ASSESSING THE WATER QUANTITY AND QUALITY IN THE UPPER TANA CATCHMENT OF KENYA: A CASE STUDY OF EMBU AND KIRINYAGA COUNTIES.

Final Report

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ABBREVIATIONS AND ACRONYMS

- **Catchment –** The area from which rainfall flows into a river, lake or reservoir
- **FDA –** Focal Development Areas
- **IFAD –** International Fund for Agricultural Development
- **PCT –** Project Coordinating Team
- **Quality –** The standard of something as measured against other things of a similar kind; the degree of excellence of something
- **Quantity –** The amount or number of a material or abstract thing not usually estimated by spatial measurement
- **River Basins –** An area of land drained by a river and its tributaries
- **SCMPs –** Sub-Catchment Management Plans
- **UTaNRMP –** Upper Tana Natural Resources Management Project
- **Vulnerability –** The state of being exposed to the possibility of being attacked or harmed
- **WRMA** – Water Resources Management Association
- **WRUA –** Water Resources Users Association
- **WVI** – Water Vulnerability Index

EXECUTIVE SUMMARY

The overall objective of this research was to assess water quantity and quality in the Upper Tana Catchment and the extent to which the Upper Tana Natural Resources Management Project (UTaNRMP) project interventions have contributed to sustainable natural resource management of the beneficiary communities.

The Upper Tana catchment has been experiencing a drastic reduction of surface water availability especially during the dry season, which is a manifestation of high runoff rates and decreasing groundwater recharge (UTaNRMP Baseline Survey, 2014). Also, the catchment generally receives high precipitation in the upper recharge area but floods account for over 70% of the total flow, so most of this water is not available for use. The current patterns of river flow and water management leave very little scope for further development of surface water resources for economic activities. Therefore this study is aimed at assessing the activities of the Upper Tana Natural Resource Management Project (UTaNRMP) in promoting the water resources quality and quantity in the project area thereby resulting in sustainable management of the water resources.

The study was expected to: Assess the vulnerability to water scarcity of the project study area; Assess water efficient utilization technologies used by households and farmers in the catchment; Assess the Water Resources Users Associations (WRUAs) as a community based organization in promoting water quality and quantity; and analyse water quality and quantity data so as to assess the water quality and quantity trends in the study area.

The study was carried out in two (2) of the UTaNRMP six (6) counties, Embu and Kirinyaga; and covered four (4) River Basins: Rupingazi and Thuci (Embu County), Nyamindi and Thiba (Kirinyaga County). This survey utilized a number of approaches and methodology including literature review of numerous Project documents, and other published literature sources. In addition, quantitative and qualitative research methodologies were applied including: individual household (HH) interviews; Focus Group Discussions (FGDs); Key Informant Interviews and observation and informed judgment. A total of 421 Individual Household Interviews were carried out; 4 FGDs and 8 KIIs.

The findings generated from this study were discussed in five sections: social and economic characteristics of households; and specific findings based on the four (4) research objectives. In regards to social economic data of households, it was found that 57% of HHs were female, while 43% were male. These findings did not exactly correspond (but was similar in that it showed that female were higher in population) to national statistics which indicate that women account for 50.3% of the population while men account for 49.7% of the population as per the Kenya

National Bureau of Statistics (KNBS, 2009). It was also established that 85% of Heads of HHs were male while 13% were female and this confirmed that the Project area was largely a patriarchal society. Regarding age of HHs; 6.4% were below the age of 30; while 57.5% were below the age of 50 years, which implied the Project had targeted beneficiaries who were energetic and therefore able to carry out agricultural activities. It was also established that only 12% of HHs were completely illiterate, meaning they had not attended any formal schooling, with the rest of the HHs (88%) having attended some form of schooling (Primary, Secondary, College/University or Vocational training)

In the analysis of the water vulnerability index (WVI), Embu county had the highest percentage for water resources in Rupingazi River Basin 85% water quality, water reliability (86.7%) and water adequacy (91.7%) while Thuci had the highest percentage of water treatment 72%. Rupingazi also had the highest percentage of access to water. WRUA membership is highest in Rupingazi and lowest in Thuci with high rate of water conflict and pollution in the Thiba river basin. Nyamindi has the highest level of water use at 79.4%. The result of the Chi-Square ranking of the obtained value for each component of WVI based on weighted averages shows that there are variances in the vulnerability level across the counties and across river basins in the study region. Specifically, Thuci river basin in Embu County has the lowest vulnerability index of value 0.5820, which makes it most vulnerable; while Rupingazi river basin had the highest vulnerability index value of 0.6766 which makes it the least vulnerable.

Regarding the assess to water efficient utilization technologies used by households and farmers in Embu and Kirinyaga Counties, The project had developed/rehabilitated 22% of the water drinking sources in the counties. There was also observed increase in the percentage of people who used improved water sources (protected spring, protected well, borehole and piped water); 61.70%, 42.70%, 47.10%, 39.10%; in Rupingazi, Thuci, Nyamindi and Thiba River basins; 87.4% of the people are involved in water harvesting and 59.1% do crop land irrigation farming.

The project had established 33 WRUAs according to the Impact Analysis Survey of 2017 and each WRUA had developed SCMP with technical support from WRMA. The WRUAs however sampled for this study were; Upper Rupingazi WRUA, Thuci WRUA (Embu County) and Lower Nyamindi WRUA, Upper Thiba WRUA (Kirinyaga County). The WRUAs all had a SCMP but Lower Nyamindi WRUA had not been able to implement any activity in the SCMP due to lack of funding. Twenty six (26) water harvesting tanks have been provided by the 3 WRUAs so far including promotion of rain water harvesting across the river basins. 5 Springs have been rehabilitated in Upper Rupingazi RB; 20,000 trees planted across the Thuci RB; as well as mapping of riparian areas and installation of master meters in the Thiba RB.

The project had supported construction and equipping of 2 modern and advanced water laboratories, established 90 water quality and water Base-flow monitoring points and trained 4 staff in lab analysis and lab management skills.

Regarding the assessment of sediment load, baseflow and coliforms, in the study area; it was found that suspended sediment load has decreased across the counties. The decrease was attributed to conservation activities and decreased base-flow caused by drought in 2016. Generally, discharge in rivers and streams had decreased over years largely attributed to effects of climate change. The number of feacal coliforms also decreased attributed to hygiene and sanitation awareness creation. It was also established that base-flow and water quality results were being used to guide catchment protection, conservation and management activities.

One of the significant lesson learnt which contributes to the success of the project so far is that the use of community contribution towards implementation of water sector activities. This had created ownership hence provided for sustainability of activities. In addition, the establishment of modern and advanced water laboratories had created a one-stop-shop for water quality and base flow data for planning and management of water resources and environment.

As recommendations, there is need to improve the timeliness of appraisals of proposals for funding and cash disbursements to ensure proposed activities on time. Capacity building of WRUAs needs to be enhanced to improve the chances of funding. More work also needs to be done in terms of sensitization on the project and proper water management practices.

CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

The availability of water in adequate quantity and quality is a necessary condition for sustainable development. Water, the basic element of the life support system of the planet, is indispensable to sustain any form of life and virtually every human activity. Sustainable water management therefore is a critical component of sustainable development, and accounts for similar issues as sustainability. However, water shortage is likely to be one of the most dominant water problems in the forthcoming century basically due to population growth and by increase of the per capita water use, jeopardizing sustainable development.

According to the United Nations World Water Development Report 2018, 2.1 billion people in the world lack access to safely managed drinking water services and it estimated that by 2050, the world's population will have grown by an estimated 2 billion people and global water demand could be up to 30% higher than today. The UN Water Conference in 1977 agreed that "all peoples, whatever their stage of development and their social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs". Access to safe water has therefore become a kind of human right. The UN International Drinking Water Supply and Sanitation Decade (1981-1990) had the goal of arranging for access to safe drinking water and sanitation for the whole population of the Globe.

The definition proposed by (Alley *et al*., 1999) for groundwater management cites protection of the components in the sustainability triple bottom line: environment, economy, and society. A more holistic objective is provided in United Nations Agenda 21 which ensures that "adequate supplies of water of good quality are maintained for the entire population of the planet, while preserving the hydrological, biological and chemical functions of ecosystems, adapting human activities within the capacity limits of nature and to combat vectors of water-related diseases."

The Upper Tana River Basin covers approximately 17,000 km^2 and is home to 5.3 million people (TNC, 2015). The basin covers Mount Kenya and the Aberdare highlands with elevations ranging from 4,500m at Mount Kenya to about 400m above sea level in the east of the catchment (Dijkshoorn et al., 2011). There are two rainy seasons and rainfall is relatively high with average

annual rainfall of about 2,000mm at higher altitudes (Hunink et al., 2013). The water this area provides is of critical importance to the Kenyan economy. It fuels one of Kenya's most important agricultural areas, provides half of the country's hydropower output, supplies 95% of Nairobi's water and is home to national parks and reserves which are important areas of biodiversity (TNC, 2015).

In Upper Tana despite her enormous potentials, environmental and social challenges threaten the living conditions of the people (UTaNRMP Baseline, 2014). Therefore the activities of the Upper Tana Natural Resource Management Project (UTaNRMP) among others intend to tackle catchment degradation arising from the various unsustainable land use practices that include deforestation and encroachment for farming/grazing/settlement on fragile areas especially wetlands, riparian reserves and steep slopes/hill tops leading to soil erosion, low agricultural productivity and water pollution.

These challenges among many others prompted the establishment of the Upper Tana Natural Resource Management Project (UTaNRMP). Upper Tana Natural Resources Management Project is an eight year project (2012 – 2020) funded by Government of Kenya, International Fund for Agricultural Development (IFAD), Spanish Trust Fund and the Local community.

This study however focuses on the Sustainable Water and Natural Resource Management Component of the Project, and majors on the Sustainable Water Resources sub-component which is designed to improve the sustainable utilization of water and other natural resources, mainly using community groups including the WRUAs. Remedial works at environmental hotspots: This targets hotspots that contribute to silt loads and pollution to water. The project target specific problem areas such as road embankments, borrow pits, quarries, denuded hilltops, coffee processing plants, eroding riverbanks, wetlands, springs and urban waste disposal facilities.

1.2 Problem Statement

The Upper Tana catchment has been experiencing a drastic reduction of surface water availability especially during the dry season, which is a manifestation of high runoff rates and decreasing groundwater recharge (UTaNRMP Baseline Survey, 2014). Also, the catchment generally receives high precipitation in the upper recharge area but floods account for over 70%

of the total flow, so most of this water is not available for use. The current patterns of river flow and water management leave very little scope for further development of surface water resources for economic activities.

One other major challenge in the Upper Tana is that upstream human activities (such as deforestation, pollution of rivers, poor farming methods) as well as soil erosion, are causing increased sedimentation in the basin's rivers, reducing the capacity of reservoirs and increasing the costs for water treatment (TNC, 2015). In addition, water quality is compromised as few agricultural and pastoral land use measures are in place to keep pollutants out of the rivers.

Water scarcity and community vulnerability to extreme climate change implications maybe perhaps have increased. Consequently, assessment of probable effects on water resources due to climate change and unsustainable management of water resources is crucial for structural development, readiness to disasters and irrigation planning.

Therefore this study is aimed at assessing the activities of the Upper Tana Natural Resource Management Project (UTaNRMP) in promoting the water resources quality and quantity in the project area thereby resulting in sustainable management of the water resources.

1.3 Justification of the Study

With the high potential of the Tana catchment and as part of IFAD global strategy for agricultural development and natural resources conservation, the UTaNRMP activities can achieve a sustainable management of natural resources for provision of environmental services in the catchment hence the result of this study has potential to provide in-depth information to key stakeholders such as farmers, policy makers and researchers on the quality and quantity of water in Embu and Kirinyaga counties of the catchment which may be useful for future project intervention and development policies for natural resources conservation

1.4 Research questions

i. What is the level of water vulnerability in Embu and Kirinyaga counties of the Upper Tana catchment area?

ii. What are the water saving technology employed by households and farmers in promoting efficient water resource management?

iii. To what extent has the activities of the Water Resource Users Associations improved on the water quality and quantity of the river basins in the counties?

iv. What is the trend of water quality and quantity in the study area?

1.5 Objectives of the Study

The objectives of the study are:

i. To assess the vulnerability to water scarcity of the project study area

ii. To assess water efficient utilization technologies used by households and farmers in the catchment

iii. To assess the Water Resources Users Associations (WRUAs) as a community based organization in promoting water quality and quantity

iv. To analyse water quality and quantity data so as to assess the water quality and quantity trends in the study area.

1.5.1 Analysis of the objectives of the study

Research Objectives	Type of variable	Indicators	Measuring of indicator	Data collection method	Tools of analysis	Type of Analysis
i. To assess the vulnerability to water scarcity of the project study area	Dependent				Mean	Descriptive
- **Resource (R)**		Water quality	Level of water quality	Questionnaire	Percentage	Content
		Water treatment	Water treatment methods	Questionnaire		
		Water reliability	Duration of water rationing	Questionnaire	Cross-tabulation	Correlation
		Water adequacy	Water available enough to meet household needs	Questionnaire Also including: FGD, KII		WV Index
- **Access (A)**		Access to water types	Types of Water sources	Questionnaire		
		Proximity to water source	Distance to water source	Questionnaire		
		Time spent on water collection	Time taken to get water from the nearest source	Questionnaire Also including: FGD, KII		

- **Capacity (C)**		Occurrence of water related illness Membership of group Capacity building Water information	Incidences of illness due water borne diseases Belonging to a WRUA Types of training received Access to water information	Questionnaire Questionnaire Questionnaire Questionnaire Also including: FGD, KII		
- **Use (U)**		Quantity of water used	Volume of water use per household per day	Questionnaire		
- **Environment**		Waste disposal Water conflict Water pollution	Methods of disposing waste Incidence of conflicts related to water issues Incidence of pollution No. of pollution points Base flow of river basins River turbidity Suspended Sediment Load (SSL)	Questionnaire Questionnaire Questionnaire Laboratory analysis Laboratory analysis Laboratory analysis		

			Total Coliform and Faecal (E. coli) bacteria	Laboratory analysis Also including: FGD, KII		
ii. To assess water use and water efficient utilization technologies used by households and farmers in the catchment	Independent	Types of technologies use in water utilization Development of sources water (springs, boreholes, shallow wells) Support to Rain water harvesting demonstration structures Upgrading of irrigation schemes	No of water efficient technologies adopted No of alternative water sources constructed or rehabilitated Percentage of people adopting rain water harvesting Method of irrigation system used Percentage of people adopting irrigation schemes Impact of the irrigation system on farmers	Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire Questionnaire Also including: FGD, KII	Mean Percentage Cross-tabulation	Descriptive Content Correlation
iii. Assessment of the WRUAs as a community based organization in promoting water quality	Independent	Coordination and management of WRUAs Formation of SCMP	Leadership and management style of the WRUAs No. of WRUA record keeping books well kept	Focused Group Discussions Interview	Mean Percentage	Descriptive Content

and quantity		Implementation of the SCMPs Water Conflict Resolution	No. of Sub-catchment management plan formed No. of activities in the sub-catchment plan implemented Frequency of water resource conflict No. of conflicts resolved	Focused Group Discussions Interview Focused Group Discussions Interview Questionnaire		Correlation
iv. To analyse water quality and quantity data so as to assess the water quality and quantity trends	Independent	Types of data available Frequency of data collection Methods used to communicate data and information Adequacy of the data collected Application of the data collected	Parameters used for data analysis No. of times data is collected in a year Means of passing and receiving lab results to make decisions Competence of data collectors and data collected Level of use of data collected	UTaNRMP Laboratory Analysis Result Interview Interview Interview Interview	Mean Percentage	Descriptive Content Correlation

1.6 Research hypothesis

The researcher expects variances in the water vulnerability index (WVI) of each study river basin depending on the land, water-related livelihoods and also in relation to different socio-demographic characteristics. The researcher also expects that the activities of the Water Resources Users Association (WRUA) will affect the WVI and water trends as that the WRUAs are key in the conservation of water resources in the catchment.

1.7 Limitation of the study

The study was limited to only two (2) out of the six (6) Counties covered by the Upper Tana Natural Resources management Project (UTaNRMP) and this was majorly due to time and financial constraints. Language was also limitation as interpreters and enumerators needed to be used and this limited indepth communication with respondents.

CHAPTER TWO: LITERATURE REVIEW

2.1 Water Resources Management

Water resources will steadily decline because of population growth, pollution and expected climate change (Hemson *et al.,* 2008). It has been estimated that the global demand for water doubles approximately every two decades (Meyer, 2007) and that water will even become as expensive as oil in the future (Holland, 2005). "*In the year 2000, global water use was twice as high as it was in 1960*" (Clarke and King, 2004:19). Unfortunately this trend is expected to continue. Also with the increasing issues with climate change, there is an increasing agreement that water is strongly related to poverty.

Water has a positive effect on socio-economic development especially in Africa where most of the economic activities depend on water availability. With this view, the huge investment in water infrastructure and promotion of water governance can make a contribution to both absolute and chronic poverty alleviation in developing countries, this can be done by supporting such broad purposes as economic growth, rural and agricultural development and national food security. However, a contradictory view holds that in spite of these positive outcomes, water resources development can be considered directly or indirectly unsustainable and destructive to the environment example can also be seen in countries where dams, canals, boreholes e.t.c. are constructed with disregard to the soil conditions. These had further led to destruction of the environment and distortion of the water table. But despite the differences in the views, it cannot be denied that water resources play a vital role (either positively or negatively) on the development of any country. Water can contribute to domestic welfare, agricultural production, industry and conservation of the environment, it can also lead to water-borne diseases such as malaria and other dangerous diseases and could cause degradation through water logging and salinization. I believe the proper management of is key to enjoying its benefits and avoiding the dangers to be experienced.

In addition to these views, Savenije (2000) assumes that the lack of water for agricultural production is due principally to the physical limitation of water resources such as rivers, streams etc. so most communities with water resources can easily take part in agricultural production with ease, while the lack of water for domestic purposes is, in most cases, linked to social, political and

economic problems a community or country faces; this is true as residents are expected to pay for water provided which is controlled by policies from government. These problems could also be the main cause of low or lack of access to safe water which results directly or indirectly in decreasing human productivity. Therefore combining the measure of water availability and the socioeconomic capacity to access to it gives new insights in the fields of water resources management and poverty alleviation.

2.2 Water in Kenya

Kenya is classified as a chronically water-scarce country. This is because the country's freshwater is limited by an estimated annual supply of $534m^3$ per capita as at 2009 which is less than $1000m^3$ threshold below which a country is considered as water scarce (World Bank, 2010); and this impacts on the social, economic and environmental development goals. Kenya's renewable fresh water resources per capita is projected to decrease as the population increases. This fresh water resources are also unevenly distributed in space and time leading to inequalities in water available to the population.

Kenya has five (5) drainage basins; Lake Victoria, Rift Valley, Ewaso Nyiro North, Athi River and Tana River; all these have unequal availability of water. Only Lake Victoria and Tana Basins have a water surplus while the rest of the basins suffer from water deficits (USAID, 2000)

2.3 The Upper Tana River Basins

The project area is Upper Tana catchment which covers an area of 17,420 km^2, is home to 5.2 million people and includes 24 river basins. The upper Tana catchment that provides water for about half the country's population, and most of the country's hydroelectric power. The area includes the Mount Kenya and Aberdares National parks and surrounding forest reserves. The area is under heavy and growing population pressure with an average of about 250 inhabitants per km^2.

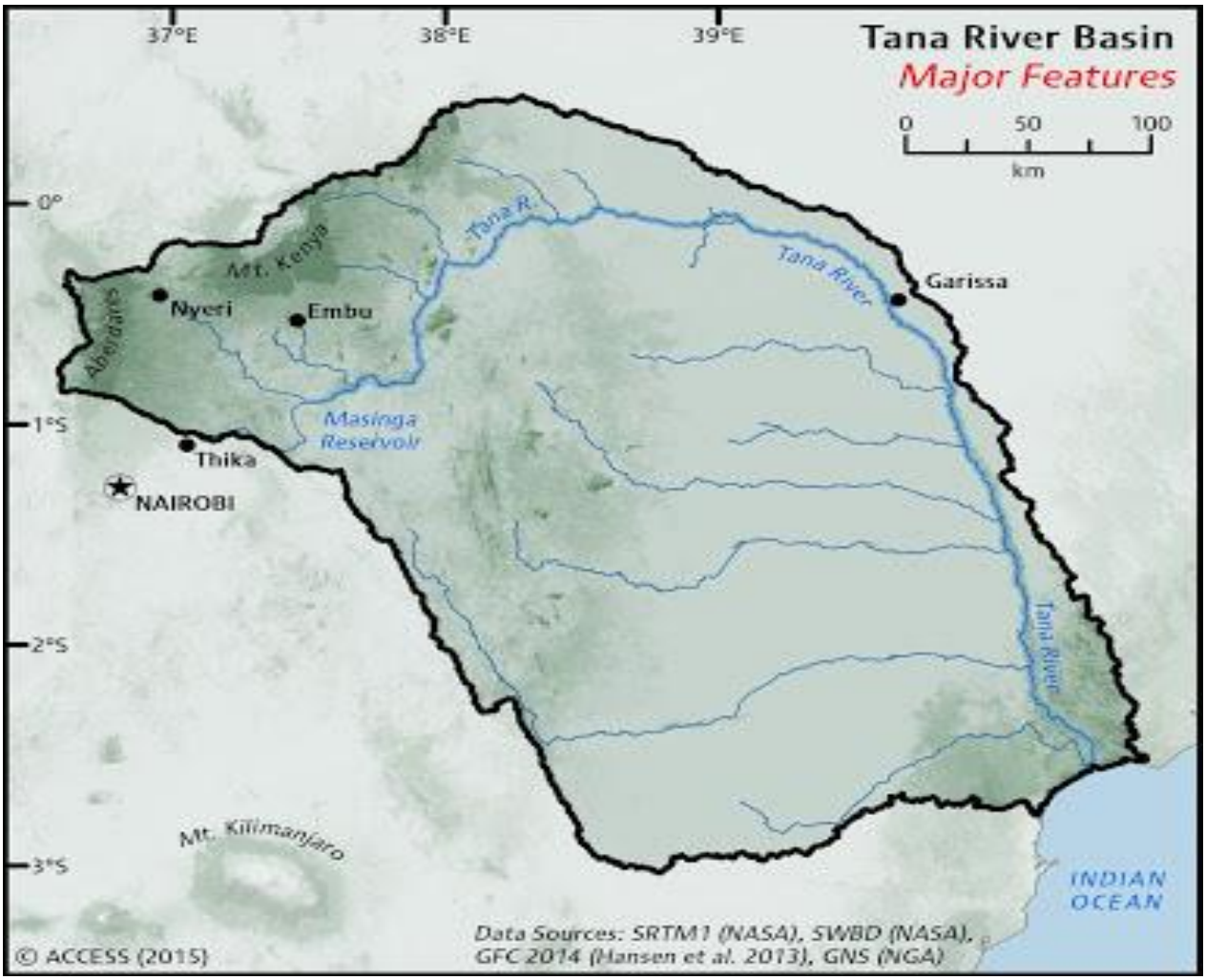


Figure 2.1: Map of the Tana River Basin (Source: SRTM1 NASA)

The Tana is the longest and one of the most important river basin in Kenya, its flow constituting 27% of the total discharge of the country's rivers. The Upper Tana catchment includes 25% of Kenya's gazetted forests and has experienced considerable land degradation and a drastic reduction of surface water availability during the dry season, and poor water quality during the wet season due to high silt loads. These same factors contribute to the persistently high levels of rural poverty; and also has serious consequences for power supply (the Tana River contributes 70% of the power supply in Kenya), the supply of water to Nairobi, and the availability of water for irrigation, livestock raising, fisheries and domestic purposes. The Upper Tana area is also densely populated, with large concentrations of poor and very poor people, particularly in the mid-altitude zone. Landholdings are small and diminishing as population grows, crop yields are low and

declining due to fertility depletion and erosion, and rural households are poorly linked to markets and services.

2.4 Upper Tana Natural Resources Management Project

Upper Tana Natural Resources Management Project (UTaNRMP) is an eight year project (2012-2020) funded by Government of Kenya (GOK), International Fund for Agricultural Development (IFAD), Spanish Trust Fund (STF) and the local community. The goal of the project is to *"contribute to reduction of rural poverty in the Upper Tana river catchment"*. This goal is pursued via two development objectives which reflect the poverty-environment nexus namely:

(i) Increased sustainable food production and incomes for poor rural households living in the project area; and

(ii) Sustainable management of natural resources for provision of environmental services.

The objectives of UTaNRMP are in line with:

Kenya's Vision 2030: The Kenya's long term development blueprint which aims at creating a *"globally competitive and prosperous country with a high quality of life by 2030"* and *"providing a high quality of life to all its citizens in a clean and secure environment".*

And is directly addressing the following SDGs:

Goal 2: End Hunger, achieve food security, improved nutrition and promote sustainable agriculture;

Goal 5: Achieve gender equality and empower all women and girls;

Goal 6: Ensure access to water and sanitation for all;

Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all;

Goal 13: Take urgent action to combat climate change and its impacts;

Goals 15: sustainably manage forests, combat desertification, halt and reverse land degradation halt biodiversity loss.

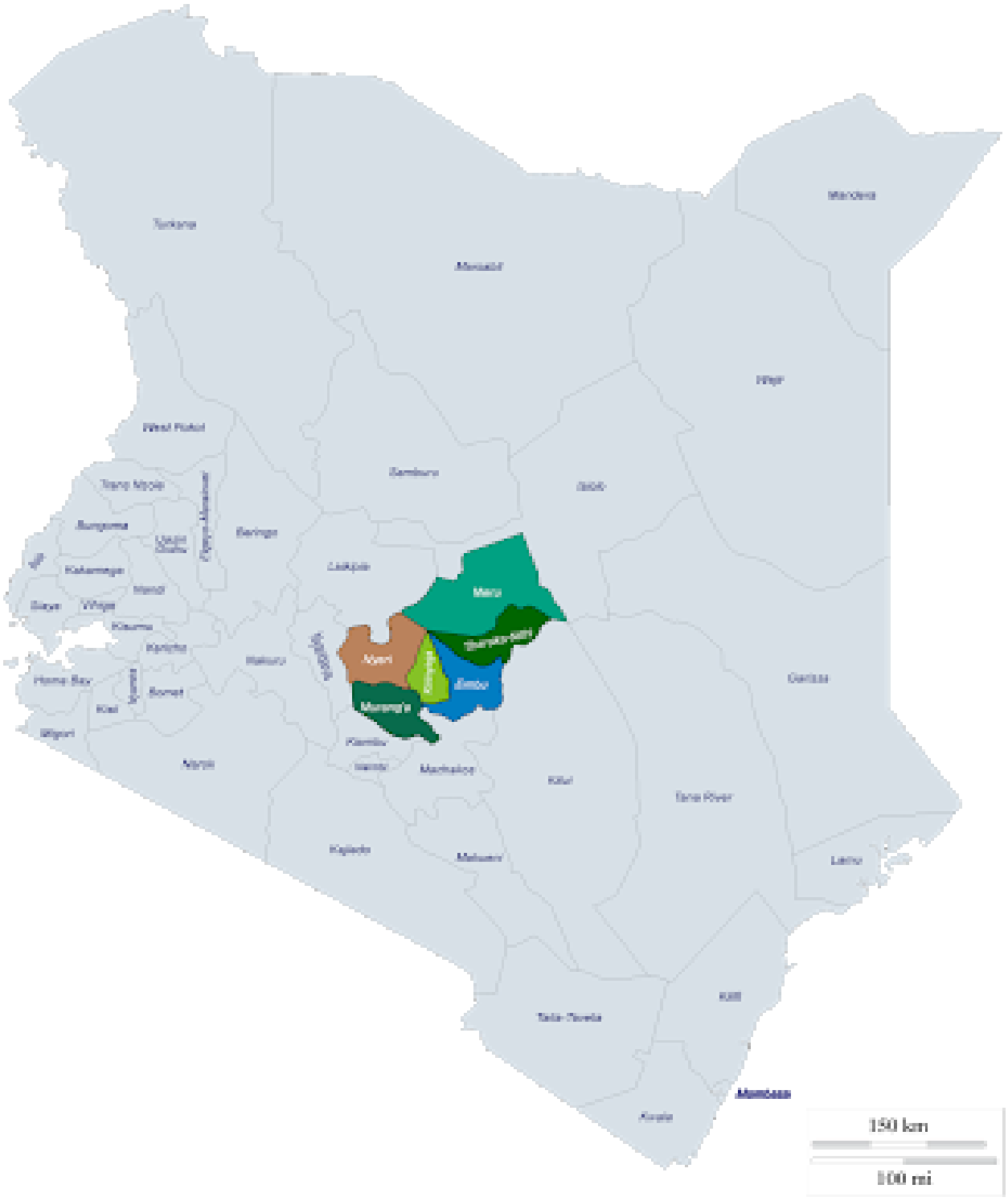


Fig. 2.2: Map of Kenya showing the coverage of the UTaNRMP

2.4.1 Components of UTaNRMP

The UTaNRMP is implemented through the following components:

- **Community Empowerment Component:** This component is designed to empower communities to sustainably manage natural resources. It aims at engaging communities to build their capacity to develop plans aimed at improving NRM while also improving their livelihoods, food security and nutrition.
- **Sustainable Rural Livelihoods Component:** This component aims to improve the incomes and living standards of the target group using interventions that are beneficial to the management of the natural resource base.
- **Sustainable Water and Natural Resource Management Component:** This component is designed to improve the sustainable utilization of water and other natural resources, mainly using community groups including the Water Resources Users Associations (WRUAs) and the Community Forest Associations (CFAs).

  The component has two sub-components namely:

  (a) Sustainable management of water resources, and

  (b) Sustainable management of forest and agricultural ecosystems.
- **Project Management and Coordination Component:** This component is designed to ensure that the project is effectively and efficiently managed. The objective of the component is to enhance management in implementation and coordination of project activities so as to ensure the project is implemented to achieve its objectives.

2.4.2 Water Resources Users Associations (WRUAs)

Reforms have been carried out in Kenya since 2002 to improve water resources management and increase access to water as well as sanitation for both the rural and urban populations. Re-evaluation of the roles of different actors in the water sector was carried out leading to re-assignment in some cases. The reforms led to the creation of Water Resources Management Association (WRMA) whose responsibility is to manage water resources at the catchment level while the Water Resources Users Associations (WRUAs) were also established as a medium for cooperative management and conflict resolution at the sub-catchment level. The Water Services Trust Fund (WSTF) also has a role of financing water service investments in poor areas.

A WRUA is an association of water users, riparian land owners, non-consumptive members or other stakeholders who are formally and voluntarily associated for the purposes co-operatively, sharing, managing and conserving a common water resource (definition from WRMA rules 2007).

According to (MoWI, 2007) the reforms have had some positive impact especially in rural areas where coverage has been increased through financing (through the government or organizations e.g. IFAD) for communities by the WSTF as well as participatory management improvement through the WRUA. These the researcher will also investigate in this study.

2.5 Theoretical Literature Review

The degree, to which a system is susceptible to, or unable to cope with, adverse effects of environmental change, defines its vulnerability. Vulnerability of a natural and socio-economic system can be determined by the character, magnitude, and rate of the hazard on the one side and the system's sensitivity and its adaptive capacity on the other (IPCC 2001; NERI 2002).

Vulnerability levels can thus be described as combinations of exposure, system sensitivity, and characteristics related to a range of factors describing the adaptability of the system. Vulnerability can be understood as combinations of high sensitivity and low adaptive capacity (DOE 2001). Vulnerability of water resources systems is multifaceted and is related to change and variability in flow, pollution, population growth, competition over water, data availability and quality, and knowledge gaps (Brooks et al. 2005).

The WPI is based on five components: Resources, Access, Capacity, Environment and Use as argued by Lawrence (2002). It can be used then through its individual figures or in the form of its components as an inter-disciplinary and monitoring tool that expresses precisely the water situation in various areas. Sullivan (2003) suggested that the WPI is applicable at a range of scales. It has since been applied at an international scale by Lawrence (2002), at a water and community scale by Heidecke (2006) and discussed in several papers Molle (2003), Rijsberman (2006), Shah (2006) and recently improved by Manandhar (2011) and Pérez (2011).

The sub-components of the WVI is described briefly below:

- **Resources (R)**

The Resource component concerns the physical availability of water resources in the chosen study area. A higher value of this component reflects a better water situation (i.e abundant water resources with less variability).

- **Access (A)**

Regular and adequate access to improved drinking water encourages necessarily better hygiene and sanitation conditions (Curtis, 2000) but is not sufficient to counter extreme poverty (Sullivan, 2003). On the other hand, the inadequate access to safe water will eventually lead to loss of time spent collecting water that could be used for productive activities.

- **Capacity (C)**

The Capacity sub-component comprises a set of socio-economic indicators which can exhibit the effectiveness of people's ability to supply and manage water and sanitation services. Appelgren (1999) emphasized the importance of such social and economic capabilities to managing water scarcity.

- **Environment**

The Environment sub-component comprises a number of indicators which not only cover water quality but also variables linked to ecological integrity and a number of environmental studies.

- **Use**

The Use sub-component is aimed to capture the use people make of water resources and its contribution to the wider economy because water use is a basic pre-requisite to various human activities and tends to increase with economic development (Sullivan, 2001).

2.6 Review of Empirical Studies

Water Vulnerability Index (WVI) also described to as Water Poverty Index (WPI) by some researchers as they both employ the five (5) components discussed earlier is a useful tool in communicating the level of the existing water resources in a particular space at any given time (Policy Research Initiative, 2007) and can be used further to enable decision makers to prioritize issues and resources related to water management (Juwana *et al.*, 2009).

This is an integrated tool that uses objective indicators to focus on the challenges to water supply and can be applied in various forms to compare water resources either on a large scale across communities/ river basins as used in this study.

2.6.1 Application of WVI at National Level

Lawrence *et. al.* (2002) used the index to carry out a comparison of water resources situation in 147 countries with a set of relatively complete data. The results revealed that most of the countries that scored high are either developed countries or richer developing countries. On the scale for African countries, Kenya had a WPI of 47.3 comparatively scoring low on the resources and access component; while Nigeria had 43.9 also scoring comparatively low on the resources and access sub-components. South Africa has a higher WPI of 52.2 scoring higher in water access and capacity. The highest ranking country however was Finland with an index of 78.0 scoring least in the water use component.

2.6.2 Application at Community Level

While Sullivan *et. al.* (2003) were developing the index, a composite index methodology was tested at pilot sites in Tanzania, Sri Lanka and South Africa using various household data. The index was also used by Oloukoi (2014) where she carried out a WVI survey in three (3) study communities (Iseyin, Okeho and Shaki) in the Oke-Ogun region of Nigeria. She divided the study areas into formal and informal neighborhoods with the informal neighborhoods in Iseyin scoring the least. She concluded that population vulnerability in relation to water supply shortages varies across areas depending on neighborhood types, demographic composition, access to water, capacity to cope and other biophysical factors.

The results of Water Vulnerability Index at a community scale provides useful information of areas where more assistance can be targeted at to bring about sustainable development.

2.6.3 Application at Catchment Level

The index methodology has also been applied at the catchment scale in countries like Nepal, India and Pakistan (Merz, 2003; Manandhar *et. al.*, 20011). In the study by Merz, Bhetagad catchment in India scored the worst compared to other catchments in the study area while in the study by

Manandhar *et. al.,* they were able to point out differences in the components of the various scales studied.

2.6.4 Application at Administrative Level

The scale at which the most cost-effective use of the index can be used is at the municipal scale (Sullivan and Meigh, 2006). This is because most operational water management decisions are made at this level. In the West Java province of Indonesia for instance, a composite index based in part on the WVI was used to develop a sustained and integrated water management approach (Juwana *et. al.,* 2009).

In Kenya, Garriga *et. al.,* (2009) used a case study of Turkana district to analyze a government programme that was started to tackle water and sanitation issues in some part of the country known as Water Sanitation and Hygiene (WASH) programme. The authors forecasted scenarios using the WVI approach thereby showing that the programme would be effective to address overall the water poverty in the district.

2.7 Analytical Review

The analytical framework was based on the "iSAW: Integrating Structure, Actors and Water to Study Socio-Hydro-Ecological Systems" developed by Melissa Haeffner *et. al.* (2015). The proposed framework is an integrated framework for human-water system sustainability.

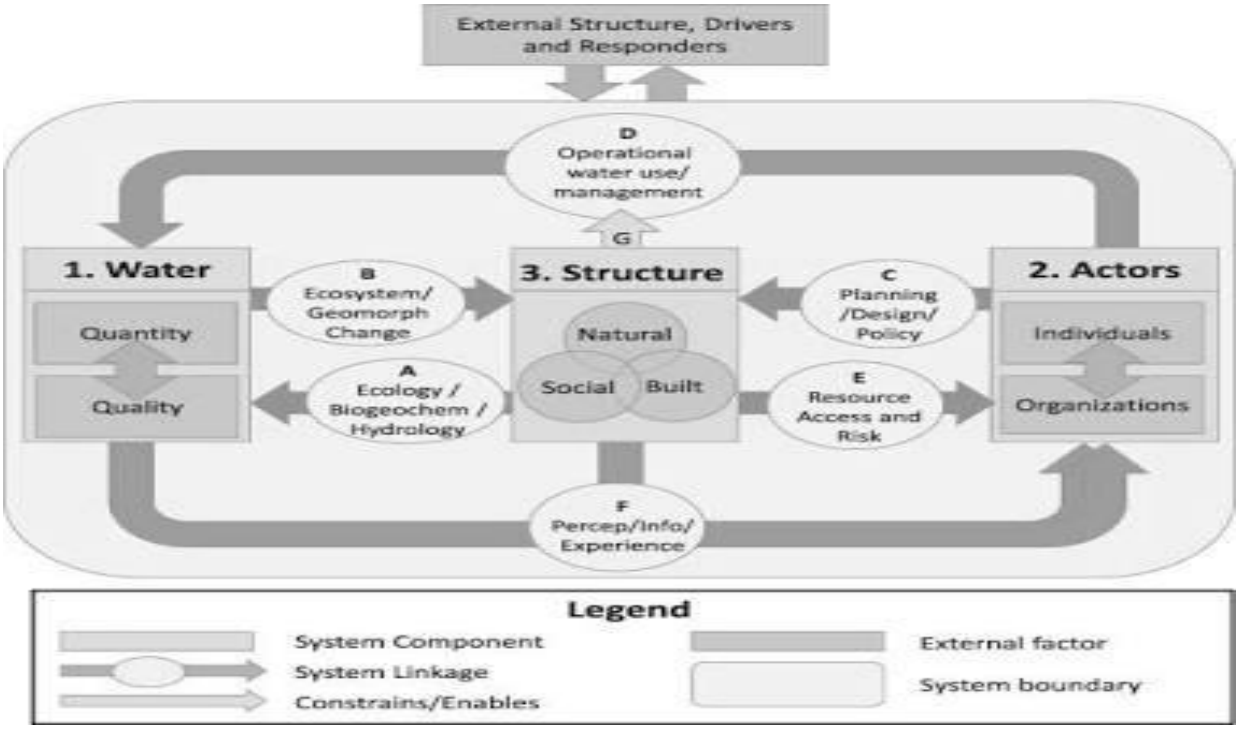
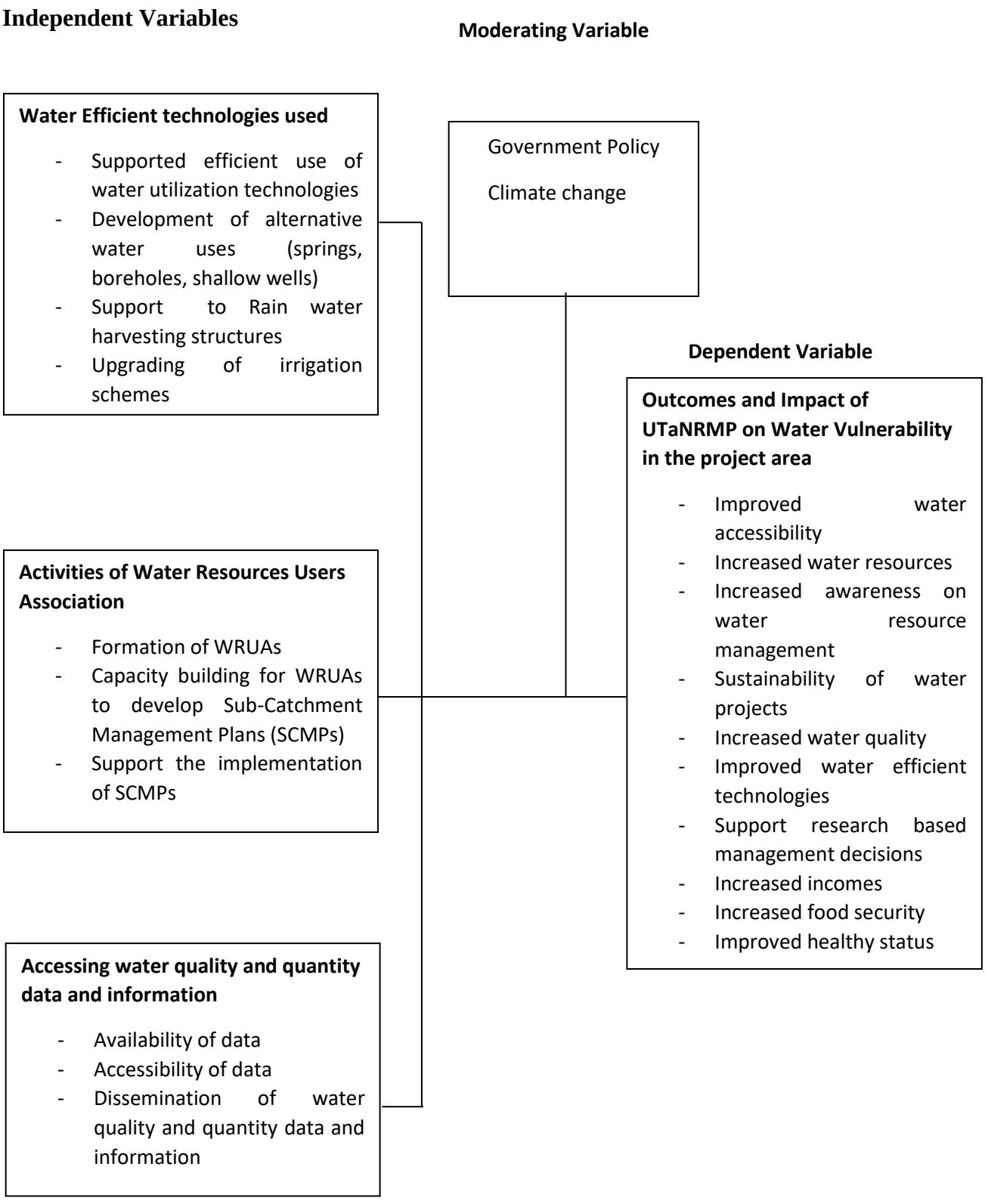


Fig 2.3: iSAW Analytical Framework (Melissa Haeffner *et. al.;* 2015)

Furthermore, the proposed analytical framework accounts for the relationship between Water, Structure, and Actors in water use and management. For the purpose of this study, the Actors (water users, WRUA, government and other organisations) affect the structure of water which also affects the water quantity and quality. The actors are also responsible for the level of water quality and quantity.

2.8 Conceptual framework of the study



CHAPTER THREE: METHODOLOGY

3.1 Study Area

Although the Upper Tana Natural Resources Management Project area covers six Counties namely: **Murang'a, Nyeri, Kirinyaga, Embu, Meru** and **Tharaka Nithi**; the area which also includes the Mt. Kenya and Aberdares National Parks and surrounding Forest Reserves. However only two (2) counties; **Embu** and **Kirinyaga** of the participating counties were selected for this research.

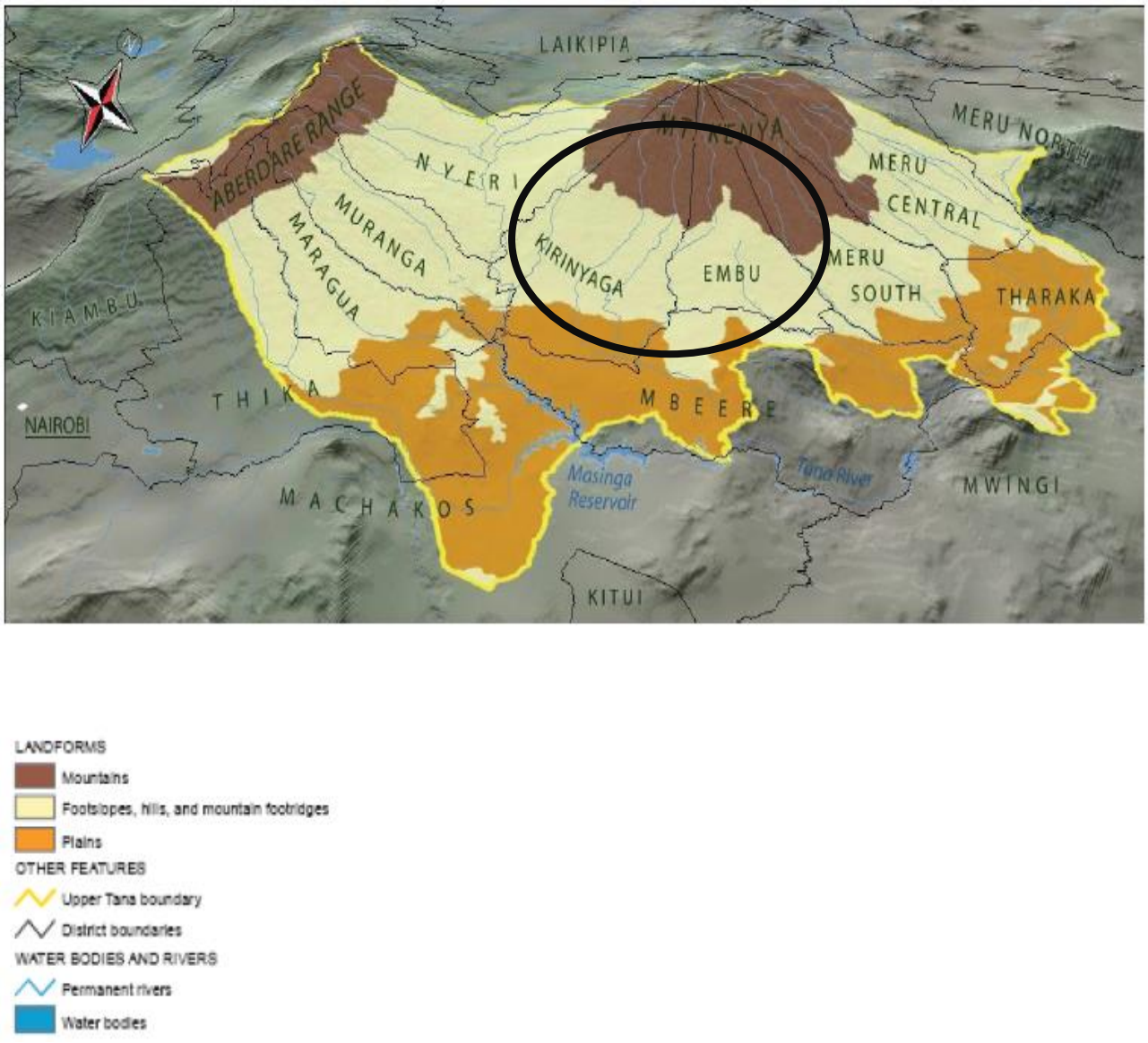


Fig 3.1: Map showing the counties covered by UTaNRMP (Source: UTaNRMP SEA Report,2014)

These were selected because of the extent off the activities of UTaNRMP carried out in the counties, closeness to project head office, and time constraint.

3.1.1 Embu County

Embu County is situated at the centre of the former Eastern Province and covers 2,818 square kilometers with a population of 516,212 persons. The County is inhabited by the Embu, Mbeere, Kamba and Kikuyu communities and hence presents a cosmopolitan complexion. The river basins in the county are: Rupingazi, Kabingazi, Mutonga/Thuci, Thura, Rwanjoga, Gangara, Itimbogo, Itabua/Rupingazi.

3.1.2 Kirinyaga County

Kirinyaga County is situated in Central Kenya. It measures 1,479 square kilometers with a population of 528,054. The County is dominated by the Ndia and Gichugu sub tribes, though with minority Kamba, Embu, Meru, Mbeere and other communities residing mainly in the Mwea rice settlement scheme. The river basins in the county are: Kirwara, Kiwe, Rwamuthabmi, Thiba, Nyamindi, Mugaka

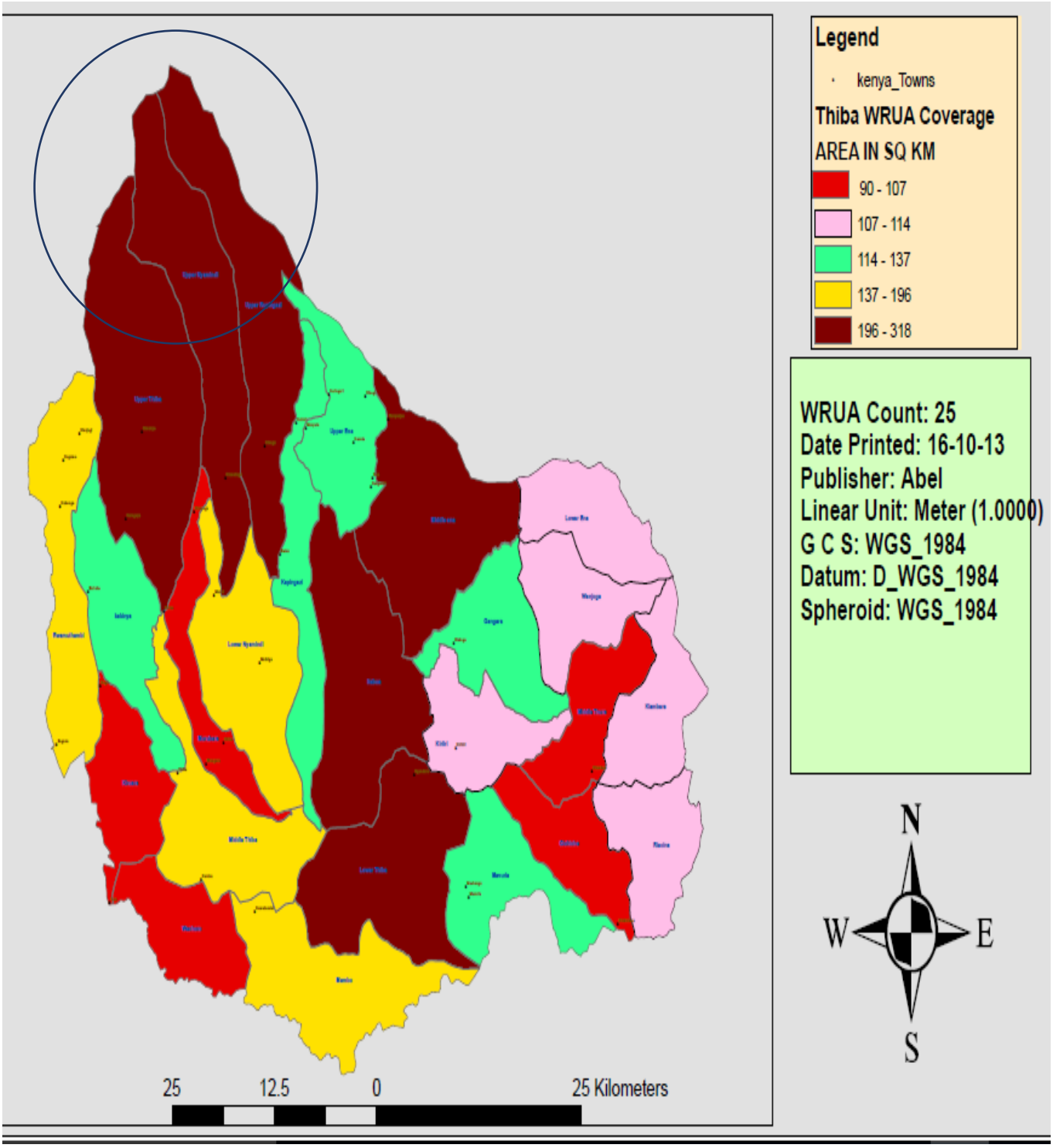


Fig. 3.2: Map showing the River Basins in the Thiba (Embu and Kirinyaga) WRUA coverage.

(Source: WRMA Thiba WRUA Coverage, 2018)

However for the purpose of this research, the following river basins have been purposively selected for the study based on cost limitation and time limitation of study.

Table 3.1: River basins selected for the study

S/No.	County	River Basin
1	Embu	1. Rupingazi
		2. Thuci
2	Kirinyaga	3. Nyamindi
		4. Thiba

3.2 Nature and Sources of Data Collection

In order to achieve the objectives of this research, the survey approach applied a number of techniques including: desk review of relevant documents, Quantitative Research consisting of Individual Household Interviews, Qualitative Research consisting of Key Informant Interviews (KIIs), Focus Group Discussions (FGDs) with community groups-WRUAs, FDAs and observation combined with use of informed judgment through field visits.

Quantitative Research: Quantitative research was used to establish metrics of the established indicators through use of a statistical sample. Individual structured questionnaires were then administered and this methodology generated numerical data, provided uniformity in data-collection.

Qualitative Research: Qualitative participatory research was used to explore and understand people's beliefs, experiences, attitudes, behavior and interactions. This method generated non-numerical data and consisted of Key Informant Interviews (KIIs), Focus Groups Discussions (FGDs) and Observation/Informed Judgment.

3.2.1 Target population

The target population will be members of households and WRUAs in the chosen river basins in the study area (Embu and Kirinyaga Counties) of the UTaNRMP area. Purposive sampling was used to select participants for the Focused Group Discussions (FGD) and Key Informant Interview (KII) depending on the study objectives.

3.2.2 Sampling size

The representative sample for household interview will be determined scientifically. The sample size will be determined using Cochran (1963:75) formula for calculating sample size.

$$SS = \frac{Z^2 \times (p) \times (1-p)}{E^2}$$

Where:

SS = sample size

Z = confidence level

p = estimated proportion of an attribute that is present in the population

E = margin of error (in decimal)

3.2.3 Determination of sample size

The target population of the project area (Embu and Kirinyaga) will be initially stratified along the river basins chosen (based on distance and extent of activities carried out) in the area constituting the first stratum.

Each river basin (first tier stratum) will then be divided into three sub-strata representing the upper, middle and lower sections of the river basin (second tier stratum). Since population along the river basin was not equally distributed, and taking into consideration that the upper and lower zones of the river basins were normally less densely populated than the middle zones of the river basin, the sample of each river will then divided in the ratio of 1:2:1 for the upper, middle and lower sections respectively (UTaNRMP IAE Report, 2017).

The sample size per river basin was then determined proportionately depending on the number of FDAs per river basin.

Table 3.2: Sample size determination across the river basins

S/No.	County	River Basins	Size	Total No. of FDAs	Proportionate Sample size	Adjusted Sample size
1.	**EMBU 516,212 183 sq km**	Rupingazi	354	4	44	60
2.		Thuci	152	5	55	75

1.	**KIRINYAGA 537,054 357 sq km**	Nyamindi	453	10	110	110
2.		Thiba	715	16	176	176
				36	**385**	**421**

3.3 Data validity, reliability and credibility

Validity involves how accurately the data obtained represents the variables of study while reliability refers to the degree to which a research instrument yields consistent results or data after repeated trials (Saunders, *et. al.;* 2003). Validity of the instruments was established by the researcher. To ensure reliability, the questionnaires were pre-tested on a pilot scale through selected respondents outside the study area. The objectives of pre-testting allowed for modification of various questions in order to either rephrase, clarify or clear up any short comings in the questionnaires before administering them to the actual respondents.

3.4 Analytical Methods/Techniques

Descriptive and correlation will be used to answer questions concerning the study. The study will also adopt the equation element that was used for Water Poverty Index by Sullivan et al (2003) which was also adopted by Adeniji (2010). The water vulnerability index was designed as a composite, inter disciplinary tool, linking indicators of water and human welfare to indicate the degree to which water scarcity impacts on the human population.

The five key components are combined using the following mathematical expression:

$$WVI = \frac{\sum N\ w_i X_i}{\sum N\ w_i} \qquad i = 1 \qquad \ldots (1)$$

This can be re-written as:

$$WVI = \frac{w_r R + w_a A + w_c C + w_u U + W_e E}{W_r + w_a + w_c + w_u + w_e} \qquad \ldots (2)$$

(Source: Sullivan et al. 2003; Adeniji, 2010)

Where w is the weighted average of the five components: Resources (R), Access (A), Capacity (C), Use (U) and Environment (E). Each component will first be standardized so that it falls in the range of 0 – 100; thus the resulting WVI value will also be between 0 and 100. The highest value

100, is taken to be the best situation (or the lowest possible level of water vulnerability), while 0 is the worst.

Since this study is also aimed at understanding relationships, correlation research will be used. The tools will include structured questionnaires, Focused Group Discussion (FGD) and Key Informant Interview (KII). The discussion and interview will be conducted to give in-depth information which might have been omitted by the questionnaire.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Demographic and Socioeconomic Characteristics

4.1.1 Number of Respondents Interviewed

The survey targeted to conduct interviews with 421 household respondents, across two (2) target counties (Embu and Kirinyaga) and four (4) river basins (Rupingazi, Thuci, Nyamindi and Thiba).

Table 4.1: Number of respondents interviewed

S/No	County	River Basin	Number of Respondents interviewed	Percentage (%)
1	Embu	Rupingazi	60	14.3
	(135 Respondents)	Thuci	75	17.8
2	Kirinyaga	Nyamindi	102	24.2
	(286 Respondents)	Thiba	184	43.7
	Total		**421**	**100**

The survey also panned to conduct four (4) Focused Group Discussions (FGDs) and fifteen (15) Key Informal Interviews (KIIs). A total of 4 FGDs and 12 KIIs were however conducted. It was challenging to achieve 100% of the interview due to time constraint.

4.1.2 Gender of respondents

The research also got information of the on the proportion of household respondents by gender. It was found out that 57% of the respondents were male and 43% of the respondents were female.

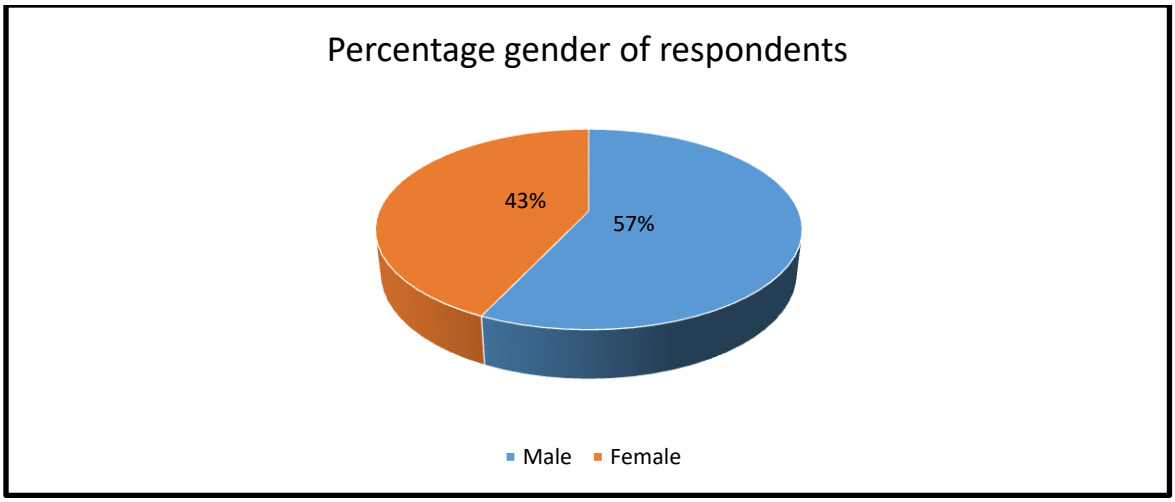


Figure 4.1a: Field Survey, 2018

According to the Kenyan Population and Housing Census report of 2009, women accounted for 50.3% of the population while men accounted for 49.7% of the population. This was however only consistent in Rupingazi (48.3% male, 51.7% female) and Thuci (48% male, 52% female) river basins both in Embu county while in Kirinyaga there was major difference against the report.

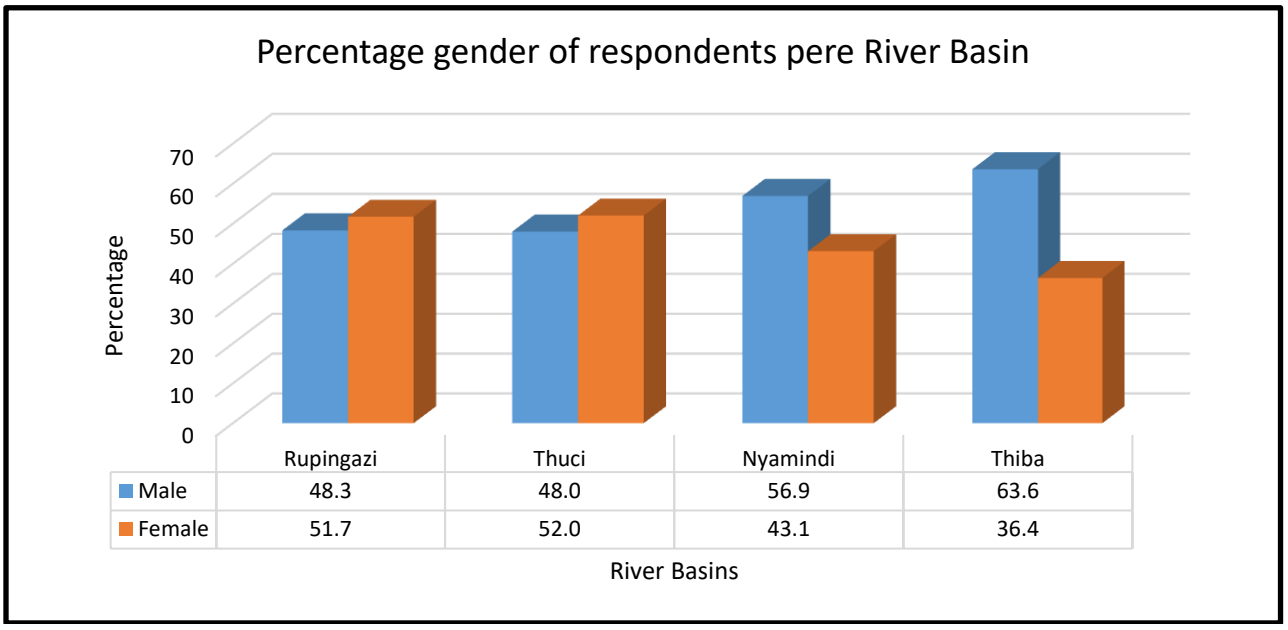


Figure 4.1b: Field Survey, 2018

4.1.3 Head of household

The survey established that 85% of the households were men headed while 13% were women headed and 2% were headed by youths (1% male youth, 2% female youth).

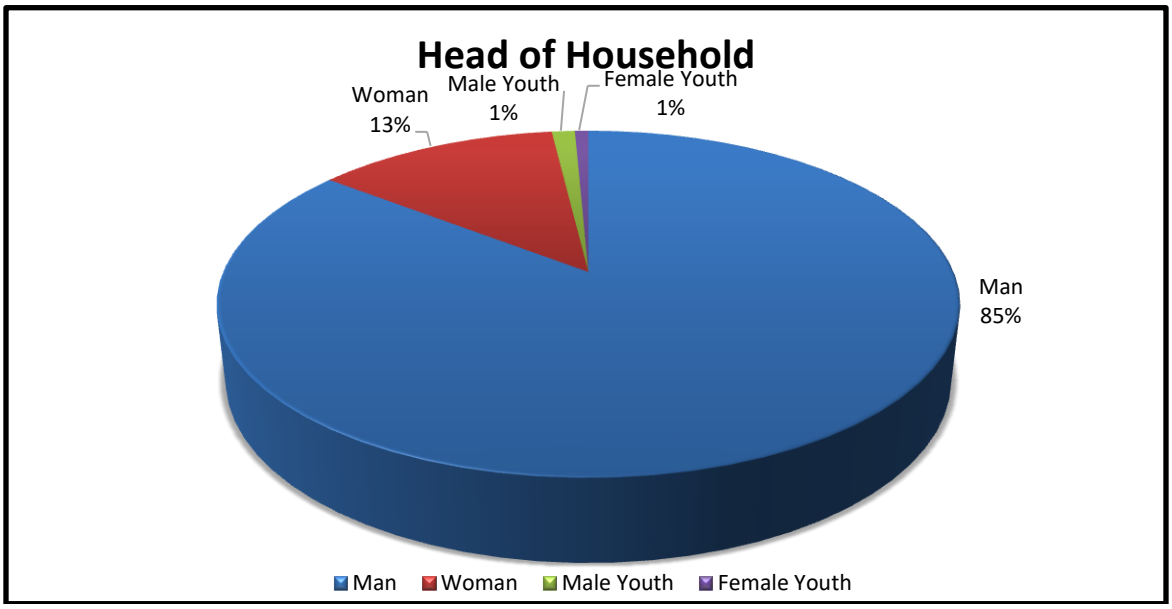


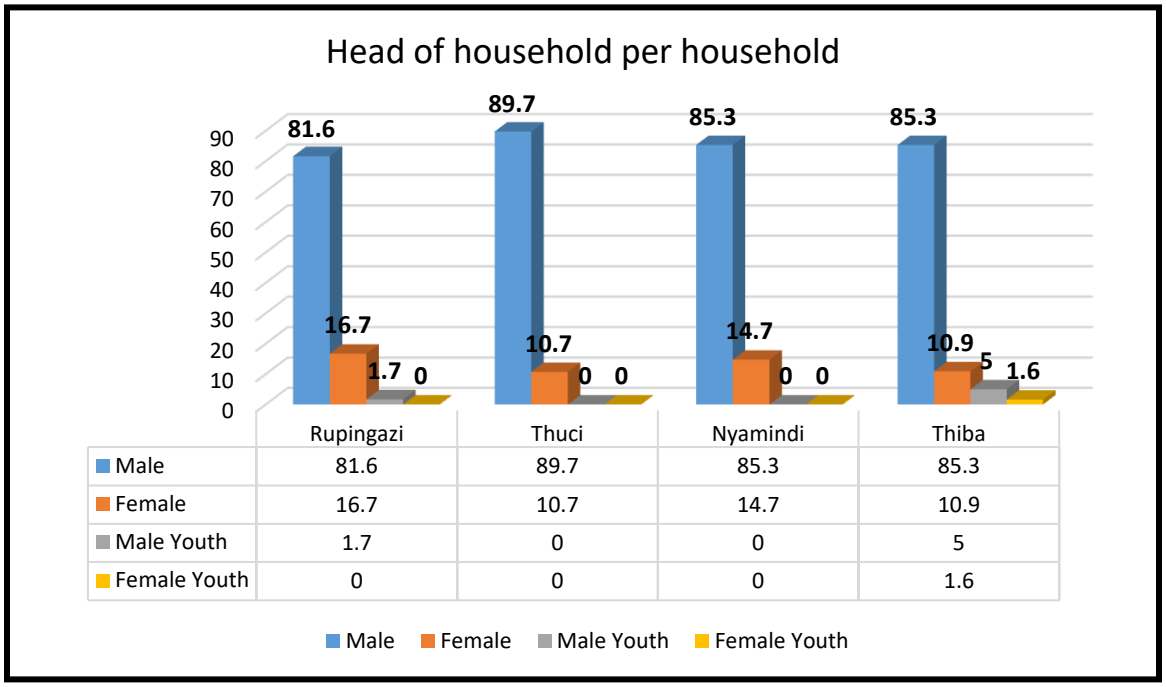
Figure 4.2a: Field Survey, 2018

This data supports the Impact Assessment Survey 2017 of the UTaNRMP where 78.7% of households were men headed, 18.3% of households were women headed and 3% were youth headed. This further indicates that the study area is majorly a patriarchal society.

The UTaNRMP gender baseline survey 2014 also revealed that women accounted for less than 20% as heads in homes across the project area. These finding are also consistent with the national statistics carried out which provided that less than 29% of households are female headed (KDHS, 2010). Reason could be that majority of the men migrate from the rural areas to urban areas in search of better economic opportunities.

Data on head of household crosstabulated by river basin also revealed that Rupingazi has the highest number of female headed household while Thiba had the highest number of male youth

and female youth headed household. Thuci has the highest number of male headed household at 89.7% as seen in table below:



	Rupingazi	Thuci	Nyamindi	Thiba
Male	81.6	89.7	85.3	85.3
Female	16.7	10.7	14.7	10.9
Male Youth	1.7	0	0	5
Female Youth	0	0	0	1.6

Fig 4.2b: Field Survey, 2018

4.1.4 Age distribution of the respondents

The survey revealed that only 6.4% of the respondents were below 30 years (youths) and majority of respondents 93.6% were above the age of 30% with 31.6% of the respondents between 41 – 50 years and 25.9% between 51 – 60 years.

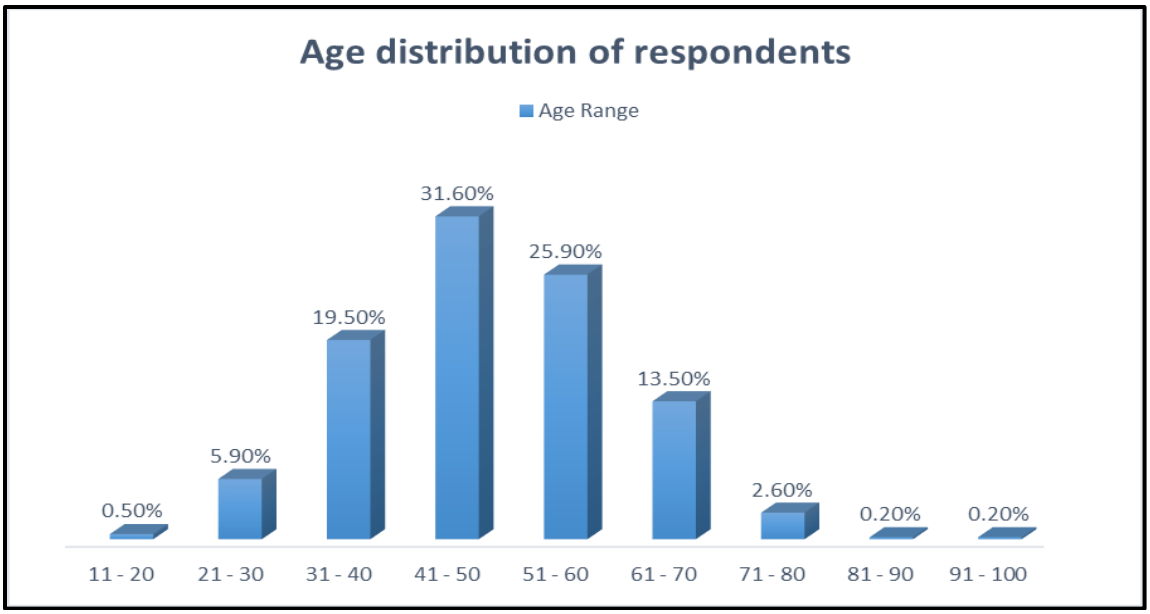


Figure 4.3: Field Survey, 2018

4.1.5 Marital Status of the respondents

The results showed that 85% of respondents are married, 7% of the respondents are single, 6% and 1% of the respondents are widows and widowers respectively while 1% of respondents divorced. This is an indication that the project activities are embraced more by individuals within a family setting.

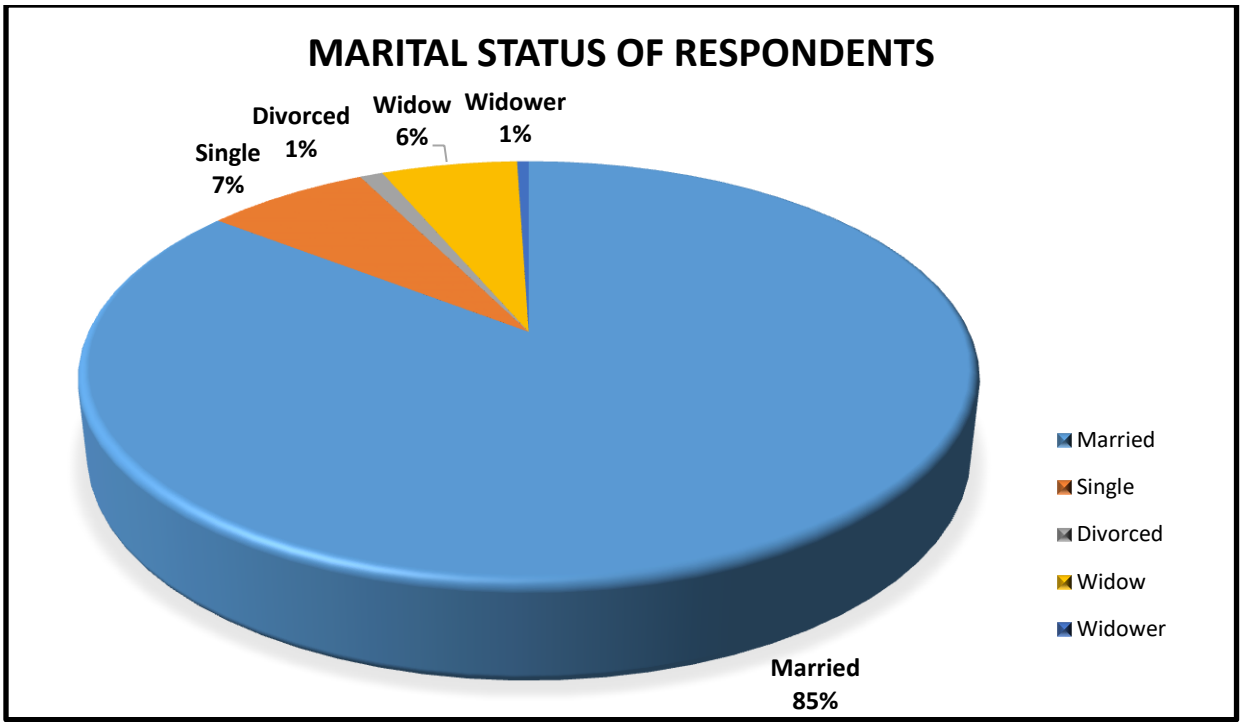
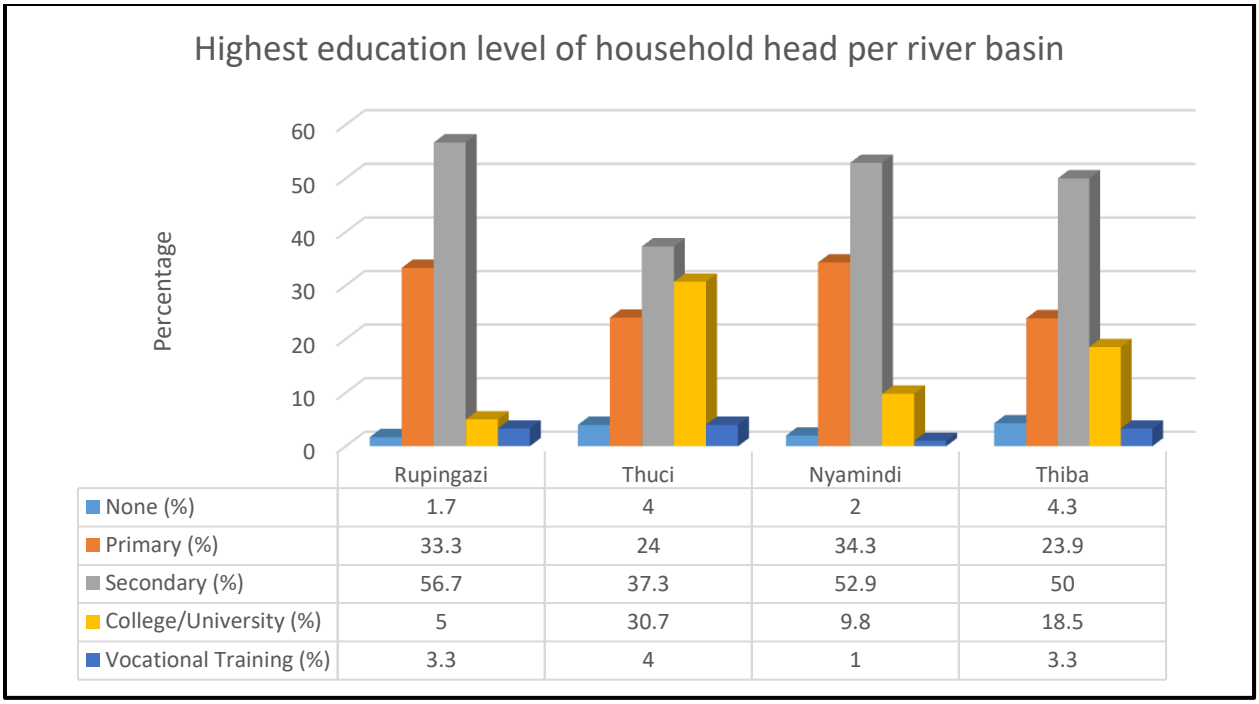


Figure 4.4: Field Survey, 2018

There is however a cultural stigma attached to either being single at an older age or being divorced as I discovered that some respondents in those categories (as attested to by neighbors) still prefer to respond as single.

4.1.6 Educational level of household head

The highest level of education of household head was determined across the river basins in the study area. The findings showed that Thiba (4.3%) had the highest number of household heads with no form of education while Thuci had 30.7% household heads with college/university education. This was the highest across the river basins.



	Rupingazi	Thuci	Nyamindi	Thiba
None (%)	1.7	4	2	4.3
Primary (%)	33.3	24	34.3	23.9
Secondary (%)	56.7	37.3	52.9	50
College/University (%)	5	30.7	9.8	18.5
Vocational Training (%)	3.3	4	1	3.3

Figure 4.5: Field Survey, 2018

The highest educational level of household heads across the river basins however is secondary education with 56.7%, 37.3%, 52.9% and 50% across Rupingazi, Thuci, Nyamindi and Thiba river basins respectively. This findings show that majority of the household heads has a form of formal education which has a positive effect on the capacity of the household and their ability to enjoy basic sanitation adherence as well as manage water related information properly.

4.1.7 Household size of the respondents

The research sought information on the average household size of respondents. This data is important because it provides information on water consumption. It was established however that the mean household size was 4.862 with household size of 4 as 29.20% and household size of 5 as 23%. As seen in figure 4.6 below.

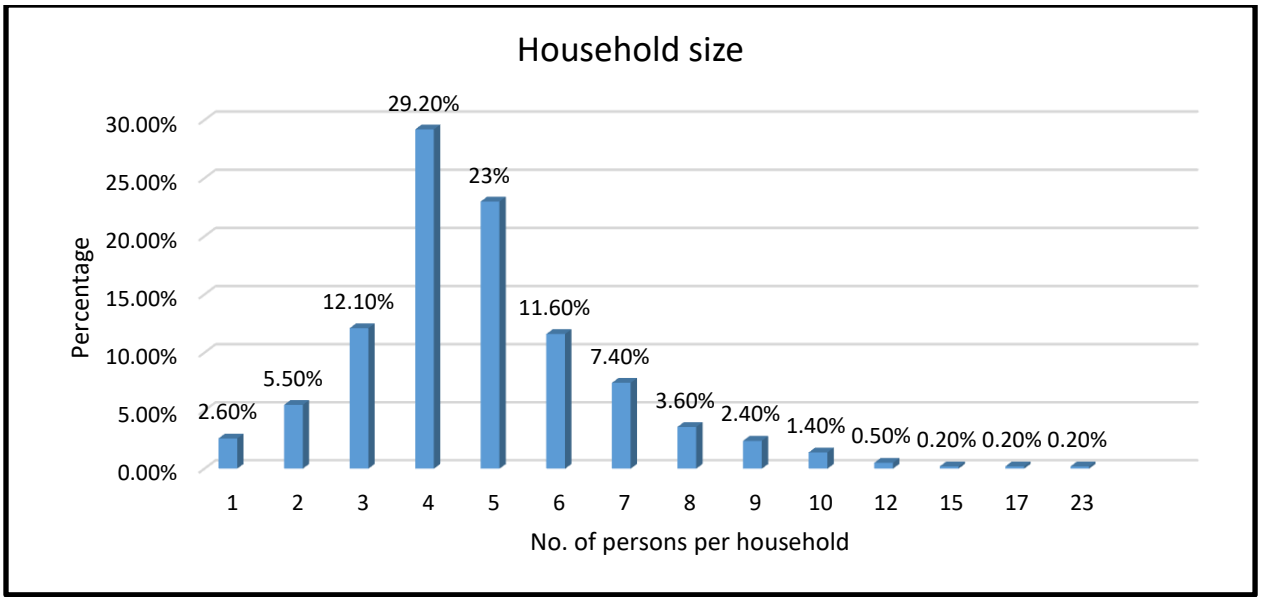


Figure 4.6: Field Survey, 2018

4.2 WATER VULNERABILITY INDEX

The analysis of the WVI in Embu and Kirinyaga counties indicate a spatial variation within the subcomponent of the WVI. The desirable benchmark for the study counties shows that the indicators of each subcomponent of WVI are not the same indicating spatial difference across the counties (Table 4.2). It is also observed from the analysis of the subcomponents of the WVI and their contributing indicator that effectiveness of the WRUA has a significance to the vulnerability of the selected river basins.

Embu county had the highest percentage for water resources, Rupingazi 85% water quality, water reliability (86.7%) and water adequacy (91.7%) while Thuci had the highest percentage of water treatment 72%. Rupingazi also had the highest percentage of access to water. WRUA membership is highest in Rupingazi and lowest in Thuci with high rate of water conflict and pollution in the Thiba river basin. Nyamindi has the highest level of water use at 79.4%

Table 4.2: Measuring the water vulnerability index in Embu and Kirinyaga Counties

Counties		River Basins			
		Embu		Kirinyaga	
Sub-Components	Indicators	Rupingazi N=60	Thuci N=75	Nyamindi N=176	Thiba N=110
Resources (R)	Water quality	85.0	68.0	52.0	54.3
	Water treatment	71.7	72.0	45.1	69.6
	Water reliability	86.7	85.3	77.5	82.1
	Water adequacy	91.7	52.0	43.1	58.2
Access (A)	Access to water (type)	100.0	96.0	82.4	85.9
	Proximity to water point	98.3	81.3	87.3	88.0
	Time spent in water collection	96.7	81.3	88.2	91.8
Capacity (C)	Occurrence of water related illnesses	18.3	20.0	28.4	23.4
	Membership of WRUA (Water resources users association)	75.0	14.7	45.1	57.1
	Training on water management	50.0	45.3	15.7	47.3
	Access to water information	91.7	81.3	77.5	80.4
Environment (E)	Water conflict	35.0	12.0	40.2	50.5
	Water pollution	33.3	46.7	38.2	52.2
Use(U)	Quantity of water (litre) per-household, per-day	63.3	73.3	79.4	58.7

Note: The analysis is based on frequencies percentages. Values represent the percentiles of the frequency (f/100) of each subcomponent which were derived from the variables in the questionnaire.

The lowest WVI values both within the component and within the weighted average indicate the most critical zone (most vulnerable river basin) which might need the most intervention.

Table 4.3: Aggregate of subcomponents of WVI for Embu and Kirinyaga

Counties		Embu	Kirinyaga
Indicators	Sub components	Total N=135	Total N=286
Resources (R)	Water quality	0.765	0.532
	Water treatment	0.719	0.574
	Water reliability	0.860	0.798
	Water adequacy	0.719	0.507
Access (A)	Access to water (type)	0.980	0.842
	Proximity to water point	0.898	0.877
	Time spent in water collection	0.890	0.900
Capacity (C)	Occurrence of water related illnesses	0.192	0.260
	Membership of WRUA (Water resources users association)	0.449	0.511
	Training on water management	0.477	0.315
	Access to water information	0.8656	0.789
Environment (E)	Water conflict	0.235	0.454
	Water pollution	0.399	0.452
Use(U)	Quantity of water (litre) per-household, per-day	0.683	0.691

The result of the Chi-Square ranking of the obtained value for each component of WVI based on weighted averages shows that there are variances in the vulnerability level across the counties and across river basins in the study region (Table 4.4). Specifically, residents in Thuci river basin in Embu county has the lowest vulnerability index of value 0.5820, which makes it most vulnerable.

Table 4.4: Ranking of WVI components for River Basins in Embu and Kirinyaga

Sub component of WVI	Embu		Kirinyaga	
	Rupingazi N=60	Thuci N=75	Nyamindi N=176	Thiba N=110
Resource (R)	0.8376[1]	0.6183[3]	0.5443[4]	0.6610[2]
Access (A)	0.9833[1]	0.8620[3]	0.8597[4]	0.8857[2]
Capacity (C)	0.5875[1]	0.4033[4]	0.4168[3]	0.5210[2]
Environment (E)	0.3415[3]	0.2935[4]	0.3920[2]	0.5135[1]
Use (U)	0.6330[3]	0.7330[2]	0.7940[1]	0.5870[4]
WVI Weighted Averages	0.6766[1]	0.5820[4]	0.6014[3]	0.6336[2]

Note to numbers in superscript: (4) - the most vulnerable and (1) – the less vulnerable.

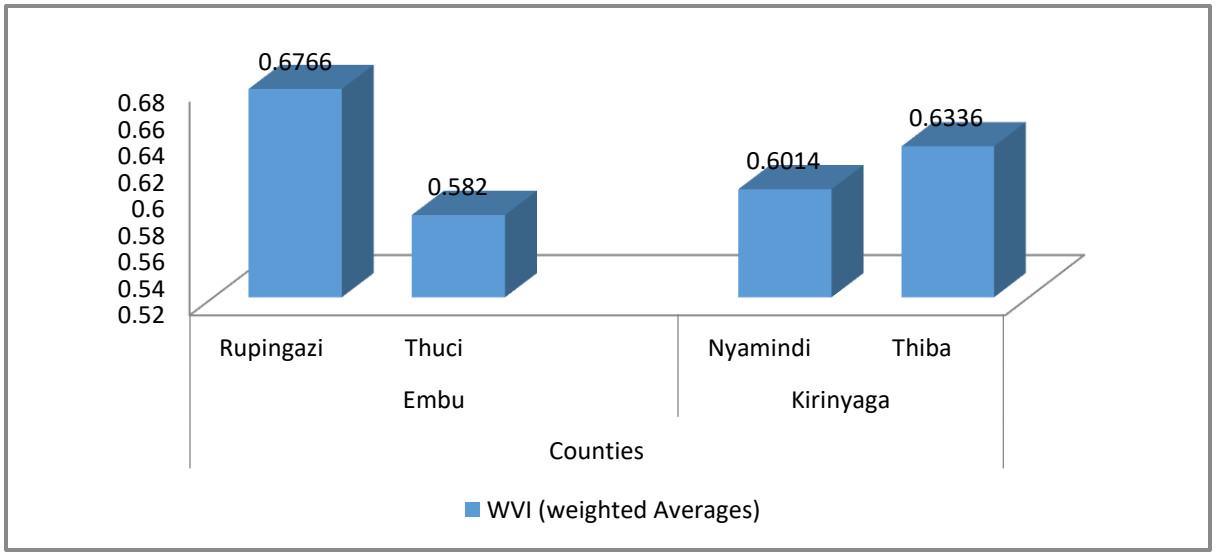


Fig 4.7: Weighted averages of WVI for the four (4) river basins (Field Survey, 2018)

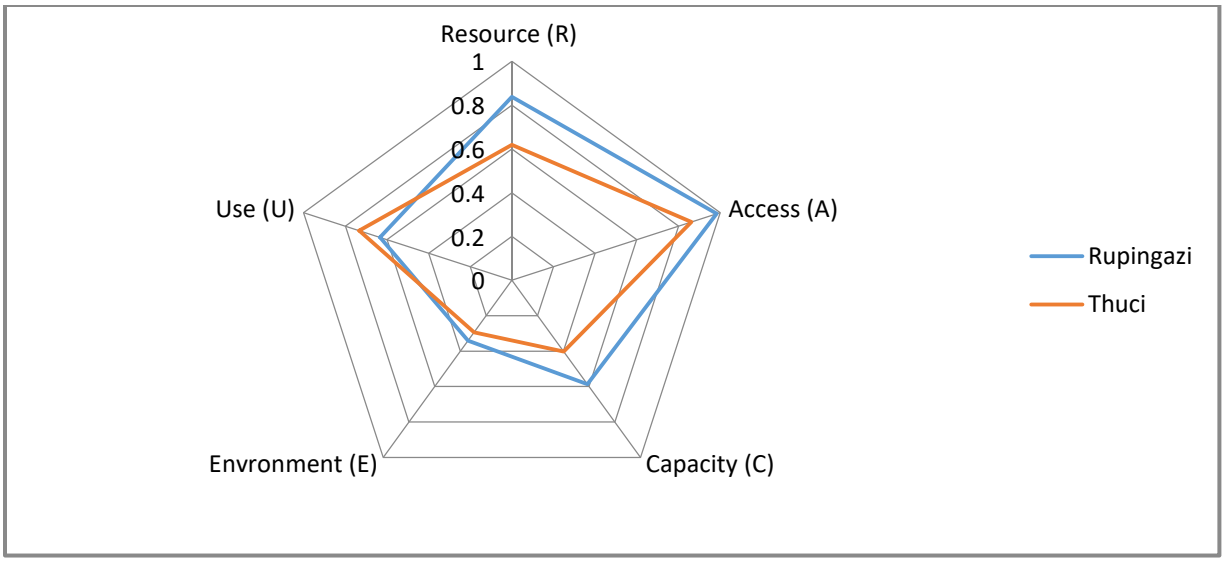


Fig 4.8a: Weighted averages of WVI for the river basins in Embu County (Field Survey, 2018)

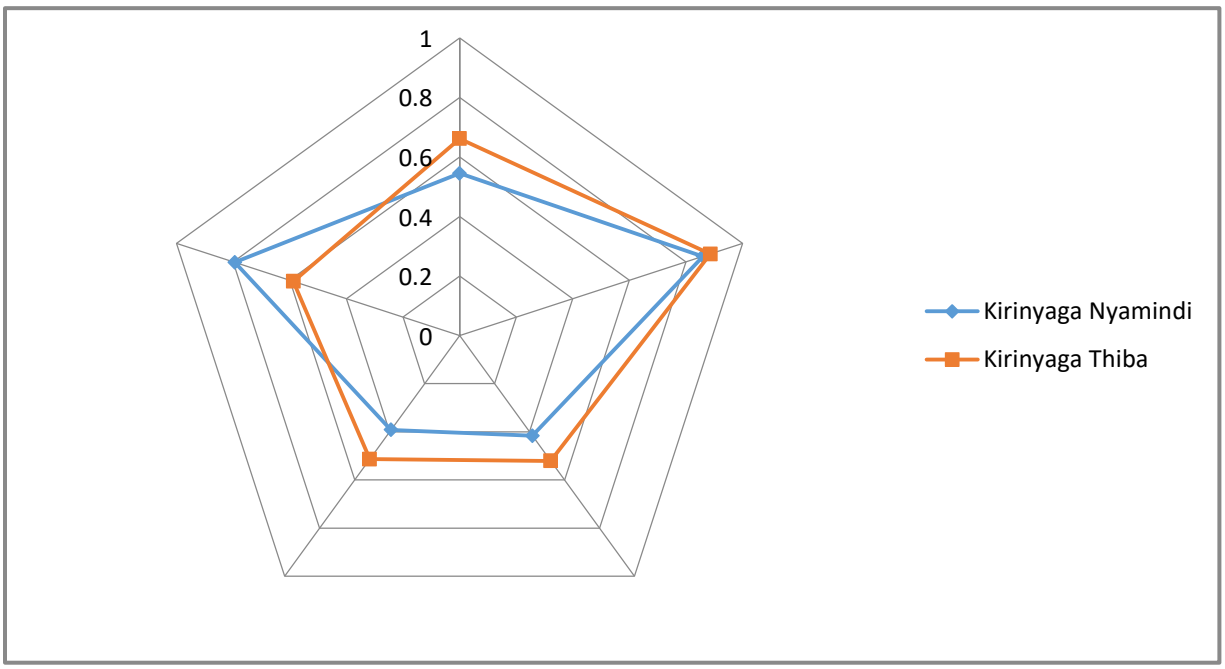


Fig 4.8b: Weighted WVI averages for the river basins in Kirinyaga County (Field Survey, 2018)

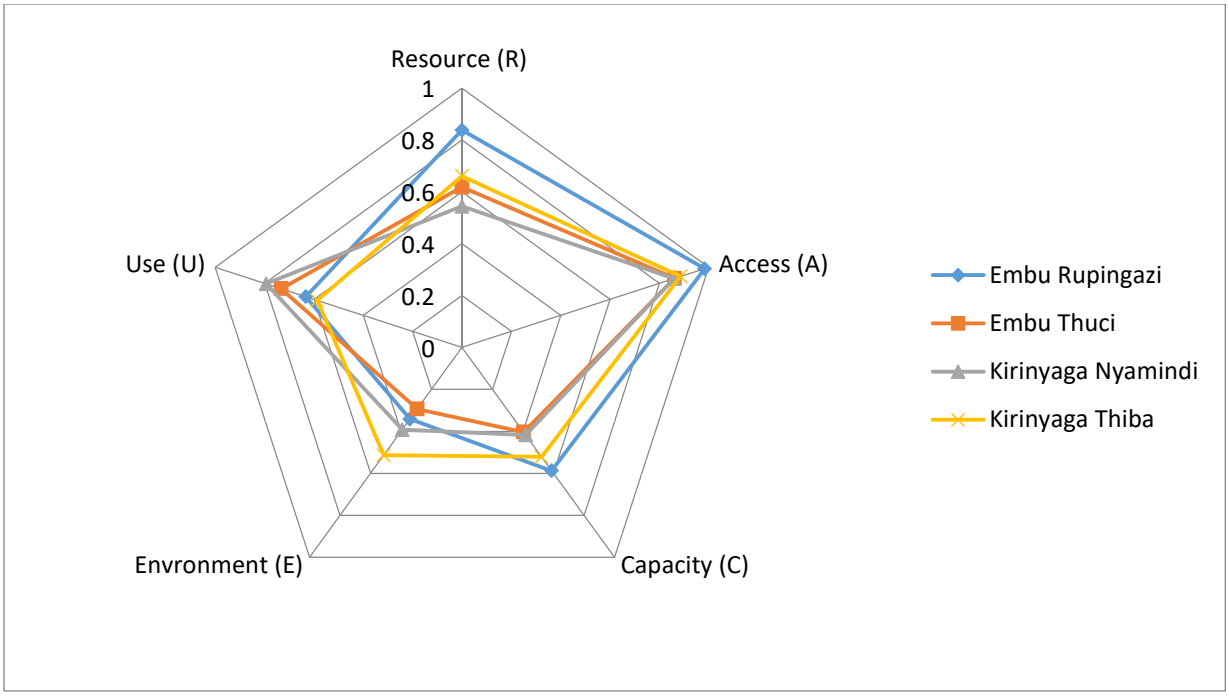


Fig 4.8c: Weighted averages of WVI for the four (4) river basins (Field Survey, 2018)

4.3 WATER TECHNOLOGIES AND USES

This objective evaluates the percentage improvement in water sources and sanitation from project inception (2012) to date. It also checks the access to developed or rehabilitated water sources in the study river basins and the organizations that rehabilitated them. The frequencies of rain water harvesting and irrigation system used across the river basins was also analysed.

4.3.1 Water sources available before and during the project

The findings show that as there was an improvement in the number of HHs accessing water from clean sources such as piped water with the highest improvement being recorded in Thuci river basin from 59% to 84%; other notable improvements were in the number of households receiving water from protected springs, protected wells and boreholes. There was however a slight decrease is percentage of those involved in rain water harvesting as presented in table 4.5 below.

Table 4.5: Sources of water in the study river basins for domestic use

County	River Basin	Piped water		Protected spring		Unprotected spring		Protected well		Unprotected well		Borehole		Rain water		Dams		Others	
		Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)
Embu	Rupingazi	87	97	15	12	10	7	7	8	7	2	0	1.7	52	52	2	2	2	0
	Thuci	59	84	1	1	1	0	4	5	0	0	17	20	84	73	0	0	7	3
Kirin-yaga	Nyamindi	67	75	7	8	3	2	4	6	4	1	7	9	65	66	2	4	22	19
	Thiba	51	77	4	6	12	4	7	10	3	1	14	14	54	52	2	2	20	13

4.3.2 Sanitation facilities available

The findings show that there was an improvement in many aspects of sanitation in the study area within the period of project implementation. For example, there was a reduction in the number of households that used open field with the highest improvement in Thiba river basin from 3% to 0%; households had also improved their latrines by constructing permanent walls, and raised slabs; there was also an improvement in households who used ventilated improved latrines (VIP latrines) with the highest improvement being in Thiba river basins from 6% to 11% as presented in table 4.6 below.

Table 4.6: Sanitation facilities used in the study river basins

County	River Basin	Open field		Pit latrine **with no** permanent wall and raised slab		Pit latrine **with no** permanent wall **without** raised slab		Pit latrine **with** permanent wall and raised slab		Pit latrine **with** permanent wall **without** raised slab		Ventilated improved pit latrine		Flush toilet	
		Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)	Before 2012 (%)	After 2012 (%)
Embu	Rupingazi	2	2	30	28	42	40	18	22	2	2	8	8	7	10
	Thuci	4	3	12	15	28	24	49	52	7	8	3	3	12	13
Kirinyaga	Nyamindi	2	0	47	48	31	24	19	18	3	6	7	11	4	5
	Thiba	3	0	42	43	29	20	17	22	4	7	6	11	5	10

4.3.3 Water sources developed/rehabilitated

Through the study river basins, respondents indicated if they are benefitting from water sources that have been developed or rehabilitated. The highest percentage of beneficiaries are in the Rupingazi river basin with 61.70% while the lowest number are found in Thiba river basin.

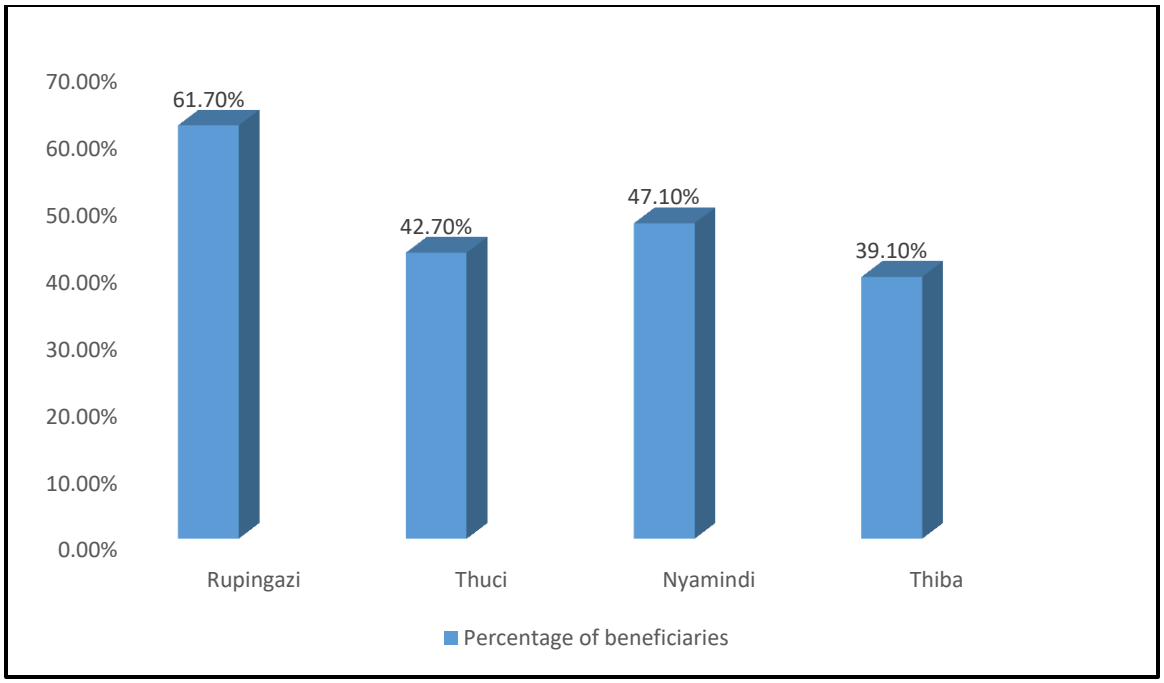


Fig. 4.9: Percentage of beneficiaries of rehabilitated or developed water source per River basin (Field Survey, 2018)

4.3.4 Organizations who developed/rehabilitated the water sources

The beneficiaries of the water sources also indicated organizations responsible for the development or rehabilitation. These included Community projects, County (Embu/Kirinyaga) governments, water sanitation companies (EWASCO/KIRIWASCO), National Irrigation Board (NIB), Ministry of water resources, Upper Tana Natural Resources Management Project as well as other water projects. 1% of the water sources was developed or rehabilitated by the NIB. This was found majorly in Kirinyaga which is a major irrigation rice hub in Kenya. The Water Sanitation Companies were also involved in rehabilitating or developing 7% of these water sources while the UTaNRMP was also involved in 22% of these projects, joint highest with other projects. These projects range from borehole installation, pipe-borne water connections and construction of other water sources for both agricultural and domestic uses.

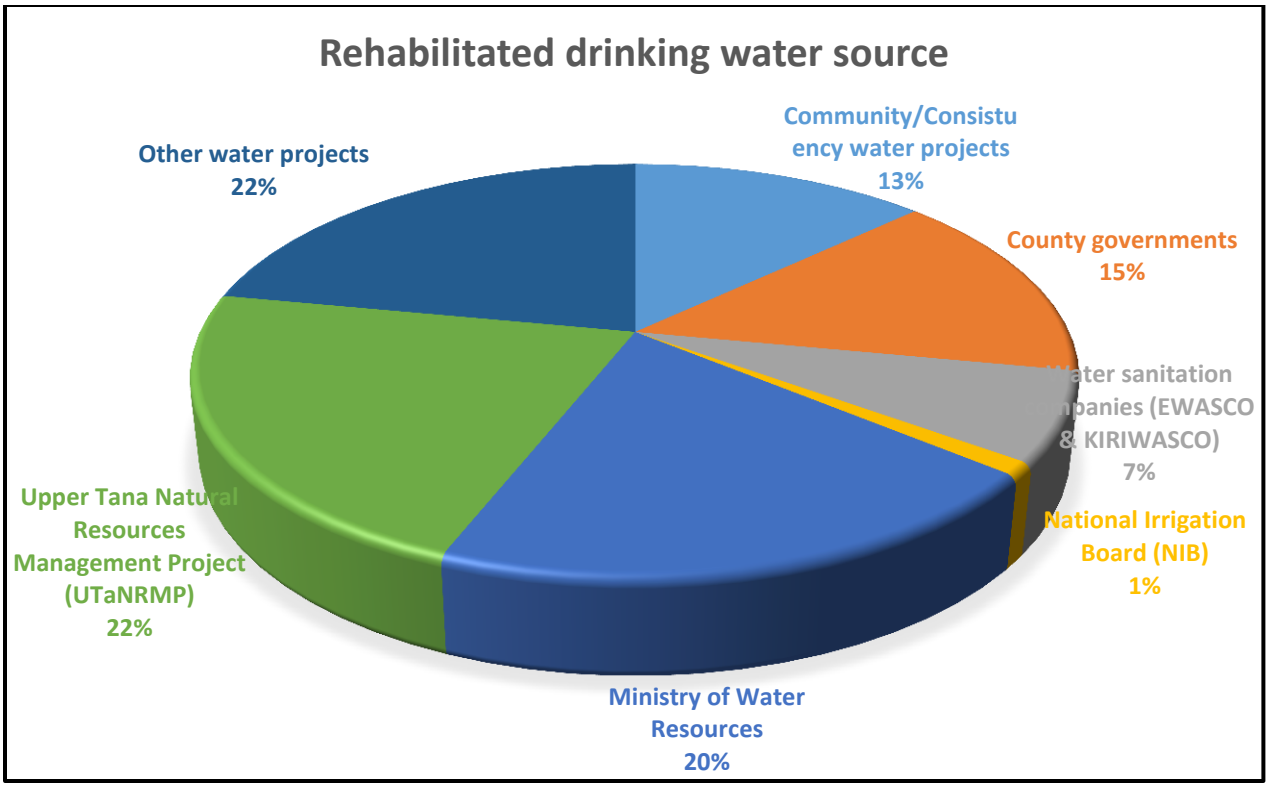
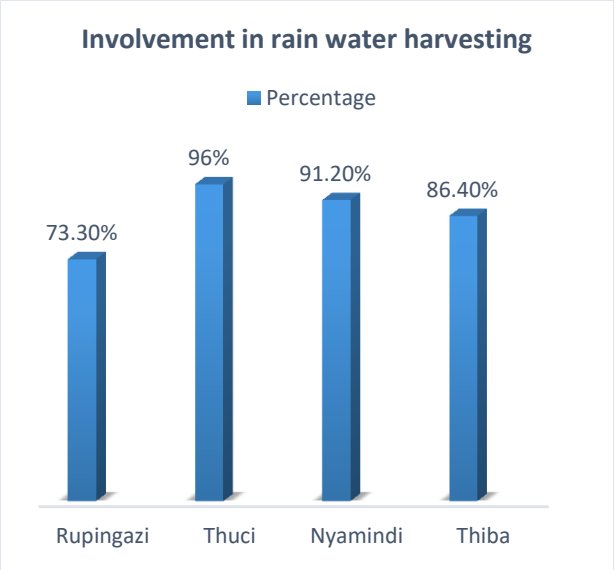


Fig. 4.10: Field Survey, 2018

4.3.4 Water management

In the involvement with water management activities across the study river basins, Thuci at 96% recorded the highest number of respondents engaged in rain water harvesting while Rupingazi had 73% of water users engaged in rain water harvesting. It is therefore safe to say that more than 70% of water users engage in rain water harvesting across the river basins. Some of the reasons for non-involvement include either having enough water or having no water storage tanks.

Kirinyaga county had the highest number of respondents engaged in irrigation farming across the two (2) study river basins although 71.70% is the highest with Rupingazi river basin. Kirinyaga County (specifically the Mwea area) is well known for rice cultivation majorly done through irrigation farming.



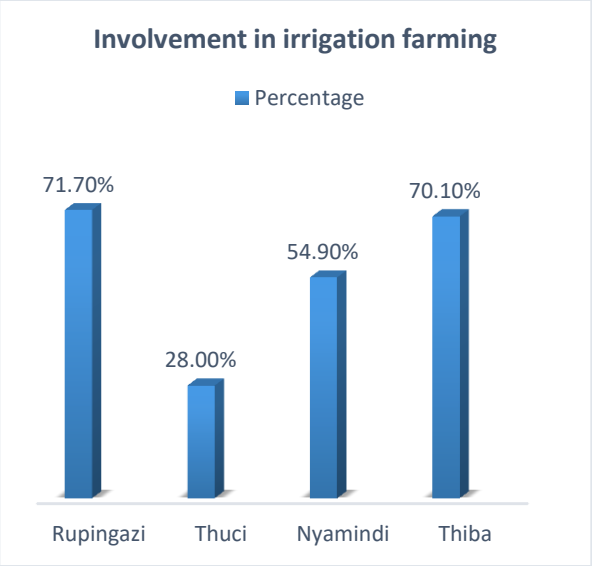
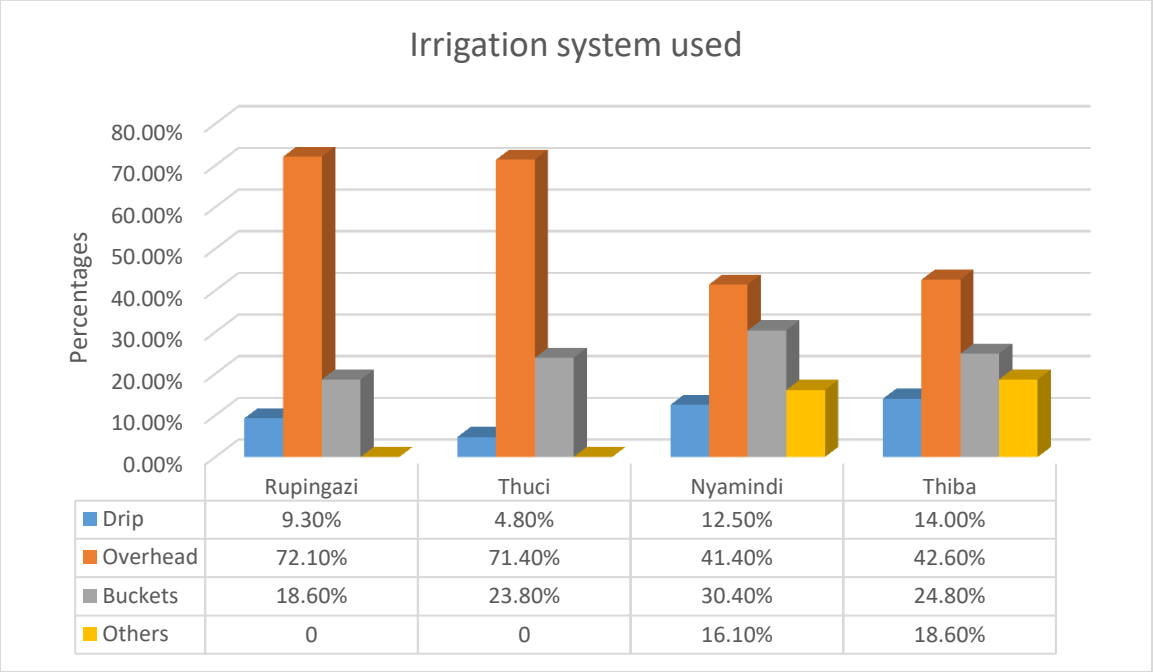


Fig. 4.11: Field Survey, 2018

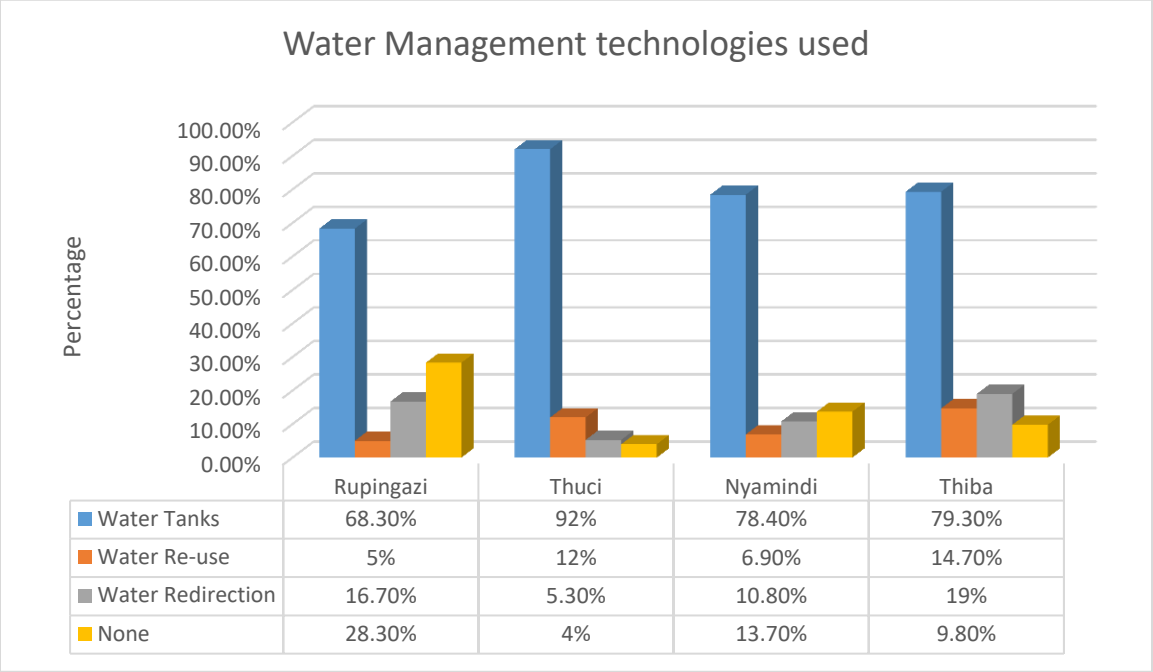
The irrigation system majorly used across the river basins is overhead irrigation with the highest level of use recorded in Thuci. The least used is the drip irrigation. However in Kirinyaga County (Nyamindi and Thiba), respondents also indicated the use of canals as an irrigation source directly to their farmlands.



	Rupingazi	Thuci	Nyamindi	Thiba
Drip	9.30%	4.80%	12.50%	14.00%
Overhead	72.10%	71.40%	41.40%	42.60%
Buckets	18.60%	23.80%	30.40%	24.80%
Others	0	0	16.10%	18.60%

Fig. 4.12: Field Survey, 2018

In water management, respondents across the study area use mostly water tanks while some do not use any technology whatsoever highest in Ripingazi river basin. Some other water management like water re-use and water re-direction are also used and both recording high percentage of use in Thiba river basin.



	Rupingazi	Thuci	Nyamindi	Thiba
Water Tanks	68.30%	92%	78.40%	79.30%
Water Re-use	5%	12%	6.90%	14.70%
Water Redirection	16.70%	5.30%	10.80%	19%
None	28.30%	4%	13.70%	9.80%

Fig. 4.13: Field Survey, 2018

4.4 Water Resources Users Associations' Activities in Improving Water Quantity and Quality

The WRUA is a model for community based participation in water resources management. The model is based on the premise that the water resource users, being the principle beneficiary or direct stakeholders of water resources should be integrally involved in the management of the water resources, since their live hood is at stake. The water resources users are mobilized to undertake water resources management activities that serve their best interests. It is more efficient for the WRUA to mobilize the water users to solve problems at the grassroots level. UTaNRMP through the WRMA as the agency in charge of the WRUAs manages the water activities and provide funding for the implementation of SCMP through the WSTF usually through calls for proposal

Table 4.7: WRUA activities in the study area

Name of WRUA	No. of projects and members	Availability of SCMP	Projects executed in the SCMP	Trainings participated	Activities
Upper Rupingazi	65 projects (more than 20,000 registered members)	Yes	- 13 water harvesting tanks provided - Promotion of roof water harvesting - Rehabilitation and conservation of wetlands - 5 springs rehabilitated	- Integrated water management training - Financial management - Conflict management - Capacity building	Water conflict resolution which has reduced over the past few years Preventing illegal water abstractors Funding of activities for management of catchment
Lower Thuci	125 projects	Yes	- 8 water harvesting tanks provided - Riparian area conservation - Planting 16,000 indigenous trees and 4,000 giant bamboos with over 50% survival rate - Abstraction survey	- Integrated water management training - Financial management - Conflict management - Capacity building	Water conflict resolution which has reduced over the past few years Preventing illegal water abstractors Funding of activities for management of catchment
Lower Nyamindi	14 projects	Yes	None	- Capacity building	Water conflict resolution which has reduced over the past few years Preventing illegal water abstractors

					Funding of activities for management of catchment
Upper Thiba	128 projects	Yes	- 5 water harvesting tanks provided - Installation of Master Meters - Mapping of Riparian areas	- Integrated water management training - Financial management - Conflict management - Capacity building	Water conflict resolution which has reduced over the past few years Preventing illegal water abstractors Funding of activities for management of catchment

The WRUAs used for this study showed different activities and implementation levels. They all demonstrated high level of coordination and management. They also all had Sub-catchment Management Plans (SCMPs) and have all executed the first level of activities in the plan except Lower Nyamindi WRUA who though having a SCMP had not executed activities; this is due to the lack of access to funds.

4.5 Assessment of Water Quality Parameters

4.5.1 Assessment of the base flow, silt load and coliform trends and their impacts in the river basins

The conservation efforts of the natural resources by the project is geared towards increasing the amount of water in the river basins for down ward users, reduction of silt load and pollution of water resources. The survey was to establish the average base flow in the river basins, silt loads and levels of pollution and compare with the levels at baseline, deduce trends and their implications.

4.5.2 Monitoring points and the target parameters

The project had established ninety (90) water monitoring points for both base flow and water quality and had also established teams for testing water quality for twenty (20) water springs and wells. The project had set two peak seasons – dry season in August and wet season in November - for sample collection for water quality analysis (chemical, physical and biological) and base flow measurements. The design of the project set to determine Base flow, Silt load, Coliforms and Turbidity at mid-term and end term and to measure achievements compared to baseline figures. Comparisons of achievement would focus on wet seasons when the parameters manifest themselves. These parameters were key indicators in determining the level of protection and conservation activities being carried out in the project area.

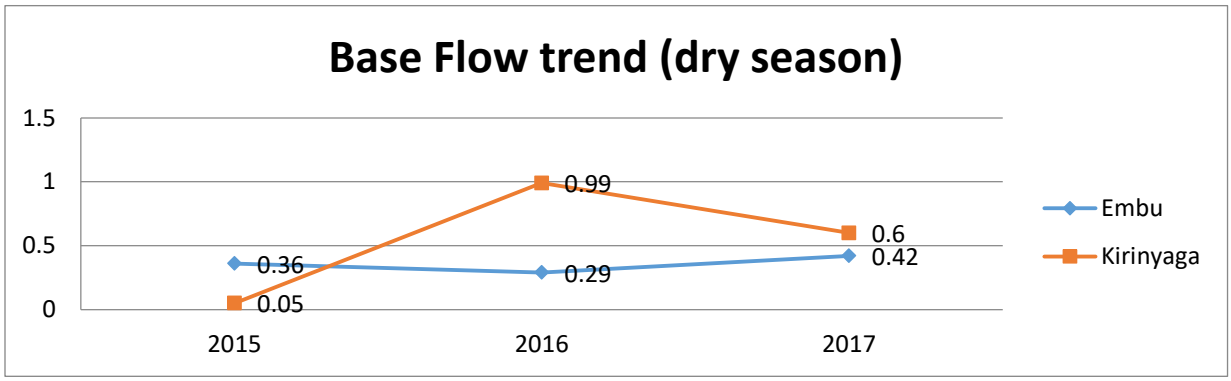


Fig. 4.14a: UTaNRMP Water Laboratory Results, 2018

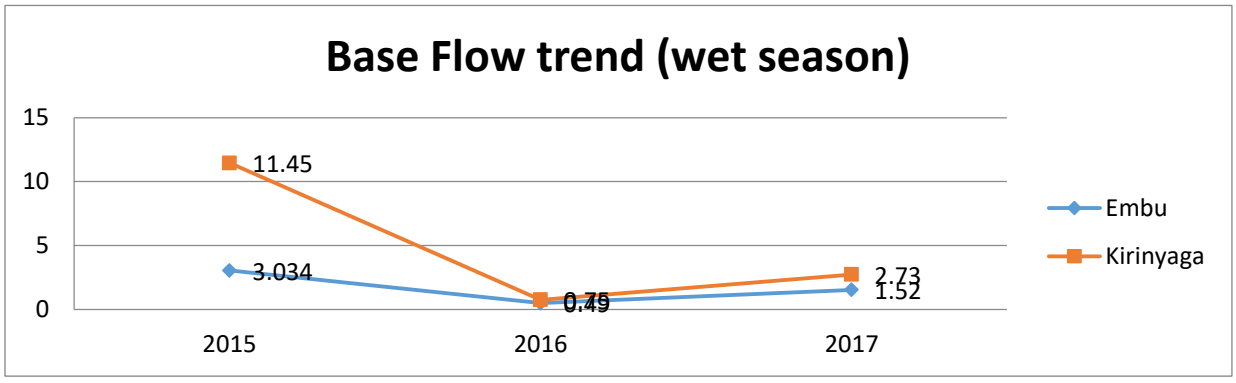


Fig. 4.14b: UTaNRMP Water Laboratory Results, 2018

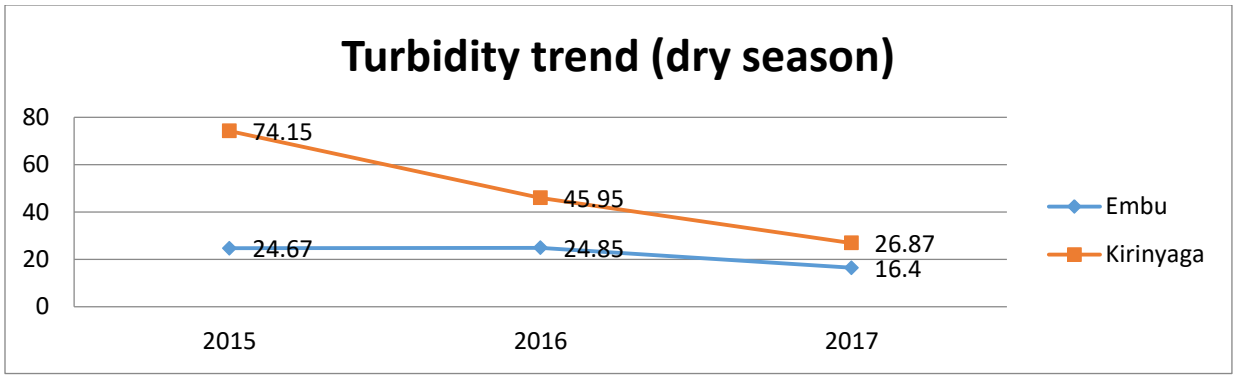


Fig. 4.15a: UTaNRMP Water Laboratory Results, 2018

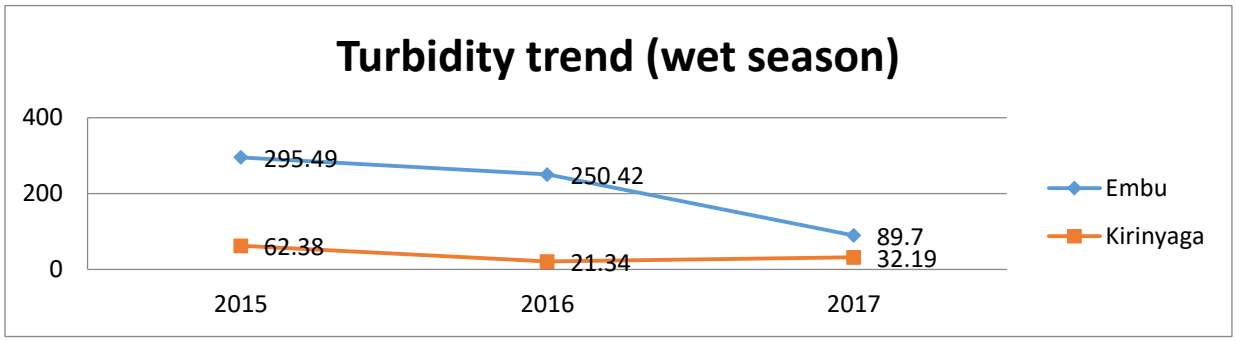


Fig. 4.15b: UTaNRMP Water Laboratory Results, 2018

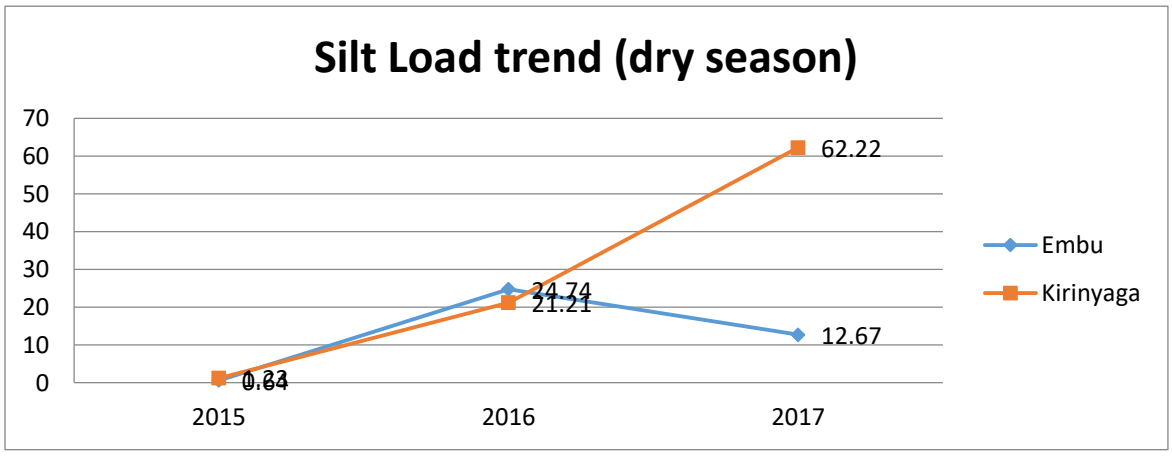


Fig. 4.16a: UTaNRMP Water Laboratory Results, 2018

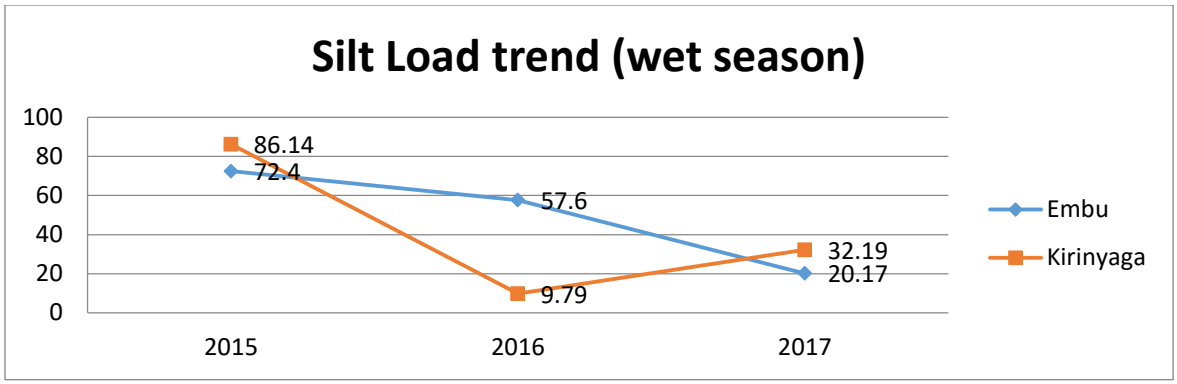


Fig. 4.16b: UTaNRMP Water Laboratory Results, 2018

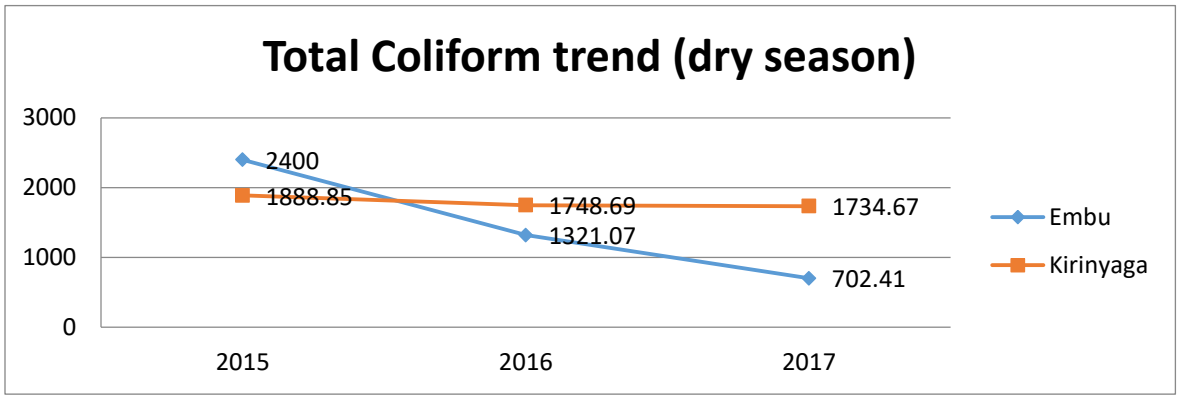


Fig. 4.17a: UTaNRMP Water Laboratory Results, 2018

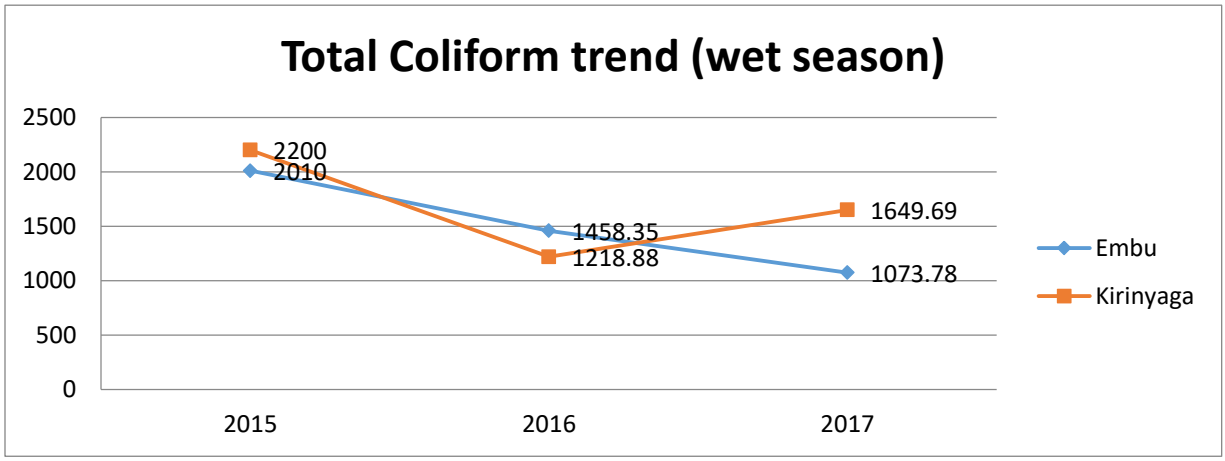


Fig. 4.17b: UTaNRMP Water Laboratory Results, 2018

CHAPRTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This study assessed the water quantity and quality in the Upper Tana catchment of Kenya using Embu and Kirinyaga counties as case studies. This was done by first determining the water vulnerability index in the study area, assessing the water technologies used by water users, assessing the activities of the WRUAs and the water quality trends in the study area; and established that:

There are slightly more men than women in the study area as opposed to the KPHC report of 2009 and most of the households have men as head. More than half of the population was also discovered to be within the range of 41 – 60 years with more than half of the population married. More people have also attained some level of education with secondary school level being the highest across the study area and more than half of the households have 4 – 5 persons.

The water vulnerability across the study area is low as the components indicate. Water resources available is as high as 91% and the lowest at 43%. There is however an increased level of access to water with a river basin reaching 100% level of access and the lowest just 81%. There is however a low capacity to water management indicated by low WRUA membership and trainings. The study area however recorded quite impressively a low level of occurrence of water-borne diseases. There is also decreased incidence of water conflict and about 50% level of water pollution. The quantity of water used in litres per household per day is also well above average.

Use of safe water sources as well as improved sanitation facilities also recorded improvement compared to when the project started and more people more than 50% have benefitted from a developed or rehabilitated water source. UTaNRMP has also recorded a 22% level of improvement of water source which is higher than other organizations involved. More than 70% of the population are involved in water harvesting as well as irrigation farming except in Thuci. Overhead irrigation system is also the most commonly used across the study area.

The Water Resources Users Association have also proved critical to the improvement of water quality and quantity as they have all executed projects in their SCMP except Lower Nyamindi WRUA. The WRUAs are also involved majorly in providing water harvesting tanks, land

conservation and creating awareness on water resources management as well as conflict resolution leading to lower levels of water conflicts in the study area.

The counties also generally recorded generally decreased base flow, decreased water turbidity, as well as decreased suspended sediment load from 2015 – 2017. The coliform levels also recorded decrease within the project years.

5.2 Conclusion

The UTaNRMP has improved the water quality and quantity in the study area. This is evident with a better water vulnerability in the study areas with a weighted average of 0.6293 for Embu and 0.6175 for Kirinyaga; this compared to results of Water poverty Index by Yvonne Githora in 2012 with: Nairobi 0.6098, Kiambu 0.5046, Muranga'a 0.495, Nyandarua 0.3908.

The project has also recorded within the past few years' improvement in use of safe water and sanitation facilities across the project areas. The funding of WRUAs through the WSTF and the community contribution towards implementation of water sector activities has created ownership hence sustainability of the project. It is also of interest that reduced level of water vulnerability was recorded in river basins with the most active WRUA.

Establishment of modern and advanced water laboratories has created a one-stop-shop for water quality and base flow data for planning and management of water resources and environment however more work needs to be done in the dissemination of the results to the end users especially the local farmers. More work will also need to be done in the enforcement of regulations to improve water management and use.

Finally the UTaNRMP is on track towards achieving set targets in improving water quality and quantity. Completed activities have also shown positive impacts on livelihoods of the communities and environment.

5.3 Recommendations

The following are my recommendations for improved project activities to achieve the expected results:

- The proposal process for funds should be inclusive and done as a group to encourage those who cannot do this on their own;

- The timeliness of appraisals of proposals for funding and cash disbursements should be improved to ensure swift project execution;
- There is need to improve protection and conservation best practices in the river basins to increase and enhance base flow and water quality;
- Capacity building of WRUAs needs to be enhanced to improve the chances of funding;
- The use of water quality results from the set up laboratories should be properly disseminated to enforce rules, regulations and guidelines on pollution water sources and make enforcement.

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APPENDICES

APPENDIX I: LIST OF INDIVIDUALS AND GROUPS INTERVIEWED

I) List of Key Informants Interviewed

S/No.	Name	Designation	County
1.	Agnes Muchira	County Project Co-ordinator	Embu
2.	Nicolas Nyaga	County Project Co-ordinator	Kirinyaga
3.	Lucy Fundi	WRMA Official	Embu & Kirinyaga
4.	Esther Karithi	Water Quality Officer	Embu & Kirinyaga
5.	Moses Kamau	Upper Rupingazi WRUA Chairman	Embu
6.	Christopher Guchutha	Lower Thuci WRUA Chairman	Embu
7.	Tarcisius Weru	Lower Nyamindi WRUA Chairman	Kirinyaga
8.	Kariithi Chuma Geoffrey	Upper Thiba WRUA Chairman	Kirinyaga
9.	Christopher Njue Njagi	Clinical Officer Karau Health Centre	Embu
10.	Diouisius Njue Njeru	Public Health Officer Kauyuambora Dispensary	Embu

II) List of participants in the Focused Group Discussions

S/No.	Name of Group	Type of Group	River Basin	County
1.	Upper Rupingazi WRUA	WRUA	Rupingazi	Embu
2.	Lower Thuci WRUA	WRUA	Thuci	Embu
3.	Lower Nyamindi WRUA	WRUA	Nyamindi	Kirinyaga
4.	Upper Thiba WRUA	WRUA	Thiba	Kirinyaga

APPENDIX II: DATA COLLECTION TOOLS

I) Household Questionnaire

IFAD-MDP WIN WIN FIELD PRACTICUM (QUESTIONNAIRE)

ASSESSMENT OF THE UPPER TANA NATURAL RESOURCE MANAGEMENT PROJECT (UTaNRMP)

Please tick (√) where necessary and provide suggestions where required. Thank you.

Name of respondent: …… **Date:** …… **S/No.:** ……

County of Residence: …… **Name of Sub-County:** ……

Name of River Basin: …….. **River Basin:** Upper (Tea) [ ] Middle (Coffee) [ ] Lower (Cotton) [ ]

Name of FDA/CFA/WRUA/CIG: ..... **Position held** .....

Name of Enumerator: …… **GPS Coordinates:** Longitude:…… Latitude: …… Altitude: …….

SECTION A: <u>SOCIO ECONOMIC CHARACTERISTICS OF HOUSEHOLDS</u>

1. Gender of Respondent Male [ ] Female [ ] **2. Age of Respondent?** …… (Years)

3. How long have you lived in this area? …… (Years) **4a. Are your household members aware of any community group?** Yes [] No []

4b. Which group are they engaged in? FDA [] CFA [ ] WRUA [] CIG [ ] Other [ ] specify _____

5**. Do you belong to a social group**? [ ] Yes, please specify _____

[ ] No, give reason _____

6. Who is the head of your household? Man [ ] Woman [ ] Male Youth [ ] Female Youth [ ]

7a. Household Size……? **7b. Number of household members working …….? 7c.Number of household members not working ……?**

8. What is the highest level of education?

9. Highest Education Level	**None**	**Primary**	**Secondary**	**College/ University**	**Vocational Training**
Household Head					
Household Spouse					
Children					

10a. Main occupation of household head? Farming [ ] Off-Farm [ ] Employment [ ] Other (Please specify): ……

10b. Main occupation of spouse of household head? Farming [ ] Off-Farm [ ] Employment [ ] Other (Please specify): ……

11. Other occupation of household? Farming [ ] Off-Farm [ ] Employment [ ] Other (Please specify): ……

12. What is the total land area owned by household? …… (Acres)

13. What is the land ownership status in (Q12) above? Private with titles [ ] Private with no titles [ ] Communal land [ ] Other (please specify): …… **14. Is the land mentioned in Q 12 above accessible to every member of the family?** Yes [ ] No [ ] **15. What are your <u>Main</u> sources of income?**

Crop Farming [ ]: Crops sold: ……..
Livestock [ ]: Sale of animals/animal products: ……
Sale of seeds [ ]: Types of seeds ……
Sale of Trees/Charcoal [ ]: Tree Species: Indigenous [ ] Exotic [ ]
Business [ ]: Type of Business: ……..

Employment: Temporary [ ] Permanent [ ] Remittance [ ] Others [ ]: ……..

16. Household Income and Expenditure in the past one (1) month:

INCOME			**EXPENDITURE**		
S/No.	**Particulars**	**Amount (KShs)**	**S/No.**	**Particulars**	**Amount (KShs)**
a.	Livestock sales		a.	Transport (boda boda, matatu)	
b.	Livestock products (eggs, milk, meat honey)		b.	Buying food	
C	Business/ Entrepreneurship		c	Buying of Fuel Wood	
D	Unearned income(interest, dividend, royalties, capital gains)		d	Building houses	
e	Sale of horticultural produce		e	Communication (airtime)	
F	Sale of food crop		f	Belongings(Tv, Shoes, Clothing)	
g	Sale of seeds		g	Leisure (bar, sports, movies)	
H	Petty trade (hawking)		h	Investment in business (non-agriculture)	
I	Leasing out agricultural equipment		i	Water bill	
J	Formal employment		j	Electricity bill	
K	Sales of wood/tree/charcoal		k	Medical expenses	
L	Land lease		l	School Fees/College	
M	Casual employment		m	Insurance	
N	Land sale		n	Merry go round	
O	Other income (please specify)		o	Other expenditure (specify)	

17. Assets owned (number owned = 1, year it was bought = 2 note: insert numbers and dates)

Farm mach.	**1**	**2**	**House hold**	**1**	**2**	**HH.**	**1**	**2**	**Agric. Tools**	**1**	**2**	**Agric. tools**	**1**	**2**
Tractor			Tv			Computer			Panga			Knapsacks		
Oxen plough			Phone			Bicycle			Jembe			Watering can		
Spray pump			Car			radio			Jembe fork			Wheelbarrow		
Irrigation pump			Fridge			Motorcycle			Sickle			Milking can		
Other			Gas cooker			others			Secateurs			Fishing gear		
			Motor Bikes						Rake			others		

18. Structures on farm (type: Permanent = 1, Semi permanent = 2, temporary =3)

S/No	**Structures**	**Numbers**	**type**
a.	Residential house		
b.	Granary (grain store)		
c.	Equipment store		
d.	Toilet Facility		
e.	Other		

19a. Have your family members eaten one meal per day in the last one year? Yes [ ] No [ ]

19b. If yes Q 19a above, how long was it? Within a month [ ]2-3 months [ ] Above 3 months [ ]

20. How many meals do you normally take per day? 1 meal [ ] 2 meals [ ] 3 meals [ ] above three meals [ ]

21. What is the composition of your meals (tick as much as possible)? Maize [ ] Rice [ ] Wheat products [ ] Meat/Fish [ ] Legumes [ ] Fruits [ ] Vegetables [ ]

22. Does the household head own a bank account? Yes [ ] No [ ]

23. If Yes in Q22 above, how often is the account used? Always [ ] Often [ ] Sometimes [ ] Never [ ]

24. What is the marital Status of Household head? Single [ ] Married [ ] Divorced [ ] Widow [ ] Widower [ ]

WATER QUALITY AND QUANTITY ASSESSMENT

Section 1

1. How would you rate the quality of water you use?

Very poor [ ] Poor [ ] Neutral [ ] Good [ ] Very Good [ ]

2a. Do you treat your water before use? Yes [ ] No [ ]

2b. If Yes; which water treatment method do you use?

None [ ] Adding chlorine [ ] Boiling [ ] Filtering [ ] Allowing water to settle [ ]

Others (please specify): ……..

3a. **Do you store water for drinking?** Yes [ ] No [ ]

3b. If Yes; How do you store water for drinking?

Metal container [ ] Open plastic [ ] Closed plastic [ ] Open traditional pot [ ]

Closed traditional pot [ ] Others (please specify): ……..

4a. What is the main source of water for your domestic consumption? (Please tick where necessary)

S/No	Type of Facility	Before Project (Prior to 2012)	During Project (NOW)
1.	Piped water into the house		
2.	Protected spring		
3.	Unprotected spring		
4.	Protected well		
5.	Unprotected well		
6.	Borehole		
7.	Rain water		
8.	Dams		
9.	Water pans		
10.	Others (Please specify)		

4b. Do you consider your present water source ADEQUATE for your household needs? Yes [ ] No [ ]

5. What kind of toilet facility does your household use?

S/No	Type of Facility	Before Project (Prior to 2012)	During Project (NOW)
1.	Open Field		
2.	Pit Latrine – No permanent wall (wood, zinc) **with raised slab**		
3.	Pit Latrine – No permanent wall (wood, zinc) **without raised slab**		
4.	Pit Latrine – With permanent wall (bricks) **with raised slab**		
5.	Pit Latrine – With permanent wall (bricks) **without raised slab**		
6.	Ventilated improved Pit Latrine		
7.	Flush Toilet		
8.	Others (Please specify)		

6. What is the average distance to the nearest source of water?
Less than 1km [ ] 1 – 2km [ ] 3 – 5km [ ] Over 5km [ ]

7. How long does it take to fetch water and back?
Less than 15 minutes [ ] 15 – 30 minutes [ ] 31 minutes – 1 hour [ ] More than 1 hour [ ]

8a. Do you pay for water? Yes [ ] No [ ]
8b. If Yes; How much do you pay for water per month? (KSh) ……

9a. Do you experience water shortage/ration? Yes [ ] No [ ]
9b. If Yes; How frequent is the water shortage? Less than 3 days [ ] 4 - 7 days [ ] More than one week [ ]

10a. Are you aware of water borne diseases like cholera, Diarrhea, Dysentery, Typhoid? Yes [ ] No [ ]

10b. Has any household member suffered water borne diseases in the past one year? Yes [ ] No [ ]
10c. If Yes; How many people? ……
10d. How many were for under five children? …… **10e. How many were for over five?** ……
10f. Were there fatalities (surgical operations, death) as a result of the water-borne diseases? Yes [ ] No [ ]

11a. Are you a member of a WRUA? Yes [ ] No [ ]
11b. If Yes; What are the benefits of being a member of WRUA? ……
……

12a. Have you received any training on how to improve water quality? Yes [ ] No [ ]
12b. If Yes; what type of training and by whom? ……

13a. Have you received any training on management of household waste (solid, liquid and human waste)? Yes [ ] No [ ]
13b. If Yes; What type of training and by whom? ……

14. How do you get information on water resources? ……

15. Approximately how many litres of water do your household use daily? (Request for water bills if available) ……

16. For what use is the water supplied majorly used for? ……

17a. How do you dispose of your waste? ……
17b. How far is your waste disposal point from the house (km)? ……

18a. Has there been any conflict arising from the water sources? Yes [ ] No [ ]
18b. If Yes; what was the nature/source of the conflict? ……
18c. How was the conflict above resolved? ……
……
……

19a. Are there Rivers, Hilltops, Wetlands, or springs in your area (near your household or farmland? Yes [ ] No [ ]

19b. If Yes; Please give details (Location and name) of these water sources? ……
……

20a. Are there sources of pollution in the water sources listed above? (factories, human and animal activities etc.)
Yes [ ] No [ ]
If Yes; Please give details of these?
20b. Sources of pollution ……
20c. Location of pollution: ……
20d. Distance of pollution from household? ……

21a. Have you benefitted from any drinking water source developed /rehabilitated? Yes [ ] No [ ]
21b. If yes who rehabilitated them? …….

SECTION 2 -Water Technologies

1a. Do you harvest rain water? Yes [ ] No [ ]
1b. If No; Why? ……

2a. Do you irrigate your crop land? Yes [ ] No [ ]
2b. If Yes; what method do you use? Drip [ ] Overhead [ ] Buckets [ ] Others (please specify): ……
2c. What crops do you grow under irrigation? (List) ……
2d. Has there been any changes in crop production due to availability of water for irrigation? Yes [ ] No [ ]
2e. If Yes; Explain? ……

3a. Has there been an increase in the area under crop as a result of irrigation? Yes [ ] No [ ]
3b. If Yes; How has changes in crop production impacted on your livelihood? ……
……

4. What other water management technology do you use (tick as many)? Water Tanks [ ] Water Re-use [ ] Re-direction of water flow [ ] Others Please Specify……

II) Focused Group Discussion Guide

IFAD-MDP WIN WIN FIELD PRACTICUM

Upper Tana Natural Resource Management Project (UTaNRMP), Embu Kenya

(Water Sub-Component)

FOCUSED GROUP DISCUSSION		**Responses from FGD participants**
1.	**Contact Details** Name of the person Position of the person Phone Number of the contact	
2.	**Water Resource Users Association (WRUA) Details**	
2a	Name of the WRUA	

2b	Name of the River Basin	
2c	Location of the WRUA (County, sub-county, ward)	
2d	Membership details of WRUA (Men, Women, Young Men, Young Women, PLWD)	
2e	Brief history of WRUA (When started, why it started)	
2f	Is your WRUA registered Do you have a group constitution	
2g	Does your WRUA have an Executive Committee What are the roles of the Committee What is the composition of this committee (Men, Women, Young Men, Young Women, PLWD) Do you have other sub-committees What are their roles	
2h	What are the core activities of this WRUA?	
2i	How are Women, Youth and PLWD involved in your group's activities?	
3. <u>ASSESSING WRUAs AS A COMMUNITY BASED ORGANIZATION IIN PROMOTING WATER QUALITY AND QUANTITY</u>		
3a	How would you rate your WRUA's ability to undertake your activities? (Development and implementation of SCMPs, control of abstraction and resolution of water conflicts) List some of the key activities implemented under SCMPs What hotspots have been developed/ rehabilitated and what are the impacts? What are some of the challenges in fulfilling your role? What support would you require to deal with these challenges?	
3b	What type of trainings supported by the project have you been involved in? How was the composition of the trained group (M/F) Were these trainings relevant to your needs? What kind of equipment do you have? What are the impacts of the equipment? Which equipment are support from	

	UTaNRMP? How did this impact to your group activities? (consider how women, youth and PLWD benefitted) How can the trainings aspects be improved for better benefits?	
3c	How many of your group executive committee members have benefitted from training and capacity building on leadership and management?	
3d	What is the nature and source of conflict in your group? How do you compare frequency of conflicts? How do you resolve conflicts in your group?	**2012** **NOW**
3e	Have you benefitted from matching grants from the project? If Yes, how much? What are the activities undertaken with these grants? Are these activities undertaken bearing any fruits?	
3f	What type of water sources under your WUA mandated area were developed/ rehabilitated? How many (number) of these water sources were developed/ rehabilitated? Who developed/rehabilitated these water sources? How do you describe the approaches to the civil works done by the project? How do you describe water quantity? (people with access to safe drinking water) How do you compare availability of water for irrigation? How do you describe water quality in your area? How have the distances to the water sources changed? What is your observation on base flow of the river(s) in your water basin?	**2012** **NOW**
3g	Do you receive any information on water quality and quantity from UTaNRMP? If Yes, how often? Has the information assisted you? If Yes, How?	

III) Key Informant Schedule

1) SUB-COUNTY HEALTH CENTRE

i) What is the status of water quality in the river basin?

ii) What is the level of prevalence of water borne diseases (monthly) in the river basin **before 2012**?
   a. -Number of children (below 5 years) affected;
   b. -Number of people (above 5 years) affected;

iii) What is the level of prevalence of water borne diseases (monthly) in the river basin **PRESENTLY**?
   a. -Number of children (below 5 years) affected;
   b. -Number of people (above 5 years) affected;

iv) In your opinion, what could be the likely causes of these water borne diseases and how can they be addressed?

v) How is the health seeking behavior of parents with children under five years old?

vi) Which other health problems are commonly experienced by children under five years in this area?

vii) In your opinion, what could be the likely causes of these health problems and how can they be addressed?

viii) Which initiatives have been put in place by the County/government and other development partners to address water borne diseases concerns?

ix) What challenges are being experienced in addressing water borne diseases?

x) How do you think they can be dealt with to ensure food security for all?

2) THIBA WRUA COVERAGE - WATER COUNTY OFFICER

i) The project was to support various water sources in this river basin. What sources (number and type) have been developed/ rehabilitated?

ii) What was the status of the targeted sites for development/rehabilitation? Had they been categorized as hotspots and why?

iii) Was the development/rehabilitation of the attended water sources a priority in the basin? If so, why?

iv) What could be number of beneficiaries (M:F) accessing safe, reliable and affordable drinking water?

v) What could be the acreage put under irrigation from developed/rehabilitated water sources? What are the effects of the irrigation to the communities and the general economy?

vi) Has there been sources of water developed/rehabilitated as a complementary of this project?

vii) Has the project achieved its intended results? what more can be done?

3. WATER RESOURCE USERS ASSOCIATIONS (WRUA) - WRUA CHAIRMAN

a) Capacity building and institutional support

i) What is the name of the WRUA and in which water basin?
ii) In which year was the WRUA established and registered?
iii) When did the WRUA formulate SCMP? Who supported the formulation? When do you start implementing the SCMP?
iv) Can you give key activities and results of implementation of the SCMP components?
v) What trainings have you received? Who did the trainings? Can you list them and give key results of each training?
vi) Have received any financial support? Which agency contributed how much? What key activities and the key results have been achieved from using the funds?

b) Sharing of water resources

i) How is the distribution of water sources in your sub-catchment?
ii) Is the production of water sources adequate for the upstream and downstream users? If not, have there been conflicts amongst water users in the sub-catchment? If yes, how many incidences, their nature and how have gone about it?
iii) What are the water sources available, their production, uses and beneficiaries?
iv) What are the key aspects that can improve availability of water resources for all users in the sub-catchment?

3) UTaNRMP – WATER LABORATORY OFFICER

i) Quality of water in the basin could be varied? How do you describe water quality in area?
ii) What could be the contributory factors of the quality you have described?
iii) How would you describe the water quantity changes in the area
iv) The project has carried out various interventions in the sector towards improved water quality. Could the quality you have described resulted from the project?
v) The project has been doing monitoring of water quality. How has the project been carrying out water analysis?
vi) How do you disseminate information on water quality to the people?
vii) Do you carry out awareness/sensitization based on the results gotten? If yes; how do you go about it?
viii) How do you describe the water quality since implementation of the project? Is it within standards recommended by the regulation authorities?
ix) Do you think there is need for improvement of water quality? If so, then what are your recommendations?

4) UTaNRMP - WATER COUNTY COORDINATOR

a) Distance to water sources

i) From your monitoring of the project activities, how has average distances to water sources changed? What are the key contributory factors?

ii) What effects do the changes in average distances have in the communities?

iii) What is your opinion on the current average distance to water sources?

b) Quality of water

x) Quality of water in the basin could be varied? How do you describe water quality in this river basin?

xi) What could be the contributory factors of the quality you have described?

xii) The project has carried out various interventions in the sector towards improved water quality. Could the quality you have described resulted from the project?

xiii) The project has been doing monitoring of water quality. How has the project been carrying out water analysis?

xiv) How do you describe the water quality since implementation of the project? Is it within standards recommended by the regulation authorities?

xv) Do you think there is need for improvement of water quality? If so, then what are your recommendations?

c) Institutional support and capacity building

i) The project had foreseen establishment of WRUAs in each basin? How many WRUAs have been established so far by the project? How many have been registered?

ii) The project was to carry out various trainings in water basins. What trainings have been carried out so far to WRUAs, WUAs? What are the impacts of the trainings?

iii) How many WRUAs have developed SCMPs since the commencement of the project? How many SCMPs have been operationalised?

iv) What key results have been achieved so far from operationalisation of SCMPs?

v) Are there impeding factors towards operationalisation of the SCMPs? What are the intended solutions?

vi) What trainings have been carried out to government officials and what their impacts?

vii) How many people have been reached so far (M:F) for each training?

viii) What equipment's and facilities were provided to communities and how are their impacts so far?

ix) What facilities have been provided to government departments? What are the impacts so far?

x) Has there been leveraging of funds from other development partners besides key funding agencies of the project?

xi) Which community institutions and government departments have been funded in cash or in kind? Please give the key impacts of the funding.

xii) What is your opinions on the institutional support and capacity building the project has offered so far?

APPENDIX III: PLAN OF STUDY

S/N	Activities	Timeline (Weeks)									
		2	1	1	1	4	2	4	1	1	1
1	Preparation of internship proposal and communication with on-site supervisor ***(5th March - 16th March)***										
2	Arrival at Upper Tana Natural Resources Management (UTaNRMP) Familiarization with host community Meeting with the Project Coordinating Team (PCT) at UTaNRMP ***(19th March - 23rd March)***										
3	Review of baseline survey, formulation of research questions and survey instruments ***(26th March - 30th March)***										
4	Conduct and review research tools' validity (pre-test) ***(2nd April - 6th April)***										
5	Data Collection - Administration of Questionnaires, Conducting Focused Group Discussions and Interviews ***(9th April - 4th May)***										
6	Data coding and entry Presentation of preliminary report to the PCT at UTaNRMP ***(30th April - 11th May)***										
7	Trip back to Nigeria ***(13th May)***										
8	Data analysis and evaluation of research findings ***(14th May - 8th June)***										
9	Writing of internship report ***(11th June - 15th June)***										
10	Submitting draft report to both my on-site supervisor and academic supervisor for corrections ***(18th June - 22nd June)***										
11	Final submission of internship report ***(25th June - 29th June)***										
			Weeks on the field								

APPENDIX IV: FIELD PHOTOS

Data Collection and Key Informant Interview

One of the water collection tanks in a secondary school in Embu County


SDGs Awareness Campaign at St. Ursla School, Embu County


Data Collection and focused Group Discussion in Lower Nyamindi and Lower Thuci WRUA


Data Collection and questionnaire administration (Kirinyaga County)



Data Collection and questionnaire administration (Embu County)


Data Collection and questionnaire administration


Data Collection and questionnaire administration


Water sample collection for testing

Water sample collection for testing

Water testing in the UTaNRMP Water Laboratory, Embu County