ANALYSIS OF DRIVERS AND ECONOMIC CONSEQUENCES OF WETLAND DEGRADATION ALONG RUVU RIVERINE IN COASTAL TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENVIROMENTAL AND NATURAL RESOURCES ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE.

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ABSTRACT

The current study intended to analyse the drivers, communities' awareness and economic consequences of wetland degradation to local population living along the Ruvu riverine in Morogoro rural and Kibaha districts. The study deployed a number of methodologies including household questionnaire survey, interview, focus group discussion and review of satellite images of land use change in the riverine to collect data. Data were analysed using Statistical Software for Social Science, content analysis, Land Ecosystem Disturbance Adaptive Processing System and ArcGIS 10 software. The findings from satellite imagery analysis indicate the prevalence of wetland degradation within the study area. Findings from field survey show that livestock grazing is the main cause of wetland degradation accounting for 53% (n=122) of the degradation, arable farming was ranked as the second most prominent driver accounting for 48% (n=122), brick making was ranked as the third significant driver contributing 46% (n=122) and fishing was ranked as the fourth prominent driver contributing 39%. The findings also revealed that the majority of the respondents were mostly aware of direct benefits of wetlands. About 75% of the respondents confirmed that floods are the main consequence of wetland degradation in the area. The findings show further, that the local community perceive wetland degradation as having great negative effects on their economic status especially with regards to accessing food and generating income. Furthermore, independent variable was able to explain about 33.2 % of the variation in the dependent variable. The study concludes that anthropogenic activities associated with low awareness on values of wetland significantly results to wetland degradation which has serious economic costs to the local communities and the government. The study recommends that awareness on the

direct and indirect benefits of wetlands and proper land use practices should be raised among the communities to enable proper use of wetlands.

DECLARATION

I, Gerubin Liberath, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted to any other institution.

_____ _____

Gerubin Liberath Date

(MSc. Candidate)

The above declaration is confirmed by;

_____ _____

Prof. John Francis Kessy Date

(Supervisor)

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DEDICATION

This work is dedicated to my beloved parents Mr. Liberatus Msaki and Theresia Liberatus who laid the foundation of my education. This work is also dedicated to my Uncle Gabriel John Silayo for his support and encouragement during the entire time of my studies.

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LIST OF ABBREVIATIONS AND ACRONYMS

ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
FGD	Focus Group Discussion
GIS	Geographic Information System
ha	Hectare
IUCN	International Union for Conservation of Nature and Natural Resources
Km^2	Square Kilometres
Lab	Laboratory
LEDAPS	Land Ecosystem Disturbance Adaptive Processing System
LULC	Land Use Land Cover
MJNUAT	Mwalimu Julius K. Nyerere University of Agriculture and Technology
MNRT	Ministry of Natural Resource and Tourism
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Statistics
NRM	Natural Resource Management
NS	Not significant
OLI	Landsat Operational Land Imager
P	Probability level
R^2	Coefficient of determination
SPSS	Statistical Package for Social Sciences

SUA	Sokoine University of Agriculture
TM	Landsat Thematic Mapper
URT	United Republic of Tanzania
USGS	United States Geological Surveys
WRBWO	Wami/Ruvu Basin Water Office.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

An internationally agreed upon definition of wetlands is unavailable. However, the common and overriding theme of most definitions consists of some component related to hydrologic conditions (Zedler and Kercher, 2005; Moore, 2008). Perhaps one of the best current definitions of a wetland, at minimum for the context of this work, was that set by the Ramsar Convention. The Ramsar Convention on Wetlands (1971) produced an international, intergovernmental treaty which defined wetlands somewhat broadly as "areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, brackish or salty, including areas of marine water the depth of which, at low tide, does not exceed six meters".

The global wetland area is estimated to be 7 to 9 million km^2 which is equivalent to 4% to 6% of the land surface of the earth (Mitsch *et al.,* 2004). Global wetlands are categorized into Coastal wetlands, Inland wetlands, and Human-made wetlands (Ramsar Convention Secretariat, 2013).

Wetlands are among the most biologically productive ecosystems as they are rich in species diversity and habitats (Mironga, 2005; Mwakaje, 2009). Since, wetlands contain numerous goods and services that have economic value, they support millions of people living in their periphery as well as those living outside the wetlands at the national, regional and global levels (USAID, 2014). The wetlands are also habitats for a number of biota (Ramachandra *et al.*, 2011; Roy *et al*., 2012; Hagos *et al.*, 2014).

Human activities taking place around and within the wetland area are the most driving force for wetland degradation globally (Ramsar, 2015). As Davidson (2014) points out, the global extent of wetlands is estimated to have declined between 64 and 71% in the 20th century, and wetland losses and degradation continue worldwide.

Wetlands in Africa, which are estimated to cover about 131 Million ha, provide an important source of water and nutrients which are necessary for biological productivity and people's survival. Despite their importance, wetlands in Africa are being modified or reclaimed; measures which are often driven by economic and financial motives. Sustainable management of wetlands is therefore critical to the long-term health, safety, and welfare of many African communities (USAID, 2014).

In Tanzania, about 10% of the country's land is covered by wetland resources such as the great lake system, inland drainage systems, major river networks and deltaic mangroves and degradation threat them leading to change in their size and functions that they can provide to the ecosystem. Some of the major wetlands systems forming the valley bottom wetlands in Tanzania include the Great Ruaha, Wami, Kilombero, Pangani, Malagarasi, Ruvu and Katavi River. The largest in this category is the Great Ruaha river system with wetlands covering 6950 ha (MNRT, 2003). As stated earlier, wetlands have significant economic, social, cultural and biological values (URT, 2007) and perform a number of functions such as production of electricity, groundwater recharge, control of floods, water retention, prevention of eutrophication of rivers and lakes, supporting specific biota and traditional uses. Also, , wetlands contribute significantly to the country's Gross Domestic Product through tourism (URT, 2007).

Ruvu River, which originates from Uluguru Mountains, is another most important wetland in Tanzania. The Uluguru Mountains are part of the Eastern Arc Mountains. Ruvu River is a catchment of water supply for both domestic and industrial purposes to Dar es Salaam, Coast and Morogoro regions (URT, 2008). According to Munishi *et al.* (2007) reported that, the main Ruvu-Kibungo sub catchment, which drains a bigger proportion of the river, is relatively more degraded because of agricultural activities that have high potential for further degradation which is likely to cause more negative impact on the flow of water downstream.

Wetland degradation deprives the society of quality water, enough quantity of water, fish and wildlife habitat, as well as recreation benefits, and increases the cost to the society of replacing wetland services. Wetland conversion through development or agricultural production is said to generate "negative externalities" or unintended harmful effects on individuals. Therefore, this study intended to explore the contribution of various economic activities (drivers) to wetland degradation, community awareness on the value of wetland and wetland degradation as well as the economic implication of this degradation to the local population living in and around the Ruvu riverine wetland area in Kibaha and Morogoro rural districts which both lies in coastal Tanzania.

1.2 Problem Statement

Human populations in and around the Ruvu riverine basin are heavily dependent on this river for various socio-economic activities and the influence of these populations has left its mark on the River's ecosystem (USAID, 2014). Human activities carried out along the basin have continued to alter the natural flow regimes of the River and have major consequences to wetland ecosystems and the community that depend on them (Yanda *et al.,* 2007). Wetlands degradation is caused by human activities that take place within them and by activities that take place within the wider catchment (Kashaigili *et al.*, 2006).

A study by Sakataka *et al.* (2014) shows that in many developing countries, which rely on agricultural and other land-based resources, population boom coupled with diminishing reliability of rainfall and declining yields have resulted to the expansion of livelihood activities into wetlands resulting to intensive degradation of wetland areas. In this regard, studies (e.g. Ngana *et al.*, 2010; Millennium Ecosystem Assessment, 2005; Coleman *et al.,* 2008; Vermaat *et al.,* 2013) have shown that agriculture, which involves both modifications of land cover and irrigation abstractions, is the foremost cause of wetland loss and degradation in many wetland ecosystems. However, little is known regarding the percentage contribution of various economic drivers to wetland degradation. This therefore impedes efforts on combating wetland degradation in many wetland areas in Tanzania. Furthermore, little is documented on the consequences of wetlands degradation to the ecosystems and to the communities living downstream and which depends on these wetlands for various uses in Tanzania.

People living in the settlements close to wetlands and earning their living from wetland resources remain unaware of conservation policies, ignorant of the implications of their practices and uninformed of the new messages or the long-term benefits they could achieve from wetland resources (Mironga, 2005). Most studies in Ruvu riverine (i.e. Munishi *et al.,* 2007; Kashaigili, 2011; USAID, 2014) have focused on rapid Environmental flow assessment and hydrological and land use cover change. However, little has been done to assess the general awareness of the communities residing close to and around this wetland on the value and degradation of wetlands and control measures of wetland degradation in the area.

Generally although previous studies (e.g. Ngana *et al*., 2010; Munishi *et al.*, 2007; Kashaigili, 2011; USAID, 2014) have been carried out in Ruvu river wetland none of these has explicitly quantified the contribution of various drivers to wetland degradation and economic consequences of wetland degradation to the local population living along the Ruvu riverine wetland area. Also none of these studies investigated community awareness on the value of wetlands and consequences of their degradation as well as community practices against wetland degradation in the area. Therefore, the present study intended to fill this knowledge gap and improve understanding of the contribution of each driver to wetland degradation, implication of wetland degradation to the local community income and the level of the local community awareness on the value of wetland and the likely consequences of degradation. Furthermore, the study will give an understanding on the community practices towards controlling wetland degradation within the study area.

1.3 Study Justification

The findings from this study provide useful information to researchers, farmers, environmental experts, water management authorities, wetland conservation institutions, policy makers and planners as a basis for decision making in enhancing sustainable wetland use and management. Further, the findings obtained are also useful in prioritizing drivers to wetland degradation that need more attention and therefore taking immediate measures to offset them. Furthermore, the findings also provide baseline data with regard to contribution of various drivers to wetland degradation, the level of community awareness on the value of wetland and economic consequences of wetland degradation which will specifically help in all setups aimed at ensuring the conservation of wetland resources in the country.

1.4 General Objective

The general objective of this study was to quantify the contribution of various drivers to wetland degradation, community awareness and economic consequences of wetlands degradation along Ruvu riverine in Coastal Tanzania.

1.4.1Specific Objectives

The specific objectives were to:

(i) Establish evidence on the extent of degradation within the study area,

(ii) Analyse contribution of various economic activities to wetland degradation,

(iii) Assess community awareness on the value of wetland, causes and consequences of its degradation and their practices on controlling it and

(iv) Estimate economic implications of wetland degradation to household income

1.4.2 Research Questions

(i) What is the extent of wetland degradation in riverine wetland area?

(ii) What is the contribution of various economic activities to wetland degradation?

(iii) What is the level of awareness in the community on the values of wetland and their practices on controlling wetland degradation?

(iv) What are the implications of wetland degradation to the income of the local population around the wetland area?

1.5 Limitations of the Study

The study encountered several limitations during data collection. However, necessary measures were taken to overcome them to ensure success. The following were limitation's encountered during this study;

(i) Poor recalling of information

Some respondents were unable to recall their annual average income of the past five years 2011-2015. This was due to poor record keeping on the amount of income accrued by the respondents over a period of time. This was minimized by asking the respondents to recall the quantity of products they extracted from wetlands and then estimate the annual income and this was complemented with some secondary data obtained from village offices.

(ii) Unwillingness to disclose income information

Some respondents were not willing to disclose their average annual income level information due to the fear of insecurity in spite of the researcher's efforts to explain the purpose of the study. However, this was minimized by using alternative questions and altered the methods of questioning which made households to disclose their information unknowingly.

(iii) Poor record keeping

During this study a problem of getting secondary data of incomes, wetland productivity and average river flow was encountered. In most villages, there were difficulties in getting data on average income and productivity from wetland; however this problem was minimized by consulting previous village leaders and contacting Wami-Ruvu basin water officers that used to work at Ruvu riverine.

(iv) Inadequate funds

Funds for various research activities that were proposed during the proposal writing to the sponsor was also a problem because the sponsor had provided only 44.44% of the basic university research fund required for MSc. Study. This led to a number of problems in purchasing field gears as well as accessing secondary materials that were needed to be purchased such as satellite image of change detection. However, this was minimized by using researcher's own money to ensure success of the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

This chapter presents summary of relevant scholarly perspectives on definitions of various terms, wetland management and conservation in Tanzania; wetland degradation; various drivers of wetland degradation; community awareness on values of wetland and wetland degradation and the control practices and the economic implication of wetland degradation to local communities and biodiversity.

2.2 Definition of terms

2.2.1 Wetland Degradation

Wetland degradation is the alteration of an existing wetland through impairment of some physical and chemical property leading to decrease functions and values that it can provide to the ecosystem and human population. Wetland degradation is caused by both human and natural activities taking place around and within the wetland area and are the most driving force for wetland degradation globally (Ramsar, 2015).

2.2.2 Riverine

A riverine is a landscape formed by the natural movement of a water system such as a river. A riverine landscape includes the ecosystems (all living things including plants and animals) in and around the area of a river. A riverine may also be defined as a network of rivers and surrounding land. Riverine landscapes are excellent for agricultural uses such as farming because the land is rich and fertile. They are a valuable resource for growing food (Ramsar Convention Secretariat, 2013).

2.3 Wetland Management in Tanzania

There are several wetland management strategies that are aimed at attaining sustainable wetland management in Tanzania. The strategies include provisions in natural resources management policies and guidelines that address important matters that are related to the conservation and management of wetlands. Various policies such as National Agriculture Policy (2013), National Water Policy (2002), Fisheries Policy (2015), National Forest Policy (1998), Land policy (1997), The National Environmental Policy (1997), Wildlife policy (2007) and Livestock policy (2006) and National Guidelines for Sustainable wetland Management all of these incorporated the need for proper management and use of wetlands in Tanzania. However, these policies and guidelines are fragmented and uncoordinated due to diverse sectorial objectives, goals, administration and specialized legislation and, as a result, many wetlands in Tanzania are being degraded by diverse human economic activities. Thus, some of the policies need to attain successful utilization of these resources regardless of the impacts of the practices stipulated in the policy (URT, 2007). For example, the land policy of 1997 categorizes wetlands as hazardous areas and therefore these areas are not allowed by law to be entitled to any individual or group of individuals for whatever use (URT, 1997), the agriculture policy on the other hand encourages efforts to be taken to develop an effective irrigation system in the country. This is because irrigation ion is considered to be essential for increased productivity and production as it mitigates vagaries of weather, which are becoming more frequent and intensive because of global climate change. This policy however does not say specifically as to what sustainable wetland management measures need to be established under irrigation schemes and therefore creating a loophole for more degradation of wetlands in the country (URT, 2013). A part from the various policies and guidelines on wetland management mentioned above in year 2000 Tanzania ratified the convention of international importance on wetlands known as Ramsar Convention which

essentially encourages the wise use of wetlands among contracting parties. Among the wetland that has been listed as Ramsar sites in Tanzania include the Malagarasi – Muyovozi Wetlands, Lake Natron Basin, Kilombero valley floodplain and Rufiji-Mafia-Kilwa Marine Ramsar Site. The convention calls upon the contracting parties to establish appropriate laws and policies to ensure that wetland resources are not depleted. This has remarkably helped to reduce degradation in these areas as opposed to those areas which are not designated into this category (Majamba, 2012).

2.4 Wetland Degradation

Over years human activities has been the main cause of wetland degradation and loss by changing water quality, quantity or flow rates, increasing pollution and change the make-up of the species within habitat as well as the total functions and values that wetlands can provide to human and the ecosystem. As Bai *et al*. (2013) observe, with the rapid growth in human populations, wetlands worldwide are suffering from serious degradation or loss resulting from wetland pollution, wetland reclamation, civilization and land use changes. Wetland degradation has potential negative influence on human health, biodiversity, regional climate, and regional ecological security. The use of various remote sensing and GIS techniques for environmental policy development and evidencing degradation is now quite common and useful in assessing the state of ecosystems, as images from remote sensing platforms are often used to focus attention on emerging environmental issues and spur debate on potential policy solutions and conservation of natural resources in many parts of the world. However, the use of these instruments in policy implementation and evaluation has not been examined in much detail. Remote sensing data have been used extensively both to assess the loss of wetland area and, to a lesser degree, to assess the loss of wetland functions and services. These efforts have led to a more detailed understanding of wetland conditions such as vegetation community

characteristics, hydrologic regimes, and soil conditions. These biophysical details can identify degradation that affects the total functional area of a wetland, as well as the ecosystem services it may provide. However, these efforts have rarely led to anything beyond limited requirements for monitoring (Mayer *et al.,* 2011). Xie *et al.* (2008) reported that Satellite remote sensing has several advantages for monitoring wetland resources, especially for large geographic areas and no man's land since it gives clear evidence of the land use change that has been happening over the years.

2.5 Drivers of Wetland Degradation

Over the years, wetland health has been affected by poor agricultural practices which cause negative changes to wetland environments. A study by Vermaat *et al.* (2013) on meta-analysis of 105 wetland study cases reported that agricultural development has been the main proximate cause of wetland conversion whereby economic growth and population density are the most frequently identified underlying forces. Significant factors explaining wetland conversion in the order of importance include market influence, total wetland area, mean annual temperature and cropland or built up area.

According to Munishi *et al.* (2014), the major reasons for degradation in many parts of Tanzania are increasing human population, exploitation of wetland resources and conversion of wetlands into agricultural land. Inappropriate grazing regimes and stocking rates associated with increasing livestock population, increasing irrigation activities as well as lack of proper wetland management policies and strategies continue to threat wetland areas in different parts of the world causing changes in the services and goods accrued from wetland resources (URT, 2007).

Conflicts between famers and livestock keepers are now very common in the Tanzania especially in wetland areas which are rich in soil and biodiversity; this is due to increased

human population resulting into increased demand for areas for agriculture and livestock keeping, food and income generation. This demand has resulted into serious wetland degradation because such wetlands become overexploited (Kashaigili *et al.,* 2006).

Various communities (the local farmers as well as the immigrant livestock keepers) encroach the wetland areas in different parts of the world. The multiple uses of the rivers and insufficient human and financial resources for proper water resources management threaten the efforts of conserving the natural resource, and the diversity of users. Further, people's relationships with the environment have also posed additional challenges to wetlands management plans country wide. Among other reasons that have been witnessed to function as drivers of degradation include urbanization, industrial development, and population growth. Absence of specific policy on wetland adds to poor implementation of the existing policies which have connections to wetlands and thus putting wetlands under pressure of degradation by various anthropogenic activities. On the other hand, lack of well-organized institutional arrangement provides a loop for various driving forces to wetland degradation to have severe consequences in many parts of the world.

2.6 Awareness on the Values of Wetland and Consequences of Degradation and controlling practices

Awareness is the ability to directly know and perceive or to be conscious of events, conditions, situations or objects existing in a particular area. Local communities living around wetlands areas are relatively unaware of diverse ecosystem service that can be accrued from wetland areas. Kateregga (2005) shows that most wetland resource users are relatively aware of only three direct benefits of using wetlands such as water for agriculture activity, water for domestic and industrial use and fishing activity making

them to underrate the present and future values of wetlands. Such perceptions and attitude have often led to inappropriate management practices and consequently wetland degradation. Low awareness on the total value of wetland among the communities living adjacent to wetlands is one of the reasons for improper use and poor management of wetlands resources. A study by Finlayson *et al.* (1999) shows lack of adequate information and awareness on national inventories on wetland degradation that indicates the real extent and loss of wetlands as well as consequences of that degradation as the main reasons for persistent wetland degradation. Further, there is little information on the values and benefits (products, functions and attributes) derived from wetlands and how these have been degraded or lost. Moreover, lack of awareness and understanding on non-ecological causes of wetland degradation continue to threaten wetlands in many parts of the world. It is generally accepted that community involvement in understanding local resources increases the possibilities of taking management measures. For example, local knowledge has been used in monitoring water quality and grazing landscapes to understand how ecological changes happened on such landscapes over time and space. A study by Pender *et al*. (2008) found out that there is a strong association between awareness and compliance with Natural Resource Management bylaws. Therefore, this suggests that there is a need to promote environmental education as part of the strategy to increase compliance with NRM bylaws.

2.7 Economic Implications of Wetland Degradation to Household's Income

According to Wasswa *et al.* (2013), degradation of wetlands implies serious economic costs to the government and local communities reflected in high expenditures in duplication of wetland services, foregone incomes, livelihood support and alternative employment. According to Ramsar (2015) wetlands support family livelihoods through crop production, grazing pastures, fishing, hunting, harvesting medicinal plants and artisanal works. However, with all the potential benefits wetland provides and given the

extent of ongoing exploitation of these wetlands resources there are many reasons to believe that these important areas are fast degrading and disappearing before much is known about them. Ramsar (2015) report shows that the trend of services and goods offered by wetlands decline overtime due to increased human population and utilization pressure of the wetland resources in different parts of the world. Also because of wetland losses and degradation, people are deprived of the ecosystem services that wetlands provide. Adverse changes to wetlands are estimated to result in more than 20 trillion US$ in losses of ecosystem services annually globally (Ramsar, 2015). Wetlands also play an essential role in food security, especially during dry seasons or drought years, when dry land farming, which is limited to the rainfall season, cannot adequately cater for the needs of these households (URT, 2007). Similarly, Mekonnen *et al.* (2011) reported that wetland losses are affecting the rural food security, water availability, climatic variability, and biodiversity.

A study by McCartney *et al*. (2004) revealed that in Kilombero, the wetlands contribute 98% to the food security intake of all households in the villages. Forty percent of the households acknowledge using wetlands as a coping strategy during food shortages but this is estimated to decline due to improper wetland use which results to degradation. Farming activities are among the major economic pursuits around wetlands areas. The crops cultivated include paddy, maize, and various types of vegetables and fruits (URT, 2007). The practice of growing rice in swampy areas is increasing in many African countries and the world at large as it contributes to food supply and income generation. Although many wetlands have been supporting local communities, these activities, population boom, and the need for development tend to threaten these wetlands result to degradation and a decline in goods and services offered by these wetlands.

CHAPTER THREE

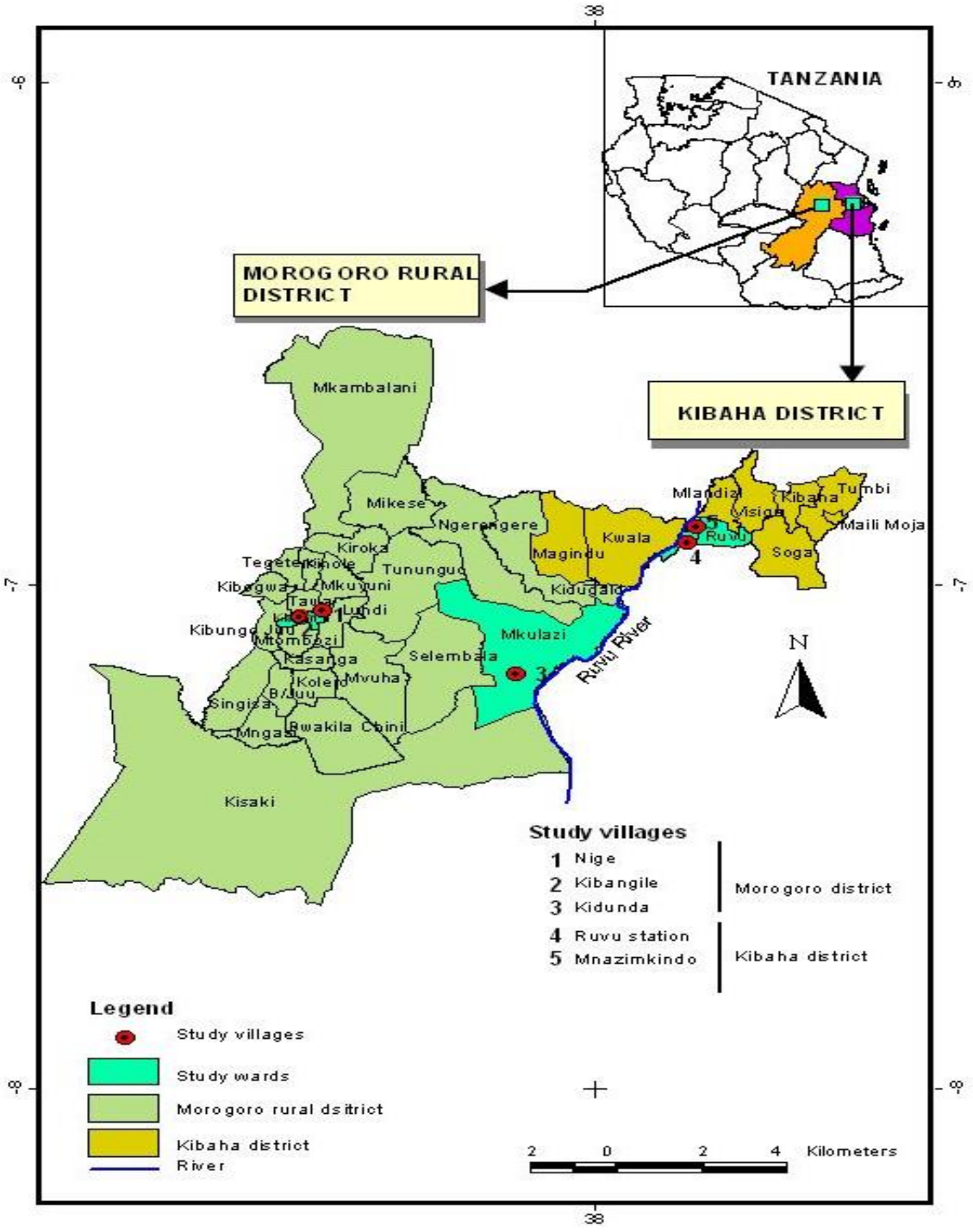
3.0 METHODOLOGY

3.1 Overview

This chapter is organized into three main sections, the first section presents study area descriptions, the second section presents the methods used in this study and the last section presents the data analysis techniques used in this study.

3.2 Study Site Description

The study was conducted in five villages namely Kidunda, Kibangile, Nige, Ruvu Stesheni, and Minazimikinda which are close to Ruvu riverine wetland area. Ruvu River is one of the major East African rivers that drain the Eastern Arc Mountains, with a basin area of approximately 18 000 km^2. This basin is typically sub-divided into smaller catchments: the Mgeta, Ngerengere, Upper Ruvu of the Morogogo region, and the Middle and Lower Ruvu in the Coast Region (USAID, 2014). The Ruvu River and its tributaries are one of the systems that form part of the Wami/Ruvu Basin, an administrative designation by the Tanzanian Ministry of Water under which the Ruvu, Wami, and coastal drainages are collectively managed by the Wami/Ruvu Basin Water Office (WRBWO). The catchment of the River lies in the Eastern Arc Mountain at latitudes 6° 05’ and 7° 45’ south and longitudes 37° 15’ and 39° 00’ east. This study was conducted in the villages lying close to the upper, middle and lower parts of the Ruvu riverine wetland area located in Morogoro and Coast regions to account for the contribution of various drivers to wetland degradation, awareness of the local community on values of wetland, and the consequences as well as the economic impact of wetland degradation.



Source: Sokoine University GIS Lab.

Figure 1: Map showing the location of the study area

3.3 Methods

3.3.1 Research Design

A cross sectional survey design was used in this study. The study design was chosen because it is well suited to the goal of describing variables and their distribution patterns and it allows data to be collected at a single point in time. Therefore the design is economic in nature; and it is suitable in situations where time is limited (Hulley *et al*., 2013).

3.3.2 Sampling procedure

A purposive sampling technique was used to select three wards from the study area, one from each of the following, Upper Ruvu, Middle Ruvu, and Lower Ruvu. Two villages from Upper Ruvu, one from Middle Ruvu and two from Lower Ruvu, making a total of five study villages were purposively selected based on their proximity to the wetland and the use of the wetland area for various socio-economic activities. Simple random sampling was employed to obtain a sample population, and which was obtained from the updated village register from the Village Chairman using a lottery technique. A total of 122 respondents were selected from the five study villages. Purposive sampling technique was used for administering interview to key informants namely water committee members in each village, government agricultural officials, and Ruvu basin officials who formed a part of the sampling frame for this study. One focus group discussion with 6 to 10 individuals was carried out in each village to obtain more primary data for answering the specific objectives.

3.3.3 Sample size determination

A sample size was calculated based on Boyd *et al.* (1981 cited by Munishi *et al.,* 2012) who recommend that a random sample should constitute at least` 5% of the total

population to be representative of the whole study population. The formula for determining sample size is:

$n/N \geq 5\%$

Where: N = is the total households in the village

n = is the number of selected households.

Table 1: Number of respondents interviewed in the surveyed study villages

Village	Total number of households	Number of sampled households	Sample size (%)
Kidunda	640	32	5
Kibangile	560	28	5
Nige	445	22	5
Ruvu stesheni	280	14	5
Minazimikinda	520	26	5
Total	**2 445**	**122**	**5**

3.3.4 Data collection

Both qualitative and quantitative methods were used in data collection for this study where the primary and secondary data were collected.

3.3.4.1 Primary data collection

(a) Reconnaissance survey

Prior to the actual field data collection, a reconnaissance survey was carried out so as to pre -test the questionnaire to ascertain the validity and reliability of the questions. A total of 15 households were randomly selected to pre-test the questionnaire. Amendments were done to increase precision of the tool for data collection. Reconnaissance survey helped the researcher to familiarize with the study area, study population and the proper method of administering data collection tools.

(b) Questionnaire survey

A questionnaire with open and closed ended questions (Appendix 1) was used to obtain primary data during this study. The sampling unit for the study was households where a total of 122 households were surveyed during this study. A household is defined as that which consists of all people who occupy a particular housing unit as their usual residence where each occupied housing unit contains one and only one household (American Housing Survey, 2013). The questionnaire was designed to collect socio-economic characteristics of the respondents, community perceptions as well as other variables from specific objectives of this study.

Plate 1: Interviewer administering a questionnaire to respondent

(c) Checklist

A checklist of questions was used to guide interview for key informants (Appendix 2). The key informants for this study were one Water Committee members in each of the studied villages, Government Agricultural Officials and Ruvu Basin officials.

(d) Focus group discussion (FGD)

Five focus group discussions were carried out during this study one from each village. The selection of FGD members considered age and sex and the groups were limited to 6 to 10 members. The groups constitute of village elders, village leaders and other village members who were practising various economic activities such as fishing, arable farming and livestock grazing in the wetland area. A checklist of questions is attached in Appendix 3.

Plate 2: A group photo after FGD at Kibangile village

(e) Direct observation

According to Erlandson *et al*. (1993), observations enable the researcher to describe the existing situations using five senses, providing a "written photograph" of the situation under study. During this study, a number of field visits were made to ascertain the presence of degradation along the wetland area. Photographs were taken as evidence of wetland degradation in the study area. Supplementary information, which was obtained from field visits, was used to cross check the information obtained from questionnaire and the secondary data which were obtained from various sources.

Plate 3: Tree along the wetland defoliated by livestock keepers for feeding their livestock

3.3.4.2 Secondary data

During this study, a review of key literature was used to obtain secondary data. A review of satellite images was used to provide evidence of various incidences of disturbance which lead to wetland degradation. Other relevant sources from Wami Ruvu Water Basin Offices and Sokoine National Library were used to provide more secondary data for this study.

3.3.4.3 Satellite image acquisition

Time analyses of land cover change requires a proper selection and preparation to ensure that there is compatibility of the Landsat images. In this study the images were downloaded from freely available United States Geological Surveys (USGS) and Earth Explorer websites. The images were selected from the same season (July-September) and with minimal cloud cover (<10%). The images were from different sensors with similar spectral resolution of 30 meters. The images used were from the Landsat Thematic Mapper(TM) and Landsat Operational Land Imager (OLI) for years 2007 and 2016 respectively.

3.4 Data Analysis

3.4.1 Descriptive analysis

The data from households' questionnaire survey were coded and assigned variables in Statistical Package for Social Sciences (SPSS) whereby quantitative data were subjected to descriptive statistics. Outputs such as frequencies and percentages were obtained.

3.4.2 Content analysis

Information obtained from Focus Group Discussions, key informants interviews and other qualitative information from household questionnaire was analysed using content analysis whereby raw data were broken down into meaningful units of information (Kothari,

2004). The information was categorized according to the study objectives and discussed to develop themes and tendencies that answer the study objectives.

3.4.3 Simple linear regression model

Simple linear regression model was used to measure the relationship between average river discharge and a change in income of the respondents whereby the average income of all the respondents for five years was regressed against the average river flow in five years (2011-2015). This enabled to predict whether or not the dependent and independent variable were significantly related and this enabled to measure the strength of their relationship and ascertain whether a change in the average river discharge has impacted on the livelihood of the local population living alongside the Ruvu River wetland area. The length of time of five years was found to be suitable due to the reason that the estimates of income were relying on memory and therefore taking too many years could be difficult for the respondents to remember. The estimated empirical regression model, which was used, is specified in the equation below.

$Y = \beta_0 + \beta X + \varepsilon$ ..... (i)

Where;

Y = dependent variable (Average households annual income in past five years)

X = independent variables (X =Average annual river discharge in past five years).

β_0, β= parameters estimated;

ε = error term.

X =Average river water discharge

It was hypothesized (keeping other factors constant) that change in average river discharge would have some influence in a decrease or an increase of the average annual household income in the study area. An increase in the average discharge was expected to

lead to an increase in productivity of agricultural crops and fish population. Therefore, an increase in incomes and a decrease in the average river discharge were expected to lead to a decrease in the average annual household's income in the study area. The coefficient of determination R^2 was used to tell how much variations of the dependent variable has been explained by the independent variable.

3.4.4 Satellite image analysis

3.4.4.1 Image pre-processing

The Images were radiometrically and atmospherically corrected using the LEDAPS tool. The Landsat Ecosystem Disturbance Adaptive Processing System (LEDAPS) is a NASA project which maps disturbance, regrowth, and permanent forest conversion across the continent (Masek *et al.,* 2006). The LEDAPS processes Landsat imagery to surface reflectance, using atmospheric correction routines developed for the Terra MODIS instrument (Vermote *et al.,* 1997).

3.4.4.2 Classification and collection of the training signatures

The Supervised classification is the methodology which was adopted for classifying the images. The supervised classification is the type of classification where the user collects samples of the land cover classes (training data sets) for different land cover classes and the image classification software determines each class in terms of what it resembles most in the training signatures to perform the classification. The images were classified into 6 different land cover classes as shown in the Table 2.

Table 2: Land Use Land Cover (LULC) Categories

Land Use Land Cover (LULC) Categories	LULC Categories for mapping	National Land Cover Description
Forest	Woodland	an area of land with at least 0.5 ha, with a minimum tree crown cover of 10% or with existing tree species planted or natural having the potential of attaining more than 10% crown cover, and with trees which have the potential or have reached a minimum height of 5m at maturity in situ. It includes Montane, lowland, mangrove and plantation forests, woodlands and thickets.
Bushland	Bushland	Bushland is fundamentally defined as being predominantly comprised of plants that are multi-stemmed from a single root base. It includes dense and open bushland
Grassland	Grassland	For the most part, grassland occurs in combination with either a limited wooded or bushed component, or with scattered subsistence cultivation
Agriculture Land	Cultivated Land with Scattered Settlements	Land actively used grow agriculture crops including agro forestry systems, wooded crops, herbaceous crops and grain crops
Other Lands	Bare Soil	Land that includes bare land and rock outcrop, Costal bare lands, Ice cap / snow
Water	Water	Includes inland water/Riverine

3.4.4.3 Post-classification processing

Post-classification processing included recoding, majority filtering, clumping, elimination and mosaicking. The 3 by 3 majority filter was employed to the recoded image to reduce the salt and paper effect. And lastly, the classes where filtered to a minimum mapping unit of about 0.5 ha to conform to the forest definition, that is the minimum size is 0.5 ha.

3.4.4.4 Land cover change analysis and cross tabulation

Change detection is one of the most important applications of remote sensing techniques due to its capability of repetitive acquisition imageries with consistent image quality, at short intervals, on a global scale, and during complete seasonal cycles (Kashaigili, 2006).

The Land Cover change detection was done using ArcGIS10 software. The two classified Land cover layers that is, Land cover 2007 and 2016 were used. The spatial analysis tool using the spatial analysis zonal tabulate area function was used to generate land cover change matrix. The function calculates cross-tabulated areas between two datasets and outputs a table. The table displays a record for each unique value of the zone dataset and a field for each unique value of the class dataset. The calculated geometry was used to calculate the areas (in hectares) of each land cover in the matrix.

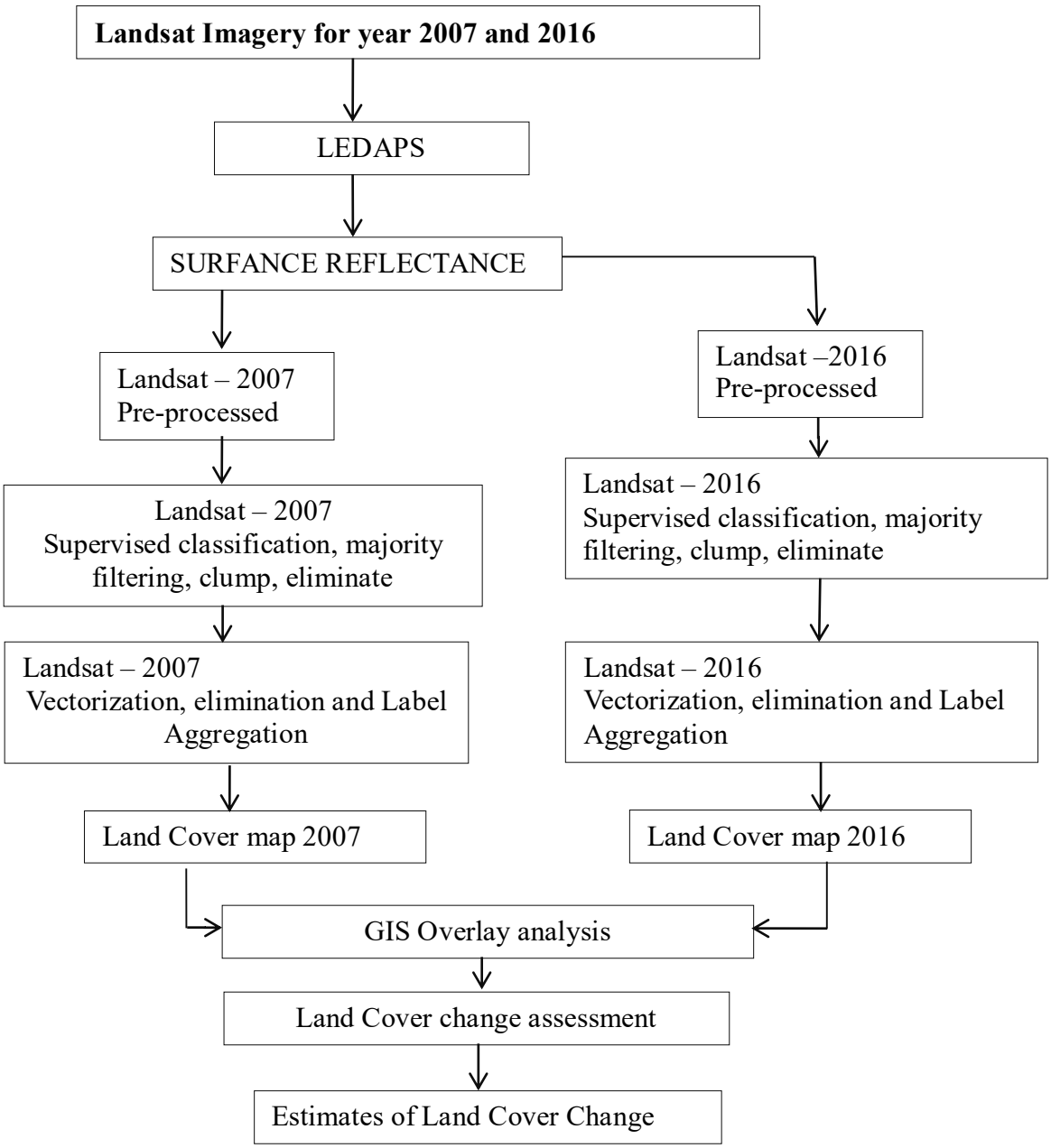


Figure 2: Methodology adopted

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview

This chapter is organized into five sections, the first section presents socio-economic characteristics of the respondents; the second section presents evidence of wetland degradation from satellite; the third section presents the contributions of various economic activities to wetland degradation in the study area; the fourth section presents results on community awareness on values of wetland, causes and consequences of its degradation and control practices and the last section presents the economic implication of wetland degradation to household income.

4.2 Social Economic Characteristics of the Respondents

4.2.1 Education level of the household heads

Findings in Table 3 present education level of the household heads. As indicated in Table 3, the study shows that 77.90% of the household heads had primary education while 18% of the household heads had no formal education; 2.50% of the household heads had secondary education and very few of the household heads had college education. The findings imply that the level of education in the study area is low as even those who attended primary education some did not finish Class Seven; therefore education level among the respondents was low. The level of education has a direct link with sustainable utilization of wetland resources as well as understanding of drivers of wetland degradation and the consequences of wetland degradation to the livelihood of the area. As argued by Kateregga (2015), education is an important variable that influences individual's choice with respect to resource use. Education is believed to shape people's perception of their environment and what it can offer hence it helps them build up their socio-economic status. Education also may influence the way people use their natural resources.

Table 3: Socio-economic characteristics of respondents

Variable	Sample Villages					
	Kidunda (n=32)	Kibangile (n=28)	Nige (n=22)	Ruvu station (n=14)	Minazimikinda (n=26)	Total (n=122)
Sex						
Male	19(59.4)	13(46.4)	13(59.1)	11(78.6)	10(38.5)	66(54.1)
Female	12(40.6)	15(53.6)	9(40.9)	3(21.4)	16(61.5)	56(45.9)
Age of respondent						
18-28	2(6.2)	4(14.3)	3(13.6)	1(7.1)	4(15.4)	14(11.5)
29-39	7(21.9)	7(25.0)	7(31.8)	4(28.6)	8(30.8)	33(27.0)
40-50	10(31.2)	10(35.7)	3(13.6)	4(28.6)	7(26.9)	34(27.9)
51-61	7(21.9)	5(17.9)	3(13.6)	2(14.3)	5(19.2)	22(18.0)
62-72	5(15.6)	2(7.1)	6(27.3)	3(21.4)	2(7.7)	18(14.4)
73 and Above	1(3.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Education level of respondent						
No formal education	8(25.0)	7(25.0)	2(9.1)	1(7.1)	4(15.4)	22(18.0)
Primary education	24(75.0)	20(71.4)	19(86.4)	12(85.7)	20(76.9)	95(77.9)
Secondary education	0(0.0)	1(3.6)	1(4.5)	0(0.0)	1(3.8)	3(2.5)
Attended collage	0(0.0)	0(0.0)	0(0.0)	1(7.1)	1(3.8)	2(1.6)
Marital status of the respondents						
Married	26(81.2)	28(10)	17(77.3)	11(78.6)	21(80.8)	103(84.4)
Single	1(3.1)	0(0.0)	2(9.1)	3(21.4)	3(11.5)	9(7.4)
Widow	3(9.4)	0(0.0)	2(9.1)	0(0.0)	2(7.7)	7(5.7)
Divorced	0(0.0)	0(0.0)	1(4.5)	0(0.0)	0(0.0)	1(0.8)
Separated	1(3.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Widower	1(3.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Household Size						
1-3	2(6.3)	7(25.0)	6(27.3)	6(42.9)	6(23.1)	27(22.1)
4-7	22(68.8)	19(67.9)	16(72.8)	8(57.1)	20(76.9)	85(69.7)
8-11	8(25.0)	1(3.6)	0(0.0)	0(0.0)	0(0.0)	9(7.2)
12 and Above	0(0.0)	1(3.6)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Occupation of respondents						
Farming	20(62.5)	20(71.4)	14(63.6)	5(35.7)	5(19.2)	64(52.5)
Farming and fishing activities	8(25.0)	4(14.3)	2(9.1)	6(42.9)	6(23.1)	26(21.3)
Farming and entrepreneurship	3(9.4)	4(14.3)	6(27.3)	2(14.3)	14(53.8)	29(23.8)
Farmer and wage employment	1(3.1)	0(0.0)	0(0.0)	1(7.1)	1(3.8)	3(2.5)
Farm size of respondents						
0-4	29(90.6)	27(96.4)	21(95.5)	7(50.0)	23(88.5)	107(87.7)
5-9	2(6.3)	0(0.0)	1(4.5)	4(28.6)	1(3.9)	8(6.6)
10-14	1(3.1)	1(3.6)	0(0.0)	3(21.4)	2(7.7)	7(5.7)
Types of crop grown along the wetland						
Maize	5(15.6)	4(14.3)	3(13.6)	1(7.1)	3(11.5)	16(13.1)
Rice	2(6.2)	1(3.6)	4(18.2)	10(71.4)	22(84.6)	39(32.0)
Maize and Rice	3(9.4)	16(57.1)	10(45.5)	2(14.3)	1(3.8)	32(26.2)
Vegetables	12(37.5)	3(10.3)	5(22.7)	1(7.1)	0(0.0)	21(17.2)
Sesame	1(3.1)	3(10.3)	0(0.0)	0(0.0)	0(0.0)	4(3.3)
Millet	9(28.1)	1(3.6)	0(0.0)	0(0.0)	0(0.0)	10(8.2)

Key: In brackets are percentages

4.2.2 Marital status of the household heads

Results in Table 3 show that 84.4% of the surveyed households were married, 7.40% were single, 5.70% were widows while only 1% of the surveyed household were divorced, separated and widower respectively. The results imply that most of the surveyed households had a husband and a wife plus children who were able to engage in various production activities along the wetland area.

4.2.3 Household size

Results in Table 3 indicate that 69.77% of the surveyed households had a size of 4-7 people. This average household size conforms to the national household size which is 4.8. Kibaha District and Morogoro Rural District had household sizes of 4.1 and 4.2 respectively (NBS, 2012). Large household size has an implication on wetland resource utilization. Having many individuals in the family is more likely to have them engaged in various wetland resource utilization such as farming, fishing and the like, which leads to an increase of the chance of degradation due to an increase in resource utilization pressure. The findings are in line with those in a study by Hatibu (2010) who indicated that large household size has an implication in resource utilization because large household size means high consumption units within the household and which can lead to more resource extraction leading to the degradation of that particular resource.

4.2.4 Occupation of the respondents

Findings from Table 3 show that 52.50% of the respondents were engaged in farming activities along the wetland. About 21% of the respondents were engaged in both farming and fishing while 23.80% were engaged in farming and entrepreneurial activities. Only a small percentage of the respondents were engaged in farming and wage employment. The results show that farming is the most prevalent occupation of the respondents in the

area as it functions as a source of income and food among the respondents. Therefore, farming practices contribute to wetland degradation in the area. The availability of fertile soil and wet area that support farming year round is the main reason for most of the respondents to engage in farming activities along the wetland in the study area. The findings concur with those from a study by Lippu (2008) who reported that crop production was a dominant activity as it support livelihood in many communities.

4.2.5 Farm size of the respondents

Results in Table 3 show that 87.70% of the respondents had farms in the wetland with average sizes of 0 to 4 acres, 6.56% had average sizes of 5 to 9 acres; few respondents had farms with average sizes of 10-14 acres. The study reveals that most of the farmers had small farm sizes in the wetland area because of the nature of the landscape. In areas which are dominated by hills and uplands people were found to have small farm sizes while in areas such as Ruvu ward which had flat terrain respondents were found to have large farm sizes. Farm sizes are directly linked to wetland use for those who practice irrigation agriculture whereby farmers with very large farms are more likely to abstract large volumes of water from the river than the ones with small size farms. On the other hand, having large farm size means application of more chemicals which in turn leads to chemical spills to wetland resulting to significant degradation of these areas. Also, large sizes of farms influence productivity; the respondents who had large farms were found to have being producing more agricultural crops than farmers who owned very small farms.

4.2.6 Types of crops grown

Table 3 depicts the main type of crops that were grown within the study area. Rice was found to be the main crop that was grown in the area whereby 32% of the respondents were engaged in rice production and 26.20% of the respondents were engaged in both

maize and rice production . A significant number of respondents were found to be mostly engaged in vegetable production during the dry season of the year whereby most of the wetland areas have low water volume. The results reveal that abstraction of water for watering crops is normally done during the dry season for watering vegetables and this significantly affects the wetland area. The types of crops grown in the wetland areas have different requirements of water for growth: some crops require large amount of water and therefore increases the likelihood of high water abstraction from wetland, while other crops require a little amount of water for growth and maturity.

4.3 Evidence of Wetland Degradation from Satellite Images

An increase in human populations triggers pressure to land and other resources due to increased needs for areas for settlement, farming and grazing, and therefore subjecting these areas to environmental destructions. Figures 3, 4, and 5 provide evidence of degradation along Ruvu riverine wetland area from satellite imagery of the study wards. According to the findings, a change in land use including agriculture expansion, mining, and livestock grazing along the area has been found to cause significant wetland degradation due to clearing of forests for opening up new farms and feeding livestock within the study wards.

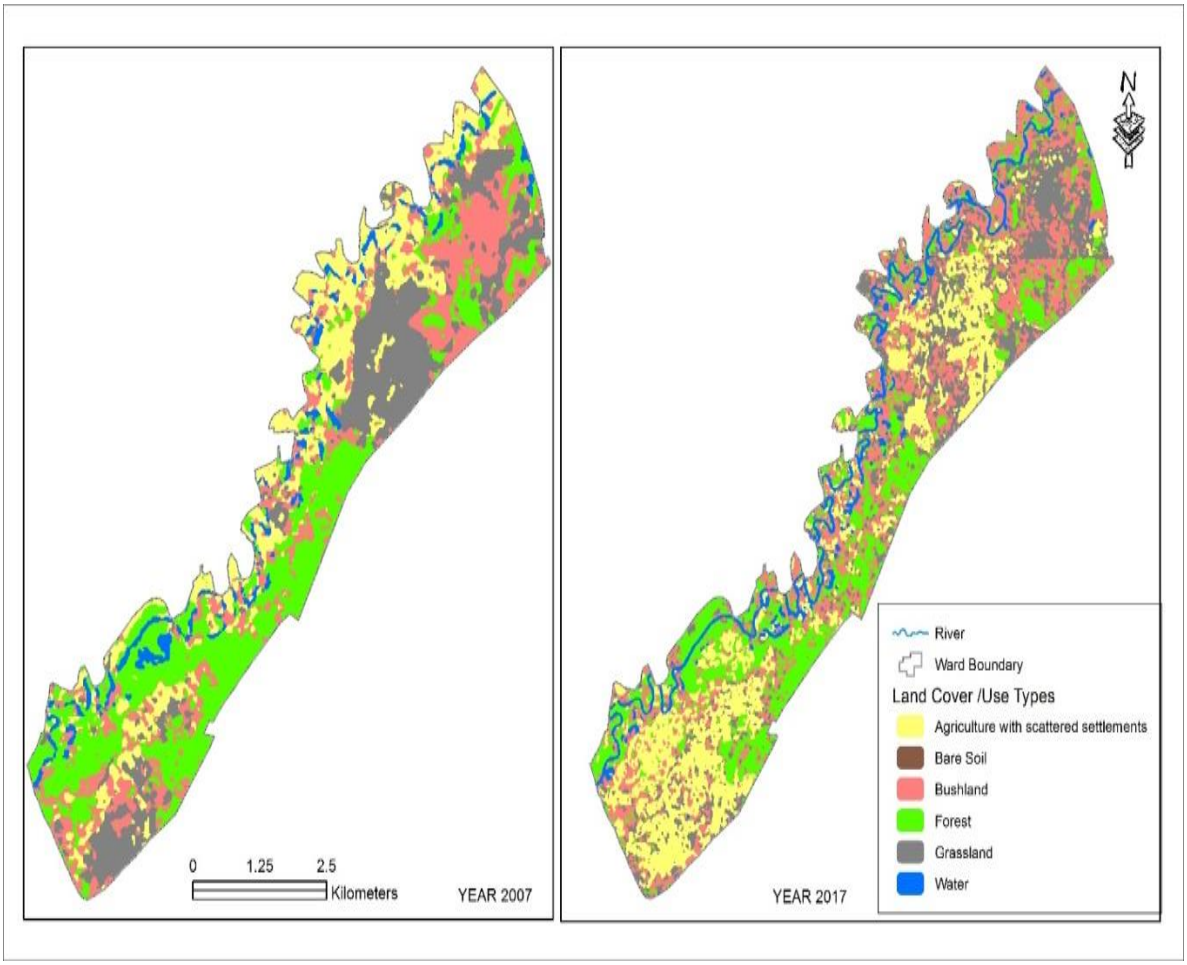
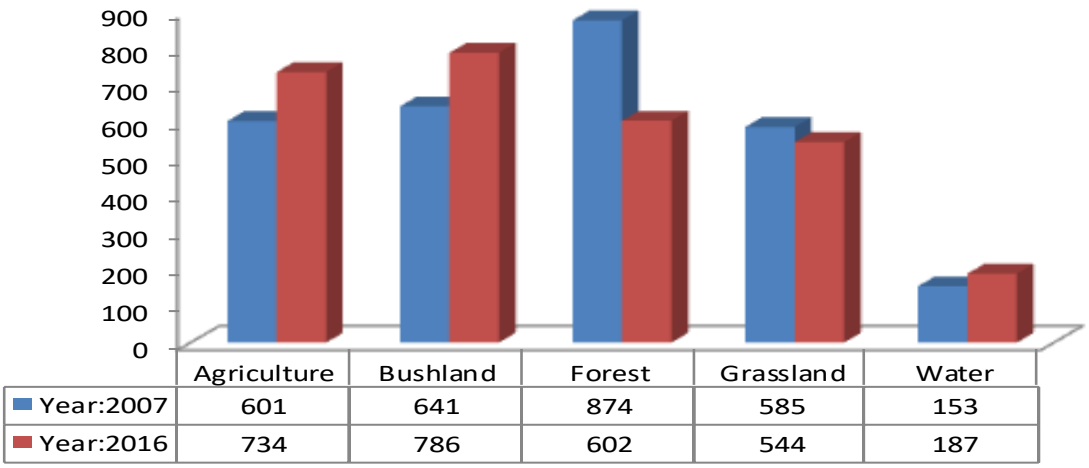


Figure 3 (a): Degradation in Ruvu ward as detected by 2007-17 Imagery



	Agriculture	Bushland	Forest	Grassland	Water
Year:2007	601	641	874	585	153
Year:2016	734	786	602	544	187

Figure 3 (b): Land use change in Ruvu ward as computed from 2007-16 imagery

Figures 3 (a) and (b) show degradation in Ruvu ward; the area is highly dominated by agriculture activities due to the presence of flat terrain which supports crop farming. Findings in Table 4 show that agriculture expansion has increased by 2.2% whereas forest cover has decline by -4.1%.

Table 4: Land cover change in Ruvu ward

Land Use/ Cover Types	Land Cover				Land Cover Change	Annual change rate
	Year: 2007		Year: 2016			2007-2016
	Ha	%	Ha	%	Ha	%
Agriculture	601	21	734	26	133	2.2
Bushland	641	22	786	28	145	2.3
Forest	874	31	602	21	-272	-4.1
Grassland	585	20	544	19	-41	-0.8
Water	153	5	187	7	34	2.2
Total	**2 854**	100	**2 853**	100	-1	

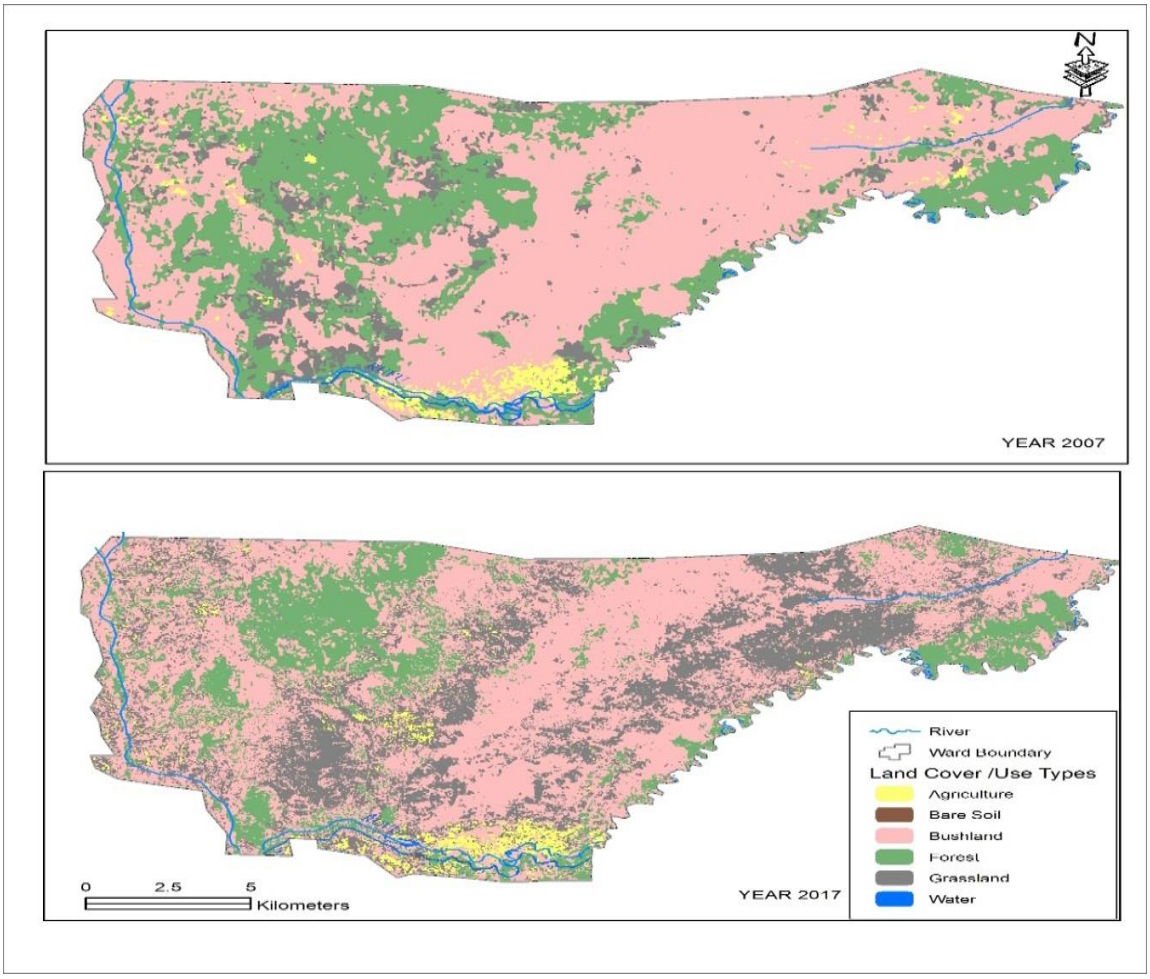
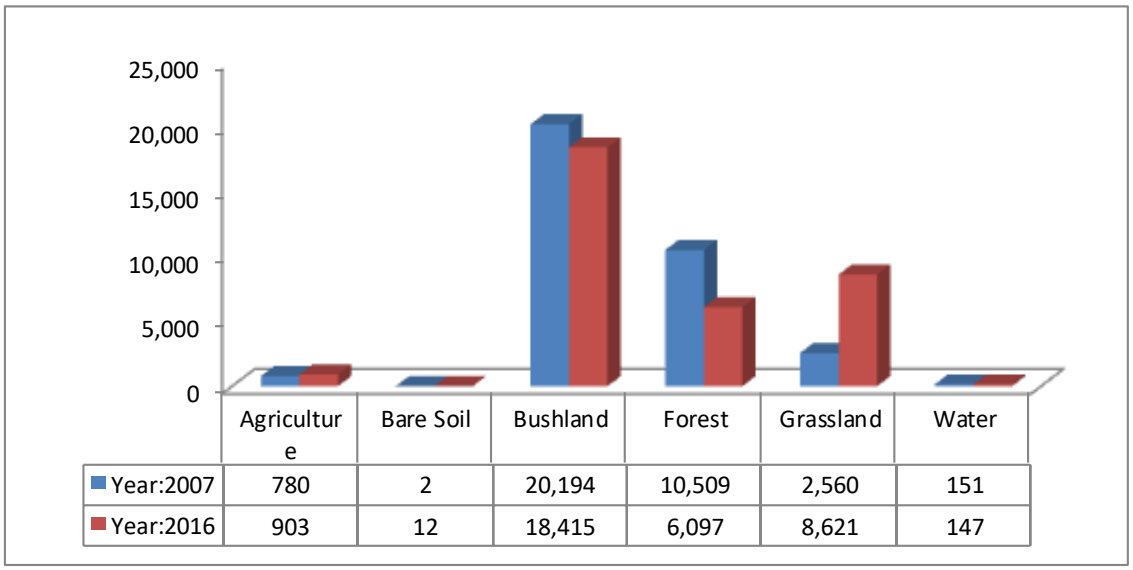


Figure 4 (a): Degradation in Mkulazi ward as detected by 2007-17 Imagery



	Agriculture	Bare Soil	Bushland	Forest	Grassland	Water
Year:2007	780	2	20,194	10,509	2,560	151
Year:2016	903	12	18,415	6,097	8,621	147

Figure 4 (b): Land use change in Mkulazi ward as computed from 2007-16 imagery

Figures 4 a and b show degradation in Mkulazi ward;, the findings reveal that the area is dominated by farming due to the presence of flat terrain and fertile land close to wetland area. Further findings in Table 5 show that agriculture expansion has increased by 1.6 % from 2007-2016. Bush land has been reduced by -1.0 % due to invasion by livestock keepers who cut down trees to feed their livestock along these areas. Also the findings show that the forest area has been reduced by -6% and this is due to the opening up of new farms close to the wetland area hence exposing the wetland area to more degradation.

Table 5: Land use cover change in Mkulazi ward

Land Use/ Cover Types	Land Cover				Land Cover Change	Annual change rate
	Year: 2007		Year: 2016			2007-2016
	Ha	%	Ha	%	Ha	%
Agriculture	780	2	903	3	123	1.6
Bare Soil	2	0	12	0	10	19.9
Bushland	20 194	59	18 415	54	-1 779	-1.0
Forest	10 509	31	6 097	18	-4 412	-6.0
Grassland	2 560	7	8 621	25	6 061	13.5
Water	151	0	147	0	-4	-0.3
Total	**34 196**	100	**34 195**	100		

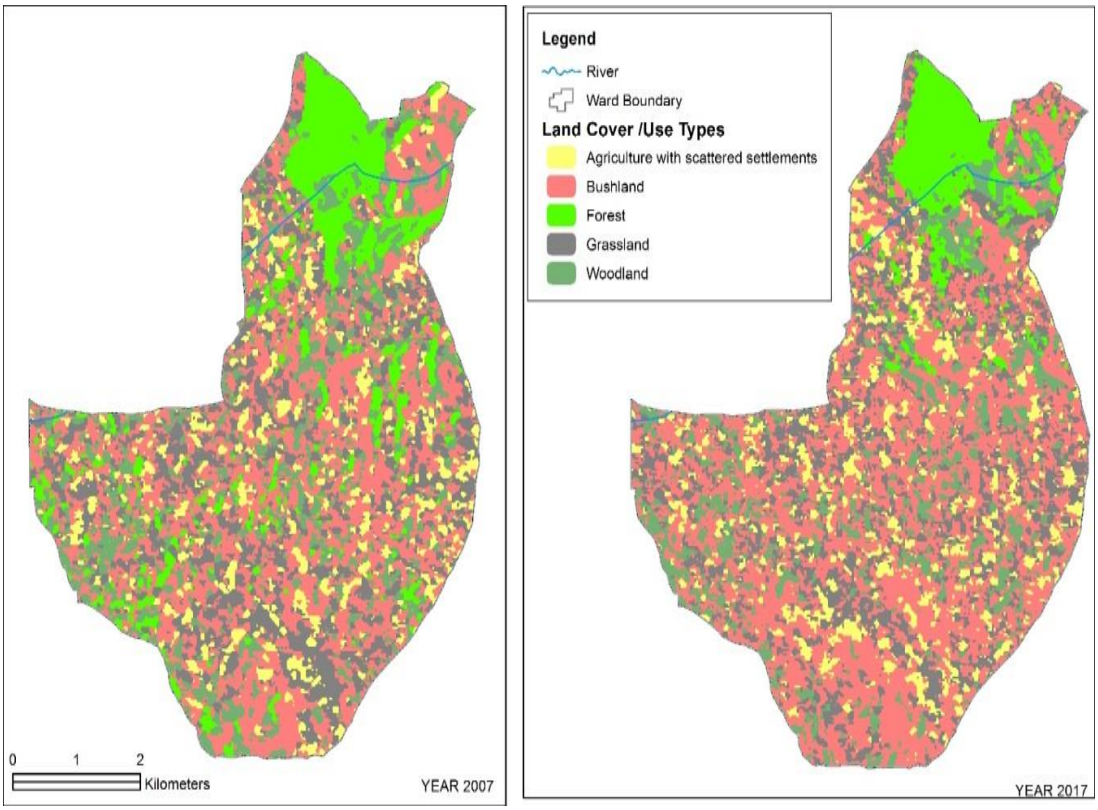
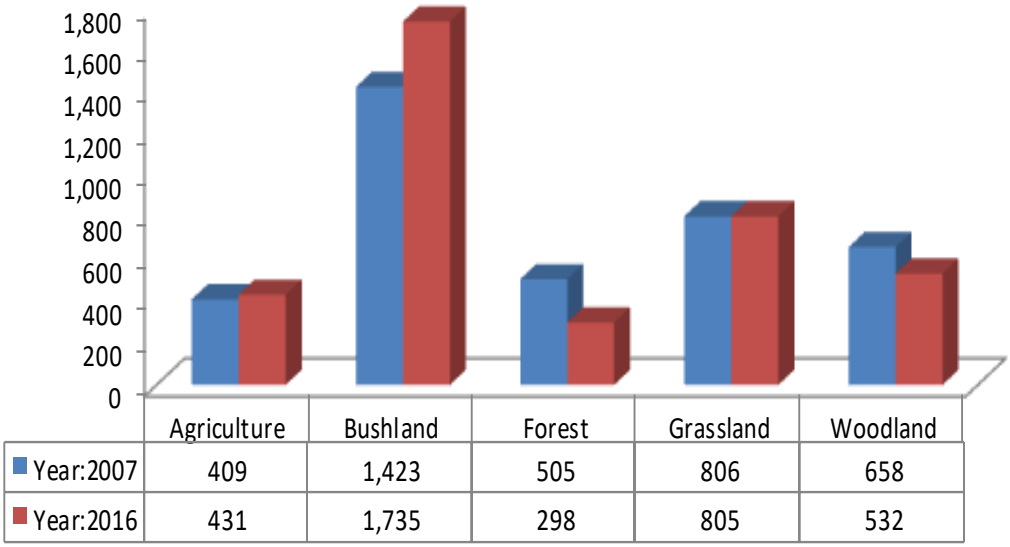


Figure 5 (a): Degradation in Kisemu ward as detected by 2007-17 Imagery



	Agriculture	Bushland	Forest	Grassland	Woodland
Year:2007	409	1,423	505	806	658
Year:2016	431	1,735	298	805	532

Figure 5 (b): Land use change in Kisemu ward as computed from 2007-16 imagery

The findings in Figures 5 a and b show that Kisemu ward is dominated by bush land and therefore supports more grazing which seriously affects the wetland area. Further, the findings in Table 6 show that bushland has increased by 2.2%. The presence of bush land in this area attracted a number of livestock keepers including the Wasukuma and Wamasai from Tabora and Dodoma in search for green pasture. On the other hand, forest cover close to wetland area of Kimboza forest reserve, which forms an important catchment of Ruvu riverine, has been reduced by -5.9% due to invasion by people for settlement as well as farming activities.

Table 6: Land cover change in Kisemu ward

Land Use/ Cover Types	Land Cover				Land Cover Change	Annual change rate
	Year: 2007		Year: 2016			2007-2016
	Ha	%	Ha	%	Ha	%
Agriculture	409	11	431	11	22	0.6
Bushland	1 423	37	1 735	46	312	2.2
Forest	505	13	298	8	-207	-5.9
Grassland	806	21	805	21	-1	0.0
Woodland	658	17	532	14	-126	-2.4
TOTAL	**3 801**	100	**3 801**	100	0	

Various vegetation types that were close to the wetland have been cleared for opening up new farms for crop cultivation, settlements and livestock feeding in most study wards. On the other hand, improper irrigation systems threaten the wetland due to extensive abstraction of water for watering crops. Chemicals from agriculture and industrial effluent degrade the wetland causing massive loss of various animal species within this wetland. The study also found out that degradation results into a change of river flow and therefore impacts negatively on the livelihood of the community that depends on it for various services. The findings are not different from those in a study by Yanda and Munishi (2007) and Kashaigili (2008), who reported that land use change leads to wetland degradation and this has a critical impact on hydrological regimes in Tanzania resulting to myriad of consequences to the livelihood of the communities that depend on the wetlands.

Also the results do not differ much from the study by Mutie *et al.* (2005) who reported that changes in Land use/cover results in significant hydrologic changes, whereby removal of forest cover results to decreased interception, evapotranspiration and increased runoff volumes. According to CSIRO (2005) in Mutie *et al*. (2005), a tree canopy can intercept 10-40% of incoming precipitation (commonly 10-20%) depending on factors such as tree species, density of stand, age of stand, location, rainfall intensity; and evaporation during or after a rainfall event, forest disruption, such as logging, forest fires and wind damage all of which can have major effects upon the canopy characteristics of forest stands and hydrological processes in the watershed. Where forest cover is permanently removed for the purposes of agriculture or urbanization, the hydrologic effects are more long lasting.

In general, the results from satellite imagery show that there is degradation within this wetland which is mainly derived by various anthropogenic activities practised along the wetland area. These results are not different from those from a study by Munishi *et al*. (2007) on hydrological land use/cover change along the Ruvu and Sigi river watersheds which showed that the area was under the threat of more degradation from anthropogenic activities which are carried out along these areas. These have an impact on flow downstream hence affecting the livelihood of the community which depends on it for various uses.

4.4 Contribution of various economic activities to wetland degradation

Table 7 presents the results on contributions of various economic activities to wetland degradation in the study area. The overall result of this study shows that invasion of livestock in Ruvu riverine basin in search for green pasture is the foremost activity that contributes to wetland degradation within the study villages by about 52.50% (n=122).

The results imply that improper animal grazing along the wetland cause significant degradation of wetland vegetation and land through regular feeding and trampling. Cutting down of trees for feeding livestock as well as normal feed by livestock reduce vegetative cover which act as a barrier for soil erosion since surface sediments become more exposed therefore unstable and subject to weathering and erosion. Livestock trampling cause soil compaction which prevents infiltration, which in turn prevents the groundwater table from recharging and therefore increases surface runoff. This increases the likely chance of a change of river flow and frequent floods. The results are not different from those in a study by Droogers (2006) who reported that cropland is limited in the Ruvu basin due to the reason that much of the basin area is covered by scrubs which are used for extensive grazing. This could be the reason for livestock grazing to become the leading cause of degradation in this area. The findings is also supported by those in a study conducted by Ngana *et al.* (2010) which reported that pastoralism is wide spread in Ruvu sub-basin due to large livestock migration that has been taking place over the years from various regions to Ruvu basin due to the availability of good pasture and water. Livestock is therefore highly contributing to wetland degradation within the Ruvu ecosystem.

On the other hand, the result shows that arable farming was ranked as the second significant driver to degradation within the study area accounting for about 48%(n=122) of degradation. The results reveal that arable farming is one of the main practices by the indigenous communities living along these areas and which contributes to wetland degradation. Improper cultivation is rampant along the wetland due to inadequate knowledge on how to perform sustainable agriculture within the area; this therefore leads to wetland degradation. A study by Kashaigili (2011) shows that agriculture is the major land use by the indigenous community living close to this wetland where irrigated

agriculture was found in the lower Ruvu and the western slopes of the Uluguru Mountains. Over the years, arable farming has been functioning as an important means of food production and income generation to the indigenous communities living adjacent to the wetlands. As Malatu *et al.* (2015) pointed out, a decline of upland productivity triggers more pressure to wetland cultivation which lead to more degradation to the wetland. A study by Ngana *et al.* (2010) on situation analysis of Ruvu-basin revealed that encroachment activities such as crop cultivation along the river-banks cause degradation in the area.

Brick making ranked as a third significant driver by about 46% (n=122). Brick making in most villages in the study area has been carried out at medium scale to supplement building material. Only in few areas in the study villages brick making has been carried out as a means of acquiring income by the community; therefore it slightly contributes to the degradation of wetland in the study area. Clay soil extraction for bricks making significantly result to land degradation in the wetlands as it creates holes which tend to lower the water table leading to a decrease in water level and drying of wetlands. On the other hand, the demand for wood fuel for burning the bricks has been causing a massive deforestation of wetland vegetation in the area.

Table 7: Contributions of various economic activities wetland degradation in the study area

Contribution of various economic activities to wetland degradation in study villages						
	Kidunda (n=32)	**Kibangile (n=28)**	**Nige (n=22)**	**Ruvu station (n=14)**	**Minazimikinda(n=26)**	**Total (n=122)**
Drivers						
First prominent driver						
Arable farming	3(9.4)	3(10.7)	1(4.5)	1(7.1)	2(7.7)	10(8.2)
Livestock grazing	26(81.2)	1(3.6)	0(0.0)	13(92.9)	24(92.3)	64(52.5)
Brick making	3(9.4)	4(14.3)	5(22.7)	0(0.0)	0(0.0)	12(9.8)
Gold mining	0(0.0)	20(71.4)	16(72.7)	0(0.0)	0(0.0)	36(29.5)
Fishing	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Second prominent driver						
Arable farming	15(46.9)	9(32.1)	5(22.7)	12(85.7)	18(69.2)	59(48.4)
Livestock grazing	6(18.8)	1(3.6)	5(22.7)	1(7.1)	2(7.7)	15(12.3)
Brick making	8(25.0)	10(35.7)	11(50.0)	0(0.0)	6(23.1)	35(28.7)
Gold mining	2(6.2)	8(28.6)	1(4.5)	1(7.1)	0(0.0)	12(9.8)
Fishing	1(3.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(0.8)
Third prominent driver						
Arable farming	7(21.9)	6(21.4)	4(18.2)	0(0.0)	4(15.4)	21(17.2)
Livestock grazing	0(0.0)	9(32.1)	5(22.7)	0(0.0)	1(3.8)	15(12.3)
Brick making	19(59.4)	13(46.4)	13(59.1)	4(28.6)	7(26.9)	56(45.9)
Gold mining	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
Fishing	6(18.8)	0(0.0)	0(0.0)	10(71.4)	14(53.8)	30(24.6)
Fourth prominent driver						
Arable farming	1(3.1)	5(17.9)	3(13.6)	0(0.0)	0(0.0)	9(7.4)
Livestock grazing	0(0.0)	9(32.1)	9(40.9)	0(0.0)	0(0.0)	18(14.8)
Brick making	6(18.8)	6(21.4)	3(13.6)	11(78.6)	15(57.7)	41(33.6)
Gold mining	0(0.0)	1(3.6)	5(22.7)	0(0.0)	0(0.0)	6(4.9)
Fishing	25(78.10)	7(25.0)	2(9.1)	3(21.4)	11(42.3)	48(39.3)

Key: In brackets are percentages

Fishing was ranked as the fourth significant driver to degradation by about 39% (n=122). The study found out that fishing using local method called Migono which involves setting traps inside the river and the removal/ cutting down of vegetation along the wetland has been threatening the wetland as its carried out for harvesting of fish for food and business therefore affecting the wetland vegetation. Improper fishing practices such as the use of chemicals and setting traps tend to affect wetland ecosystem by killing plants and other

animal species existing in the wetland area. A study by Mombo *et al.* (2011) indicates that fishing is negatively affecting the vitality of the wetlands due to bad fishing practices. Results show further that there is a considerable variation of drivers to wetland degradation from one study village to another and this is mainly because of variation in the main practices carried out by the local community within the specified areas as well as restriction on land use along the wetland.

Results show that villages such as Kibangile and Nige which lie close to Kimboza Forest reserve, livestock grazing has not contributed to degradation due to restrictions on land use. However, the presence of gold along the wetland within these villages has been the second significant driver to degradation accounting for 29.50% of degradation. The contribution of other human activities to wetland degradation in the area was found to be smaller than the ones mentioned above. Generally, the study found out that the wetland is being threaten by over-exploitation of its functions, products and services from increased anthropogenic activities including livestock grazing by immigrants from various regions in Tanzania and Agriculture (plate 4), brick making, fishing as well a growing population in Dar es Salaam city and in the nearby small towns lead to increased demand for food, income, and areas for settlement.

Plate 4: Degradation due to improper agricultural practices and livestock grazing close to the wetland

4.5 Community Awareness on the Values of Wetland, causes and Consequences of its Degradation

4.5.1 Awareness on the Values of wetland

Awareness on the value of a resource makes communities more conscious on ensuring protection of that particular resource against degradation. Table 8 presents the findings on awareness of the respondents on the value of wetlands. The results show that most respondents were aware of the direct benefits that they can accrue from wetlands area. As indicated in Table 8, 96.7% of the respondents have higher awareness on the direct value of wetland as they agreed that crop cultivation is something of value they obtain from the wetland area. This is because the areas are suitable for crops cultivation all-round the year. The results indicate that majority of the respondents have high awareness on the extractable benefits that sustain their day to day needs for living. Findings from this study show further that most of the indigenous people living close to Ruvu riverine wetland practice agriculture as their main economic activity; therefore they do value the wetland as the area supports their livelihood through agricultural production.

Table 8: Awareness on the value of wetland

	Respondents responses % (n=122)		
Values of wetlands	**Agreed**	**Undecided**	**Disagree**
Food and cash crop	96.7	0.8	2.5
Water for domestic use	73.8	0.0	26.2
Fishing	50.0	0.0	50.0
Soil erosion and Flood control	39.4	0.0	59.8
Carbon storage and climate regulation	31.1	0.0	68.5
Storage and recycling of nutrients and human wastes	26.5	1.50	72.0

About 73.8% of the respondents agreed that water for domestic use is the second item of value that they do get from the wetland. Few respondents were aware of the indirect benefits of wetlands such as soil erosion and flood control whereby 39.4% of the respondents agreed that wetland helps in controlling soil erosion and floods as they act as

a water sink from various channels and reduce surface runoffs. The results concur with those from the study by Mombo *et al*. (2011) who reported that majority of the households living nearby wetlands are aware of direct benefits such as crop cultivation and water for domestic use accrued from wetland. These results do not differ much from those reported by Kateregga (2015) whose study showed that 72% of the respondents ranked crop cultivation and water for domestic use as the direct benefits of wetlands, 18% ranked indirect while only 10% valued the ethical benefits of wetlands. Generally, the study revealed that most indigenous communities who depend directly on wetland for various services were found to be mostly aware of extractable benefits of wetland rather than non-extractable benefits of wetland and other natural resources. Therefore, they tend to underrate the total value of these resources in a long term.

4.5.2 Awareness on the causes of wetland degradation

Table 9 presents the results on the awareness of causes of wetland degradation among the respondents in the study village. The results show that most of the respondents were aware of the fact that livestock grazing and farming practices were the main causes of wetland degradation in the area. As indicated in Table 9, 68.9% of the respondents agreed that invasion by livestock was the main cause of wetland degradation in the area. The results imply that the local communities are aware that the ongoing climate change which is associated with drought in different regions of the country exert more pressure on wetland ecosystems caused by livestock encroachment in search for green pasture by pastoral communities. For example in the study area, the respondents reported to have experienced continuous immigration of livestock keepers from various areas including Tabora and Dodoma to Ruvu basin in search for green pasture. This has triggered serious repercussions on the wetland due to cutting down of vegetation along the wetland to feed their livestock, hence, exposing the wetland to direct sunlight which in some areas has led

to drying of water in the wetland. On the other hand, livestock trampling on the wetland has led to soils compaction and erosion leading to the drying of wetlands in the area.

Table 9: Awareness on the causes of wetland degradation

	Respondents responses % (n=122)		
Causes of wetland degradation	Agree	Undecided	Disagree
Livestock grazing along the wetland	68.9	12.2	18.9
Arable farming along the wetland	58.2	21.3	20.5
Mining in the wetland	42.6	3.3	54.1
Brick making nearby wetland	66.4	7.4	26.2
Deforestation of wetland vegetation	69.7	3.3	27.0
Illegal fishing practices	80.3	25	17.2

About 58.2% of the respondents agreed that improper crop cultivation associated with poor irrigation facilities is seriously affecting the wetland as it results into clearing of vegetation's, breaking of the river banks and soil erosion along the wetland area. Generally, the study revealed that where local communities are aware of the main causes of wetland degradation they tend to be much concerned on how to prevent further degradation by employing better livelihood practices in their areas such as avoiding improper livestock grazing as well as improper agriculture practices along the wetland area.

4.5.3 Awareness on the consequences of wetland degradation

Awareness on the consequences of wetland degradation help individuals to set measures of offsetting degradation and sometimes restoring the ecosystems to their original condition so as to continue gaining benefits rather than suffering the consequences. Findings in Table 10 present the results on the awareness of the respondents on the consequences of wetland degradation. As indicated in Table 10, majority (75.4%) of the respondents agreed that occurrence of floods is the foremost consequences of wetland degradation within the study villages. Most of the respondents showed interest in ensuring

that wetland degradation is controlled due to the endurances they go through. The results indicate further that local communities are aware that continued development patterns associated with increased population which extends to wetland areas make the area more vulnerable to flooding which has a serious cost to the livelihood of the surrounding communities. Respondents who live in the villages in lower Ruvu reported that for the past three years floods have been destructing their crops making them harvest nothing and causing massive destructions of lives and properties leading to food insecurity in the area. . Interviewed respondents reported further that floods are a result of improper wetland use through cultivation along the wetland and invasion by livestock keepers in the area, all of which involve opening and clearing of the vegetation which acts as a barrier to water runoff from upper catchment. Improper livestock grazing and cultivation along the wetland have led to the erosion of river banks and shifting of the river due to the many openings that allow water to pass during heavy rains.

Table 10: Awareness on the consequences of wetland degradation

	Respondent responses % (n=122)		
Consequences of wetland degradation	Agreed	Undecided	Disagree
Occurrence of floods	75.4	12.3	12.3
Reduced crop yield from wetland	43.4	18	38.5
Wetland loss/Dries up	17.2	34.4	48.4
Soil erosion	34.4	13.5	52.1

4.5.4 Community practices on wetland use and controlling degradation

Table 10 presents the results on community practices on wetland use and controlling wetland degradation. Majority (70.50%) of the respondents reported to have been carrying out their activities close to wetland although they were aware of its impact, but local communities have been motivated by the availability of fertile soil and wetness that support crops production throughout the year.

Table 11: Community practices on wetland use and controlling degradation

	Respondent Response(n=122)				
Practices	Strongly Agree (%)	Agree (%)	Not sure (%)	Disagree (%)	Strongly disagree (%)
Farming 60 meters away from the wetland	0.00	29.50	0.00	70.50	0.00
Not clearing of vegetation along the wetland	2.60	54.00	0.00	43.40	0.00
Using proper fishing method	1.00	40.00	0.00	59.00	0.00
Abide to the government regulations on wetland management and use (practice activity 60 m away from the wetland)	3.20	30.50	0.00	66.30	0.00
Using various methods to control wetland degradation	4.90	50.00	0.00	45.10	0.00
I teach others on proper methods of protecting wetlands	0.00	46.70	2.50	53.30	0.00

Further about 66.30% of the respondents reported to have been not abiding by Government regulations on wetland management and use that provide that no human activities are allowed within 60 meter from the wetland area. Most of the respondents said that one of the main Government regulations they know is that it is prohibited to practice farming activities close to the wetland. However, majority of respondents said that most of the farmers do not abide by this regulation and therefore they continue carrying out activities very close to the wetland area and this is especially because 60 meters away from the wetland, the land becomes dry and unfertile and it therefore cannot produce high quality and quantity of crops. Some of the respondents on the other hand, said that the relevant Government organs did not show them the wetland boundaries 60 meters from the wetland; as a result this regulation was not effectively enforced by the relevant authorities. Furthermore, a number of respondents (54.00%) reported no to have been clearing vegetation along the wetland so as to preserve it. Vegetation acts as a major and important cover protecting the wetland from direct sunlight which may cause drying up of the wetland. Clearing of vegetation for opening farms cause wetlands to dry. Moreover, 50% of the respondents reported to be using traditional methods such as planting trees and grasses including sugarcane, banana trees and fruits trees to protect wetlands from degradation. Generally, the study found out that community practices on wetland use and

management vary from one area to another depending on the awareness of the value of that particular resource and the consequences of its degradation to their livelihood. Also, the study found that a community that has suffered from frequent floods tends to change their practices towards using wetland (Plate 5) by preventing them from further degradation. Enforcement of law and regulation that guide sustainable wetland use tends to improve the conservation status of natural resources. This is because such enforcements prevent unsustainable utilization of wetlands through regulating day to day practices on resource use. Similar findings are reported in a study by Kessy *et al.* (2015) who revealed that when communities are aware of the potential benefits of a resource their attitude towards its use would normally change. On the other hand, findings by Kateregga (2015) showed that practices normally follow the level of awareness; having a good awareness on the value of a resource makes people abide by sustainable use of wetland and its resources.

Plate 5: Water resistant grasses and banana trees planted by the community as one of their practices in controlling wetland degradation

4.6 Economic Implications of Wetland Degradation

4.6.1 Community Perceptions on economic implications of wetland degradation

Table 12 presents results on community perceptions towards economic implications of wetland degradation. As indicated in the Table, majority of the respondents perceived that access to food and cash crops, income, clean water and fish has highly been affected by wetland degradation making and has made them incur high economic costs in accessing these needs. About 66% of the respondents said that degradation of the wetland has highly affected the amount of food and cash crop that used to be harvested in theirs farms which are located in the wetland area. And 31% of the respondents said that access to food and cash crop has been affected by wetland degradation. The results imply that degradation leads to a change in the river flow therefore impacting on crop farming activities in the study area. High flow leads to inundation which destructs crops whereas low flow leads to drying up of wetland therefore affecting crops production.

Table 12: Community Perceptions on economic consequences of wetland degradation

Variable	Highly affected %	Affected %	Somehow affected %	Not Affected %	Total (n=122) %
Access to food and cash crop	66.4	31.1	2.5	0	100
Access to income	69.7	27.9	2.5	0	100
Access to clean water	66.4	30.3	3.3	0	100
Access to Fish	23	14.8	20.5	41.8	100

Further about 70% of the respondents said that access to income that used to gain from various activities in the wetland area has been highly affected by wetland degradation. Income from activities such as agriculture and fishing has decreased due to a decreased crop yield and fish population due to drying up of wetland areas in the study area. Majority (66.4%) of the respondent said that access to clean water has been affected by improper wetland use. Activities such as livestock grazing within the wetland, chemical

spills and water abstraction from agricultural practices as well as industrial effluent have significantly affected the quality of water in the wetlands and therefore causing increased cost of water treatment for domestic uses.

About 23% of the surveyed respondents said that fishing has been highly affected by wetland degradation, while majority (41.8%) of the respondents said that fishing has not been affected by wetland degradation in the study area. The findings from field observation show that some of the dams which originate from the main Ruvu riverine, and which used to harbour big numbers of fish stocks throughout the year, have dried up due to overutilization of wetland through improper grazing practices and abstraction of water for irrigation activities. Similar findings were reported from focus group discussion that most of the permanent dams from Ruvu riverine wetland area including Mongomore dam in lower Ruvu (plate 6), and which used to harbour big numbers of fish have dried up resulting to inadequate access to fish for food and income generation in the area.

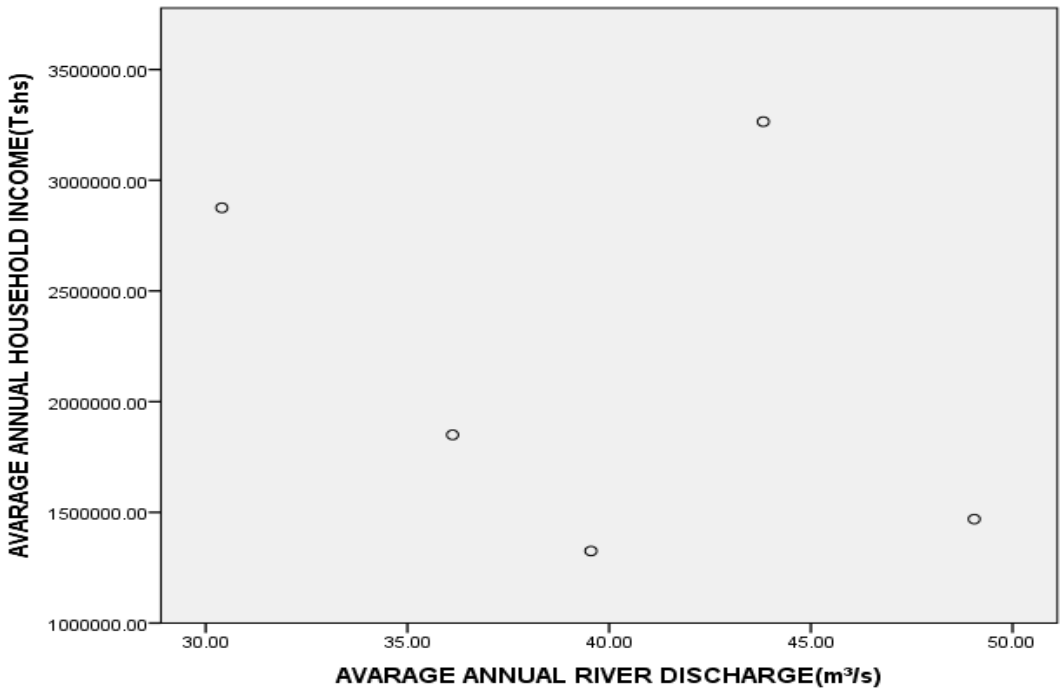
The overall findings on community perception reveals that the local community believe that degradation of wetland has led to a decline in various services and products that wetland has been offering to them in the past and therefore posing a threat to their livelihood options. These findings are in line with the findings from a study by Wasswa *et al.* (2013) who revealed that wetland degradation deprives societies of various services including income from agriculture, fish, and wildlife habitat, quality water, water quantity, and recreation benefits, as well as an increase of the cost for replacing wetland services. Further the findings are in agreement with the findings from a study sstudy by Crecious *et al*. (2013) who reported that cultivation has also been negatively impacted by wetland degradation whereby clearing of land for cultivation, results to direct reduction in

evapotranspiration. This reduces water vapour and hence precipitation and therefore reducing crop yields which seriously affect the livelihood of the communities living close to the wetlands. Furthermore the findings are in line with the findings in a study by Zinhiva *et al*. (2014) who reported that degradation of the wetland significantly influences the dwindling of livelihood options which are available to the local households and worsens the plight of the rural poor since the inhabitants experience food insecurity, malnutrition, and water shortages and income loss mostly during the dry season.

Plate 6: Dried permanent natural dam (originates from main Ruvu river) which used to harbour high fish stock has dried (Mongomore dam)

4.6.2 Implication of change in average river discharge to household income

Figure 6 presents results on the implication of change in the average river discharge to household's income in a visualization scatter plot. The visualization scatter plot shows that there is no significant relationship between change in the average water discharge and change in household's incomes. According to the results in the scatter plot, there is an inverse relationship between the dependent and independent variable whereas in some years an increase in the average river discharge cause a decrease or an increase in the average income which was expected to increase as the river discharge increases and decrease as the river discharge decreases; the trend which is attributed to an increase in the river flow which normally leads to frequent floods. Such floods have an impact on households' properties, lives and crops in terms of a decrease in yields and therefore affecting household income. Information from focus group discussion reveal that majority of participants reported that change in the average river flow in Ruvu riverine has been happening due to wetland degradation associated with improper land use along the area. Most of the respondents reported to have been witnessing a change especially an increase of the river flow during rainy seasons which normally start from mid of March to late May ever year within the area. These changes are associated with high inundation that normally destructs crops, houses and lives. Respondents revealed further that during dry season, which normally begin in September to late February, the average river flow tends to decrease and some parts of the wetland become dry therefore and thereby impacting negatively on the wetland cultivation and the life of the various living organisms within the area. As a result this impacts their sources of income including farming and fishing activities. Findings from the study by Theodory (2014) reported that increased land conversion had on impact on the flow characteristics of the catchment this was likely to impact on sources of earning provided by the Riverine.



Source: Field survey and secondary data

Figure 6: Implication of change in average water discharge to household income

Table 13 presents the findings on the test for significance on the relationship between change in the average water discharge and household income in the study area. The findings show that the R^2=0.332 which implies that the model explains 33.2% of the variation in income. The relationship between the dependent variable (average annual income) and independent variable (average annual river discharge) was found to be non-significant (p=0.309) and this could be due to the reason that there is an inverse relationship between the dependent and independent variable.

An increase and extremely increase in the average flow it occurs and is normally associated with a number of consequences such as floods which has an impact on agricultural productivity, human properties, lives and fish population hence affecting household's income and decrease in flow impact also productivity from various sources of incomes.

Table 13: Regression analysis of change in average water discharge to household income

Estimate	Value	S.E	t	P-value	R^2
Constant (β_o)	4460868.124	1920700.815	2.323	0.103	0.332
variable (β)	-54254.726	44405.504	-1.222	0.309	NS

R^2= Coefficient of determination

t=Student t- test

Beta=Regression coefficients

NS= statistically not significant at 0.01, 0.05, 0.1 levels of significance

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The findings from this study reveal that there is wetland degradation within the area caused by various land use changes done by human population that is living in the area as well as by immigrant livestock keepers who invades the area in search for green pasture for their livestock.

The analysis of contribution of various economic activities to wetland degradation found out that livestock grazing is the major driver of wetland degradation followed by unsustainable arable farming practices, brick making and fishing. This has been caused by the presence of large scrubland along this wetland therefore providing good pasture as well as water for livestock. On the other hand, the findings show that there is considerable variation on the contribution of these drivers from one study village to another due to the main practices by the communities living in these areas.

The study also shows that local communities in the study area has higher awareness on the direct values of wetland but low awareness on the indirect values of wetland since majority of them ranked most the direct values of wetland. Majority of the respondents reported that farming along the wetland and water for domestic use are the most significant values they obtain over years from using wetland while very few respondents mentioned the indirect values that wetland provides to them.

Further, findings from the study show that local community practices on wetland and wetland degradation control are not good enough due to the ongoing improper farming

practices, livestock grazing, poor fishing practices as well as gold mining within the wetland. Most of the respondents reported that the reason for the continued improper use of wetland is the belief that these areas have been used over years by their ancestors and therefore there is no reason for them to leave this area or to change practices for conservation purposes.

Furthermore, the study shows that community perceive that wetland degradation has highly affected their economic condition including access to reliable income from agriculture and fishing as well as clean water for domestic use. There was no significant relationship ($p=0.309$) between a change in the average annual households income and a change in the average river discharge in the study area; thus, there was an inverse relationship between these two variables and few observations due to lack of long-term data of these two variables.

5.2 Recommendations

Based on the findings, discussion and conclusions above, the following are the recommendation that can be made;

(i) As evidence from satellite image showed is the prevalence of wetland degradation in the study area, there is a need for the government and wetland management authorities to devise measures of controlling degradation in the area, which may include diversification of livelihood options in the area and replacing them with those which have little or no impact (i.e. beekeeping and tree planting projects in areas close to wetland) on this fragile ecosystem, which is of utmost importance in the country in both environmental and socio-economic perspectives.

(ii) Since livestock grazing and farming along the wetlands have been the major problems in the area leading to high degradation, the government should develop and provide better infrastructures for both livestock keepers (i.e. building cattle trough) and farmers for enhancing sustainable use of wetland areas. Further the government should set areas for livestock keepers (rangelands) which are suitable for grazing and located far away from the wetland areas. Furthermore, farmers should be provided with knowledge on proper agricultural practices in the area close to the wetland so as to reduce degradation. Moreover, the government and wetland management authorities should strengthen enforcement of the regulation that restrict human activities 60 meters close to wetland and support tree planting campaigns as well as other income generating activity such as beekeeping projects close to wetlands to supplement farming and livestock keeping close to wetlands.

(iii) Awareness on direct and indirect values which local communities can accrue if wetlands are utilised sustainably should be raised. This is because awareness on the values of wetland will help to improve conservation of wetland resources. on the other hand, awareness on the causes and implication of wetland degradation as well as their indicators should be given to the community so as to make them conserve these resources for the benefit of the present and the coming generations; Also there is a need for developing specific wetland management plan to regulate utilization practices of wetland resources by the local community in the respective areas.

(iv) Since wetland degradation has been found to have serious economic costs to the government and local communities reflected in high expenditures in replacing wetland services, foregone incomes, livelihood support and alternative

employment, efforts should be made to ensure that proper management of wetland ecosystems is attained so as to sustain economic and ecological services offered by these ecosystems. Education campaigns should be established so as to raise awareness on economic implications of wetland degradation in the area. On the other hand, there is a need for establishing institutions duly empowered to issue and implement wetland laws and coordinate management activities in Tanzania for improved wetland management and reduce wetland degradation which has serious economic cost to the government and community.

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APPENDICES

Appendix 1: Household questionnaire

Dear respondent the aim of this interview is for study purposes only and the information that you will provide is strictly confidential and will not be used for any other purposes therefore be free to share everything you know about what i will ask you for the successful completion of this study.

Part A: General information

1. Questionnaire no…….
2. Village……. Household No…….
3. Household size…….
4. Date of interview…….Name of interviewer…….
5. Sex:1- Male 2-Female
6. Age…….
7. Education…….
8. Marital status: Married ( ) Single ( ) Widow ( ) Divorced ( ) Separated ( ) Widower ( )
9. Occupation…….....
10. Household assets along the wetland

	How was it acquired			
Property	**Bought**	**Inherited**	**Rent**	**Quantity/number**
1-Farm land				
2-Fishing gears				
3-Brick making site				
4-Mining assets/site				
Any other				
5				
6				

Part B: Economic activities that lead to wetland degradation (Circle appropriate answer)

11. a) In past ten years has the population in this area changed? 1-Yes 2-No

b) If yes has it 1-increased or 2-decreased

12. a) Does the population change leads to wetland degradation? 1-Yes 2-No

b) If yes what have you noticed of degradation from population increase?

……

……

13. a) In past ten years has the amount of rainfall in the area changed? 1-Yes 2-No

b) If yes has it 1-Increased 2-Decreased

14 Does the decrease rainfall change lead to wetland degradation? 1-Yes 2-No

15. Which activities do you use wetland for?

1-Crop cultivation 2- fishing 3-Animal grazing 4-brick making and sand mining 5-forest products 6- any other specify

.....

.....

16. What crops do you cultivate using water from the wetland area?

1- Maize 2- Rice 3- Beans 4-Vegetables 5- Fruits 6- other specify

.....

.....

17. Has your planting /cropping season changed over years? 1-Yes 2-No

b) If yes how

1-one time 2-two times 3-three time 4-four times 5-other specify

c) Why?

.....

.....

18. To your understanding which activity has most prominent effect on the wetland/has significantly threat to wetland health? Rank in order of importance in affecting the wetland.

1- Crop cultivation 2- fishing 3- Animal grazing 4- brick making and sand mining 5- forest product 6- any other specify

.....

.....

19. Why is the activity mentioned above is significantly in affecting wetland health

1-Involve clearing of vegetation 2-eutrophication 3-Sedimentation 4-Draining 5-any other

20. Why does people still practice the economic activities mentioned above?

1- Supplement household incomes

2-Supplement household food supply

3 -Employment

4 -Others (specify)

…….....

.....

Part C: (i) Community awareness on the values of wetland, causes and consequences of its degradation (Likert response 5- Strongly agree, 4-Agree, 3-undecided, 2-Disagree, 1-Srrongly disagree) if strongly agree to agree and disagree to strongly disagree give reasons

21. Which of the following are the values of wetlands you know?

a) Food and cash crop
b) Water for domestic use
c) Fishing
d) Erosion and flood control
e) Carbon storage and climate regulation
f) Storage and recycling of nutrients
g) Any other specify

.....

.....

22. What do you understand when one talks about wetland degradation?

……

……

23. Has the values of wetland been affected by degradation? 1- Yes 2- No

24. Which of the following are the main causes of wetland degradation you aware of?

a) Livestock grazing along the wetland

b) Arable farming along the wetland

c) Mining within the wetland

d) Mining nearby wetland

e) Deforestation of wetland vegetation

e) Illegal fishing

f) Any others specify

.....

.....

25. Which of the following are the primary effect of wetland degradation are you aware of?

a) Occurrence of floods

b) Reduced crop yield

c) Wetland loss /dries up

e) Soil erosion

f) Any other specify

.....

.....

26. What are the indicators of wetland degradation do you know?

.....

.....

27. Do you think in your area there is wetland degradation? 1- Yes 2- No

(ii) Community practices on controlling it Practices statements ((Likert response 5-Strongly agree, 4-Agree, 3-undecided, 2-Disagree, 1-Srrongly disagree) if strongly agree to agree and disagree to strongly disagree give reasons

28 I do my farming activities 60 meters away from the wetland

……

29. I do not clear vegetation along the wetland

……

30. I use proper fishing methods

……

31. I use both traditional and modern ways of preventing wetland degradation

……

32. I teach other on proper methods of protecting wetlands

……

Part D1. Consequences of wetland degradation (Response of likert scale 1=Not affected, 2=somehow affected, 3= affected, 4=highly affected)

33. What is the level of effect of wetland degradation within this area?

.....

34. How much the does the following economic activities has been affected by wetland degradation?

a) Arable farming

.....

b) Fishing

.....

c) Livestock keeping

.....

d) Any other specify

.....

35. How much does the quantity and quality of domestic water availability has been affected by wetland degradation?

.....

36. How much does the amount of food and cash crops generated from using wetland has been affected by wetland degradation?

.....

37. How much does the amount of income generated from using wetland has been affected by wetland degradation?

.....

Part D2: Estimate of Change Quantity of Goods produced from using wetland

38. What is the average household income that has been accrued in in past five years 2011-2015?

Year	Average income Tshs.
2011	
2012	
2013	
2014	
2015	

39. Why do you think this change has happened? a) Wetland degradation b) climate change c) Both d) any other specify

.....

.....

40. Has the amount of water available for use in the wetland increased or decreased? a) Increased b) Decreased c) Remained the same

.....

41. a) Why do think so? (Changes observed)

.....

b) What are the likely impact do you think?

.....

Appendix 2: Checklist for focus group discussion

(Give brief explanation on the trend of the following activities in past years and current year)

1. Economic activities that are practised in this wetland in past and now
2. Which of the mentioned economic activity has great impact on wetland health rank in order of importance?
3. What are the values do you get from wetland as whole?
4. Are you aware of wetland degradation and its consequences?
5. What are the changes in productivity of the economic activities past (give an average for 10) years and the current productivity? In the following production activities

   a) Arable farming

   b) Fishing

   c) Livestock keeping

   d) Any other specify

6. Does change in productivity affected the access to food and income?
7. Is there any change in access to domestic water in terms of quality and volume the area?
8. What action do you take to control wetland degradation?
9. What are the local ways for maintaining wetland?

Appendix 3: Checklist for key informants

1. What are the main use of wetland by local community living adjacent the wetland area?
2. What are the main drivers of wetland degradation in Ruvu river?
3. Which is the most significant driver in order of sequence from top most to the lowest?
4. Why does this community prefer more these activity that has impact on wetland?
5. What is the level of awareness of the local community on wetland degradation?
6. What is the awareness of the local community on consequences when wetlands are degraded?
7. What are the implications of wetland degradation on access of community to food?
8. What are the implications of wetland degradation on access of community income?
9. Is there any local knowledge/modern knowledge used by these communities towards controlling wetland degradation?
10. What attitude do the people living along this area have in averting wetland degradation?
11. What are the community practices towards controlling wetland degradation