8% of respondents who depended on selling crop products were in Njage village, 15.8% of respondents were in Lumemo village (Table 5). Nevertheless, the availability and accessibility of more crop products in Njage village is attributed to good microclimate which can be explained by the fact that most of the land is covered with vegetation thus low evapotranspiration thus creating a conducive environment with good soil moisture for crop production. Kato (2007) and Baum (1968) argued that, *miombo* woodland in Kilombero valley has contributed to the three distinctive agro-ecological zones which influence the agricultural activities in the area as a major source of income. Lumemo village is the second to Njage village whereby 15.8% of the respondents depended on selling of crop products (Table 5). This can be attributed to the good microclimatic condition and geographical location of Lumemo (Fig. 1).

Observation shows that, 4.2% of respondents in Segamaganga depended on both selling crop products and livestock products. Only 1.7% of respondents in Njage village were engaged in brick making and other small scale businesses (i.e. income generating activities “IGAs”) (Table 5). As many people are striving for better life, then brick making can be attributed to the demand for good shelter in the surveyed villages. The diversification of economic activities (i.e. selling crop and livestock products, brick making, employment, crop and livestock production) reduces competition and pressure on water and other natural resources thus stabilizing and enhancing sources of income for local people.

The observed income generating activities and economic activities in the study area are water related activities. Thus water has potentials in income generating activities in the study area. Kangalawe and Liwenga (2005) argued that wetlands as the sources of fresh water has influenced various socio-economic activities such as agricultural activities, livestock production and other industrial processes in many developing countries hence supporting people’s livelihood through. Therefore, the findings of this study imply that water has potentials in various income generating activities in the surveyed villages.

4.1.4 Land ownership for households and means of acquisition

4.1.4.1 Household land size and ownership

Findings show that about 37.5% of the surveyed respondents owned 0.3 ha to less than one hectare of land, 31.6% owned one to less than two hectare, 15.8% owned two to ten hectare of land while 15.1% of the respondents owned more than ten hectares of land (Table 6). Overall, about 88.3% of the respondents own land as an input of production and 11.7% of them rent the land for crop production (Table 6). These results imply that land is accessed by local people in the surveyed villages and they can use it as an input for socio-economic activities such as crop production, brick making and livestock production. It also indicates that land is in the hands of majority while some people in the surveyed villages can access land through renting. Kadigi *et al.* (2004) and Calder (2000) argued that, land renting is common for people with small or no land and its cost varies with location and time. The results of this study can be compared with the findings of Semra (2005) in Babati who reported that 98% of Tanzanian rural households own land with the average size of 2.4 ha per household. According to Falkenmark *et al.* (1999) the land decision is water decision. Therefore, since results of this study show that majority (88.3%) of households own land and depend on it for their livelihood, therefore, it can be established that any decision made by majority regarding use of their land will have impact on water use in the surveyed villages to a great extent. This implies that good land management has positive impact on water management especially when we consider the land use relationship between upstream and downstream.

Table 6: Land ownership for household and means of acquisition

Size of Land for Household	Acquisition of Land				
	Bought	Rented in	Allocated by Village Government	Inherited	Total
	Percentage				
0.3 to <1 ha	13.3	7.5	4.2	12.5	**37.5**
1 to <2 ha	8.3	2.5	10.8	10	**31.6**
2 to 10 ha	10.8	0	3.3	1.7	**15.8**
Above 10 ha	9.2	1.7	3.3	0.8	**15.1**
Total	**41.7**	**11.7**	**21.6**	**25**	**100**

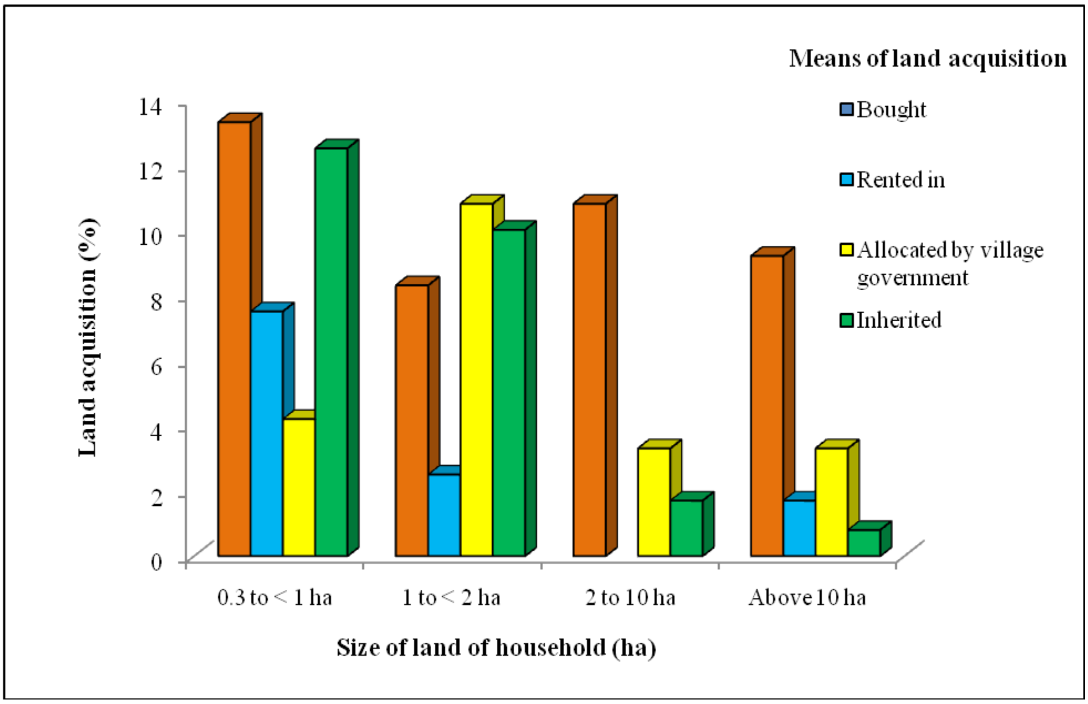

Figure 3: Size of Land for household and means of acquisition

Majority (41.7%) of the respondents had acquired land through purchasing (Table 6). Some of them acquired it through inheritance (25%) and by government allocations (21.6%) while a few (11.7%) of them used to rent the land from land owners (Table 6 and Fig. 3). The implication of these results is that, probably people may be able to use their land for various socio-economic activities thus increase the ability to sustain their lives. It can also be established from the results that people can apply for land lease certificate and use land as an asset to borrow money from banks and other institutions.

4.2 Land Use Systems

It has been observed that, according to the respondents, major land use systems in Kilombero district are agro-pastoral farming system (39.2%), crop production (37.5%) and livestock production (9.1%). However, the results also revealed that some households were engaging themselves in both brick making and crop production (12.5%) and only small group (1.7%) of the respondents were only engaged on brick making as a type of land use and a source of income (Table 7).

Nonetheless, land use systems accounted differently in each of the surveyed village. In Njage village, crop production account for 21.7% of land use, 5.8% for both crop production and brick making whereby 3.3% account for livestock production. Agro-pastoral farming account for 25% of land use in Segamaganga village and only 5.8% of household population were engaged themselves in livestock production.

Crop production (15.8%) is dominant in Lumemo village, followed by agro-pastoral farming (14.2%) whereby the results show that 6.7% accounts for both brick making and crop production and 1.7% account for only brick making (Fig. 4 and Table 7). These results imply that there is diversity of water related economic activities in Kilombero district that require proper management of water resource. Study conducted by Kangalawe and Liwenga (2005) shows that Kilombero Valley has high potential for a diversity of land uses that supports local people's socio-economic activities. Some previous studies (Falkenmark *et al.*, 1999; Baur *et al.*, 2000; Turpie *et al.*, 2003) argued that land use systems in upstream/downstream may have impacts on the use of water to either of the stakeholders (i.e. upstream or downstream). This implies that the degradation of water quality due to a certain land use type in upstream parts of a watershed can have negative effects on users in downstream parts of the watershed and the degradation affects flow through the watershed.

Table 7: Land use systems in Kilombero district, Tanzania

Name of Village	Land use systems					
	Crop production	**Livestock production**	**Brick making**	**Brick making and crop production**	**Agro-pastoral farming**	**Total**
	Percentage					
Njage	21.7	3.3	0	5.8	0	**30.8**
Segamaganga	0	5.8	0	0	25	**30.8**
Lumemo	15.8	0	1.7	6.7	14.2	**38.4**
Total	**37.5**	**9.1**	**1.7**	**12.5**	**39.2**	**100**

Lundqvist (1999) and Baur *et al.* (2000) asserts that, if water is used lavishly in one production sector (single land use type), or by one group of users, comparatively less water will be accessible for other users. Re-use is, of course, an option but it is not possible after consumptive use and the options are reduced if quality is affected (Rockstrom *et al.*, 2007; Dinar, 2000; Lundqvist, 1999). Thus, the findings of this study (Fig. 4 and Table 7) revealed that there is a diversity of land uses in the surveyed villages which are water related socio-economic activities that need the wise use of water.

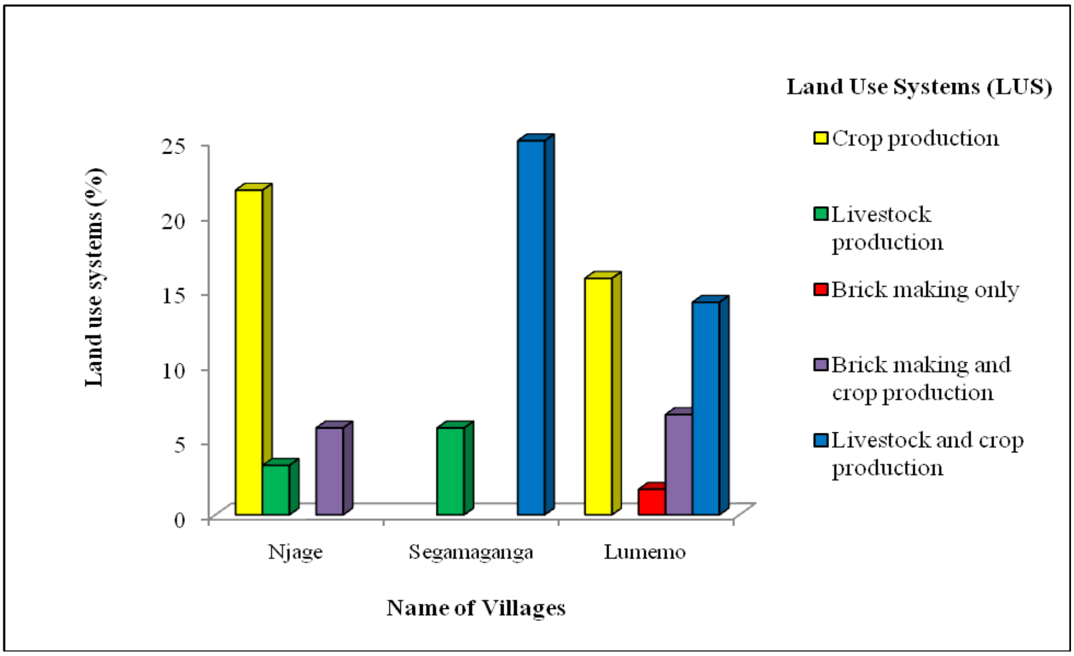

Figure 4: Land use systems in Kilombero district, Tanzania

Additionally, the findings of this study show that the estimated marginal means (EMM) for different land uses as source of income to households ranges from one to five. The estimated marginal means (EMM) for crop production ranges between one to two for respondents of all levels of education, while estimated marginal means for livestock production as a source of income is 2 (Fig. 5).

The findings show that, there is an increase in the estimated marginal means EMM (1to5) from crop production to mixed land use system (LUS). For example the EMM for both fishing and crop production ranges from one to two for people with secondary education and primary education respectively. The EMM for agro-pastoral farming system ranges from three to four for people with secondary education and people with primary education respectively (Fig. 5). From these results it can be established that, most of people with primary education tend to rely only on one LUS type while people with secondary and tertiary education tend to diversify their sources of income from different types of land uses. The implication of these results is that, education helps people to see and exploit available opportunities.

Calder (2000); Abdallah *et al.* (1992) and Aylward (2000) argued that, education is very important for people to see, explore and diversify the sources of income and various opportunities which in turn can contribute to management and sustainable use of natural resources. Nevertheless, increasing water stress is a source of personal and societal stress and will most likely hamper the progress and security of society. Conflicts over water are common. But it is also true that considerable effort is devoted to promote cooperation (Sokile and Mwaluvanda, 2005).

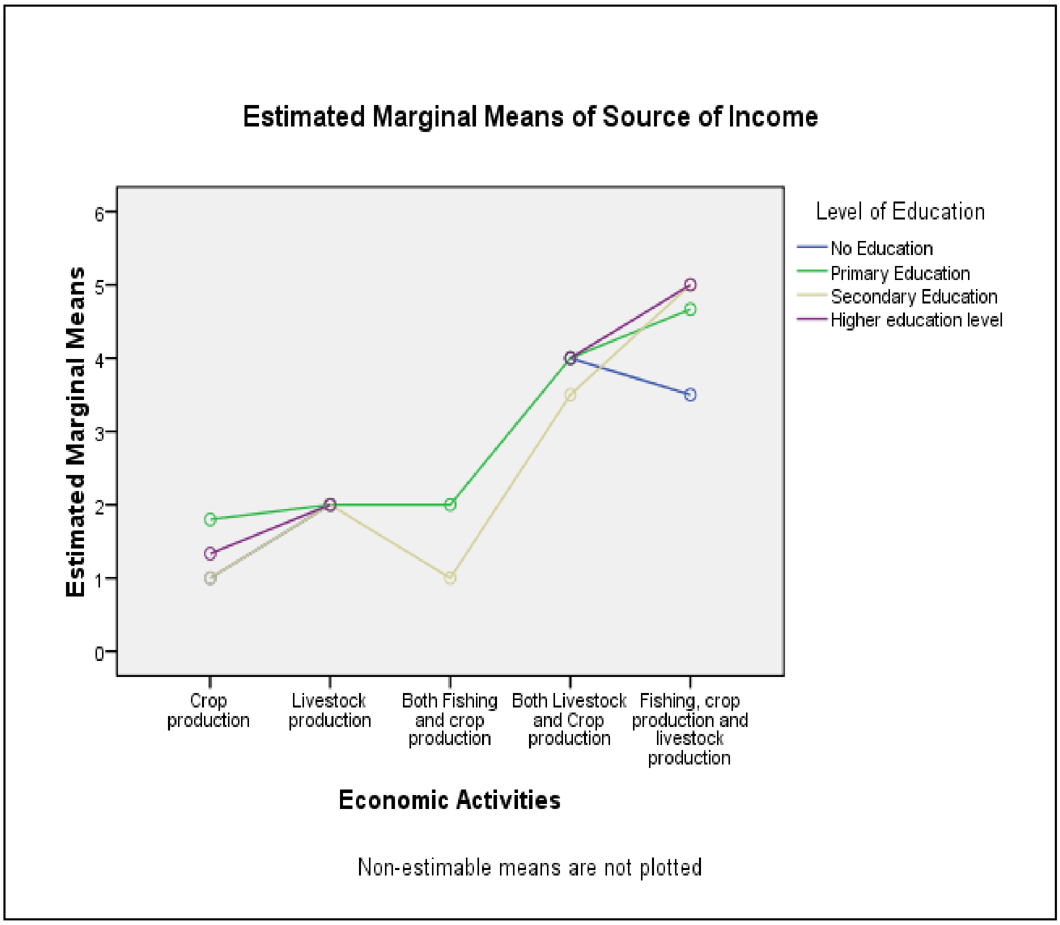

Figure 5: Estimated marginal means of sources of income

4.2.1 Sources of water for different land use production

According to interviewed respondents, most of the households in Kilombero district depends on rainfall (46%) and Kilombero valley (32%) as the sources of water for their production activities whereby few of the respondents (22%) depend on other sources of water (tape water and well) for their economic activities and for domestic uses (Fig. 6 and Fig. 7). Kato (2007) and Baum (1968) argued that Kilombero valley has a high potential as a source of water to agricultural production, livestock production, industrial processes and water for domestic uses. Notwithstanding the scale and type of crop production systems which the household practice, these results show that agro-pastoral farming mainly depends on both Kilombero valley and rainfall as the source of water while crop production depends on various sources of water (Fig. 7). This implies that, water is a critical input in different land uses in Kilombero district.

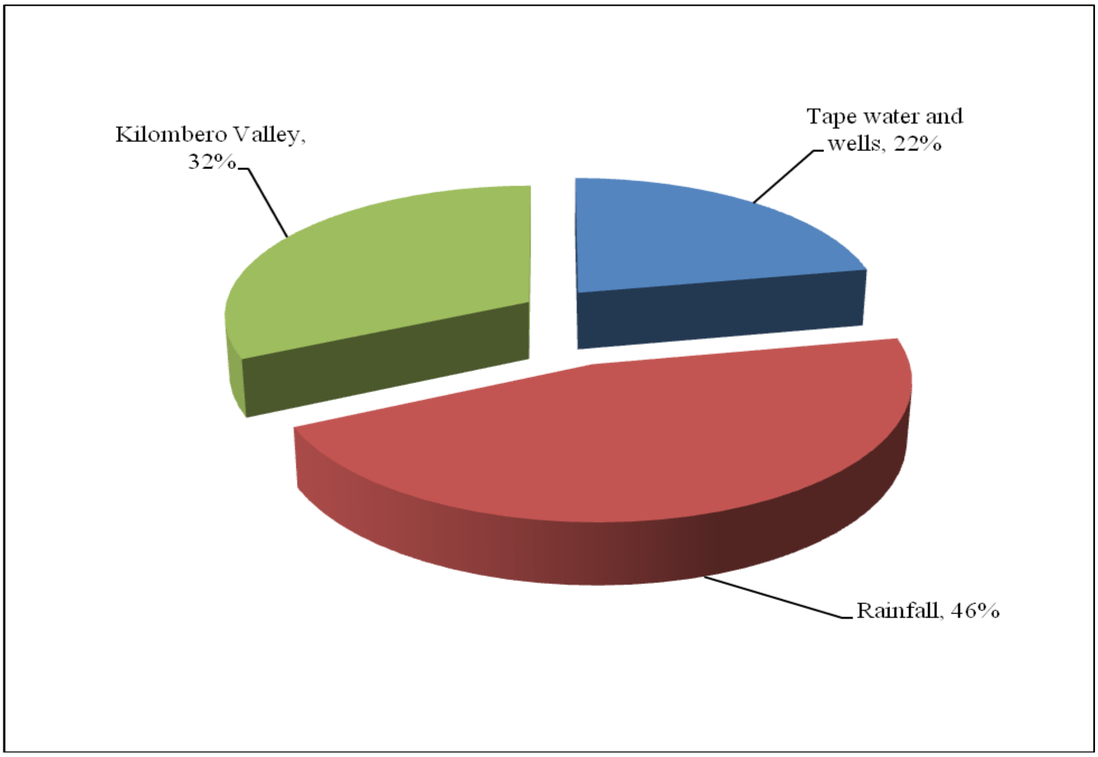

Figure 6: Main sources of water for various uses in the study villages in Kilombero

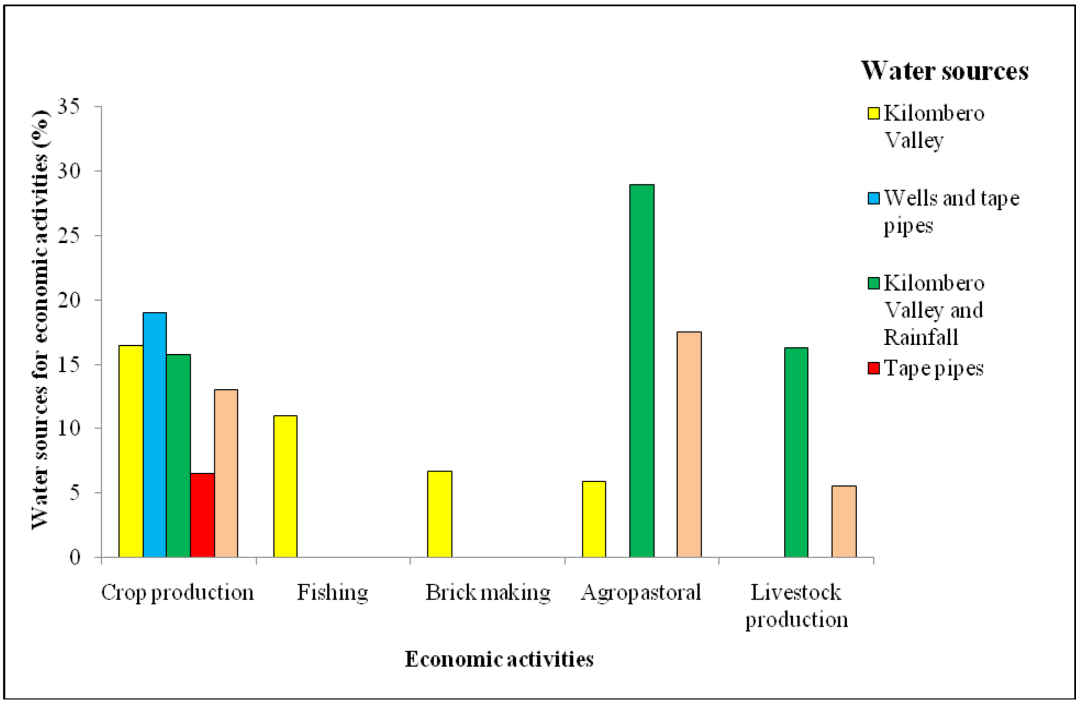

Figure 7: Main sources of water for land uses in the study villages, Kilombero district

4.2.2 Crop production

According to the interviewed households, crop production accounted for 37.5% of land use systems in the surveyed villages (Table 7). In general, majority (41.7%) of the households in Kilombero district depend on both rainfed and irrigation in crop production, 36% depends on rainfed agriculture only and few (22.3%) were practicing irrigation agriculture (Fig. 8). Previous studies (Baum, 1968; Kangalawe and Liwenga, 2004; 2005; Kato, 2007; McCartney and van Koppen, 2004; Ngaga *et al.*, 2005; URT, 2002) revealed that wetlands (including Kilombero Valley) have potentials in crop production and for ameliorating the microclimate which provides conducive environment for crop production. The findings of this study show that there is a diversity of crop production system practiced in Kilombero district of which water from KVRS is a critical input.

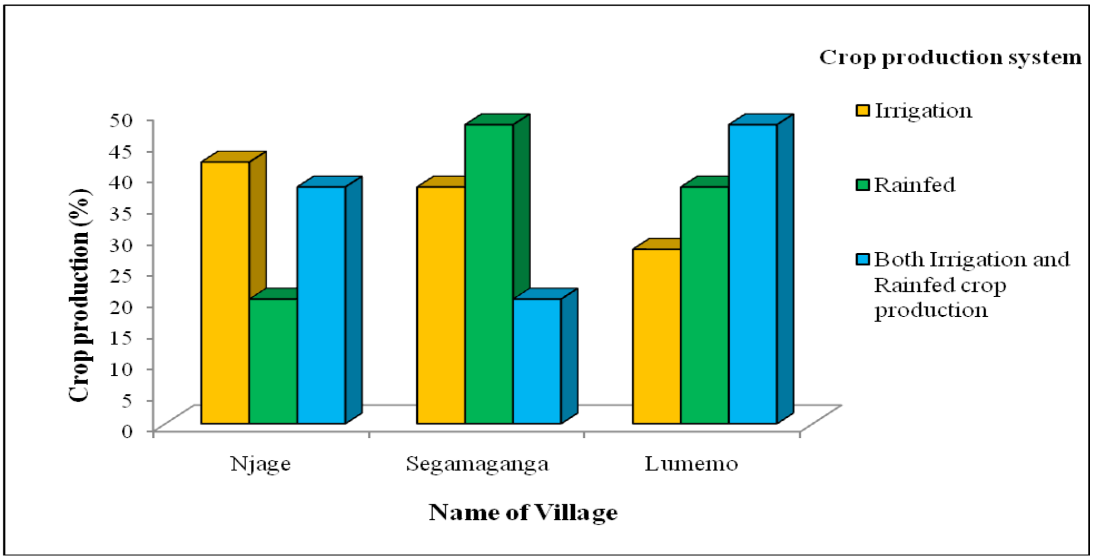

Figure 8: Crop production in the study villages, Kilombero district

There is some variation in crop production within and between surveyed villages. About 40%; 36% and 24% households were practicing irrigation agriculture in Njage, Segamaganga and Lumemo respectively. Results also show that, 45% of respondents from Segamaganga, 35% (Lumemo) and 20% (Njage) depends on rainfall for crop production. There is also a group of households (45%, 35% and 20%) from Lumemo, Njage and Segamaganga respectively who practice both rainfed and irrigation agriculture (Fig. 8). This trend can be attributed to various factors such as lack of enough capital for investing in irrigation-type of crop production. Moreover, majority (45%; 35%; 20%) of households were executing rainfed cropping system in Segamaganga, Lumemo and Njage villages respectively (Fig. 8). This implies that people in some villages such as Segamaganga and Lumemo are not able to produce surplus yields (rainfed) for selling rather they can only produce little (subsistence farming) for home consumption. The reason for this might probably be due to absence of a national irrigation scheme in Segamaganga and Lumemo villages as compared to Njage village where people are producing crops both for home consumption and for selling due to presence of irrigation project (Plate 1 and Plates 4-5).

Content analysis of the information gathered from Participatory Rural Appraisal (PRA) indicates that there is a sign of water shortage due to increased demand of water which resulted from population growth and distribution (spatially and temporal) in the study villages. Nonetheless, while some respondents were producing crops through irrigation scheme (Plates 4-5), others were practicing traditional type of irrigation particularly Segamaganga village (Plate 3). This can be attributed to insufficient capital for the latter.

Plate 3: Traditional Irrigation canal in Njage (Irrigation Agriculture)

Plates 4-5: Irrigated paddy production in Njage

Major crops which are produced in the surveyed villages are rice (*Oryza sativa*) and maize (*Zea mays*) (Plates 6-7). The average area of paddy and non-paddy fields per household is approximately 1.8 ha and 0.7 ha, respectively. However, some crops such as vegetables, tomatoes, sweet potatoes and banana were produced on the surveyed villages.

Plates 6-7: Paddy production **Maize production**

4.2.3 Livestock production and agropastoral farming

The findings show that 9.1% of respondents were involved in livestock production as a type of land use in Kilombero district (Table 7). Main livestocks kept by households in study villages were cattle, goat, sheep and poultry. Family members were the main source of labour for herding. However, the results has revealed that majority (39.2%) of households were practicing agro-pastoral farming system (Table 7). This indicates the diversity of land use systems in study villages. Moreover, majority of households in Kilombero district were practicing water related activities which demand sustainable supply of water. According to URT (2002) and Kangalawe and Liwenga (2004; 2005) many people around the Kilombero Valley are benefiting from irrigated and non-irrigated agriculture through cultivation of paddy and non-paddy crops, livestock production and water for domestic consumption. The competition for limited supplies of water will be intensified as populations expand and economies grow, hence creating conflicts among water users (Turpie *et al.,* 2005; Young, 2005).

4.2.4 Water benefits in different land uses in Kilombero district

This study has revealed that, there are various benefits accrued from water in its competing uses ranging from primary goods to secondary goods and services (Table 8). In crop production, harvestable yields and crop residue are the primary and secondary benefits respectively while soil covers to reduce erosion, enhancement of agro-biodiversity and carbon sequestration are the services (tertiary water benefits). Furthermore, water has potentials (indirectly) for the improvement of meat, milk, skin, eggs, cheese and butter as the primary benefits obtained from livestock production.

Table 8: Water related Land use production systems and their benefits

Land use production system	**Benefits**		
	Primary goods	**Secondary goods**	**Services**
Crop production	Harvestable yield	Crop residue for livestock feed	Soil cover to reduce erosion, enhancing agro-biodiversity, Carbon sequestration
Livestock production	Meat, milk, skin and eggs	Draft power, manure, leather	Ploughing

Water influences the vegetation such as *miombo* woodlands mainly consisting of *Brachystegia* spp, grasses such as guinea grass (*Panicum maximum*), *Hyparrhenia* spp, reed (*Phragmites mauritianus*) and elephant grass (*Penisetum purpureum*) in the study area (Baum, 1968; Kato, 2007; Kangalawe and Liwenga, 2004; 2005). This implies that water plays an important role in supporting livestock production by providing fodder and grazing areas to the livestocks and supporting agriculture production by improving soil structure, soil surface, porosity and soil organic matter (Table 8). Sequentially water supports the draft power, manure, leather and ploughing which is the secondary goods and services accrued from livestock production/pastoral farming.

Previous studies (Musamba, 2006; Kangalawe and Liwenga, 2004; 2005) show that the extent to which local users depend on the resource and accrue benefits for their livelihoods has serious impact on the management of that resource (water). These results indicate that water has potentials for supporting different land uses and the associated benefits. Therefore, local users who are critically dependent on water have an economic incentive to protect it.

4.3 Valuation of Economic Value of Water

Marginal values assess the value of incremental changes in the available units of water for a certain use. This is useful when considering different options for allocation of water resources, making more or less water available to different uses (Acharya and Barbier, 2000). Water valuation in different land uses such as crop production, livestock production and agro-pastoral is a function of several factors which, among others, include the level of production and the extent to which other inputs and management practices are employed as well as the levels of input and output prices. The validity and reliability of the information used for water valuation also is another aspect which is very important in determining the value of water and its productivity (Young, 1996; 2005; Dinar, 2000).

4.3.1 Responses on inputs used in different production systems

This study has revealed that various inputs were used in different production systems in Kilombero district. Some of these inputs are land, water, pesticides, fertilizers, seeds, labour and medicine for livestocks/poultry. Isinika *et al.* (2003) argued that although economic liberalisation extended the economic connection between urban and rural communities, it may have increased the risks of farming management because it increased the price of agricultural inputs, in particular agro-chemicals, and enhanced the fluctuation of crop prices in rural areas. These results show that, almost all (100%) respondents were using inputs in either of the production system. It has been shown that water is a critical input for all production systems (Table 9).

Table 9: Responses on inputs for different land use production systems in surveyed villages

Inputs used for land use production	Economic Activities					Total
	Crop production	Livestock production	Both Fishing and crop production	Both Livestock and Crop production	Fishing, crop production and livestock production	
	Percentage					
Land, fertilizer, pesticides, labour and seeds	29.2	0	0	0.8	4.7	**34.7**
Land, Pesticide and water	0.8	0	0	1.7	0	**2.5**
Land, Labour and water	0	0	0	1.7	0	**1.7**
Seeds, water, labour and land	9.2	0	2.5	3.3	2.5	**17.5**
Food for livestock or poultry, Land, water and medicine	3.3	5.8	0	1.7	1.7	**12.5**
Labour, food for livestock poultry and water	1.7	0	0	27.5	2.5	**31.7**
Total	**44.2**	**5.8**	**2.5**	**36.7**	**10.8**	**100**

About 36.7% of the interviewed farmers reported that they were applying fertilizers and pesticides in crop production (Table 9). However, the artificial inputs are commonly not used because they are too expensive and this can be due to lack of enough cash (liquidity). Due to difficulties of carrying sufficient quantities to the distant crop fields, the use of manure is very rare though it is used in the study area.

The inputs for other economic activities such as livestock production was only incurred in buying food, medicine and paying labour for livestock and poultry while the costs for fishing was due to paying labourers, buying fishing gears such as boats, hooks and nets for fishing (Table 9).

4.3.2 Value of water in crop production

According to Palanisami *et al.* (2006) and Young (1996) the term *'water productivity'* refers to the degree of output or benefit resulting from the input quantum of water as applied on a unit base. In the domain of agriculture, it is expressed as the net consumptive use efficiency in terms of yield per unit depth of water consumed per unit area of cultivation. Crop production is the major water user in the world. Table 10 and 11 respectively summarizes the costs and benefits for paddy and non-paddy crop production in the study villages. The average productivity of water for paddy and non-paddy production included both main products as well as by-products of the crops. The production of each crop was derived by multiplying the area under each crop with respective average productivity value product per unit area. The average productivity from various crops was added to get total value production from crops.

4.3.2.1 Costs, returns and value of water for paddy production

Apart from field survey, data on paddy production were available at the Kilombero district Agricultural and Livestock Development office. According to interviewed respondents in the study villages, crop production (Plate 8) uses a number of inputs such as land, seeds, tools, labour, water and agro-chemicals such as fertilizer/manure and pesticides (Table 9). Observations show that improved seed varieties are relatively expensive and they needed to be purchased at the beginning of each season, when farmers have little cash available. Nonetheless, some farmers use improved seed varieties for paddy production. Most farmers keep a small portion of previous season's harvest as next year's seed so that new seeds do not need to be purchased at the beginning of the season.

The economic value of water for crop production therefore fluctuates based on timing of planting and marketing the crops, owing to the impact of price volatility. For example, the price for rice fluctuates considerably during the year in direct relation to the quantity of produce offered on the market (Fig. 9). Rice marketed early in the season (April-May) fetches a price that can be up to two times higher than the average price later in the season (July-August). This results in fierce competition for water early in the growing season. Conversely, similar results were observed by the URT (2004) in most areas of the country.

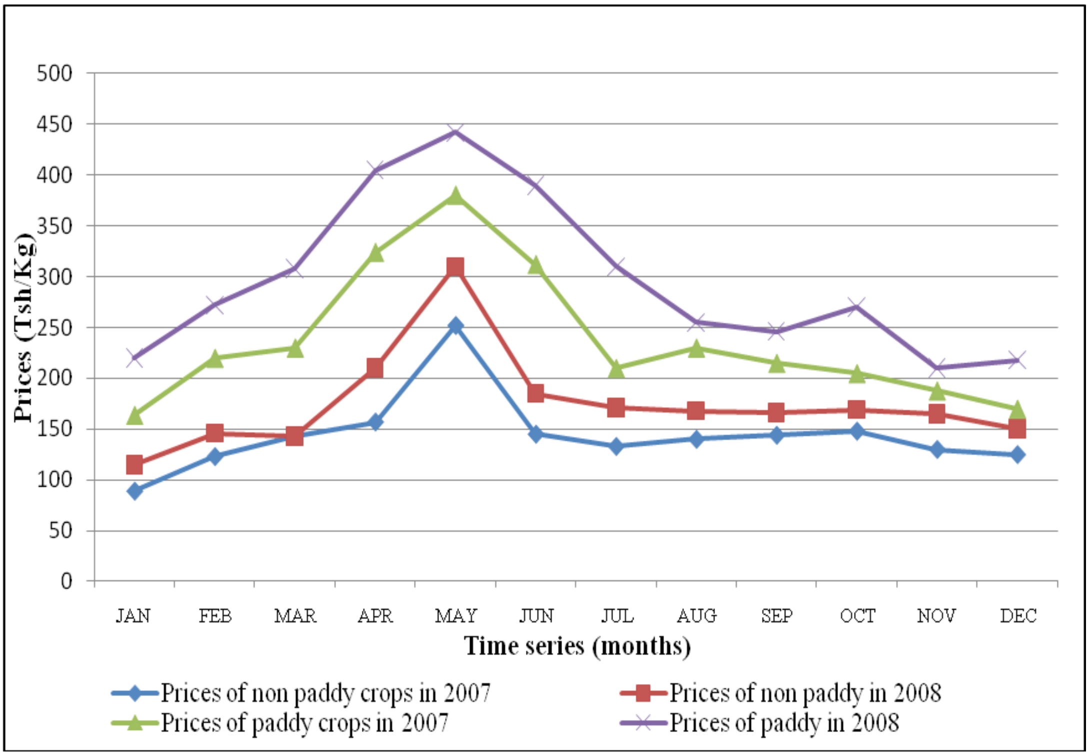

Figure 9: Price fluctuation for crops in the surveyed villages, Kilombero district

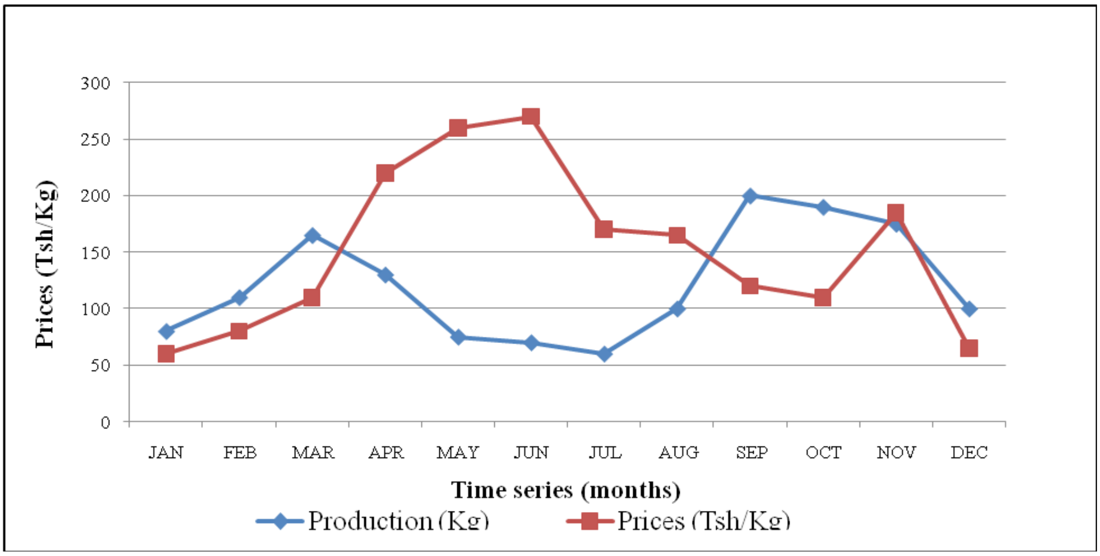

Figure 10: Rice production and prices in the study villages, Kilombero district

The results in Fig. 10 show slight linear relationship between the production and price of rice in January-March and later there are variations whereby the graph shows ups and downs which specify that, the increase in crop production influences the prices. This implies that, as the production (supply) goes up the crop prices falls and vice versa. Although yields are lower, a farmer who harvests in April-May may be able to obtain up to about Tsh. 28 500 (US$ 23.75) per bag of paddy compared to Tsh. 8 500 (US$ 7.1) to Tsh. 14 000 (11.7) later in the season (July and August) (Figure 9 and Figure 10). However, by the end of the harvesting season, the sale price can fall up to Tsh. 7 200 (US$ 6). Sokile and Mwaluvanda (2005); Kadigi (2006) and Palanisami *et al.* (2006) reported that farmers who harvests in April-May may earn Tsh. 22 000 (US$ 18.33) to Tsh. 32 000 (US$ 26.7) in most of Sub-Saharan countries. Hiring of oxen for ploughing and labour for nursery preparation, transplanting and harvesting was common to farmers with insufficient cash. Majority of the interviewed households, who do not have enough money, tend to use their own labour in ploughing their fields by hand hoe. The findings show that both hired and family labour costs approximately Tsh. 103 572 (US$ 86.31) per ha in a respective season for ploughing or transplanting work.

The costs of land was estimated at Tsh. 122 640 (US$ 102.20) per ha in a respective season whereby other variable costs for crop production were approximately Tsh. 387 960 (US$ 323.30) per ha in a respective season. Thus, the total cost (variable costs plus fixed costs) for paddy production in study villages was Tsh. 724 812 (US$ 604.01) per ha in a respective season. The findings revealed that the average income of the interviewed respondents in the surveyed villages is Tsh. 1 272 252 (US$ 1 060.2) per ha per season for paddy production (Table 10). Moreover, the gross margin for paddy production was deduced from gross income, and it was found to be Tsh. 547 440 (US$ 456.20) per ha in one season (Table 10). The average productivity of water for paddy production was estimated at 0.85 kgm^{-3} of consumed water (Table 10). Previous studies (Kadigi *et al.*, 2004; Kadigi, 2006; Palanisami *et al.*, 2006; Sokile and Mwaluvanda, 2005; FAO, 2005; Sharma *et al.*, 2005) show that the estimated productivity of water (PW) in irrigated paddy ranges from 0.059 to 0.250 kgm^{-3} (for withdrawn water) and 0.126 to 0.265 kgm^{-3} (for consumed water) which was reported to be equal to US$ 0.02 to US$ 0.9 per m^3 of water consumed.

Plate 8: Paddy crop production production in Lumemo and Njage

The main inputs used for paddy production were land, agro-chemicals such as fertilizer, hired labour and family labour (Table 9). In this study the average yield was found to be 1 704.92 kg/ha. The results also revealed that the value of consumed water in paddy production is Tsh. 273.6 (US$ 0.23) per $m^3$of consumed water. The results of this study can be compared with those of previous studies (Palanisami *et al.,* 2006; SMUWC, 2001; FAO, 2005; Sharma *et al.,* 2005) which report that water productivity in developing countries ranges from 0.18 kgm^{-3} to 1.01 kgm^{-3} of consumed water. Thus, the result of this study for water productivity (0.85 kgm^{-3}) is within the range that was reported by previous studies.

Table 10: Costs and benefits for paddy production in surveyed villages, Kilombero district

Costs for paddy production	**(Tsh)**	**(US$)**
*Variable costs per ha per season	602 172	501.81
**Fixed costs per ha per season	122 640	102.20
Gross income per ha per season	1 272 252	1 060.21
Gross margin per ha per season	547 440	456.20
Productivity of consumed water (kgm^{-3})	0.85	0.85
Benefits to costs ratio	1.755	1.755
Water		
Average volume of water consumed (m^3/ha)	2 001	2 001
Returns		
Average yield (Kg/ha)	1 704.92	1 704.92
Average value per m^3 of consumed water	273.588	0.22799

*Involves labour, agrochemicals, seeds. **Involves land, ox-plough, hand hoe

However, the volume of water consumed in paddy production was estimated to 2001 m^3 per ha per season by the use of CROPWAT and was given in Table 10. Together with the average yield of paddy produced per ha per season (1 704.92 Kg/ha), the volume of consumed enabled the calculation for the average productivity of consumed water (0.85

Kg/m^3). Therefore, from these results, the value of water for paddy production was established to be Tsh. 273.6 per m^3 of consumed water (Table 10).

4.3.3.2 Costs, returns and value of water for non-paddy crop production

Table 11 provides a summary of the costs, returns and value of water per m^3 of consumed water for non-paddy crop production. Major non-paddy crops which are produced in the surveyed villages are maize, banana, tomatoes, sweet potatoes, vegetables and cassava (Plates 9-11). The average area for non-paddy (mixed cropping) fields per household is approximately 0.7 ha. Most respondents (36.7%) reported that they were using some agrochemicals such as fertilizers and pesticides in non-paddy crop production (Table 9). Most of the farmers who were producing non-paddy crops reported more or less similar inputs for their produce. Some of these inputs apart from land, water, fertilizers and pesticides are labour, seeds and equipments to mention few.

Plates 9-10: Non paddy crop production in study villages, Kilombero district

Plate 11: Non paddy crop production in study villages, Kilombero district

Table 11: Costs and benefits of non paddy production in surveyed villages, Kilombero district

Costs of non paddy production	(Tsh)	(US$)
*Variable costs per ha per season	353 832	294.86
**Fixed costs per ha per season	116 640	97.20
Gross income per ha per season	765 607.2	638.006
Gross margin per ha per season	295 135.2	245.946
Productivity of consumed water (kgm^{-3})	0.6896	0.6896
Benefits to costs ratio	1.63	1.63
Water		
Average volume of water consumed (m^3/ha)	3 363	3 363
Returns		
Average yield (Kg/ha)	2 319.018	2 319.018
Average value per m^3 of consumed water	87.72	0.0731

*Includes costs of labour, agrochemicals and seeds. **Includes costs of land, ox-plough and hand hoe

It was revealed that both hired and family labour costs approximately Tsh. 181 410 (US$ 151.2) per ha in a respective season for ploughing, weeding or harvesting work. Additionally, the costs of land was estimated at Tsh. 91 080 (US$ 75.9) per ha in a respective season whereby other variable costs for crop production were approximately Tsh. 197 880 (US$ 164.9) per ha in a respective season. The total cost (variable costs plus fixed costs) for non-paddy production in study villages was Tsh. 470 472 (US$

392.06) per ha in a respective season. The average income for non paddy crop production in the surveyed villages was estimated at Tsh. 765 607.2 (US$ 638) per season (Table 11). However, the gross margin for non-paddy production (US$ 245.95 per ha in one season) was observed to be less than gross margin for paddy production. The average productivity of water for non-paddy production was estimated at 0.69 kg per m^3 of consumed water and the average yield was found to be 2 319 kg/ha. The average value of consumed water in non-paddy production is Tsh. 87.7 (US$ 0.07) per $m^3$of consumed water (Table 11).

These results on estimated values of water in this study can be compared with those reported in other studies in developing countries like Tanzania and elsewhere around the World. For instance; Turpie *et al.* (2003) estimated the average gross income per unit water used in irrigation at the range of US$ 0.1 to 1.4 per m^3 of consumed water depending on area of the basin and type of irrigation. In the study conducted by Kadigi *et al.* (2004) and Kadigi (2006) in Usangu basin, the estimated value of water in crop production ranging between US$ 0.04 to 0.17 per m^3 of consumed water. This study shows that, the gross income per m^3 of water consumed in paddy production in Kilombero Valley is Tsh. 273.6 (US$ 0.23) and Tsh. 87.72 (US$ 0.07) for non-paddy production. The difference may be attributed to higher water consumption (6 319 m^3/ha per season) and low yields (842 kg/ha per season) for crop production in Usangu compared to Kilombero Valley. This study revealed that 2 001 m^3/ha and 3 363 m^3/ha of water per season was consumed to produce 1 704.92 kg/ha per season and 2 319 kg/ha per season with 0.69 kgm^{-3} and 0.85 kgm^{-3} (Table 10 and Table 11) respectively as the productivity of consumed water for non-paddy and paddy production in the surveyed villages. Also it might be due to loss of water quality by pollutants from industries and the agricultural industry itself. The water productivity of food-grain in India was estimated at 0.48 kg per m^3 of consumed water in the year 2000 (FAO, 2005; Rosegrant *et al.*, 2000; Dinar, 2000).

The results of this study show that water productivity for paddy and non-paddy crop production is 0.85 kgm^{-3} and 0.69 kgm^{-3} of consumed water respectively (Tables 10 and 11). The differences may be attributed by varying cropping and land-use patterns, low growth in yield levels and agro-climatic factors for the former as compared to Kilombero district. Additionally, the latter may have relatively high availability and accessibility of water. However, the key element for the higher water value of the latter is the low non-water inputs used by the farmers which lead to relatively low variable costs of crop production in Kilombero district. Kumar *et al.* (2008) suggested improvements of non-water inputs with better water management as an effective strategy for increasing yield and water productivity in India.

4.3.4 Value of water in livestock production

Average quantity of milk and dung produced per animal per day was worked out from the data collected from farmers. This was multiplied with the actual number of animals in the command area to get the total production per day. Average prices were used to value this physical production. Then this value was multiplied by the number of days in the accounting period to get total value production per household.

4.3.4.1 Costs, returns and value of water for livestock production

The ratio of outputs such as meat, milk, eggs or traction to water depleted is a livestock water productivity and is defined as scale dependent ratio of livestock production (or services) produced per unit of water depleted (Turpie *et al.*, 2003; Young, 1996; 2005).

Table 12: Costs and benefits of Livestock production in surveyed villages, Kilombero district

Costs for Livestock production	(Tsh)	(US$)
*Variable costs (US$)	134 952	112.46
**Fixed cost (US$)	38 400	32.00
Gross income (US$)	1 512 204	1 260.17
Gross Margin (US$)	1 338 804	1 115.67
Benefits to costs ratio	8.7	8.7
Water		
Average volume of water consumed (m^3)	777.61	777.61
Average value per m^3 consumed	1 721.7	1.43475

*Includes costs of labour, agrochemicals. **Includes costs of tax

These results show that the total costs (variable costs and fixed costs) for livestock production was Tsh. 173 352 (US$ 144.46) which includes labour costs for herding, medicine and other variable costs. The average income for the household was estimated at Tsh. 1 512 204 (US$ 1 260.2). The gross margin for livestock production was estimated at Tsh. 1 115 670 (USD 1 115.67) in the surveyed villages. Therefore, the overall average value of water for livestock in Kilombero district is Tsh. 1 721.7 (US$ 1.43) per m^3 of consumed water (Table 12). The results of this study can be compared with those of the study conducted by Kadigi (2006) in Great Ruaha River which gave the estimates of the average value of water as Tsh. 1 176.55 (US$ 1.11) per m^3 of consumed water. However, it should be noted that the estimated values given in Table 12 are short run values based on direct water consumption by livestock and average annual net income generated from sales of live animal and livestock products and by-products.

Additionally, it also takes into account only the variable costs and not fixed costs of equipments, building and depreciation costs. Livestock use water indirectly in their food apart from drinking water, however, this water is usually not available and inaccessible for other sectors and may have some significant opportunity costs. Similar results were observed by Kadigi (2006) in Great Ruaha River, Rosegrant *et al.* (2002) in China and South-East Asian countries and by Kumar *et al.* (2008); Palanisami *et al.* (2006) and Sharma *et al.* (2005) in India. Even if we could consider this water for estimating the value of water, there would have been insignificant changes, due to the fact that the variable costs for livestock keeping is relatively low. This is because herding of livestock is usually done by family members or friends who are usually being paid low wage plus in-kind type of payment.

On average, the return to labour in crop production was less than return to labour in livestock production. When gross margins per hectare are compared, the differences would be described as determined more by the extent to which commercial inputs were used and less by the differences in economies of scale, including of course the levels of crop, livestock and water management.

4.3.5 Value of water for domestic uses

Table 13 summarizes various sources of water for households in the study villages. It has been observed that majority (45.8%) of the interviewed households depend on Kilombero valley and wells as their main sources of water for domestic uses and other uses. Only 11.7% of the households in Kilombero district have connection to pipe water for domestic uses. About 31.7% of households are using an average of 7.5 containers of 20 litres each per day for domestic uses, 30% are using an average of 10.5 containers of 20 litres each, whereby 22.5% are using an average of 13.5 containers of a 20 litres each and only 15.8% are using more than 15 containers for domestic uses per household per day (Table 13). The overall average of daily domestic water consumption was 9 to 13 containers of 20 litres each (Table 13). Kumar *et al.* (2008) and FAO (2005) argued that, family size and lifestyle can influence the use of water in a household.

Table 13: Responses on household domestic water use in surveyed villages, Kilombero district

Sources of water for domestic uses	**Domestic water consumption per day (20Litres/day)**				
	6 to 9 containers	**9 to 12 Containers**	**12 to 15 Containers**	**More than 15 containers**	**Total**
	Percentage				
Wells	1.7	4.2	1.7	2.5	**10**
Both Kilombero Valley and Wells	22.5	8.3	8.3	6.7	**45.8**
Both Kilombero Valley, Wells, Tape pipe, Rivers and Rainfall	5	16.7	6.7	4.2	**32.5**
Tape pipes and wells	2.5	0.8	4.2	2.5	**11.7**
Total	**31.7**	**30**	**22.5**	**15.8**	**100**

Moreover, previous studies (Palanisami *et al.,* 2006; Marshall and Toffel, 2005; Sharma *et al.,* 2005) also revealed that, behavior and lifestyle of the household can influence water consumption per household per day. This may increase the household's ecological footprint. The ecological footprint is a resource management tool that measures how much land and water which a human population requires to support the resources they consume, and absorb the wastes they generate, taking into account prevailing technology (Marshall and Toffel, 2005). Similarly, the differences in the amount of water used per household are attributed by the differences in household sizes and the type of water uses (Table 13). Some of the households have modern toilets while majority have pit latrines hence the former group uses relatively more water compared to the latter group. However, lifestyle and personal behavior contributes significantly on the amount of water to be used per day per household. Some people like to get shower twice a day while others prefers to get shower once a day or four times per week.

According to Young, (2005) the rates of return are measured in terms of economic benefits and economic costs. These costs and benefits have specific definitions in economics. Benefits and costs reflect either willingness to pay (WTP) to secure a gain (or benefit) or to avoid damage (a cost); or willingness to accept (WTA) compensation to forgo a gain or tolerate a cost. These WTP and WTA measures in turn reflect individuals' preferences which are the `raw material' of economic valuation. Fig. 11 shows the percentages of responses on WTP for improved water services in the study villages in Kilombero district. About 64.9%, 48.6% and 47.8% of the interviewed households from Njage, Segamaganga and Lumemo villages respectively were willing to pay less than Tsh. 100 per 20 litres container of water which on average was Tsh. 25.65 (US$ 0.02). However, Kadigi (2006); SMUWC (2001) and UN (2009) in their studies show that, the price of water in most developing countries which ranges from US$ 0.02 to US$ 0.7 per 20 litres bucket was a reflection of the willingness to pay to obtain water services in respective areas.

Some households (43.5%; 32.4% and 32.4%) from Njage, Segamaganga and Lumemo respectively were willing to pay between Tsh. 100 (US$ 0.083) and Tsh. 500 (<0.42 US$) for improved water services for domestic uses whereby only few (0.3%; 0.2% and 4.5%) in that order were willing to pay Tsh. 500 to Tsh. 1 000 (US$ 0.42 to US$ 0.83) for the same. Of the interviewed households, 2.7%; 18.7% and 4.3% from Segamaganga, Lumemo and Njage respectively were are not willing to pay for the improved water services (Fig. 11).

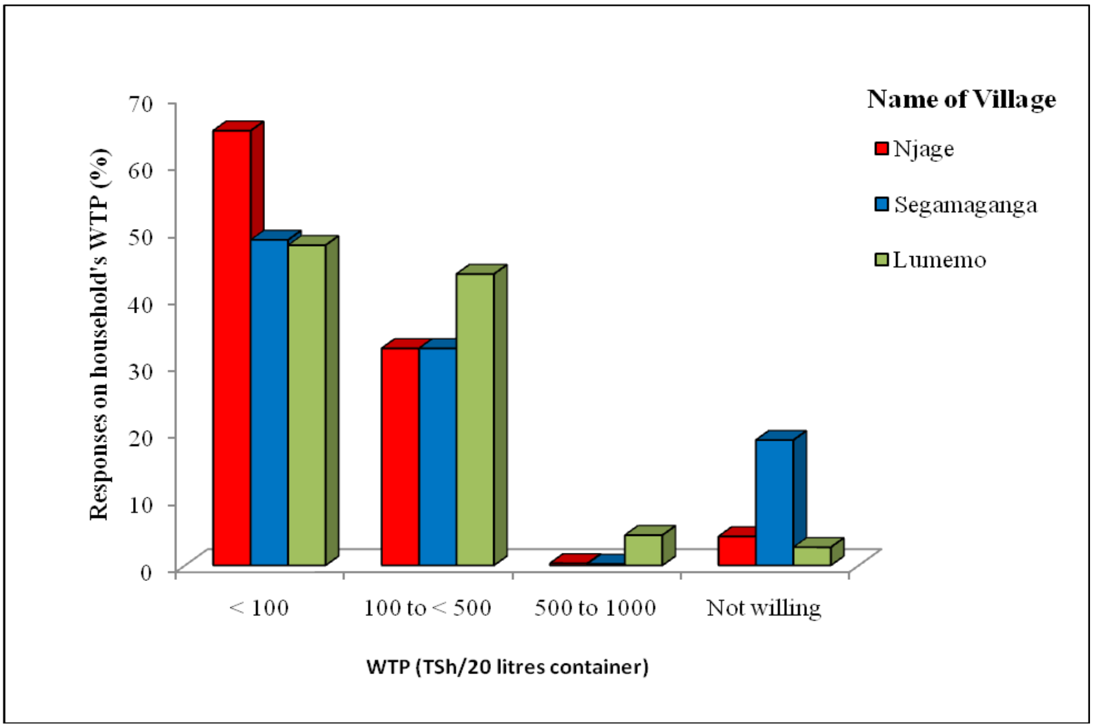

Figure 11: Willingness to pay for improved water services in Kilombero district

Previous studies such as Reisman, 1968; Young, 1996; 2005; Whittington *et al.*, 2002; World Bank, 2002; Ward and Michelsen, 2002; Turpie *et al.*, 2005; Kadigi, 2006; Kumar *et al.*, 2008 and UN, 2009 revealed that willingness to pay is a key concept designed to obtain information on the value placed on different levels of service, natural resources and/or environment (including water) which in turn allows for the fixing of charges which ensure that operation and maintenance costs can be recovered. They further argued that the estimation of willingness to pay schedules should be regarded as an integral component in formulating economically sound environmental policies. Thus from the findings of this study (Fig. 11; 12 and 13) it can be established that local people in the surveyed villages are willing to pay to obtain water services.

Young (1996; 2005); Ward and Michelsen (2002); Turpie *et al.* (2005); Whittington *et al.* (2002) and Kumar *et al.* (2008) argued that the willingness to pay can be influenced by various factors such as household's income, opportunity cost of benefit foregone, characteristics (such as distance and quality) of a matter in question. Similarly, the disparities in the WTP in this study can be attributed by the distance of households to the sources of water. Majority of those who are near to the sources of water were willing to pay less whereby those who are relatively far from water sources were willing to pay high amount for improved water services (Fig. 12; 13 and 14). This can be due to the opportunity cost of time used by those who are far from water sources in fetching water for domestic uses because the time would have been used for other activities. The other possible reason, might be due to the low utility of availability and accessibility of water for those who are near to the water sources. The availability and accessibility of water for nearer households might lead them to perceive water as not scarce hence place less value to it through their WTP.

Nonetheless, the study shows that water is a critical resources even for domestic uses. This is shown by majority (97.3%; 95.8% and 81.5%) of households from Njage, Lumemo and Segamaganga respectively being willing to pay for water services regardless of how much they are willing to offer for improved water services (Fig. 11). The small group (2.7%; 18.7% and 4.3% from Njage, Segamaganga and Lumemo villages respectively), that was not willing to pay for improved water services, claimed that they had been active in supporting development movements in the study area but there is insignificant change. This demonstrates that social capital is indispensable in managing water resource and other natural resources in any social system. Many people have the confidence to invest in collective activities, such as management of natural resources (including water resource) knowing that others will also do so. They are also less likely to engage in unfettered private actions with negative outcomes, such as resource degradation (Randall *et al.*, 2002). Therefore, this study revealed that to some extent willingness to pay is also influenced by the social capital within a society.

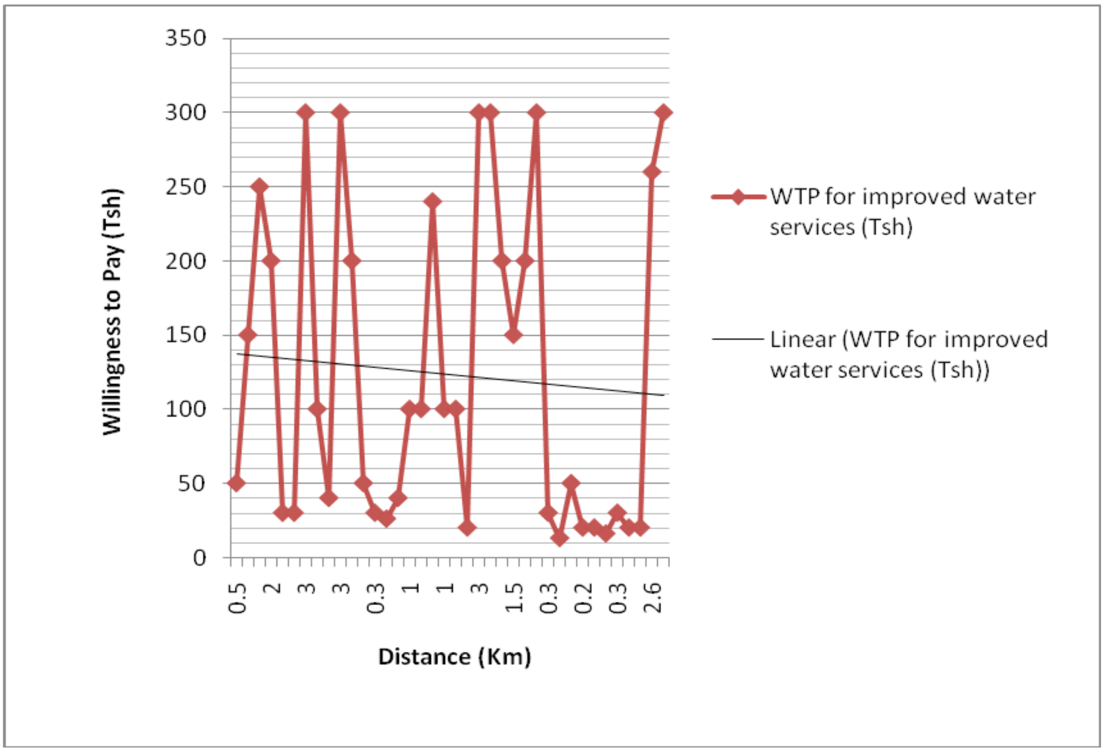

Figure 12: Variation of household willingness to pay for improved water services with distance

Fig. 12 and Fig. 14 shows the dynamics of the household's WTP in relation to distance. It can be deduced from Figure 13 that *ceteris paribus*, the WTP for improved water services varies as the distance from the water sources varies.

At distances 0.2 km to 0.4 km from water sources the households are willing to pay less amount e.g. less than Tsh. 30 (<0.025 US$) whereby at distances 1 km, 2 km, 2.6 km, 3 km the graph shows high values of household's WTP. This implies that respondents were willing to pay high values such as Tsh. 100 (US$ 0.08) to Tsh. 320 (US$ 0.27) as the distances from water sources increases (Fig. 12 and Plate 12). However, other factors such as lifestyle, family size, individual's behaviour, opportunity cost of water resource, opportunity cost of time for fetching water, intrinsic values of water, quantity and quality of water may also attribute to up and downs potrayed in Fig. 12 and 14.

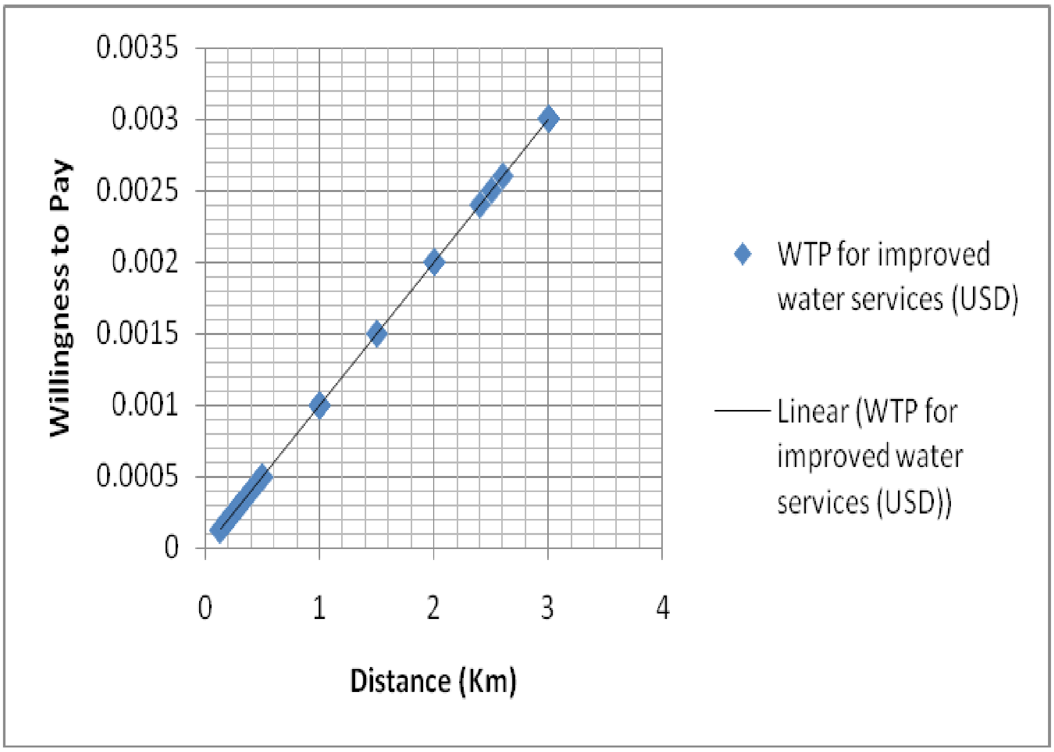

Figure 13: Household willingness to pay for improved water services with distance

Furthermore, it can also be observed from Fig. 13, that the WTP for improved water services in the study villages is directly proportional to the increase in distance from or to water sources. The increase in WTP for an increase in one unit of a distance indicates that, the household is willing to pay 0.1% of their income as an extra amount for an increment of a unit distance in order to improve water services for domestic use. The marginal willingness to pay (MWTP) can be deduced from Figure 13 and can be expressed by the following equation:

$$\frac{\partial WTP}{\partial x} = MWTP \qquad [21]$$

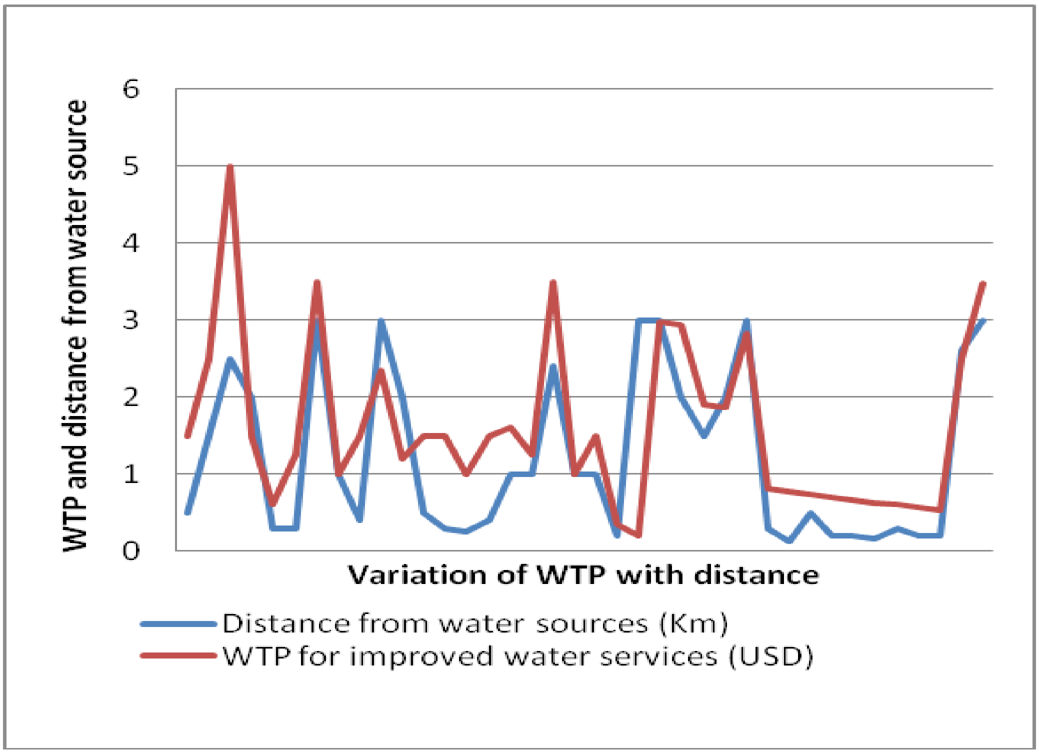

Figure 14: Trends of variation of WTP with distance of household from water sources

Plate 12: Local people fetching water from the drilled well for domestic use

Plates 13-14: Use of domestic water in production of local alcohol *"machicha"*

The average amount of money that the respondents were willing to pay per bucket of 20 litres was Tsh. 25.65 (Tsh. 1282.5 per m^3 of water used) equivalent to USD 1.3 per m^3 of water used (Fig. 11). This can be compared to the market price of domestic water, which was reported in Kilombero Valley and the price charged to cover the maintenance and operational costs for a private well that was drilled by household or a tape pipe water (Plate 12). Based on direct observation in the surveyed villages, domestic water use range from normal uses (i.e. water for washing, cooking, drinking, bathing, cleanliness) to small scale commercial use of water (Plates 12-14). This can contributes on the higher value placed on domestic water use. However, these results can be compared to those from other studies, for example the study conducted by Kadigi (2006) in Great Ruaha River Catchment in Tanzania estimated the value of domestic water consumption at USD 0.95 per m^3 of water.

4.3.6 Value of water for brick making

About 14.2% of the households interviewed in the study area are involved in brick making (Table 7 and Plate 15). The average number of bricks made per household per annum was estimated at 816; 653 and 320 for Lumemo, Njage and Segamaganga villages respectively. This study has revealed that the average productivity of water on brick making is 145 bricks per m^3 of water (Table 14). The CINI Approach was employed and the findings show that the average value of water for brick making in Kilombero district was Tsh. 3 186.7 (USD 2.7) per m^3 of water used.

Plate 15: Brick making in the surveyed villages, Kilombero district

Table 14: Water value for brick making in Kilombero district

	Lumemo	Njage	Segamaganga	Overall Average
Average number of bricks/hd/yr	816	653	320	596.00
Gross income (Tsh)	44 064.00	35 262.00	17 280.00	32 606.00
Production costs (Tsh)	25 642.46	22 261.36	10 909.10	19 604.31
Gross margin (Tsh)	18 421.54	13 000.64	6 370.90	13 001.69
Volume of water consumed (m^3)	5.21	4.61	2.42	4.08
Productivity of water (bricks/ m^3)	157.00	142.00	132.00	145.00
Average value of water (Tsh/m^3)	3 535.8	2 820.1	2 123.6	3 186.69

The productivity of water for brick making in Kilombero district was observed to be the lowest in terms of the number of bricks produced per m^3 of water (Table 14). Despite the lowest productivity of water for brick making, the gross margin and the average value of water per m^3 was the highest (Table 14). This can be described by the relatively higher level of output (i.e. number of bricks produced per annum) and the higher revenue to operational cost ratio in the study area.

The market prices for bricks varied slightly among the sample villages with the average price of Tsh. 54 (USD 0.045) per brick. However, there was variation in prices per brick between villages whereby the high price was reported in places where there are many farmers (most areas of Lumemo and Njage villages) and low value in areas with many pastoralists (most areas of Segamaganga village). This variation can be explained by the fact that, the chances for pastoralists in the study area to shift during drought season seeking food for their herds is relatively higher than farmers who have to take care of their crops especially irrigated crops. Therefore, the former group prefers not to build permanent buildings rather they prefer to build temporary buildings which use less bricks, but the latter prefer to build permanent buildings.

4.3.7 Values of water in different uses

The findings revealed that, the net economic values of water for brick making, livestock production and domestic uses are the highest (Fig. 14). The high net economic value of water for domestic uses (Briscoe, 1996; Kadigi, 2006) is commonly observed cross sectors and it is due to the reason that domestic water use is very important for human health and sanitation. However, the economic values of water in livestock production and brick making are the highest. This might be due to low non-water inputs used in the production processes of bricks and livestock, which are mainly labour costs for both livestock production and brick making and probably medical costs for livestock production. The low non-water inputs used in livestock production and brick making leads to high benefits to cost ratio (Table 12 and Table 14). Furthermore, agricultural sector has a low average value compared to other sectors and this can be attributed by the high non-water inputs which lead to low benefits to cost ratio and in some cases it can be described by relatively low market price of agricultural products (Table 10 and Table 11).

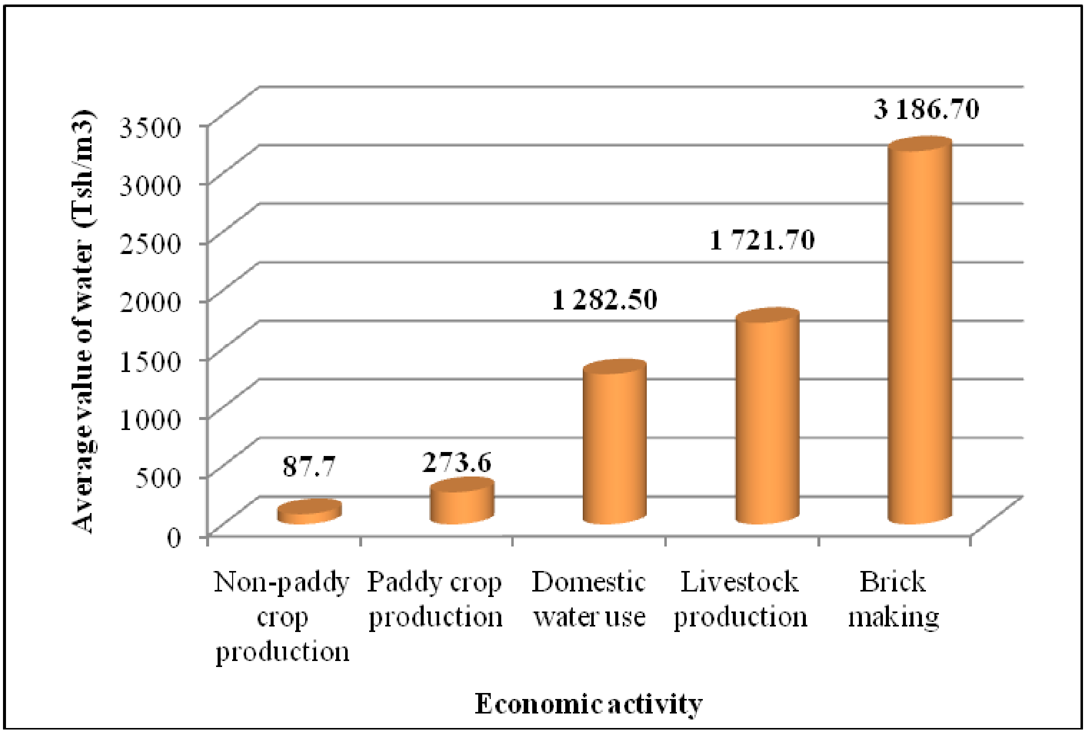

Figure 15: Average values of water in different land uses in Kilombero district

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

The study has used the case of sample villages around the Kilombero Valley Ramsar Site to assess the current net benefit of water in its competing uses in order to fill the gap of knowledge on the net value of water from different land uses in the surveyed villages.

5.1 Conclusion

5.1.1 Main land uses

Access to water and suitable land for wet and dry irrigation agriculture forms one of the most critical key determinants for different land uses in the surveyed villages. Cultivation of paddy and non paddy crops such as maize, banana, tomatoes and vegetables for example requires a land with suitable soils and easy access to water of which is the function of the ability of the household to own or rent such a land. Irrigation and rainfed agriculture, livestock keeping, brick making, small scale business and vegetables production were the main land uses in Kilombero district. Despite its potentials, agricultural sector has relatively small returns to cost ratio as compared to other land uses and yet it is the main water consumer in the study area.

5.1.2 Value of water in different land use

Of all water uses in different land uses the net values of water for brick making, livestock and domestic use are very high averaging at around Tsh. 3 186.7 (US$ 1.7) Tsh. 1 721.7 (US$ 1.4) and Tsh. 1 282.5 (US$ 1.3) per m^3 of water consumed respectively. For irrigated crops such as paddy and non paddy crops the net values were estimated to Tsh. 273.6 (US$ 0.23) and Tsh. 87.7 (US$ 0.073) per m^3 of consumed water respectively. However, the study shows that the return from agriculture is smaller compared to returns from other water uses. This might be due to high input costs in the agriculture sector. The high value for domestic uses which is Tsh. 1 282.5 (US$ 1.3) per m^3 of consumed water relative to agriculture is observed in water value estimates and is due to the fact that domestic uses are crucial for health and sanitation and are relatively low in terms of volume consumption.

Based on the average values per m^3 of water used in different uses, one can conclude that water should be allocated to brick making, livestock and domestic uses because they are the ones which respectively generates high net values of Tsh. 3 186.7 (US$ 1.7), Tsh. 1 721.7 (USD 1.4) and Tsh. 1 282.5 (USD 1.3) per m^3 of water consumed. However, this should not be done just by considering the net values of water rather it should take into account other welfare considerations.

5.1.3 The opportunity cost of water

The opportunity cost of water transfer from irrigated paddy to other alternative uses downstream is considerable both at local and national levels. Rice from Kilombero constitutes 9% of the total national supply in Tanzania. If farmers in this area stop producing irrigated paddy, there will be shrinkage in the national annual rice production with possible increase on paddy and rice prices, unless this gap is covered by increase in rice production from other regions.

5.2 Recommendations

Based on results obtained and conclusion, this study recommends the following to be done for good management of natural resources (including water):

(i) Although, return from agriculture is smaller compared to returns from other water uses, it is a very important land use especially considering that more than 88% of respondents are depending on agriculture for their livelihood. Therefore, this study recommends that emphasis should be put on effective and efficient use of water (e.g. by applying drip irrigation) in order to improve its productivity in agriculture sector. For example water requirement for tomatoes is different from that of maize, therefore applying water (irrigating) at the right time based on different plant water requirement may improve water use by avoiding water loss.

(ii) The benefit-costs ratio and average productivity per m^3 of consumed water for agriculture was observed to be very low compared to other water related land use which was probably due to high costs of inputs in agricultural production compared to other sector. Therefore, this study recommends for a government intervention (tax exemption) to reduce the costs of inputs of production in agriculture sector apart from efficient use of water. However, emphasis should be put on the efficient and proper use of agro-chemicals to avoid unnecessary costs of using them and other problems that may arise such as salinization rather they can use other traditional inputs such as farm yard manure.

(iii) Since, majority (88.3%) of respondents in the study area are owning land, this study recommends good land use practices and conservation of water sources such as Kilombero Valley, raising awareness among water users, involvement of local communities in sustainable land use plan and water management for raising the sense of accountability amongst water users. This is due to the fact that their decision on land use might have impact on water use in the area and may cause water source degradation, thus lead to conflicts amongst water users.

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APPENDICES

Appendix 1: Questionnaire for Household

Questionnaire No. ………………………………………………………………………...

Village…………………….Ward…………………Division …………………………..

Town ....District.......................Name of Enumerator:.............................

Date: ....Checked by: ....

A1: HOUSEHOLD CHARACTERISTICS

1. Are you a head of this household?

   (a) YES [ ]

   (b) NO [ ]

2. Level of Education..

3. Household members' composition. (Table 1)

Age (years)	Male	Female
18 to 30		
31to 43		
44 to 56		
Above 56		

4. What is your main source of income?

   (a) Sales of crops [ ]

   (b) Sales of livestock [ ]

   (c) Small scale business [ ]

   (d) Brick making [ ]

   (e) Salary (specify) [ ]

B: SOCIO-ECONOMIC ACTIVITIES AND LAND USE SYSTEM

5. What are your main economic activities in this area?

   (a) Fishing [ ]

(b) Crop production [ ]

(c) Livestock production [ ]

(d) Brick making [ ]

(e) Others (specify) ……………………………………………………………………….

6. Do what you have mentioned in question number 5 depends on water availability?

(a) YES [ ]

(b) NO [ ]

6.1 If yes; what are the sources of water for the activities?

(a) Kilombero Valley [ ]

(b) Wells [ ]

(c) Tape pipes [ ]

(d) Other sources (Specify) ……………………………………………………………

7. Do your household have land?

(a) YES [ ]

(b) NO [ ]

8. How did you acquire that land?

(a) Bought [ ]

(b) Rented [ ]

(c) Allocated by village government [ ]

(d) Leased [ ]

(e) Inherited [ ]

9. How much money do you spend for hiring land (Tsh per acre per season)?…………Tsh per acre per season.

10.1 How many acres of land do the household own? …….….. (Acres)

10.2 By considering the size of land that your household have; please fill Table 2

Field ID	Area	Ownership	Rent in land	Rent out land
	Area of each field or plot (acres)	1=Owned (idle) 2=Owned (used) 3=Own (rented out) 4=Rented in 5=Borrowed	Amount paid (Tsh)	Amount received (Tsh)

A				
B				
C				
D				
E				
F				

Sub-Totals (Rental Tsh)

Total number of plots (sum codes 1-3 under ownership	Total area owned	Total area used for farming(include land rented in or borrowed)

11. What activities are you doing on this land (that you have mentioned in question 5)?

(a) Crop production (Go to section C) [ ]

(b) Livestock production (Go to section E) [ ]

(c) For rent out [ ]

(d) For brick making [ ]

(e) Others (Specify) ……………………………………………………………………

C: CROP PRODUCTION

12. What type of crop production do you practising?

(a) Irrigation [if irrigation go to Qn 12.1] [ ]

(b) Reinfed [if reinfed go to Section D] [ ]

12.1 What is your source of water?

13. List the irrigated crops you cultivated last season (during the rainy/dry seasons). For each crop state the total area that was irrigated [Do it by filling table 3].

Table 3: List of crops

Crop	Irrigated area (Acre)	State if Dry/Wet season		Number of bags of 100Kg or bundle or "tenga" produced	Average price per unit
		Dry season	Wet season		

14. What inputs were used in producing the mentioned crops in table 3 (Cost-element details)

Table 4. Work sheet for calculating total production cost.

Crop	Name of inputs	Quantity of input used Q	Price per unit L

NB: If there are more inputs then use another sheet

16. Do you pay for the water you are abstracting from the source?

(a) YES [ ]

(b) NO [ ]

17. If yes, how much do you pay per month?

(a) Less than Tsh 1000 [ ]

(b) Tsh 1000 to <5000 [ ]

(c) Tsh 5000 to <10000 [ ]

(d) Tsh10000 to 30000 [ ]

(e) More than Tsh 30000 [ ]

18. Do you plan to increase the area under irrigation?

(a) YES [ ]

(b) NO [ ]

19. If yes, how much?.. (acres)

20. What is your expectation in terms of production increment under the added area? ....……………………………………………

21. Do you think that the available water will be enough for you to increase the area under irrigation?

(a) YES (if yes go to question 22) [ ]

(b) NO (if no go to question 25) [ ]

22. Are you willing to participate in conserving them?

(a) YES [ ]

(b) NO [ ]

23. Explain your answer…………………………………………………………………….

24. Are these sources sustainable in supplying water?

(a) YES [ ]

(b) NO [ ]

25. Are you willing to pay for conserving Kilombero Valley as a source of water instead of private sources?

(a) YES [ ]

(b) NO [ ]

D: RAINFED AGRICULTURE

26. List the crops you cultivated last season (during the rainy/dry seasons). For each crop state the total area [Do it by filling table 11].

Table 11. List of crops

Crop	Rainfed area (Acre)	[Number of bags of 100Kg or bundle or "*tenga*" produced]	Average price per unit

27. What inputs were used in producing the mentioned crops in table 11 (Cost-element details)

Table 12. Work sheet for calculating total production cost.

Crop	Name of inputs	Quantity of input used Q	Price per unit L

NB: If there are more inputs then use another sheet

28. Do you think that the available water is enough for agricultural activities?

(a) YES [go to question 29] [ ]

(b) NO [go to question 31] [ ]

29. Are you willing to participate in conserving water catchment?

(a) YES [go to question 29] [ ]

(b) NO [go to question 31] [ ]

30. Explain your answer?..

31. How much are willing to pay for water catchment conservation?

(a) Tsh 200 [ ]

(b) Tsh 250 to1000 [ ]

(c) Tsh1001 to 1500 [ ]

(d) More than 1500 [ ]

D2: OTHER LABOURING COSTS

This part is for labour costs on farms and Organizations.

32. Labouring on wet season irrigation (Table 5)

Jobs	Unit (days, hours or piece)	Quantity of unit in one season A	Fee per unit (Tsh) B
Land clearing			
Hoeing			
Nursery/Seedlings			
Repair or make *vijaruba*			
Intake repair*			
Canal clearing*			
Irrigating			
Transplanting			
Weeding			
Applying fertilizer, herbicides			
Bird scaring			
Harvesting			
Threshing			
Packing			
Drying			
Transporting			
Sub total of wet season irrigation			

**Paid work, possibly by village government and/or Water Users Association*

33. Labouring on dry season irrigation (Table 6)

Jobs	Unit (days, hours or piece)	Quantity of unit in one season A	Fee per unit (Tsh) B
Land clearing			
Hoeing			
Nursery/Seedlings			
Repair or make vijaruba			
Intake repair*			
Canal clearing*			
Irrigating			
Transplanting			
Weeding			
Applying fertilizer, herbicides			
Bird scaring			
Harvesting			
Threshing			
Packing			
Drying			
Others (specify)			
Sub total of dry season irrigation			

*****Paid work, possibly by village government and/or Water Users Association*

34. Labouring on rain-fed land (Table 7)

Jobs	Unit (days, hours or piece)	Quantity of unit in one season A	Fee per unit (Tsh) B
Land clearing			
Hoeing			
Nursery/Seedlings			
Repair or make vijaruba			
Weeding			
Applying fertilizer, herbicides			
Bird scaring			
Harvesting			
Threshing			
Packing			
Drying			
Transporting			
Others (specify)			
Sub total of rain-fed land			

Grand total cost for labour (32+33+34)

E: LIVESTOCK PRODUCTION

35. Do you keep livestock?

(a) YES [ ]

(b) NO [ ]

36. If yes what type of livestock mode of feeding and products produced? (Fill the table 8)

Livestock type	Number	Mode of grazing		Quantity of livestock products produced			
		Dry season	Wet season	Milk (Litre)	Meat (Kg)	Eggs	Others name
Cattle							
Goats							
Sheep							
Chicken							
Ducks							
Donkey							
Others specify							

37. What inputs were used in producing the mentioned above (Cost-element details)

Table 9: Work sheet for calculating total production cost (including labour)

Type of Livestock	[Name of inputs]	[Quantity of input used] Q	[Price per unit] L	Cost of input W=Q*L	Total Cost for each Crop (Sum of "W" values)
Cattle					
Goats					
Sheep					
Chicken					
Ducks					
Others specify					

38. How many units of livestock products were produced for each individual?

Table 10: Work sheet for calculating net livestock output

Type of Livestock	Type	Units of livestock products produced "E"	Average price (Tsh) "F"
Cattle			
Goats			
Sheeps			
Chicken			
Ducks			
Others specify			

39. Where do you get fodder or food for your livestock for poultry?

40. Have you ever experience the fodder/poultry food shortage?

(a) YES [ ]

(b) NO [ ]

41. If yes, what do you think were the reasons?

(a) Drought [ ]

(b) Deforestation [ ]

(c) Other reasons (Mention)…………………………………………………………….

42. How do you solve the problem of fodder shortage during dry season?........................

43. How many litres of water consumed per animal (individual) per day?

44. How much does water cost per container (i.e. 20L bucket)? ……………………Tsh

45. Have you experience water shortage for your livestock in the last 5 years?

(a) YES [ ]

(b) NO [ ]

46. If yes, what do you think were the factors for water unavailability and inaccessibility?

(a) Drought [ ]

(b) Improper allocation [ ]

(c) Limitation by water authorities [ ]

(d) Others (Mention) …………………………………………………………………

47. Do you plan to increase the number of your livestock?

(a) YES [ ]

(b) NO [ ]

48. If yes, how big is the size of livestock in terms of number that would you think to have?..

49. What is your expectation in terms of production increment after this increase that you mentioned in question 47?

50. Do you think that the available water will be enough for you to increase the number of livestock considering the fodder production, drinkable and washing water for livestock?

(a) YES [ ]

(b) NO [ ]

51. If yes (question 50), are you willing to participate in conserving them?

(a) YES [ ]

(b) NO [ ]

52. If yes, explain how...

53. Are these sources sustainable in supplying water?

(a) YES [ ]

(b) NO [ ]

54. If no (question 50), are you willing to pay in conserving Kilombero Valley as a source of water instead of private sources?

(a) YES [ ]

(b) NO [ ]

55. If yes, how much money are you willing to pay per year in order to get enough water? ……………………………………………………………………………………..

56. Will this amount decreased if you got financial crisis and vice versa?

(a) YES [ ]

(b) NO [ ]

57. Explain your answer ………………………………………………………………

58. Are you willing to pay additional amount for its services improvement?

(a) YES [ ]

(b) NO [ ]

D: WATER FOR DOMESTIC USES

59. Where do you get water for your daily domestic uses during the wet season?

(a) Kilombero Valley [ ]

(b) Wells [ ]

(c) Tape pipes [ ]

(d) Rivers [ ]

(d) Other sources (Specify) ………………………………………………………………

60. What is the average amount of water (in terms of gallons or buckets of 20 litres each) do your household use per day?

61 Do you use water for brick making?

(a) YES [ ]

(b) NO [ ]

62 If yes, how many buckets of water in average do you use for making bricks? .... [20 Litres container]

63 How much money do you earn from one brick? ....Tsh/brick.

64. How far do you have to walk to fetch water?

65. Do you pay for water you are using for your domestic uses?

(a) YES [ ]

(b) NO [ ]

66. If yes, how much per container (20 Litres container)?

67. Suppose you get a tap water or pedal well installed in your village, will you be willing to pay for the service?

(a) YES [ ]

(b) NO [ ]

68. If yes, how much would you be willing to pay for the service (per a 20 litres container of water?)

………………. [Enumerator should continue asking the respondent giving specific choices in the form of a bidding game increase the amount by 10%, then 5% and continue increasing by 5% till the maximum WTP for the respondent is arrived at. Provide justification for the increase in value – relate this operation and maintenance costs/service provision]

THANK YOUFOR YOUR ATTENTION

Appendix 2: Checklist for key informants

A. Personal Information

(1) Name…………………………………………………………………………..

(2) Sex……………………………………………………………………………..

(3) Title…………………………………………………………………………….

(4) Location/place…………………………………………………………………

B. Perceptions of people on the wetland cultivation

5. (a) What are the main water based economic activities that people engaged with?

(b) What other activities people engaged with apart from water based activities?

(c) What are the major food and cash crops? (Arrange in ranking)

(i)…………………………………………………………………………………

(ii)………………………………………………………………………………..

(iii)……………………………………………………………………………….

6. What is the total annual average income per household from?

(i) Agriculture products.....................……………………………………..

(ii) Livestock products……………………………………………………

7 (a). What is the average number of people in the village cultivating around the Kilombero Valley wetland (KVRS)?

....

(b). Why people are cultivating around the wetlands? give reasons

(c). What is the average number of people in the village engaged in livestock keeping around the of Kilombero Valley wetland (KVRS)?

(d) Why do they engaged in livestock keeping around the KVRS? Give reasons

(i)………………………………………………………………………………… (ii)

…………………………………………………………………………………

8. (a) Are these wetlands valued by the District /Government?

b) If yes, why? ………………………………………………………………

c) If no, what might be reasons? ....

9. What are socio-economic factors affecting production potential of wetland areas?

10. Are all members of communities (Households) accessible to water resources?

(a) YES [ ]

(b) NO [ ]

(c) Explain your answer

C. Perceptions on cost of inputs of production

11 What are mostly types of fertilizers and pesticides used in water based cultivation?

(a) Fertilizer ………………………………………………………………… …

(b) Pesticides……………………………………………………………………

12 (a) How is the cost of fertilizer compared to the previous season? ………………

(b) How had this affect the crop production? ....

13 (a) How is the cost of inputs for livestock production compared to the previous season?

(b) How had this affect the livestock production?..

14 What is the average price of water per container [20L] Tsh………per gallon

15 What is the average number of livestock per household in the district?…………..

THANK YOU FOR YOUR TIME AND INFORMATION