FACTORS INFLUENCING THE INTENSITY OF HOUSEHOLD APPLICATION OF WATERSHED MANAGEMENT PRACTICES WITHIN THE UPPER ENA RIVER CATCHMENT IN EMBU COUNTY, KENYA

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DECLARATION

I declare that this document and the research that it describes are my original work and that they have not been presented in any other University for academic work.

20th June 2020

James Chomba Njeru Date

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This research was conducted under our supervision and is submitted with our approval as University supervisors.

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DEDICATION

This research project is dedicated to my wife, son, and daughter for encouraging me during my studies. My family's enormous support during my masters studies has been the source of my motivation to work harder and always aim at the end result.

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ABSTRACT

Community led watershed management has in recent period gained momentum in developing countries. This has been attributed partly due to the fact it is becoming a key conservation mechanism in the face of climate change and population explosion. With diversity in the uptake of both traditional and advanced watershed management technologies in several communities, this study aimed at examining factors influencing the intensity of household application of watershed management practices (WSMP) in upper Ena River catchment in Embu County, Kenya. More specifically, the study aimed at investigating the influence of the following four factors on the intensity of household application of WSMP: Socio-demographic factors (age, education level, sex and household size), collective action; household financial investment in WSMP as well as practical knowledge. Nine watershed management practices were studied, they included: mulching, minimum tillage, contour farming, terraces, afforestation, grass strips, cut off drains, and agroforestry. A descriptive research design was used. A random sample of 384 households was interviewed using a structured interview schedule. The data was then analysed using descriptive and inferential statistics in a Statistical Package for the Social Sciences (SPSS version 25). The results indicate that three of the independent variables had significant influence on the intensity of household application of WSMP, they included: collective action ($\beta=0.941$, $t=54.13$, $p< 0.001$), financial investment ($\beta=0.835$, $t=29.67$, $p< 0.001$) and farmer's practical knowledge, ($\beta=0.975$, $p< 0.001$), while the socio-demographic factors had no significant influence. We thus recommend that government to subsidize the cost of some watershed management practices, increase the knowledge base of the farmers in the region through seminars and workshops, increase extension services to the people of Upper ENA River catchment.

DEFINITION OF TERMS

Watershed Management Practices: encompasses the management and conservation of all available watershed resources in a comprehensive way (Ritter and Shirmohammadi, 2000). It provides a framework for integrating different land-use and livelihood systems (e.g. forestry, pasture and agriculture), using water as the "entry point" in the design of interventions.

Ecological restoration: the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SER, 2017). In this study ecological restoration focused on the forested mountains commonly referred as the five water towers of Kenya.

Sustainability: defines meeting the needs of the present without compromising the ability of future generations to meet their needs. The concept of sustainability is composed of three pillars: economic, environmental, and social—also known informally as profits, planet, and people (Moldan et al., 2012).

Sustainable land use practices: Practices and technologies that aim to integrate the management of land, water, biodiversity, and other environmental resources to meet human needs while ensuring the long-term sustainability of ecosystem services and livelihoods (Vörösmarty et al., 2010).

Collective action: Is the formation of groups or associations with a common interest and in this case the groups need to be within one watershed while aiming at sustainable management of the resources within the watershed (Martignago, 2011).

ABBREVIATIONS AND ACRONYMS

CBNRM:	Community-Based Natural Resource Management
FDEPS:	Fuelwood Development for Energy Project in Sudan
NACOSTI:	National Commission for Science, Technology and Innovation
OECD:	Organization for Economic Cooperation and Development
PELIS:	Plantation Establishment and Livelihood Improvement scheme
WRA:	Water Resources Authority
NGOs:	Non-Governmental Organizations
UTaNRMP:	Upper Tana Natural Resources Management Project
MKEPP:	Mount Kenya East Pilot Project
ANOVA:	Analysis of Variance
KFS:	Kenya Forest Service
BMPs:	Best Management Practices
WSMP	Watershed Management Practices

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The study looked as at the factors influencing the intensity of household application of watershed management practices within the upper Ena river catchment in Embu County, Kenya. The independent factors assessed by this study included: household socio-demographics (age, sex, household size and education level of the participants), farmer's knowledge of watershed management practices, collective action, and household financial intervention. The dependent variable for this study was the intensity of household application of watershed management practices (WSMP). This chapter introduces the study under the following sub-headings: background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, scope of the study, delimitation of the study, limitations of the study, assumptions of the study, theoretical framework, and conceptual frame work.

1.2 Background of the Study

Watershed management is becoming a key conservation mechanism in the face of climate change and population explosion. Though several studies have specific definitions of watershed management to fit their study context, this study adopts the definition of Ritter and Shirmohammadi (2000), that defines watershed management as: "an elaborate conservation mechanism of both soil and water resources that exist along a geo-hydrological unit draining to a common point by a system of drains commonly known as a watershed or water divide". In other words, watershed management includes the conservation of land surface, vegetation and water areas along this geo-hydrological unit since they have an economic value (Ali, 2010).

Several objectives for watershed management practices exist: to control pollution in watershed areas; sustainable exploitation of natural resources; to check soil erosion and sedimentation of silt; and to preserve natural resources for sustainable food security (Martignago, 2011). Such management practices can include but are not limited to: vegetative measures (e.g. strip cropping, grassland farming or pasture cropping); and structural practices (terracing of steep slopped lands, contour building, construction of check dams, construction of farm dams, construction of diversions, rock dams, gully controlling, establishing of permanent grass and stone barriers) (Shiene, 2012; Makango & Reddy, 2014).

Water as a natural resource is becoming scarce due to the increasing demand from different competing users as a result of rapid population increase and climate change. For instance, according to Cosgrove and Rijsberman (2000), the global supply of water is becoming scarcer because of increasing demands associated with industrialization, increasing urbanization and growing population. In addition, climatic conditions, such as global warming have worsened the situation. Given its role in the production of goods and services and support to life in general, water scarcity calls for an elaborate management of watershed/catchment areas to ensure sustainability of its use both to the current generation and the future generation.

In management of such watershed areas, several stakeholders and factors come into play especially after the traditional approaches to management such as command and control strategies failed to achieve the expected result. An in-depth understanding on how several factors influence efficient watershed management is important for both economic growth, development and welfare improvement of the people directly or indirectly benefiting from the drainage basin in which the river lies and serves (Tidd & Bessant 2018).

Globally, several objectives exist to efficiently manage a given watershed: to check/reduce the damage from surface runoff and degradation aimed specifically in a conservation of soil and water; to conserve the surrounding land through regeneration/rehabilitation for efficient and sustained agricultural production; to check/reduce the impact from floods in downstream areas; and to increase the rate of infiltration of rainwater (Gorelick & Zheng, 2015). In several river catchment areas with a common pool property such as a watershed, different land uses, the extent of land use, as well as their management plays a key role in the watershed management behaviour and functioning (Koite et al., 2013; Smith & Porter, 2010). For instance, changes in land use within the environs of the watershed greatly affect its collection capacity and runoff. However, land use seems to be correlated with the socio-economic factors of the people living within environ of a given watershed (Smith & Porter, 2010).

1.3 Statement of the Problem

The upper Ena river catchment in Embu County is an important tributary of major river Tana. However, a large part of its watershed has been degraded mainly due to lack of sound management practices by the inhabitants who live within the area (Baker et al., 2015). Many attempts by the government or NGOs to initiate management practices to the locals have had a low adoption rate mainly due to poor involvement strategies from the initial stages. For instance, attempts by both the local and national government of Kenya to train surrounding communities on sustainable watershed management practices have not been fully fruitful due to the slow pace of adoption of the practices by the communities. One good example of the attempts by the Government is the Upper

Tana Natural resource management project (UTaNRMP), which focused on supporting communities on sustainable river and watershed management practices within the protected areas, and ecosystem conservation and management. UTaNRMP also supports the Kenya Wildlife Service (KWS) in monitoring and evaluating the environmental impacts.

Community activities such as farming, or overgrazing continue to reduce the ground cover and increase soil erosion and flooding (Ngari, 2013). Such degradation leads to siltation and may cause unforeseen disasters such as flooding or desertification in addition to polluting the river. Watershed management remains key to the sustainability of the ever-increasing scarcity of water and conflict resolution among communities sharing a common pool resource such as a water catchment area (Oyama et al., 2012).

The upper Ena river catchment area is predominantly inhibited by people whose economic background is mainly agriculturally based (Wachira and Wambui, 2013). To reduce the degradation of the watershed by these groups of people, both the government and NGOs have from time to time introduced best management practices (BMPs). However, the adoption rate of these best management practices has been low. In this respect, this study wishes to contribute to literature by investigating the pathways through which economic and social factors influences the adoption of watershed management practices within the upper Ena River catchment area in Embu County.

1.4 Purpose of the Study

The purpose of the study was to assess the factors influencing the application of watershed management practices within the Upper Ena River catchment area in Embu County.

1.5 Objectives of the Study

The main objective of the study was to examine factors influencing the level of application of watershed management practices within the Upper Ena River catchment area in Embu County. The specific objectives were:

(i) To determine the influence of socio-demographic factors (age, sex, educational level and household size) on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

(ii) To evaluate the influence of collective action on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

(iii) To assess the influence of the household financial investment in practices on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

(iv) To evaluate the influence of farmer's practical knowledge on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

1.6 Research Questions

The following research questions guided this study:

(i) How does socio-demographic factors influence the intensity of application of watershed management practices in the upper Ena river catchment area?

(ii) How does collective action influence the intensity of household application of watershed management practices in upper Ena River catchment area?

(iii) How does financial investment by the households influence the intensity of application of watershed management practices in upper Ena River catchment area?

(iv) What influence does the farmer's practical knowledge have on the intensity of household application on watershed management practices in upper Ena River catchment area, Embu?

1.7 Significance of the Study

Water is an important consumable natural resource which remains highly scarce given its use for life support, economic production, aesthetical amenities as well as spiritual/cultural practice among many African communities. Moreover, it fluctuates wildly in space and time, its management is usually fragmented, and it is often subject to vague, arcane, and/or contradictory legal principles (Eriksson, (2012).

As a result, there has been increasing studies in efficient watershed management among communities living around watershed catchment areas (Oyama, Nair and Levitan 2012). However, these studies have largely ignored the role played by social and economic factors in the adoption of effective watershed management practices, yet these factors play a key role in determining land use within the watershed areas which greatly affects watershed management practices. This study intends to fill this knowledge gap by investigating the pathways through which economic and social factors influence the adoption of watershed management practices within the upper Ena River catchment area in Embu County. The study will empirically investigate the socio-economic factors influencing application of effective watershed management practices in the upper Ena River catchment area in Embu County. These factors have had little empirical work and so findings from this study will be important on several fronts: (i) to the policy makers in relevant authorities in natural resource management such as the Ministry of Environment and Natural Resources (MWNR), Water Resources Authority (WRA) and the Ministry of water and sanitation (MWS); (ii) to the county and national governments in matters of planning and policy formulation on water resources management and allocation. For example, the water Act 2016 as currently instituted has gaps that ignores the role of the local institutions when addressing the watershed management issues (Dell'Angelo et al., 2016). The study will fill these gaps by illustrating the influence of socio-economic factors in the adoption of effective watershed management practices. The findings will also increase the frontier of knowledge as a basis for further research in related areas of study.

1.8 Scope of the Study

The study is limited to Upper Ena River water catchment area hence cannot be generalized to any other water catchment area with different ecological and socio-economic characteristics.

1.9 Delimitations of the Study

The study covers the upper areas of the Ena watershed in Embu County, this is where most of the watershed degradation occurs, due to the steep slopes and the farming systems adopted by the farmers. The factors that were covered by the study were socio-demographic, farmer's knowledge of WSMP, collective action, and financial intervention, these were the factors considered to be relevant to the Ena river watershed.

1.10 Limitation of the Study

The study depended purely on empirical (primary) data collected from the field. As such, we expected that the study was to be constrained with resources such as time and money. Some enumerators faced un-cooperation of respondents or inaccessibility of some areas far away from the main all-weather road. Therefore, efforts were made to budget well and to seek permission in good time from the employer to overcome these challenges. Equally, efforts were made to recruit experienced enumerators to assist in the study. The researcher also provided reliable means of transport including motorbikes for data collection exercise where and when challenges arose.

1.11 Assumptions of the Study

This study assumed that the watershed in Upper Ena River catchment area is a common pool resource whose members had access to use and protect it from any harm that can cause pollution. The researcher also assumed that the respondents would be available to answer the questions to the best of their knowledge

1.12 Theoretical Framework

Two theories, the common property theory and the socioecological theory were used to guide this study.

1.12.1 The Common property Theory and Watershed Management

The upper Ena River catchment area remains a common property to the population around it and can be studied using the common property theory (Aquino & Garcia, 2014). Common property has a common pool characteristic which from the inside (members) can have an open access property characteristic but from the outside (non-members) has a private property characteristic. This implies that heterogeneity among the members based on the social and economic factors may lead to "tragedy of the commons."

Several literatures have laid optimal conditions under which a common property can be successfully managed (Eriksson, 2012; Baland & Platteau, 1996; Aquino & Garcia, 2014; Wade, 1988) while others have focused on determinants of sustainable governance of common property (Fenemor, et al., 2010; Agrawal, 2001). In the context of watershed management, the group's ability for an elaborate and effective self-governance matters a lot in effective management of the watershed. Factors that influence successful self-governance of common property such as a watershed include but are not limited to: shared norms of the group sharing the common pool resource; small sized groups; trust among the group members; appropriate leadership of the group; interdependency among and within the group; homogenous interest; same income level but specifically low poverty levels, and clear boundaries that are also respected by all (Fenemo et al., 2010). Most watershed characteristics are devoid of these factors explaining why, generally watersheds are challenging to manage.

1.12.2 The Social- Ecological Theory

This theory is based on the premise that the interaction between people at the personal level and environment factors determines their behaviour and tries to understand the multifaceted impact of human to the environment at the individual, community, interpersonal and organizational level (Germain and Gitterman, 1996). For instance, at the individual level, this theory describes characteristics that can influence behaviour on the interrelationship between person and the environment. These include an individual's attitude (valuation of the environment); educational level; religion; sexual orientation; financial resources; and gender as well as his/her development history among other factors.

At the interpersonal level, the person's social network as well as social support system plays a key role in his or her behaviour towards the environment around him/her. Whether these social networks are formal or informal does not matter in influencing the behaviour of the person towards the environment and they include the person's traditions; friends; co-workers for the employed persons; religious beliefs and network; family as well as his or her peers. At the community level, the interaction between the environment and the institutions, organization as well as informational networks play a key influence on how individuals behave towards the environment around them. Such include, but are not limited to, the built environment such as National parks and recreational facilities; the village associations in the community, quality management of the community leaders, business activities as well as the common mode of transportation.

Lastly, the social institutions in place play a key role in influencing the behaviour of the individuals toward their environment. For instance, the rules and regulations by such institutions influence how well the environmental services and resources should be utilized to achieve optimal extraction and sustainability. Such social organization can include states with policies and regulation that determine the interaction behaviour of the people towards the environment (Grimm et al., 2000).

1.13 Conceptual Framework

The conceptual framework showing the factors influencing the level of household application of watershed management practices in Ena River catchment was developed showing the independent, dependent and intervening variables. Four independent variables were identified for this study, this included: (i) household socio-demographic factors (age, education, household number and sex of the household head), (ii) collective action, which had two indicators household membership to groups and participation in group activities related to WSMP, (iii) household financial investment in WSMP , the indicator for this variable was the amount of money spent on WSMP, and (iv) household practical knowledge on WSMP, this variable was indicated by the level of knowledge that the household had received on WSMP from different sources, which included the government and non-governmental organizations.

The dependent variable for this study was the level of household application of WSMP on their portion of land. The WSMP considered for this study were nine and they included: (i) minimum tillage, (ii) use of mulch, (iii) contour planting of crops, (iv) planting of grass strips along the contours, (v) terracing, (vi) making contours within the farm, (vii) agroforestry, (viii) re-vegetation (planting grass and trees), (xi) managing the grazing animal and pastures (grazing management) as shown in Figure 1.1.

In conceptualizing this relationship between the independent and dependent variables, it was recognised that it could be affected by the intervening variables of culture and ethnicity a possible situation in the study area.

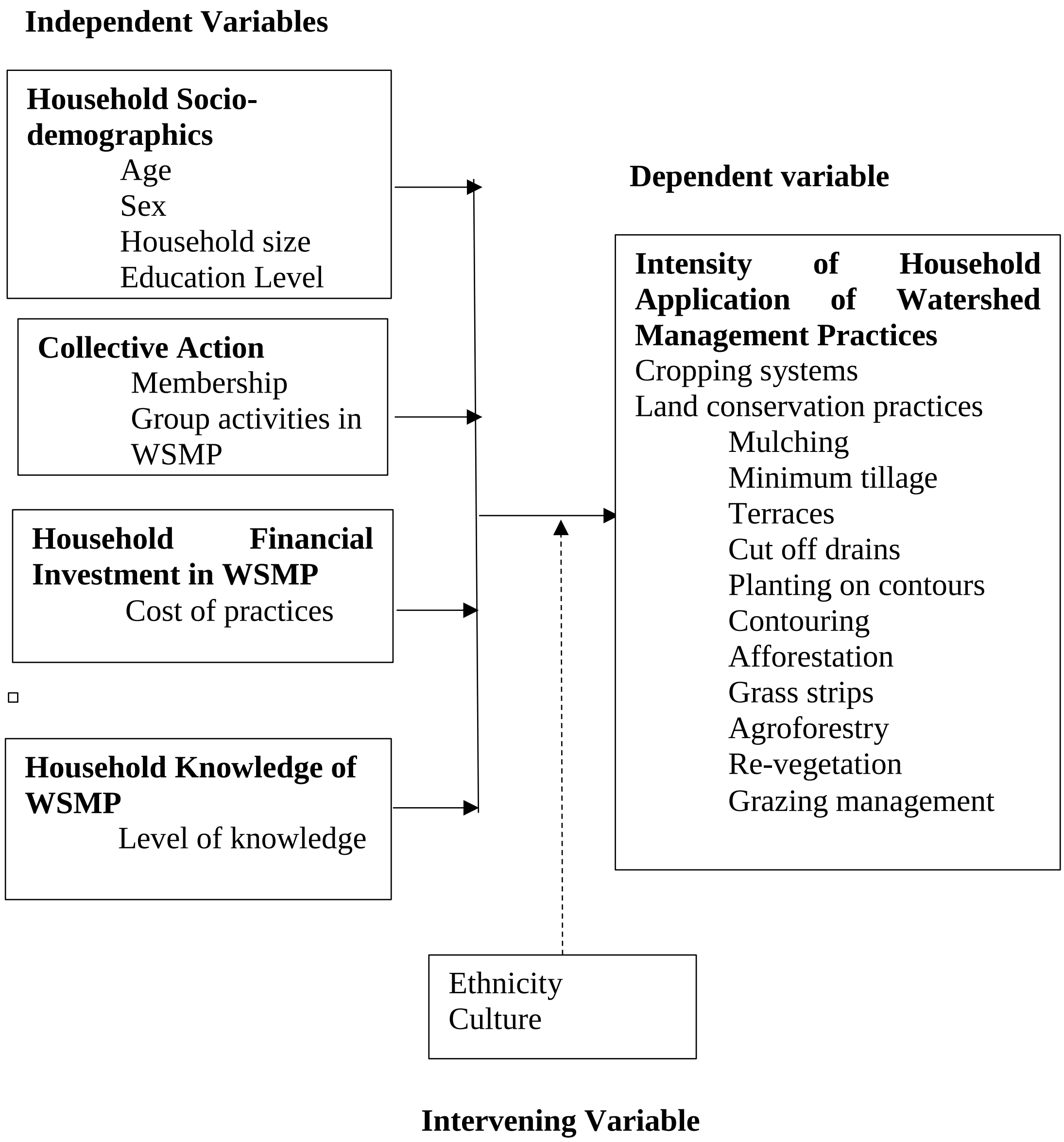


Figure 1: Conceptual framework showing the factors influencing the intensity of household application of watershed management practices in Ena River catchment

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter took a critical examination of the existing literature on the variables used in the conceptual framework, approaches and theories in watershed management practices, sociodemographic factors of the studied households, collective action, financial intervention in watershed management practices, household knowledge of watershed management practices, and the application of watershed management practices by the farmers. and finalized by giving the summary and research gap.

2.2 Watershed Management Approaches and Theories

Watershed management theories and approaches discussed include: social control theory, platforms for managing common approach, collaborative watershed management approach, holistic watershed management approach, and integrated watershed management approach.

2.2.1 Social Control Theory

Flora's (2002) model of social control applied to agroecosystem management provides a theoretical framework for assessing the factors that influence watershed management. This model links positive and negative sanctions to internal beliefs, and social, economic, and regulatory pressures. Another way to frame social-environment relations is to use community as the unit of analysis and measure residents' "sense of place." The aesthetic characteristics of "place" and respondents' responses to landscapes are key motivators for building partnerships that leverage political pressure to protect watersheds. Attachment to place is a powerful indicator of the potential intensity of residents' engagement in watershed initiatives. The community civic structure framework focuses on citizen, government and market relations, and the impacts that legal rules and social norms, communication patterns, and tolerance of differences have on policies and practices. Understandings of the variations in race, ethnicity, culture and social status, and their linkages to ecosystems can explain conflictual or cooperative relations as well as water management intervention impacts. Beliefs, values, and norms underlie individual and social responses to the environment. Knowledge of these norms provides critical explanations to why certain policies are in place and which interventions have the potential to be effective. The social science contribution must go beyond documenting socio-economic factors associated with water quality and build understandings of how social characteristics affect and are affected by the environment (Flora, 2002).

Future research must build longitudinal data bases of social, economic, and political conditions. However, selecting parsimonious indicators of critical elements will not be easy. The ideal indicator should capture the complexity of human activity, reflect changing values and norms, represent multiple view points, and predict water outcomes. This suggests that a single indicator is not sufficient. Further, multiple levels of data are needed to represent the nested scales of individual and group actions within small and large basins. Optimum levels of aggregation will vary according to the ecological system and questions asked. Indicators from individual parcels and small watersheds that are compatible with physical characteristics are not always appropriate to describe social and economic factors. A realistic goal is to identify theory-driven concepts and then develop a set of indicators. Multi-dimensional scales that represent concepts can reduce the number of indicators. The challenge is to find consensus on the appropriate concepts and indicators. The questions scientists ask are not always the same as the ones that citizens and their leaders are asking. Further, because norms and belief systems are dynamic, data that informed yesterday's questions and interventions may be irrelevant for solving future water problems.

2.2.2 Platforms for Managing Common Approach

Platforms for managing the commons 'Platforms' for analysis and negotiation have been discussed in the literature as a means to promote collective action on the commons. Steins and Edwards (1999) drew on this idea in an effort to move away from theoretical discussions about people's propensity to work collectively and toward discussions of approaches to help them do so. They produced a special journal issue to examine the use of platforms to manage complex, multiple-use common pool resources such as watersheds. They concluded that platforms have great potential to improve commons management, listing several factors that help them work.

Among the factors, group characteristics including small size, clearly defined boundaries, shared norms, trust, past successful experiences, appropriate leadership, interdependence among group members, heterogeneity of endowments but homogeneity of interests, and low levels of poverty. All of these attributes except poverty point to the advantages of working in a watershed no larger than a village, because most of these characteristics will not be found among multi-village groups. Homogeneity of interests will be difficult to achieve in most watersheds due to conflicting uses of shared water resources and upstream-downstream differences in interests. Likewise, some watershed uses are dependent on others, but dependence is not always mutual, therefore the condition of interdependence may not hold. Regarding poverty, working at a small scale makes it feasible to systematically exclude areas with high poverty rates.

The next set of conditions concerns the relationship between characteristics of the resource and the users, including overlap in location between the two, high levels of dependence by users on the resource, and sufficiently gradual demand growth and technical change to allow emerging institutional arrangements time to establish. Upstream-downstream watershed relationships sharply undermine the first of these conditions, although less so in smaller micro watersheds where at least this relationship may be perceptible and the inhabitants may know each other.

There is a long line of literature on conditions that encourage successful commons management. Wade (1988) and Ostrom (1994) offered sets of favorable conditions, and Baland and Platteau (1996) updated them. Agrawal (2001) synthesized and revised these factors, focusing on those that enable sustainable governance of the commons. For watershed projects, the key issue is a group's ability to establish a new governance system to effectively manage the watershed commons.

Almost all of these attributes present problems because they rarely characterize watershed management. For example, invisible boundaries, mobility of groundwater and surface water, unpredictability and infeasibility of improvement, and lack of traceability all pose challenges to collective action in many watershed cases. Even where some of these conditions are more favourable, mobility of water leads to an uneven distribution of benefits and costs, which raises major challenges. It is important to note that problems of mobility, clarity of boundaries, and traceability apply regardless of the scale but are mitigated somewhat in smaller watersheds.

2.2.3 Collaborative Watershed Management Approach

Collaborative watershed management has emerged in the last two decades as a promising approach to address non-point source pollution in waters. With such a wide variety of land-use patterns across watersheds, it is important that collaborative approaches to water resource management are tailored to local land-use planning efforts (Cabangon et. al, 2001) Urban and rural landscapes can have very different biological systems, leading watershed partnerships located in different areas to address different environmental issues. Moreover, collaborative management efforts in each setting can be impacted by different sets of variables, from the level of human capital (e.g., income, education) and social capital (e.g., trust, networks, norms of reciprocity) in watershed communities, to the financial, technical, and human resources made available by government agencies, NGO's, academic units, and local citizens (Hardy and Koontz, 2010).

Successful collaborative watershed management programs emphasize active stakeholder engagement, employ integrated solutions, recognize the authority of multiple agencies and jurisdictions, and build on expertise and resources across sectors. Out of bio-geophysical necessity, managing a watershed involves coordinated stewardship of the waterbody and the land area that the waterbody drains. Consequently, watershed conservation and rehabilitation is typically a function of an array of public and private programs. Representatives of local, state, and federal agencies; nonprofit group; and for-profit businesses each must bring complementary resources to the task (Golden, 1998). Ideally, collaborative watershed management refers to shared decision-making and implementation by public and private sector partners who share the common goal of conserving or enhancing hydrologic resources (Michaels, 2001).

By collaborating with local entities, states can facilitate ongoing learning; devise systems for measuring, monitoring, and evaluating; and disseminate best practices or model policies. They can actively engage in propagating local experiments. States have instrumental roles to play in achieving Dorf and Sabel's (2000) ideal of democratic experimentalism, where the deliberations and performance of one jurisdiction are considered in like jurisdictions. Since problems are encountered face-to-face at the local level, a critical function of the states is to build local collaborative, managerial, financial, and technical capacity (Cigler and Joslyn, 1998).

2.2.4 Holistic Watershed Management Approach

This approach embraces the idea that all aspects of the watershed human resources, economic development, environmental quality, infrastructure development and public safety must be considered in a holistic watershed management decision-making process. Holistic watershed management's fundament approach is in a facilitated process designed for the integration of organizations and individuals having environmental knowledge, skills and resources in the water quality and comprehensive community planning.

For instance, consider the following roles agencies could play in sustainable holistic watershed management decision-making. First, offering incentives or regulation enforcement to improve watershed environment (Water Quality to the agency representative living in the watershed experiencing a problem. Secondly, responsive agents provide technical resources as needed for sound holistic watershed management decision–making. Thirdly, stand back and let local people control the holistic watershed management planning process (Erdogan, 2003).

2.2.5 Integrated Watershed Management Approach

Previous water management efforts that were sectoral, technological and centralized have proved inadequate, because they failed to recognize and appreciate the intricacies and inter-relations of ecosystems (Pereira and Chaves (1995). Consequently, integrated watershed Management has been suggested as a solution and has been tried for decades in several countries in the world (Lant, 1999; Pereira, 1995).

An "integrated watershed management" approach should strive to create settings for collaboration and innovation by facilitating dialogue among local stakeholders. The over-riding charge under the piloting of this approach is fostering a framework for dialogue among stakeholders for problem solving examining interdisciplinary solutions that are inherently multi-objective. That is, solutions able to address more than one problem simultaneously while addressing the entire resource based on local circumstances. The Integrated Watershed Management Program proposes a framework for fostering interdisciplinary on-ground implementation activities. Interdisciplinary takes on a meaning of multiple dimensions and scales. In one instance vertical dimensions: encompassing both surface water and ground water quality at the watershed scale. In the other instance, the lateral dimension considering the varied land uses and land covers associated with agriculture, mining, and hydrologic/habitat modification activities, as well as those associated with urbanization (e.g., land development, transportation, recreation, etc.). These land uses and activities give rise to varying degrees of non-point source pollution or polluted runoff, which is the major contributor to impaired waters (National Research Council, 1999).

Over the past two decades, there have been numerous applications of integrated watershed management worldwide. For example, integrated watershed management approaches have been used for combating drought in the Jhabua watershed in India (Singh et al., 2002), assessing and managing water resources in the upper Chao Phraya in Thailand (Padma et al., 2002), assessing and managing agricultural phosphorus pollution on the Chesapeake Bay (Sharpley, 2000) and also, in the United States, the USEPA has been quite instrumental in promoting the integrated watershed approach to management (National Research Council, 1999).

The lessons learned from these and other initiatives indicate that in order to succeed, integrated watershed management must be participatory, adaptive and experimental, integrating all the relevant scientific knowledge/data and user-supplied information regarding the social, economic and environmental processes affecting natural resources at the watershed level (Steiguer et al., 2003). This is due to poor integration and coordination, which is either fostered or hindered by a complex set of environmental and socio-economic and institutional factors at various spatial levels such as legislation and regulations, policies and guidelines, administrative structures, economic and financial arrangements, political structures and processes, historical and traditional customs and values and key participants or actors, (Mitchell, 1990).

2.3 Socio-demographic Factors of the Farmers

Several Socio-demographic factors have been found to have an influence in the adoption of watershed management practices. Key among these factors include, but not limed to educational status of the household head, the gender of the household head and the age of the household head. To understand the direction of influence, the next subsection discusses them in details.

2.3.1 Age and Application of WSMP

Although the empirical studies have shown that age of the household head has an ambiguous effect on the adoption of watershed management practices among farmers, it can be hypothesized that older farmers are less likely to adopt to WSMP compared to the younger ones. For instance, according to Potter and Lobley (1992) and later by Gillespie, Kim, and Paudel (2007), as the farmer gets older, he or she is less inclined to plan over a long horizon and thus likely to give attention to WSMP. Further, as opined by Kehrig, (2002), older farmers may be less aware of the new and effective technologies used in WSMP and thus are less likely to adopt them. However, there are those of the contrary opinion that older farmers have more experience and are thus likely to adopt WSMP than their younger counterparts (Le and Beaulieu, 2005).

2.3.2 Education and Application of WSMP

The application of watershed management practices require good management and decisions making skills to obtain optimal results, it can be conjectured that education attainment of the farmers is likely to significantly influence the decision to apply WSMP (Rahelizatovo and Gillespie, 2004; Gillespie, Kim, and Paudel, 2007; Paudel et al., 2008; Ward et al., 2008). For instance, study in Iran by Bagherian et al., (2009) revealed that being aware of the benefits associated with the adoption of the WSMP led improved the relationship between farmer's attitude and their programs are perceived. That is farmers cannot be expected to exhibit positive attitudes toward watersheds if they are unaware of the benefits and cost associated with their participation. Education and knowledge about watershed management issues make people more positive in their views (Bagherian et al., 2009)

2.3.3 Sex and Application of WSMP

It is widely acknowledged that women play a key role in the collection and safeguarding of water for domestic and –in many cases – agricultural use, but that they have a much less influential role than men in management, problem analysis and in the decision-making process related to water resources (Singh, 2013).). The fact that social and cultural circumstances vary between societies suggests that the need exists to explore different mechanisms for increasing women’s access to decision-making and widening the spectrum of activities through which women can participate in watershed management. In developing the full and effective participation of women at all levels of decision-making, consideration has to be given to the way different societies assign particular social, economic and cultural roles to men and women (Eriksson, 2012). There is a need to ensure that the water sector as a whole is gender aware, a process which should begin by the implementation of training programs for water professionals and community or grass root mobilizers. In recent times rural urban migration in Kenya has been eminent in men (Geschiere and Gugler, 1998). Therefore, in most communities, women have been left behind to handle agricultural and environmental conservation issues. However, so far we do not have any government programs to empower women especially in rural set ups to carry out watershed management practices.

Equally, there is an argument that women have stronger environmental concerns then man (Zelezny, Chua, and Aldrich, 2000). Women are perhaps more concerned about the health of their family and neighbours and therefore they are potentially more inclined to adopt BMPs. However, there is little evidence to support this.8 Women make up only 4% of the primary producers in our dataset.

2.3.4 Household Number and Application of WSMP

Hypothesizing the effect of large household size on the adoption of watershed management practices remains highly controversial. Some scholars have linked household size to increase in population pressure. That is, community with large household sizes are likely to experience population pressure than a community with fewer household size. Population pressure itself has the potential of stimulating farmers to adopt water management practices so as to maintain their per capita crop production (Boserup, 2011; Geertz, 1963 and Tiffen, Motimore, and Gichuki, 1994). On the other hand, other scholars have opined that household size is directly related to debt-equity ratios (Willis, Stewart, Panuwatwanich, Williams and Hollingsworth, 2011). They argue that on average, large sized household has a high dependency ratio and thus is likely to a higher debt-equity ratio. As such they hypothesize that small sized household (implying lower debt-equity ratios) may have higher ability to afford the watershed management practices than large sized household.

2.4 Household Financial Intervention and Application of WSMP

Watershed management practices in most cases require capital. This implies that farmers have to split their scarce resources between production and purchase of the technologies for these practices making it a capital demanding exercise. Unless farmers have sufficient resources, then implementing successful WSMP becomes a great challenge. Workers (labour) will be needed for the construction of terraces, check dams, countering and given that labour remains costly, low income household earners are likely not to adopt these technologies of WSMP (Zaharia et al., 2012).

In the study area, majority of the household are subsistence farmers with little (if any) surplus to market for an income. This implies that the farmers' savings are too small to be translated into consequential investment in watershed management. In this case, these poor farmers are unable to adopt WSMP and as such farm yields are low with no or little surplus that is realized (Mautner, 2018). This translates to the farmers being trapped in a vicious cycle of poverty that impedes their watershed management effort (Seperteladze, et al., 2013).

In some economies, credit access has been seen as a possible solution to the adoption of WSMP. Agricultural credit is essential to enable farmers to adopt land management practices at least initially (Conder, Hurni, and Wolfgramm, 2013). It is possible thag poor farmers are incapable of adopting soil conservation technologies that require large capital investments. Construction costs and maintenance, materials and labour should be optimum for the adaptation of innovative technology. Despite low construction costs or labour, farmers would adopt conservation technologies only if economic returns are attractive (Mautner, 2018). Technological choice is highly dependent upon the overall cost of construction. If the initial cost is low, labour input is low, but if it requires frequent maintenance, its overall cost will be increased. Therefore, the choice of technology is such that the maintenance required should be minimum; at the same time cost of materials and labour also should be minimum (Susatyo, et al, 2017). Small farmers hesitate to adopt new technologies partly due to their suspicion about the benefits of technologies and partly due to other socio-economic constraints (Susatyo, et al, 2017).

Therefore, the net return of potential technology options should be higher than the investment in conservation measures. Using local labour and materials, job opportunities are created in the watershed. Also, increased output from crops and fodder are likely to increase their livelihood. Cost effectiveness may be achieved if the conservation measures are based on understanding a farmer's perception about soil erosion and the conditions under which they adopt and maintain conservation measures (Weekes, 2013).

The willingness of farmers to invest in land improvement; the number and proportion of participating farmers in a watershed, and the success of land management programs depends on the different conditions within the watershed (Weekes, 2013). Farmers who are most dependent on crop production for their livelihoods appear to be more willing to invest in better land management and conservation. This is usually the case in densely populated areas with a concentration of smallholdings and where land is highly valuable (Mautner, 2018)

2.5 Collective Action in Watershed Management Practices

Collective action refers to action taken together by a group of people whose goal is to enhance their condition and achieve a common objective. Collective action occurs when a number of people work together to achieve some common objective. Javernick-Will and Linden (2019) reviewed different collective action frameworks and situations they were applied to and come up with six different frameworks applied to different situations, as follows: group dynamics a framework dealing with behaviour of people in a group; collaborative governance, a framework used to explain situations, where groups collectively manage or govern a service; collaborative management and planning in natural resources, social services and infrastructural planning; collective action, a framework adapted to the context of sustainable development of water services; Learning alliances, a structured process for innovations and scale up process across different institutional levels, disciplines and actors; Platforms for partnerships, a frame work used to explain local actors and private partnerships in sustainable development. Collaborative Environmental Governance is preferred in bringing together numerous stakeholders under different political and spatial jurisdictions in managing social-ecological systems such as watersheds (Bodin, 2017).

2.5.1 Collective Action Group Membership and WSMP Practices

The adoption of WSMP by farmers can be influenced by membership to a group. Stakeholder involvement in management of watersheds enhances the use of soil and water management practices (Erdogan, 2013). That is, effective action needs to be underpinned by an understanding of the interactions between people and the environment. Experience with seven large watershed projects provides considerable insight about the needs of watershed planners, how to effectively engage them, and how to collect and integrate social data as part of watershed management. Belonging to an agro-environment club has a positive impact for most WSMP.

2.5.2 Collective Action Group Activities and Application of WSMP

Recent studies on group activity Viz adoption behaviour of watershed management practices points out that the type of approach matters most. For instance, according to the study by Campbell, Koontz and Bonnell, (2011), which aimed at comparing the rate of adoption WSMP between two groups of farmers (collaborative versus non-collaborative), found out that farmers in the watershed with the partnership were not statistically significant different in rates of best management practices adoption than farmers in the watershed with a traditional, agency-based approach encouraging adoption. However, this does not mean collaboration has no effect on WSMP adoption, as partnership participants exhibited higher levels of WSMP adoption than did nonparticipants in the same watershed. This study concludes the relationship between group activities and WSMP adoption is more appropriate for some contexts than others.

2.6 Farmer's Knowledge of Watershed Management Practices

Farmer's Knowledge can be divided into an already functioning farmers own knowledge and introduced new technologies and practices from extension or research scientists in the field (Rushemuka, Bizoza, Mowo, Bock, 2014). The introduction of new technologies and practices in integrated watershed management practices can best be done using participatory methods as was demonstrated by Liu, Abebe, McHugh, Collick, Gebrekidan, and Steenhuis (2008), where many implementing agencies, stakeholders and the community were brought together to address watershed management problems. The farmer's knowledge can be assessed using an index as demonstrated by the study of watershed farmer's knowledge on natural resource management practices (Archana, Reddy, Rao, & Vidya Sagar, 2017). In successful watershed management and changes in water quality conditions are dependent upon changes in human behaviors, therefore the human dimensions of watershed management are important especially in formulating action plans (Floress, Akamani, Halvorsen, Kozich & Davenport 2015). Farmers Knowledge determines their involved in watershed management practices, Debar and Gebretsadik (2017) found that extension and training of farmers influenced their involvement.

2.7 Watershed Management Practices

According to Adhami, Sadeghi and Sheikhmohammady (2018), Watershed Management Practices (WSMP) refers to a comprehensive collective management and conservation practices on watershed resources. Such practices include, but not limited to: cropping, terracing, contouring, contour ploughing, cut off drains; afforestation;

grass strips; agroforestry; re-vegetation; grazing management and minimum tillage. These practices do provide a framework for integrating different land-use and livelihood systems in using water as the "entry point" in the design of interventions. Watershed management practices include Best management practices (BMPs), which are alternative management options adopted by agricultural producers on or adjacent to cropped fields that conserve soil and water, prevent non-point source pollution, and improve water quality of neighbouring river systems (O'Donnell, Baffaut, Galat, 2008) Typical United States BMPs recommended for cropland have included vegetative buffer establishment at edges of fields near rivers and installation of grass waterways within fields (ibid). Implementation of BMP in agricultural landscapes improves the condition of water in rivers.

The main purpose of watershed management practices are three fold; to increase infiltration of water into the soil, increase the water holding capacity of the soil and preventing soil erosion. These purposes can be met by vegetative or agronomic measures, which include: strip cropping, pasture cropping, grassland management and maintenance of woodlands or agroforestry; engineering or structural measures: contour bunding, terracing earthen embankments, construction of check dams, construction of farm ponds, construction of diversions, rock dams, gully control structures, permanent grass and vegetation, vegetation and stone barriers and rainwater harvesting (Gharibreza & Ashraf, 2014; Mengistu & Assefa, 2019).

2.8 Watershed in Kenyan Context

Kenya's watersheds play a vital role in the four major continental (African) basins. These watersheds are: The Nile River Basin of which Lake Victoria has a significance contribution to; the Shebelli-Juba Basin of which the R. Ewaso Ng'iro has a major contribution; The Rift Valley Basin that is served by the central lakes as well as the Central East Coast Basin in which Tana River plays a key contribution (Baker et al, 2015). Water resources remain a key ingredient in a country's growth and development, whether it is an industrial based economy like many developed countries, or an agriculturally based economy like many developing nations in the Sub Sahara Africa (Sonwa et al, 2012). Kenya has for a long period relied heavily on rain-fed agriculture with a few spots of irrigation in some of her arid and semi-arid lands (ASALs). The per capita water is also diminishing at a high rate. For instance, before 1987, Kenya was meeting the globally recommended 1000 cm3 per capita (Kennish, 2002). However, due to too much pressure on this natural resource from several users as well as the climate change the country has continued to experience, the country has become a chronic water scarce with the per capita water being half of the global recommendation from 2010, as depicted in Figure 2 (Kennish, 2002).

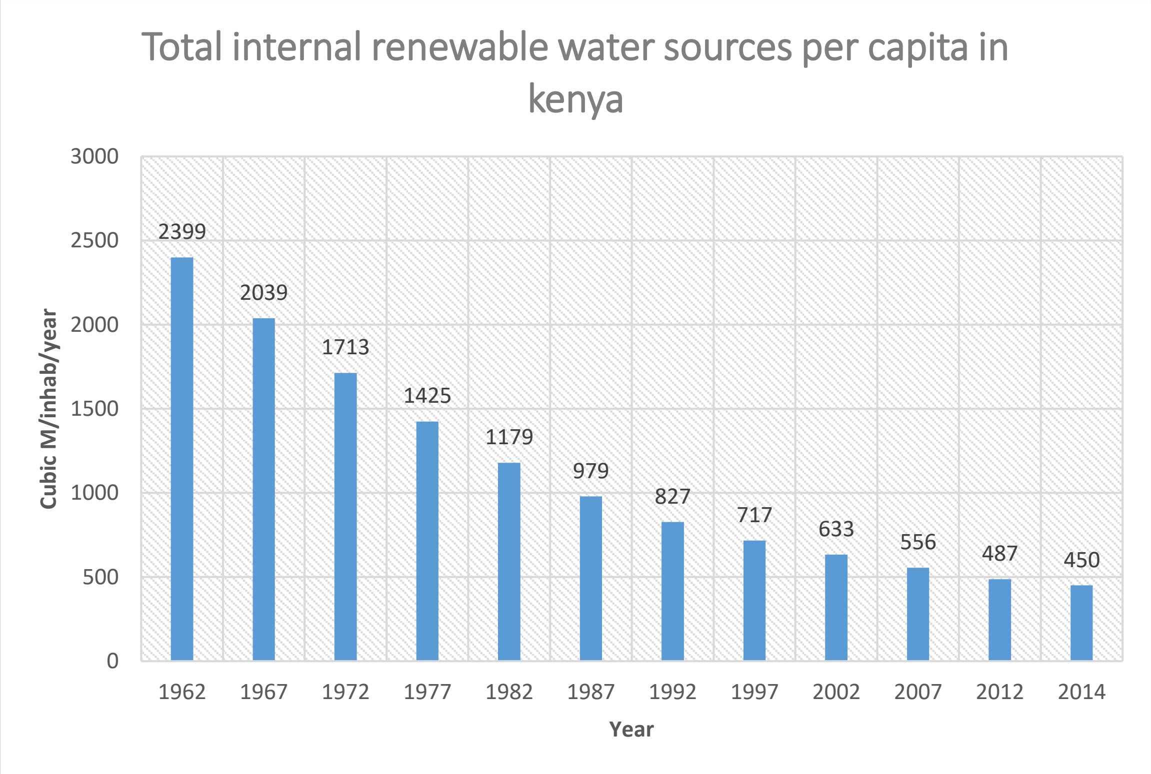


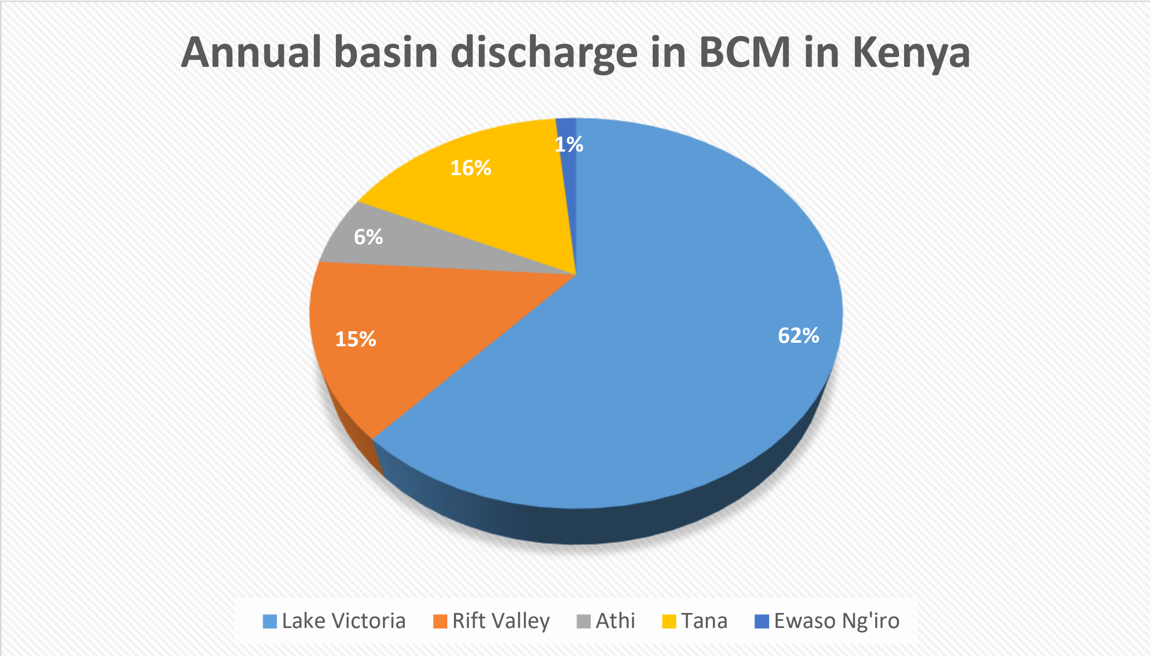
Figure 2: The total internal renewable water sources per capita in Kenya

Source: Author's computation from AQUASTAT 2018 dataset (http://www.fao.org/nr/water/aquastat/data/query/results.html)

Due to high rate of diminishing of per capita water, the SDG water stress in Kenya is on an increasing trend as shown in Graph 1. For instance, in 1990s, approximately 27% of the Kenyan population were under water stress while this has risen to 42% of the population in 2010 according to data from the AQUASTAT 2018.

Kenya's total annual basin discharge of 21.1 Billion Cubic Metres (BCM)[1] (NEMA, 2003). Lake Victoria basin has the highest basin discharge (13.80 BCM), followed by Tana basin (3.70 BCM). However, with increased economic activities along most drainage basins and watershed, the annual discharge has reduced drastically over time

(NEMA, 2003). Equally, thee has been a persistent decrease in river output per year that has been associated with decreased rainfall (resulting from either climate change or unsustainable watershed management practices on the catchments (see Figure 3).



Source: Author's computation from NEMA (2003)

Figure 3: Share of each drainage basin to the total annual basin discharge in Kenya

2.9 Tana River Drainage Basin

The basin covers approximately 126,026 km^2. According to the 1999 population census statistics, the basin was serving about 5.1 million people in its environs (KNBS, 2003). It has an annual average rainfall of 679 mm per year and a groundwater safe yield of about 431,499 m^3/day (NEMA 2013 report). Given that Tana River basin water is free of colour and turbidity, the demand for its water has been increasing, leading to the threat of its sustainability. In response, several governmental or non-governmental projects have been carried out in the area to try to reduce the depletion of water and its resources (Owuor, 2015). A good example are projects carried out by the (UTaNRMP) which aims in empowering surrounding communities to sustainable water use through mobilization and awareness, strengthening of key community structures/institutions as well as assisting in development and implementation of community action plans (Owuor, 2015).

Despite several initiatives to improve the sustainability of the Upper Tana watershed management, several obstacles exist. Most of these obstacles arise partly due to the presence of projects that focus on the short-run decision making instead of the long-run decision making among key stakeholders (Neubert, 2007). Some of the projects have also been criticized over their undermining of values and attitudes of the local community's ability, skills and intelligence in watershed management (Owuor, 2015). Lack of education, training and the strengthening of local organizations and interested parties are also some of the obstacles that hinder effective water resources management (Neubert, 2007). If these obstacles are not tackled well, overexploitation of the basin water resources (both surface and groundwater) may lead to serious risks to humanity and threats to health, social and economic wellbeing, food security, biodiversity and economic development itself (The United Nations World Water Development Report, 2015). Equally exacerbated tensions within and between various water users in different economic sectors of development have been associated with water scarcity along the Tana River drainage basin (Owuor, 2015).

Further, lack of proper ownership structure of the river has compounded its efficient management. Tana river, like other rivers in Kenya is public property owned by communities but managed by the government authority WARMA. However, the surrounding watershed is wholly owned by the community as private properties and is managed by small scale farmers (reference). Most activities of these small-scale farmers are non-sustainable (such as overstocking) and reduce water in the rivers, increase turbidity and threaten their existence (Wily, 2011; Owuor, 2015; Kamweti et al., 2009). Many attempts have been made by the government and non-governmental authorities towards management practices, but the adoption of these practices has been low. Therefore, this study seeks to assess factors that affect or influence the adoption of sustainable land management practices (Owuor, 2015).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter, the methodological approach is presented. It includes the research site, research design, target population, sampling design, data collection tools and techniques, and data analysis and presentation methods.

3.2 Research Design

The study used a descriptive research design (Kothari, 2004; Matthews & Kostelis, 2011). The descriptive survey design was chosen due to the fact that it involved an efficient method for systematic data collection from a number of individuals and also represents a variety of views (Mugenda & Mugenda, 2010). Considering the objectives of this study, a descriptive survey design was adopted. Gravertter and Forzano (2011) define a descriptive research design as that one which involves measuring a set of variables as they exist naturally. A survey is viewed as an attempt to collect data from a section of the population with the aim of determining the status of that population with respect to one or a number of variables. Through this type of design, the researcher was able to describe the attitudes, opinions, and characteristics of the population based on data collected from the study sample. The study also used inferential and descriptive analysis in analyzing for qualitative and quantitative measures among the various variables of analysis. Qualitative data is instrumental in capturing processes which otherwise may not be adequately addressed through quantitative techniques thus enhancing in-depth understanding of issues under focus. A research design is a structure that guides the execution of the research method and the subsequent analysis of acquired data (Kothari, 2004). On the same view, Matthews and Kostelis (2011) explained that a research design attempts to answer immediate questions about a current state of affairs.

3.3 Research Site

The study was carried out in Embu County. Embu County is in the former Eastern Province of Kenya. It has a total population of 516,212 (KNBS, 2010). The Population density is 183 persons per square kilometre and 40.8% of the population live below the poverty line. The county is divided into four constituencies: Siakago, Gachoka, Runyenjes, and Manyatta.

Specifically, the study location was delineated by the drainage boundaries of Ka-Ena and Kirurumwe rivers cutting across 15 sub-locations within Manyatta and Runyenjes constituencies of Embu County (as shown in Figure 4). Both Ka-Ena and Kirurumwe rivers join to form Ena River which is a major tributary of Tana River.

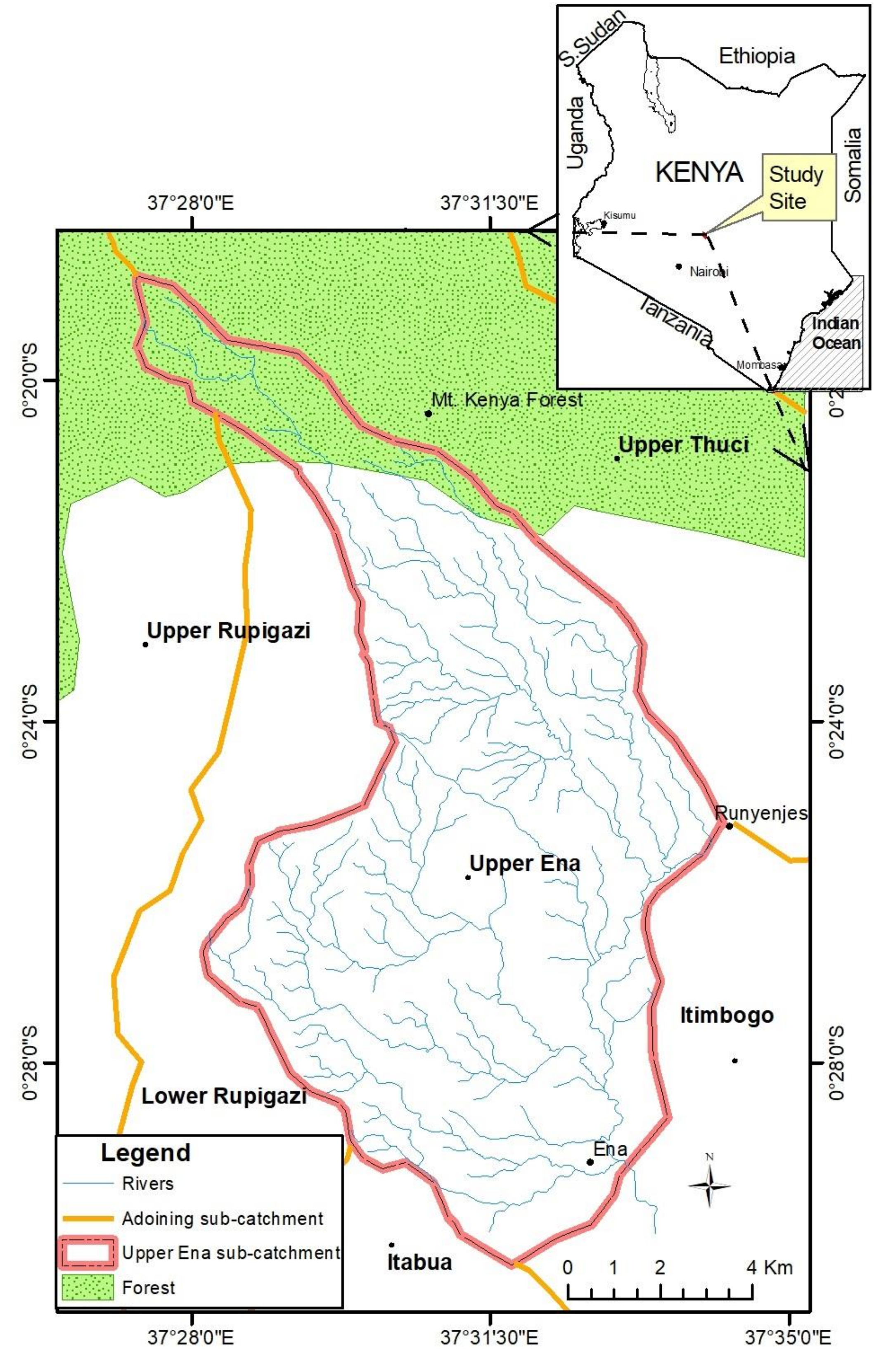


Figure 4: Upper Ena River Sub-catchment Area

3.4 Target Population

The study targeted about 58,449 people (KNBS, 2019), whose livelihoods revolve around the use of the natural resources of Upper Ena River catchment area.

3.5 Sampling Design

The study used a stratified random sampling design. The study area was divided into three portions or stratum: the upper Ena River, the middle Ena River and the lower Ena River. In each of the strata the households were selected at random, where each member of the population had an equal chance of being included in the sample. This is where each household to participate in the study was chosen entirely by chance. The feasible sample was determined by the availability of resources: time, manpower, transport, and money. Kothari (2003) further pointed out that a small sample could be adopted if the population is homogeneous while a larger sample will be required when the population is heterogeneous.

3.5.1 Sample Size

A sample is a set of data collected and / or selected from a statistical population by a defined procedure for study. A sample usually represents the characteristics of the population. According to Taena, Kolopaking, Juanda, Barus, and Boer (2016), the eventual size is normally a compromise between what is desirable and what is feasible. In order to determine the sample size, the study adopts the following formula (Creative Research Systems, 2012).

$$Sample\ Size = \frac{\frac{Z^2\ X\ P(1-P)}{e^2}}{1 + \left(\frac{Z^2\ X\ P(1-P)}{e^2 N}\right)}$$

The calculation to determine the sample size for this study assumed a confidence level of 95%. Where the Z-score (Z) used is 1.96, the margin of error (e), 0.05, the distribution (P) is 0.5, and the population size (N). Given the target Population size (N) as 58,449, the sample population is calculated as follows:

$$Sample\ Size = \frac{\dfrac{1.96^2\ X\ 0.5(1-0.5)}{0.05^2}}{1+\left(\dfrac{1.96^2\ X\ 0.5(1-0.5)}{0.05^2 X 58{,}449}\right)}$$

$n = 384$

The sample size for the study was 384 people. In order to have a proportional and representative sample size keeping in mind the available resources and time, the number of respondents were distributed across the 15 sub locations with reference to the average 2019 projected population data per sub location as indicated on Table 1.

Table 1: Projected Population per Sub-location and the Number of Samples

	2019 projected population range		**Average 2019 projected population**	**Sample distribution factor**	**Sample size / sub location**
Sub-location	**Min.**	**Max.**			
Kavutiri	4883	5129	5,006	0.01	33
Kianjuki	5130	6814	5,972	0.01	39
Manyatta	2884	3985	3,435	0.01	23
Kamviu	2884	3985	3,435	0.01	23
Kirigi	952	1992	1,472	0.01	10
Kevote	6815	9946	8,381	0.01	55
Makengi	6815	9946	8,381	0.01	55
Nembure	5130	6814	5,972	0.01	39
Gatunduri	952	1992	1,472	0.01	10
Ena East	3986	4882	4,434	0.01	29
Ena West	1993	2883	2,438	0.01	16
Kithimu	1993	2883	2,438	0.01	16
Kithegi	466	951	709	0.01	5
Kawanjara	952	1992	1,472	0.01	10
Gikuuri	2884	3985	3,435	0.01	23
Total			**58,449**		**384**

To address the objectives of the study, the sample members who were selected had a special relationship with the phenomenon that was being investigated. The study adopted systematic random sampling in selecting the main respondents for interviewing.

3.6 Data collection

This section of the thesis deals with issues related to data collection in the field, it includes: data collection instruments, reliability and the validity of instruments.

3.6.1 Data Collection Instruments

The researcher used a structured interview schedule as the primary tool for data collection. According to Kothari (2014), questionnaires capture information in a structured manner, it is less costly and easy to administer. The questionnaire is structured and organized according to the key thematic areas corresponding to specific objectives of the study (such as general information; social factors; collective action; economic condition of the household and knowledge of practice). Additionally, the questionnaire contains open and closed-ended questions with a view not only to get a factual aspect of the responses but also the opinion of the respondents about the subject matter.

3.6.2 Instrument Reliability

Instrument Reliability is defined as the extent to which an instrument consistently measures what it is supposed to measure. Reliability concerns the degree to which the scores are free from random measurement errors. . The researcher carried out a pilot-testing on a small sample of respondents outside the target population. According to Stangor (2010), pilot-testing involves trying out a questionnaire on a small group of individuals to get an idea of how they react to it before the final version is created. Pilot testing enabled the researcher to fine-tune the questionnaire for objectivity and efficiency of the process. Cronbach's alpha was used to estimate internal consistency reliability by determining how items of the instrument related to each other and to the entire instrument. A Cronbach's alpha of 0.7 is enough to confirm whether variables are reliable (Sekaran & Bougie, 2009). Field (2009) argues that a Cronbach's alpha value equal or greater than 0.5 is regarded to be an indication of reliability. Therefore, the researcher considered a coefficient alpha greater than 0.5 to indicate the reliability of the research instrument.

3.6.3 Instrument Validity

In most cases in data collection, errors usually arise from such factors as, inaccurate data coding, ambiguous instructions to the respondents, interviewers and interviewees fatigue and bias. To address that problem, the questionnaire used simple words and short sentences which were easy to understand and comprehend.

3.7 Data Collection Procedure

Data collection procedure refers to the means by which the researcher uses to gather the required data and information. The study used primary data which was collected using well-structured questionnaire. Prior to data collection exercise, the enumerators were trained on the procedures, which happened during the pilot exercise. Care and control was taken by the researcher to ensure that all the questionnaires issued to the respondents were received. To achieve this, the researcher maintained a register of questionnaires which were given to the enumerators and received back.

3.8 Data Analysis

Data analysis for this study was done in accordance with constant comparative methods suggested by Susatyo, Marsono, Kusumandari, & Supriyanto (2017). This implies that the formal analysis commenced early in the study at data collection stage. The study used overall multi-dimensional methods towards each factor, descriptive statistics, regression statistics, nonparametric tests and parametric tests.

Tabulation and chart were presented to show a comparison between the various categories. Multiple regression analysis was carried out to measure the impact of the relationship between the variables.

3.9 Legal and Ethical Consideration

According to Rao and Gupta (2014). Ethical research is considered as one that does not harm and gives informed consent and respects the rights of individuals being studied. The study considered ethical issues in each and every part of the research process. This study sought a research permit from the National Commission for Science Technology and Innovation (NACOSTI) and other relevant ethical permits from the chief and *"Nyumba kumi"* initiatives.

The researcher duly informed the respondents in the study that their participation was voluntary and that they were free to omit answers to any particular questions if they felt to do so. This is in line with Trochim (2006) who argued that voluntary participation requires that respondents in the study are not coerced into participating in the research. Jwan and Ong'ondo (2011) trigger an argument on whether the researcher should make any sort of payment or reward to the participants. They concluded that the participants should not be induced into participating. In this case, participants consent will be sought without promising them anything in return.

The researcher also assured and protected the confidentiality and identity of the respondents. This is noted by Punch (2003) who alluded that the participants should remain anonymous throughout the study. This is in line with a commitment to minimizing the risks associated with research, including psychological and social risks and maximizing the benefits that accrue to research participants

Justice is another ethical consideration that requires a commitment to ensuring a fair distribution of the risks and benefits resulting from research. To achieve justice, there was equal participation from numerous contributors to the research questions. Those who took on the burden of research participation shared in the benefits of the knowledge gained, (Ellis-Barton 2016). For this reason, the findings of the study were disseminated back to the community through local administration channels and will be shared with the scientific community through publications.

Table 2: Summary of Data Analysis and Statistical Tools

Objectives		**Variables**	**Method of Data analysis**
(i)	Determine the influence of socio-demographic factors on the household intensity of application of watershed management practices in upper Ena River catchment area, Embu	Independent variable: Age, Education, Sex, Income Number in household Dependent: intensity of application of watershed management practices	Descriptive statistics ANOVA
(ii)	Determine the influence of collective action on the household intensity of application of watershed management practices in upper Ena River catchment area, Embu	Independent variable: Group membership, Group activities Dependent: intensity of application of watershed management practices	Descriptive statistics ANOVA
(iii)	Determine the influence of financial capital spent on the household intensity of application of watershed management practices in upper Ena River catchment area, Embu	Independent variable: Affordability, Empowerment, Cost of practices Dependent: intensity of application of watershed management practices	Descriptive statistics Linear regression
(iv)	Determine the influence of practical knowledge on the household intensity of application of watershed management practices in upper Ena River catchment area, Embu	Independent variable: Level, Training Dependent: intensity of application watershed management practices	Descriptive statistics Linear regression

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.1 Introduction

This chapter presents the data and analyses the data and interprets the results of the study. The chapter is divided into eight sections as follows: (i) response rate, (ii) respondents demographic information, (iii) land use system, (iv) intensity of household application of WSMP in Ena river catchment, (v) influence of socio-demographic factors on level of household application of WSMP, (vi) influence of farmers collective action on intensity of household application of WSMP, (vii) influence of financial investment on intensity of household application of WSMP, and (viii) influence of farmers practical knowledge on intensity of household application of WSMP.

4.2 Response Rate

The study targeted a sample size of 384 residents spread in the 15 sub-location of the upper Ena River catchment area, Embu. However, only 383 respondents representing 99.74% were available for interview while the remaining 0.26% respondents declined to be interviewed for personal reasons. According to both Mugenda and Mugenda (2003) and Dixon (2012), this study's response rate is acceptable since it was above 50%, threshold for adequate response rate. Thus, it can provide a basis for statistical analysis which is presented in subsequent subsections.

4.3 Respondents' Demographic Information

Given the descriptive sampling design the study adopted, the respondent's demographic information was undertaken in order to understand their unique characteristic. Some of the key aspects considered important in this study on the household head include age, highest educational level attained, occupation status, marital status and household number. They are presented and analysed in the subsequent sub-titles under this section.

4.3.1 Age of Household Head

The respondents were asked to state their age or the year they were born the data was then categorised into five categories as follows: 20-30, 31-40, 41-50, 51-60, above 61 years old. The descriptive statistics and frequency distributions of the age are given in Table 3.

Table 3
Descriptive Statistics and Frequency Distribution for Age of the Household Head

Age Categories	Frequency	Percent
Below 30	8	2.1
31-40	82	21.4
41-50	158	41.1
51-60	112	29.2
61 and Above	24	6.3
Total	384	100.0

Mean 48±.46, Median 48, Mode 43, Std dev 9.06, Minimum 29, Maximum 72

The mean age of the household head in the study area was approximately 48 years old with a standard deviation of 9.08. The study data revealed that the oldest household head in the study area was 72 years old while the youngest was 29 years old.

A chi-square test for equality of categories of the age groups was conducted and the results are shown in Table 4.

Table 4: Chi-square test for Equality of Categories for the Age Groups

Household Head's Age Categories	Observed N	Expected N	Residual	Statistics
Below 30	8	76.8	-68.8	χ^2= 200.27
31-40	82	76.8	5.2	*df*=4
41-50	158	76.8	81.2	*p*< .001
51-60	112	76.8	35.2	
Above 60	24	76.8	-52.8	
Total	384			

The chi-square test revealed a statistical (*p* <-001) significant differences among the different household head age categories. The category with 41 to 50 years was significantly (χ^2= 200.27, *df* 4, *p* < .001) higher than the other categories, indicating that the majority of the household heads within the Ena catchment were from this category.

4.3.2 Sex of the Household Head

The gender of the household head was noted during the household survey and the frequency distribution of the data was analysed and is given in Table 5.

Table 5: Sex of the Household Head

Sex	Frequency	Percent
Male	271	70.6
Female	113	29.4
Total	384	100.0

The majority (70.6 %) of the household heads were male, while 29.4 % were female.

4.3.3 Highest level of Formal Education Attained by the Household Head

The educational status of the household head is key in decision making process in the household. In this regard, this study sought to establish the status of the education of all household heads in the study area. The frequency distribution of the data is shown in Table 6

Table 6: Household Heads Level of Formal Education

Level of Formal Education	Frequency	Percent
Never attended School	158	41.1
Primary	47	12.3
Secondary	47	12.2
College	89	23.2
Undergraduate	24	6.3
Graduate	19	4.9
Total	384	100.0

The majority (58.9 %) of the household heads had attained some form of formal schooling, while 41.1 % had not attended any formal type of education.

4.3.4 Household Size

The number of people living in each household was determined by asking the respondents to state the number. The information was then analysed and is presented in Table 7.

Table 7: Number of People Living in the Household in Ena Catchment

Number	Frequency	Percent
2	20	5.2
3	55	14.3
4	101	26.3
5	189	49.2
6	2	0.5
7	6	1.6
8	8	2.1
9	1	0.3
10	2	0.5
Total	384	100.0

Mean 4, Median 5, Mode 2, Std dev 1.18, Minimum 2, Maximum 10

The majority (75. 5 %) of the households within the Ena catchment had between 4 and 5 people living within their household.

4.3.5 Occupation of the Respondents

In this subsection, we explored the occupation of household heads in the study area. The main occupational status of the household head was established by asking the respondents. The frequency distribution of the household head occupation is given in Table 8.

Table 8: Occupation of the Household Head

Occupation	Frequency	Percent
Farming	207	53.9
Driver	68	17.7
Teaching	47	12.2
Business	39	10.2
Civil Servant	23	6.0
Total	384	100.0

The majority (53.9 %) of the respondents were farmers engaged in their farms within the Ena watershed, the rest of the households even though had farms within the watershed had other sources of income such as drivers (17.7 %), teachers (12.2 %), business (10.2 %), and civil servants (6 %).

4.3.6 Household Access to Finances

The household access to finances was determined by asking the household heads to state if they had received any finances, which they used in watershed management practices, the data was then analysed and the frequency distribution is shown in Table 9.

Table 9: Household Access to Credit

	Frequency	Percent
Accessed Credit	112	29.2
Did Not Access Credit	272	70.8
Total	384	100.0

The majority (70.8 %) of the households had not acquired credit, while 29.2 % had.

4.4 Land Use System

The land use system of the Ena catmint was described using land tenure, land size, crop production and livestock numbers.

4.4.1 Land Tenure

In regard to land tenure, the study established through inquiring from the household heads the type of land ownership they had. This was considered important to study as research has showed that farmers with permanent land ownership tended to invest more on land management practices. The data was analysed and the frequency distribution is given in Table 10.

Table 10: Status of Land Tenure

Land Tenure	Frequency	Percent (%)
Owned Without Title	232	60.4
Owned With Title	136	35.4
Borrowed	12	3.1
Rented	4	1.0
Total	384	100.0

The majority (60.4 %) of the respondents owned land but did not have a legal document to back their claim. However, approximately 35.4% of the respondents were found to own land and had a title deed to back their claim of ownership. A respective 3.1 % had borrowed the land while 1% of the respondents had rented their land in the study area.

4.4.2 Land Size Owned by Households in the Ena Catchment

The size of land owned by the households within the Ena river catchment was determined by asking the household head to state the size of land they owned, the data was analysed and the frequency distribution is shown in Table 11.

Table 11: Land Size Owned By the Households

	Frequency	Percent
1.0	67	17.4
1.10	16	4.2
1.20	41	10.7
1.30	32	8.3
1.40	5	1.3
1.50	46	12.0
1.60	17	4.4
1.70	32	8.3
1.90	31	8.1
2.00	14	3.6
3.00	37	9.6
5.00	24	6.3
6.00	17	4.4
7.00	5	1.3
Total	384	100.0

Mean 2.05±.07, Median 1.5, Mode 1.0, Std. dev 1.44, Min 1, Max 7.

Household land sizes within the Ena river catchment ranged between 1 and 7 acres, with a mean of 2.05 acres.

4.4.3 Crop Production

Four crops were found to be common within the Ena river catchment, they included maize, rice, cassava, bananas and other crops such as beans. The particulars for the different crops are shown in Table 12.

Table 12: Land Sizes for Different Crops

Crop	Average Area Acres	Minimum	Maximum	Std. dev
Maize	0.692	1	1.7	.316
Cassava	0.679	1	1.7	.309
Rice	0.645	1	1.7	.278
Banana	0.643	1	1.7	.273
Other crops	0.640	1	1.7	.268

Four main crops were found to be common in the farmers farms, they included: maize, cassava, rice, banana, and other crops.

4.4.4 Livestock Production

The area allocated to the different animal species is given in Table 13

Table 13: Livestock Species

Livestock	Average Area Acres	Minimum	Maximum	Std. dev
Chicken	0.641	1	1.7	.269
Beef Cattle	0.801	1	38.46	2.13
Dairy cattle	0.752	1	1.7	1.952
Pigs	0.684	1	1.7	.311
Sheep and Goats	.686	1	1.7	.311

Four livestock species were kept by farmers in the Ena river catchment, they included: beef and dairy cattle, sheep and goats, pigs and poultry.

4.5 Household Intensity of Application of WSMP in Ena River Catchment

The dependent variable for this study was the intensity of household application of watershed management practices within the Ena watershed. The variable was operationalized as an index, which combined two main indicators application and extent of household application of watershed management practices.

The study considered nine (9) watershed management practices common within the Ena watershed which are considered to aid in maintaining the integrity of the land resources within the watershed. The management practices included the following; (i) minimum tillage, (ii) use of mulch, (iii) contour planting of crops, (iv) planting of grass strips along the contours, (v) terracing, (vi) making contours within the farm, (vii) agroforestry, (viii) re-vegetation (planting grass and trees), (xi) managing the grazing animal and pastures (grazing management).

The intensity of application of the practices by the households was measured as a dummy variable (or a 0, 1 variable), where a farmer who was applying a given WSMP was given a score of one, while a household that was not practising a given practice was given a score of a zero (0). The scores were then added to form the indicator of WSMP application by the household. The extent of household application of WSMP was measured using a 3-score variable; with 0 indicating zero extent, 1 low extent and 2 high extent. The two indicators were then combined to form the index of the intensity of household application of WSMP within the Ena catchment.

The resulting index was grouped into categories and the descriptive statistics and frequency distribution are shown in Table 14.

Table 14: Intensity of Household Application of WSMP in Ena River Catchment

Categories	Frequency	Percent
0 (Extremely Low)	25	6.5
1-5 (Very Low)	13	3.4
6-11 (Low)	68	17.7
12-17 (Moderate)	107	27.9
18-23 (High)	116	30.2
24-30 (Very High)	55	14.3
Total	384	100.0

Mean 16±.39, median 15, mode 22, Std. dev 7.65, minimum 0, and maximum 28

The results in Table 14 indicate that the mean of the level of household participation in watershed management practices as 16 on a scale of 0 to 30. The majority (54.5 %) of the farmers had a level of participation between high and very high.

A chi-square test for equality of categories for the intensity of household application of WSMP was conducted and the results are shown in Table 15.

Table 15: Chi-square Test for the Equality of Categories for the Household Intensity of Application of WSMP

Categories	Observed N	Expected N	Residual	Statistics
0 (Extremely Low)	25	64.0	-39.0	χ^2=137.06
1-5 (Very Low)	13	64.0	-51.0	*df*=5
6-11 (Low)	68	64.0	4.0	*p*<.001
12-17 (Moderate)	107	64.0	43.0	
18-23 (High)	116	64.0	52.0	
24-30 (Very High)	55	64.0	-9.0	
Total	384			

The chi-square test revealed a statistical ($p < .001$) significant differences among the different categories of household participation. The category of high (18-23) was significantly (χ^2=137.06, $df = 5$, $p < .001$) higher than the other categories, indicating that the majority of the households had a high intensity of application of watershed management practices.

4.6 Influence of Household Socio-demographic Factors on the Intensity of Household Application of Watershed Management Practices

The first objective of this study was to determine the influence of socio-demographic factors (age, sex, household size education) on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County

4.6.1 Influence of Age, Formal Education Levels and Household Size on the Intensity of Application in WSMP

The three independent variables: age, formal education levels and household size are discussed in section 4.3 in this thesis.

The influence of age, formal education levels and household size (independent variables) on the level of household application of WSMP (dependent variable) was determined by use of simple linear regression. The results of the regression model are presented in Table 16.

Table 16: Regression Model Summary for Age, Education and Household Size and the Intensity of Household Application of WSMP

R	R Square	Adjusted R Square	Std. Error of the Estimate
.079[a]	.006	-.002	7.67417

Predictors (constant) Age, education, household size
Dependent: Intensity of Household Application of WSMP

The model indicates an adjusted R^2 value of -.002; this means that the independent variables age, education and household size explained approximately negative .02 % of the variation in the dependent variable level of household application of WSMP, which was very low. The F test for the regression model is shown in the ANOVA Table 17.

Table 17: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p
Regression	139.982	3	46.661	.792	.499[b]
Residual	22320.431	379	58.893		
Total	22460.413	382			

The overall regression model was found to be non-significant (F (3, 379) = .792, *p*=.499). The regression coefficients of the model showing the beta, t statistics and the collinearity statics are shown in Table 18.

Table 18: Regression Coefficients for Age, Education, Household Size and Intensity of Application of WSMP

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p.	VIF
(Constant)	15.764	2.476		6.366	.000	
Formal Education	.302	.249	.063	1.216	.225	
Household size	.229	.333	.035	.688	.492	
Age	-.033	.044	-.039	-.764	.445	1.000

The regression analysis shows that the three independent variables had no significant influence on the level of household application of WSMP within the Ena river catchment. The results indicate that age (β= -.039, *t*= -.764, *p* = .445), household size (β= .035, *t*= -.668, *p* = .492) and formal education (β= -.063, *t*= 1.216, *p* = .225) non-significant influence on the intensity of household application of WSMP. It therefore be concluded that they had no influence on the dependent variable.

4.6.2 Determination of the Influence of Farmers Sex on Application of WSMP

The data was analysed to determine the means of male and female headed household's intensity of application of watershed management practices within the Ena River and the results are shown in Table 19.

Table 19: Means of Male and Female Headed Households Application of WSMP

Sex	n	Mean	Std. Deviation	Std. Error Mean
Male	271	15.8155	7.74520	.47049
Female	113	16.2832	7.47313	.70301

The mean of household application of WSMP for the male headed households was lower (15.8) than for the female headed households (16.2). The t-test for the distribution of the households and the *Levene's Test* for Equality of Variances is shown in Table 20.

Table 20: Mean Comparison between the Male and Female Headed Households

	Levene's Test		*t*-test for Equality of Means			
	F	*p*	*t*	*df*	*p*	*Difference*
Equal variances assumed	.305	.581	-.545	382	.586	-.46769
Equal variances not assumed			-.553	216.757	.581	-.46769

The intensity of application in watershed management practices for both the male and female headed households was statistically (t=-.545, df= 382, p=586) not different form each other. This means that the intensity of household application of WSMP was not influenced by the sex of the household head.

4.7 Influence of Collective Action on the Intensity of Household Application of Watershed Management Practices

The second objective of this study was to evaluate the influence of collective action on the intensity of household participation in watershed management practices in upper Ena River catchment, Embu County.

4.7.1 Household Involvement in Collective Action

The independent variable household involvement in collective action was defined as the household involvement in collective action related to watershed management practices. Many WSMP are labour intensive and groups are used to provide this labour. The variable was developed as an index that involved two indicators household membership to collective action groups involved in WSMP and the participation in group activities involved in WSMP.

The variable was assessed as a dummy variable or 0,1 variable; the household heads were asked to state their use of collective action on the nine watershed management indicators used in this study, which included: mulching, minimum tillage, contour farming, terraces, afforestation, grass strips, cut off drains, and agroforestry. A score of one (1) was assigned to any positive response and a score of zero (0) was assigned to any negative response. The scores were then summed up to form the index of Collective action. The descriptive statistics and frequency distribution of the index is shown in Table 21.

Table 21: Descriptive Statistics and Frequency Distribution of the Collective Action Index

Scores	Frequency	Percent
.00	41	10.7
1.00	21	5.5
2.00	27	7.0
3.00	27	7.0
4.00	38	9.9
5.00	49	12.8
6.00	82	21.4
7.00	55	14.3
8.00	28	7.3
9.00	16	4.2
Total	384	100.0

Mean 4.68±.13, median 5, mode 6, Std. dev 2.56, minimum 0, maximum 9

The index ranged between 1 and 9 and had a mean of 4.68.

4.7.2 Influence of Collective Action on the Intensity of Application of WSMP

The influence of farmer's collective action (CA) on the level of household application of watershed management practices within the Ena river catchment was determined by the use of simple linear regression. The farmer's collective action was the independent variable, while the intensity of household application in WSMP was the dependent variable. The results of the regression model are presented in Table 22.

Table 22: Regression Model Summary for Farmers Collective Action and Intensity of Household Application of WSMP

R	R Square	Adjusted R Square	Std. Error of the Estimate
.941[a]	.885	.884	2.60464

Predictors (constant): Farmers Collective Action
Dependent: Intensity of Household Application of WSMP

The model indicates an adjusted R^2 value of 0.884, this means that the independent variable farmer's collective action explained approximately 88 % of the variation in dependent variable intensity of household application of watershed management practices. The F test for the regression model is shown in Table 23.

Table 23: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	*Mean Square*	*F*	*p*
Regression	19877.612	1	19877.612	2930.009	.001[b]
Residual	2591.544	382	6.784		
Total	22469.156	383			

The overall regression model was found to be significant (F (1, 382) =2930.0, p <. 001).

The regression coefficient of the model showing the *beta, t* statistics and the collinearity statistics is shown in Table 24.

Table 24: Regression Coefficients for Farmers Collective action and Intensity of Household Application of WSMP

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	Beta	t	p	VIF
(Constant)	2.806	.277		10.134	.001	
Collective Action	2.808	.052	.941	54.130	.001	1.000

The regression analysis shows that farmers collective action has positive significant influence (β=.941, t=54.13, p<.001) on the level of household application of WSMP in Ena river catchment. This indicates that as the farmer's collective action increases it increases the intensity of household application of WSMP.

4.8 Influence of Household Financial Investment on the Intensity of Household Application of Watershed Management Practices

The third objective of this study was to assess the influence of the household financial investment on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

4.8.1 Household Financial Investment in Watershed Management Practices

Household financial investment in watershed management practices was defined as the capacity of the household to undertake and pay for the practices related to watershed management. All the activities have a cost in terms of equipment purchase and labour. The variable was assessed by asking the farmers the amount of money they spent on watershed management practices. The total amount was summarised and the descriptive statistics and frequency distributions is shown in Table 25

Table 25: Descriptive Statistics and Frequency Distributions of the Financial Investment in WSMP by the Households within the Ena Catchment

Amount Spent in K.Shs.	Frequency	Percent
Below 10,000	76	19.8
11,000-20,000	41	10.7
21,000-30,000	127	33.1
31,000-40,000	92	24.0
41,000-50,000	48	12.5
Total	384	100.0

Mean 25,260±688, median 26,000, mode 0, Std. dev 13,498, min 0 max 50,000

The amount of money invested by the farmers on WSMP had a mean of K.Shs 25,260 and varied between K.Shs 10,000 and 50,000. The chi-square test for the equality of categories was done and the results are shown in Table 26.

Table 26: Chi-square test for the Equality of Categories of the Financial Investment in WSMP

	Observed N	Expected N	Residual	
Below 10,000	76	76.8	-.8	χ^2=63.318
11,000-20,000	41	76.8	-35.8	4
21,000-30,000	127	76.8	50.2	p<.001
31,000-40,000	92	76.8	15.2	
41,000-50,000	48	76.8	-28.8	
Total	384			

The chi-square test revealed a statistically (p<.001) significant differences among the different categories of the farmers investments in watershed management practices. The category of between K.Shs 21,000 -30,000 was significantly (χ^2=63.318, df= 4, p<.001) higher than the other categories, indicating that the majority of the farmers in the Ena river catchment spent between K.Shs. 21,000 and 30,000 on WSMP.

4.8.2 Influence of Farmers Financial Investment in WSMP and the Intensity of Household Application of WSMP

The influence of farmer's financial investment on the intensity of household application of WSMP was determined by the use of bivariate linear regression. The independent variable was amount of farmer's financial investment and the dependent variable was the level of household application of WSMP. The results of the regression model are presented in Table 27.

Table 27: Regression Model Summary for Farmers Financial Investment in WSMP and Intensity of Household Application of WSMP

R	R Square	Adjusted R Square	Std. Error of the Estimate
.835[a]	.697	.697	4.21819

Predictors (constant) farmers financial investment in WSMP
Dependent: intensity of household application of WSMP

The model indicates an adjusted R^2 value of 0.697, this means that the independent variable farmer's financial investment in WSMP explained approximately 70 % of the variation in dependent variable intensity of household application of watershed management practices. The F test for the regression model is shown in Table 28.

Table 28: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	df	Mean Square	F	p.
Regression	15672.192	1	15672.192	880.802	.001[b]
Residual	6796.964	382	17.793		
Total	22469.156	383			

The overall regression model was found to be significant ($F(1, 382) = 880.80$, $p <. 001$). The regression coefficient of the model showing the *beta, t* statistics and the collinearity statistics is shown in Table 29.

Table 29: Regression Coefficient for Farmers Financial Investment in WSMP and Intensity of Household Application of WSMP

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	p
(Constant)	5.201	.421		12.343	.001
Investment	.000	.000	.835	29.678	.001

The regression analysis shows that farmers financial investment in WSMP has positive significant influence (β=.835, t=29.67, p<.001) on the intensity of household application of WSMP in Ena river catchment. This indicates that as the farmer's investment in WSMP increases the intensity of household application of WSMP increases also.

4.9 Influence of Farmers Practical Knowledge on the Intensity of Household Application of Watershed Management Practices

The fourth objective of this study was to evaluate the influence of farmer's practical knowledge on the intensity of household application of watershed management practices in upper Ena River catchment, Embu County.

4.9.1 Farmers Practical Knowledge in Watershed Management Practices

The independent variable, farmer's practical knowledge on watershed management was operationalized as an index that combined the rating of the nine indicators of watershed management used in this study. The farmers self-rated their level of knowledge for the nine indicators of the watershed management practices on a 5-point rating scale. The rating was quantified as follows: Very Low knowledge as 1, Low knowledge as 2, Moderate knowledge as 3, High knowledge as 4 and Very High knowledge as 5. The descriptive statistics of the rating for the indicators is shown on Table 30.

Table 30: Descriptive Statistics for Farmers Knowledge of WSMP Indicators

	Farmers Rating				
Practices	Mean	Median	Mode	Range	Std. dev
Cut off drains	4.82	5	5	1	.382
Agroforestry	3.52	4	5	4	1.614
Contours farming	3.56	4	5	4	1.615
Grass strips	3.51	4	5	4	1.591
Contouring	3.44	4	5	4	1.616
Revegetation	3.52	4	5	4	1.614
Grazing management	3.52	4	5	4	1.614
Minimum tillage	3.52	4	5	4	1.616
Mulching	3.52	4	5	4	1.616

The rating for the nine indicators of the watershed management practices were summed up to form the independent variable, level of household knowledge on WSMP. The resulting scale ranged between 0 and 45 with a mean of 26.29 as shown on Table 31.

Table 31: Household Level of Knowledge on WSM Practices

Level of Knowledge	Frequency	Percent
0 (None)	24	6.3
1-7 (Very Low)	12	3.1
8-15 (Low)	55	14.3
16-23 (Moderate)	62	16.1
24-31 (High)	66	17.2
32-45 (Very High)	165	43.0
Total	384	100.0

Mean 26.29±.65, median 26, mode 45, Std. dev 12.88, minimum 0, maximum 45

The results indicate that the majority (60.2 %) of the farmers had between high and very high levels of knowledge on WSMP and only 6.3 % had no knowledge at all. A chi-square test for the equality of the categories of farmer's knowledge is shown in Table 32.

Table 32: Chi-square test for the Equality of the Categories of Farmers Knowledge

	Description	Observed N	Expected N	Residual	
0	None	24	64.0	-40.0	χ^2=228.03
1-7	Very Low	12	64.0	-52.0	5
8-15	Low	55	64.0	-9.0	p<.001
16-23	Moderate	62	64.0	-2.0	
24-31	High	66	64.0	2.0	
32-45	Very High	165	64.0	101.0	
Total		384			

The chi-square test revealed a statistical (p<. 001) significant difference among the different categories of farmers knowledge. The category of very high Knowledge (32-45) was significantly (χ^2=228.0, df=5, p <.001) higher than the others, indicating that the majority of the farmers had very high knowledge of WSMP within the Ena River catchment.

4.9.2 Sources of WSMP Knowledge for the Farmers in Ena Catchment

The sources of WSMP knowledge for the farmers was determined by asking the farmers to state their sources of knowledge and the frequency distribution for the data is shown on Table 33.

Table 33: Sources of WSMP Knowledge to the Farmers in Ena River Catchment (Multiple Response Table)

Source	Frequency	Percent
Agricultural Extension Officers	336	87.5
Farmer to Farmer communication	334	87.0
Radio	331	86.2
Group meetings	331	86.2
Public meetings (*Barazas*)	327	85.2
Person to Person communication	269	70.1
Internet	240	62.5
Television (TV)	68	17.7
Newspapers	19	4.9

n=384

The results indicate that the farmers utilised multiple sources for their WSMP knowledge. The major sources of WSMP Knowledge for the farmers within the Ena river catchment included: agricultural extension officers (87.5 %), farmer to farmer communication (87 %), Radio (86.2 %), group meetings (86.2 %), public meetings (85.2 %), and person to person communication (70.1 %). Worthy of mention is internet (62.5 %), this is a new source which is made possible by mobile forms and internet connectivity.

4.9.3 Evaluation of the Influence of Farmers Knowledge on the Intensity of Household Application of WSMP

The fourth research question for this study, sought to answer whether the practical knowledge the farmers had could influence their intensity of application of watershed management practices. This question was answered by testing the relationship between farmer's knowledge and the intensity of household WSMP using simple linear regression analysis. The independent variable was farmer's practical knowledge and the dependent variable was the intensity of household application of watershed management practices. The results of the regression model are shown in Table 34.

Table 34: Regression Model Summary for Farmers Knowledge and Intensity of Household Application of Watershed Management Practices

R	R Square	Adjusted R Square	Std. Error of the Estimate
.975[a]	.951	.951	1.69570

Predictors (constant), Farmers knowledge
Dependent: Intensity of household application of WSMP

The model indicates an adjusted R^2 value of 0.951, meaning that the independent variable farmer's knowledge explained approximately 95 % of the variation in the dependent variable intensity of household application of WSMP. The F test for the regression model is shown in the ANOVA Table 35.

Table 35: ANOVA Table for the Regression Testing the Fit of the Model

	Sum of Squares	*df*	Mean Square	*F*	*p*
Regression	21370.749	1	21370.749	7432.239	.001[b]
Residual	1098.407	382	2.875		
Total	22469.156	383			

The overall regression equation was found to be significant (F (1,382) = 7432.2, $p <$ .001). The regression coefficients of the model showing the beta, t, and the tolerance levels is shown in Table 36.

Table 36: Regression Coefficients for Farmers Knowledge and Intensity of Application of WSMP

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics
	B	Std. Error	*Beta*	*t*	*p.*	*VIF*
(Constant)	.704	.197		3.577	.001	
Level of Knowledge	.580	.007	.975	86.210	.001	1.000

The regression analysis shows that farmer's knowledge has a positive significant influence ($\beta = .975$, $p <.001$) on the intensity of household application of WSMP within the Ena river catchment. It can therefore be concluded that as the farmers practical knowledge of WSMP increases the intensity of household application of WSMP increases significantly.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

This chapter presents the summary of the findings, their discussion, conclusions and recommendations.

5.2 Summary of the Study

This study aimed at establishing the socio-economic factors influencing the intensity of household application of watershed management practices within the Ena river catchment in Embu County. More specifically, the study's objectives were four fold: to determine the socio-demographic factors influencing the intensity of household application of watershed management practices, to evaluate the influence of collective action on intensity of household application of watershed management practices, to assess the influence of the financial investment by households on the intensity of household application of watershed management practices, and to evaluate the effect of farmer's practical knowledge on the intensity of household application of watershed management practices in upper Ena River catchment area in Embu County.

In achieving these objectives, the study used primary data which was collected using a structured questionnaire that was organized according to the key thematic areas corresponding to specific objectives of the study (such as general information; socio-demographic factors; collective action; financial investment by the household and practical knowledge of WSMP). Additionally, the questionnaire contained open and closed-ended questions with a view not only to get a factual aspect of the responses but also the opinion of the respondents about the subject matter. The study then utilized descriptive statistics and inferential statistics to analyse the data.

The result showed that socio-demographic factors (age, education level, household size and sex of the household heads) did not significantly influence on the level of household application of WSMP within the Ena river catchment.

The following factors: collective action in WSMP, financial investment in WSMP and household practical knowledge in WSMP had significant influence on the intensity of household application of WSMP within the Ena river catchment.

5.3 Discussion

The study findings for this study are discussed based on the specific objectives stated in section 1.4 of this thesis.

5.3.1 Influence of Socio-demographic Factors on the Intensity of Farmers Application of Watershed Management Practices on their Farms

In this objective, the study sought to determine the social demographic factors influencing the intensity of application of watershed management practices among the farmers in upper Ena River catchment area in Embu County. The factors considered in this study included age of the household head, the sex of the household head, educational level of the household head and household size. The findings of the study indicated that all the socio-demographic factors related to the famers had no significant influence on the intensity of household application of WSMP.

The age of respondents was found to have no significant influence on the intensity of household application of WSMP in the study area, this was different from the findings of Le and Beaulieu (2005). Adong, Mwaura, and Okoboi (2013) also concluded that age influenced access to agricultural technologies and this accelerated farmer's adoption of new technics in land management.

The level of formal education attained by the household head was found to have no significant influence on the level of household application of WSMP. This is in accordance to theory as suggested by scholar such Rahelizatovo and Gillespie, 2004; Gillespie, Kim, and Paudel, 2007; Paudel et al., 2008; Ward et al., 2008 who opined that adoption of watershed management practices require good management and decisions making skills to obtain optimal results, it can be conjectured that education attainment of the farmers is likely to significantly influence the decision to adopt WSMP. Education attainment was found to be a key policy variable that influenced farmer group participation (Adong, Mwaura & Okobo, 2013).

The sex of the household head was found to have no significant influence on the level of household application of WSMP. This finding differed from Zelezny, Chua, and Aldrich (2000) who argued that Women are perhaps more concerned about the health of their family and neighbours and therefore they are potentially more inclined to adopt watershed management practices than their male counterparts. Selhausen (2016) demonstrated the embeddedness of collective action in gender relations and the positive value of women’s active participation for agricultural-marketing cooperatives.

The number of people living in the households was found to have no statistical significant influence on the level of household application of WSMP. This could be due to the fact that not all the members of the household were engaged in WSMP as some were students and other had other engagements other than on the farm work (Embu County Government, 2019). The household size has been found to have a significant influence in the adoption of WSMP, this has been so due to the fact that most the practices are labour intensive (Mengistu & Assefa, 2019).

Socio-demographic factors are important in watershed management for they do affect the process of information sharing, adoption of technology and the application of the practice on the land so as to yield ecological benefits from the natural resources.

5.3.2 Intensity of Application of Watershed Management Practices within the Ena Catchment

The households within the Ena river catchment were found to have a high level of application of WSMP. These farmer capacities are learned through formal and informal channels of communication involving experience, education, technical knowledge, government extension officers and from researchers (Tacca, 2011). The intensity of application of the WSMP; which is the application of multiple practices on the same piece of land is crucial in protecting the watershed and ensuring the many different ecological services that is received from the natural resources on the land (Mengistu & Assefa, 2019). Low levels of application of conservation practices by farmers were associated with increased degradation of the natural resources in a study conducted in Uganda by Walle, Rangsipaht and Chanprasert (2011).

Watershed Management Practices (WSMP) that can be applied to a given watershed include: soil bunds, soil and water conservation, grass strip cultivation, agroforestry practices among others (Mengistu & Assefa, 2019). The list can vary to include afforestation, terracing, grazing management, mulching, minimum tillage, grass planting, contouring, cut off drains, terraces, contour planting, composting, area closure of land. Soil fertility management, check dams (Fenta et al., 2016; Zimale et al., 2017). Conservation tillage and crop rotation (Burayu, Chinaowong, Suwanketnikom, Mala1 & Juntakool, 2006). Forest protection and establishment, compost making, manuring and crop rotation (Walle, Rangsipaht & Chanprasert, 2011).

The integration of these practices increases the intensity of their effectiveness in managing the natural resources found on the watershed because they tend to complement each other (Mengistu & Assefa, 2019). The diversified farming systems (where many different practices are performed in one farm) have been found to have a positive influence on natural resource conservation practices (Longpichai, 2013).

5.3.3 Influence of Collective Action on the Intensity of Household Application of Watershed Management Practices within the Ena Catchment

Collective action among the households, where individuals come together as a group and each one of them contributes his labour or resources to undertake activities related to improving or protecting the watershed resources. The study found that the households involved more in collective action had a higher intensity of application of WSMP. This finding could be due to the fact that collective action has the following positive effects: promotes efficient flow of information, which enhances adoption of innovations (Fischer & Quaim, 2012), enhances community participation by integrating community knowledge and community institutions (Eversole, 2012), useful in disseminating technology and resources (de Haan, 2001) and provide for long term learning process (Lyon, 2003). Development programs can work with community groups to identify and address capacity gaps, support establishment of networks with other stakeholders, and pursue strategies to institutionalize and sustain changes derived from program interventions as suggested by Sseguyaa, Mazurb, Wellsb and Matsikoa (2015).

A study by Campbell, Koontz and Bonnell, (2011) points out that the relationship between group activity and adoption behaviour of watershed management practices points out on the type of approach used. For instance, when comparing the adoption rate between collaborative group versus non-collaborative groups, Campbell, Koontz and Bonnell, (2011) revealed that found out that farmers in the watershed with the partnership were not statistically significant different in rates of best management practices adoption than farmers in the watershed with a traditional, agency-based approach encouraging adoption. They further suggested that, this result did not mean that collaboration has no effect on WSMP adoption, as partnership participants exhibited higher levels of WSMP adoption than did nonparticipants in the same watershed.

This study has confirmed the notion rooted in social exchange theory that members are motivated to join and participate in groups when they expect to access services that they may not be able to get on their own (Sseguyaa, Robert, Mazurb, Wellsb, & Matsikoa, 2015). Sondaal, Tumbahangphe, Neupane, Manandhar, Costello, Morrison1 (2019) working with groups to determine the key factors that could enable sustainability of group interventions and sustain groups, concluded that other than the participatory nature of the group and embeddedness they also needed: leadership capacity, a unifying activity such as a fund, and a strong belief in the value of their meeting.

5.3.4 Influence of the Household Financial Investment on the Intensity of Application of Watershed Management Practices

The household that invested financially in WSMP had a higher intensity of application of practices, this was attributed to the fact that WSMP have financial implications to the households and therefore their application are related to the financial capital the household can be able to bring together for the purpose. Farmer access to credit and off-farm income were found to positively influence the adoption and intensity of use land protection practices (Shimele, Janekarnkij, & Wangwachara, 2011). This is not different from the theoretical prediction which suggest that watershed management is a capital demanding exercise and thus unless farmers have sufficient resources, they cannot engage in successful watershed management (Zaharia et al., 2012). The costs incurred in the construction and maintenance, materials and labour for WSMP are important as they influence farmer adaptation of innovative technology (Mautner, 2018).

Access to financial capital to buy inputs for production and maintenance of the resources enhances conservation of land resources and production of agricultural products (Amegnaglo, 2020). Fewer farmers in the study were able to access financial capital and receive training, this should be enhanced in future operations.

5.3.5 Influence of Farmers Practical Knowledge on the Intensity of Household Application of Watershed Management Practices

Farmer's practical knowledge of watershed management practices was found to have a statistical significant influence on the intensity of household application of WSMP. This finding is in agreement with studies related to farmer's knowledge and its influence on their application of farming skills and practices. Studies conducted have found out that farmers knowledge attribute has the potential to influence technical efficiency of the farmers (Armstrong, 2009; Manevska-Tasevka, 2013; Stuiver, Leeuwis, & van der Ploeg, 2004). Farmer's knowledge influences the development of technology through farmer participatory research (FPR) as was determined by Van Asten, Kaaria, Fermont, & Delve (2008). Low levels of farmer's knowledge of sustainable soil conservation practices (SSCP) were associated with farmer lack of practical application of the practices (Luangduangsitthideth, Limnirankul, Kramol, 2019).

Farmer's knowledge is related to the human capital the household owns sometimes referred to as indigenous knowledge. Human capital consists of technical abilities, knowledge, individual and collective capacities of the famers built over time (Wilson, 2012). The knowledge the Farmer owns is normally learned through formal and informal channels involving experience, educational and technical training, relations with extension officers, researchers and connections with other institutional players working at the local levels. The knowledge a farmer has consists of information and understanding of a particular subject and this influences their perception and directs their decisions and actions (Tacca, 2011). This explains the fact that the farmers that had more practical knowledge in the study were found to have a higher level of application of the WSMP. A theory suggested by Bagherian et al., (2009) also confirms this finding as it states that the knowledge of the benefits associated with a WSMP practice would normally lead one to adopt the practice.

5.4 Conclusions

The following conclusions were made from the study:

(i) Socio-demographic factors (age, educational level, household size, and sex) had no statistical significant influence on the intensity of household application of WSMP within the Ena rivers catchment in Embu county

(ii) Collective action by the farmers in undertaking WSMP had statistical significant influence on the intensity of farmers application of watershed management practices within the Ena river catchment in Embu County

(iii) Financial investment by the farmers in WSMP was found to have a statistical significant influence on the intensity household application of watershed management practices within the Ena river catchment in Embu County.

(iv) The level of practical knowledge the farmers had on the WSMP was found to have a statistical significant influence on the intensity of application of watershed management practices within the Ena river catchment in Embu County.

5.5 Recommendations

An integrated watershed management plan for the Ena river catchment in Embu County will need to be drawn and its application be co-ordinated by a government agency in partnership with the community or the Water Resources Users Association (WRUA), the plan will involve the following policy measures:

(i) A programme of training farmers using one of practical approaches such as farmer to farmer or extension officers to farmers (and others as depicted in Table 33) to enhance farmers knowledge of WSMP and sustainable use of natural resources. The farmer to farmer model can be the best where the farmers are taken to progressive farmers to visit and learn from them,

(ii) Develop new ones or use the existing Collective Action Groups (CAG) to provide labour and technology in the application of watershed management practices within the catchment. These CAG can be used to aid in afforestation and revegetation programmes within the catchment, especially in the higher elevations,

(iii) Have Public-Private Partnerships (PPP) to provide farmers with finances at affordable rates to enable them develop watershed management practices on their farms. The increased incomes derived from the farms or agroecosystems from the increase in environmental services (especially water quantity and quality due to the implementation of these measures will provide the farmers with extra income to repay the loans and also improve on the household financial capital,

(iv) The plan will involve integration of practices to create a combined set of sustainable land and watershed intensification practices. The combining of the technologies will provide a more intense programme as the practices will complement one another.

The practices will be selected from the following WSMP list, which is not exhaustive: river bank protection, controlling water abstraction, controlling sand harvesting in the river, and pollution control, soil bunds, soil and water conservation, grass strip cultivation, agroforestry practices, afforestation, terracing, grazing management, mulching, minimum tillage, grass planting, contouring, cut off drains, terraces, contour planting, composting, area closure of land. Soil fertility management, and check dams.

5.7 Recommendations for Further Research

The following are recommended to be done for further research within the Ena river catchment:

(a). Determine the viability of the water resource management and its impact on the wellbeing of the people.

(b). Using a developed WRUA capacity assessment tool to assess the institutional capacity of. WRUAs and identify gaps for training to enhance WRUA capacity.

REFERENCES

Archana, P., Reddy, M.JM. Rao, I.S. & Vidya Sagar, G.E.Ch. (2017). Construction of Knowledge Test to Measure the Knowledge of Watershed Farmers towards Natural Resource Management Practices. *Int. J. Curr. Microbiol. App. Sci*. 6(9): 81-89.

Adong, A. Mwaura, F. & Okobo, G. (2013). What Factors Determine Membership to Farmer Groups in Uganda? Evidence from the Uganda Census of Agriculture 2008/9. Journal of Sustainable Development; Vol. 6, No. 4; 2013

Agrawal, A. (2001). Common property institutions and sustainable governance of resources. *World development*, *29*(10), 1649-1672.

Amegnaglo, C. J. (2020). Determinants of maize performance in Benin West Africa. *Kasetsart Journal of Social Sciences 41 (2020) 296–302*

Ali, H. (2010). *Fundamentals of irrigation and on-farm water management* (Vol. 1). Springer Science & Business Media.

Armstrong, M. (2014), Human resource management practice, London, Kogan Page

Aquino, A., & Garcia, F. (2014). Watershed Restoration and Environmental Education.

Bagherian, R., Samah, B., Samah, A. A., & Ahmad, S. (2009). Factors influencing local people's participation in watershed management programs in Iran. American-Eurasian J. Agric. & Environ. Sci, 6(5), 532-538.

Bagherian, R., Samah, B., Samah, A. A., & Ahmad, S. (2009). Factors influencing local people's participation in watershed management programs in Iran. American-Eurasian J. Agric. & Environ. Sci, 6(5), 532-538.

Burayu W., Chinaowong, S. Suwanketnikom, R., Mala1, T. and Juntakool, S. (2006). Conservation Tillage and Crop Rotation: Concomitant Systems to Incorporate Tef [*Eragrostis tef* (Zucc.) Trotter] Production with Sustainability in the Dryland Oromia. *Kasetsart J. (Nat. Sci.)* 40: 314 – 321.

Baker, T., Kiptala, J., Olaka, L., Oates, N., Hussain, A., & McCartney, M. (2015). *Baseline review and ecosystem services assessment of the Tana River Basin, Kenya* (Vol. 165). International Water Management Institute (IWMI).

Baland, J. M., & Platteau, J. P. (1996). *Halting degradation of natural resources: is there a role for rural communities?*. Food & Agriculture Organization (FAO).

Bodin, O. (2017).Collaborative environmental governance: Achieving collective action in social-ecological systems. *Science* 357, eaan1114

Boserup, E. (2011). *The conditions of agricultural growth: The economics of agrarin change under population pressure*. Transaction Publishers.

Cabangon, R. J., Castillo, E. G., Bao, L. X., Lu, G., Wang, G. H., Cui, Y. L., ... & Wang, J. Z. (2001). Impact of alternate wetting and drying irrigation on rice growth and resource-use efficiency. *Barker R, Loeve R, Li YH, Tuong TP, editors*, 55-80.

Cigler, A., & Joslyn, M. R. (2002). The extensiveness of group membership and social capital: The impact on political tolerance attitudes. *Political Research Quarterly*, *55*(1), 7-25.

Conder, M., Hurni, H., & Wolfgramm, B. (2013). Sustainable Land Management by Disaster Risk Reduction in Muminabad district, Tajikistan, using WOCAT methods (Doctoral dissertation, Verlag nicht ermittelbar).

Cosgrove, W. J., & Rijsberman, F. R. (2000). Challenge for the 21st century: Making water everybody's business. *Sustainable Development International*, *2*, 149-156.

De Steiguer, J. E., Duberstein, J., & Lopes, V. (2003, October). The analytic hierarchy process as a means for integrated watershed management. In *First interagency conference on research on the watersheds* (pp. 736-740). Agricultural Research Service, US Department of Agriculture, Agricultural Research Service, Benson, Ariz.

Dell'Angelo, J., McCord, P. F., Gower, D., Carpenter, S., Caylor, K. K., & Evans, T. P. (2016). Community water governance on Mount Kenya: an assessment based on Ostrom's design principles of natural resource management. *Mountain Research and Development*, *36*(1), 102-116.

Dorf, M. C., & Sabel, C. F. (2000). Drug treatment courts and emergent experimentalist government. *Vand. L. Rev.*, *53*, 829.

Debara, M & Gebretsadik T. (2017) Assessment of knowledge, Attitude and practice of the local community on watershed management at Kindo Koysha Woreda of Wolayta Zone, Southern Ethiopia. *International Journal of Agriculture* 2, (1): 1-17

Ellis-Barton, C. (2016). Ethical considerations in research participation virality. *Journal of Empirical Research on Human Research Ethics*, *11*(3), 281-285.

Embu County Government (2019). *County Integrated development Plan 2018-2022*. Embu County Government

Erdogan, R. (2013). Stakeholder involvement in sustainable watershed management. In *Advances in Landscape Architecture*. IntechOpen.

Eriksson, S. (2012). Water quality in the Koga Irrigation Project, Ethiopia: A snapshot of general quality parameters.

Fenemor, A., Meurk, C., Hunter, G., Aalbersberg, B., Thaman, R., Tuiwawa, M., ... & Dayal, B. (2010). BEST PRACTICE GUIDE FOR WATERSHED MANAGEMENT IN PACIFIC ISLANDS.

Fenta, A.A., Yasuda, H., Shimizu, K. Haregeweyn, N. & Negussie, A. (2016) Dynamics of Soil Erosion as Influenced by Watershed Management Practices: A Case Study of the Agula Watershed in the Semi-Arid Highlands of Northern Ethiopia. *Environmental Management* 58: 889–905

Fischer, E. & Qaim, M. (2012) Linking Smallholders to Markets: Determinants and Impacts of Farmer Collective Action in Kenya. *World Development* Vol. 40, (6), pp. 1255–1268.

Floress, K., Akamani, K., Halvorsen, K.E., Kozich, A.T., & Davenport, M. (2015) The Role of Social Science in Successfully Implementing Watershed Management Strategies. *Universities Council on Water Resources. Journal of Contemporary Water Research & Education* 154: 85-105.

Flora, C. B. (2004). Social aspects of small water systems. *Journal of contemporary water research & education*, *128*(1), 6-12.

Germain, C. B., & Gitterman, A. (1996). *The life model of social work practice: Advances in theory & practice* (Vol. 4). New York: Columbia University Press.

Geschiere, P., & Gugler, J. (1998). Introduction: the urban–rural connection: changing issues of belonging and identification. Africa, 68(3), 309-319.

Gharibreza M., Ashraf M.A. (2014) Watershed Management Practices pp183-199. In: *Applied Limnology*. Springer, Tokyo.

Gorelick, S. M., & Zheng, C. (2015). Global change and the groundwater management challenge. *Water Resources Research*, *51*(5), 3031-3051.

Hardy, S. D., & Koontz, T. M. (2010). Collaborative watershed partnerships in urban and rural areas: Different pathways to success. *Landscape and Urban Planning*, *95*(3), 79-90.

Ho, T. Q. (2011). Analysis of socio-economic factors affecting technical efficiency of small-holder coffee farming in the Krong Ana Watershed, Dak Lak Province, Vietnam (Doctoral dissertation, [Honolulu]:[University of Hawaii at Manoa],[August 2011]).

Jwan, J. O., & Ong'ondo, C. O. (2011). Qualitative research: An introduction to principles and techniques. *Eldoret, Moi University*.

Kamweti, D., Osiro, D., & Mwiturubani, D. A. (2009). Nature and extent of environmental crime in Kenya. *Institute for Security Studies Monographs*, *2009*(166), 78.

Kennish, M. J. (2002). Environmental threats and environmental future of estuaries. Environmental conservation, 29(1), 78-107.

Koiter, A. J., Owens, P. N., Petticrew, E. L., & Lobb, D. A. (2013). The behavioural characteristics of sediment properties and their implications for sediment fingerprinting as an approach for identifying sediment sources in river basins. *Earth-Science Reviews, 125,* 24-42.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.

Lal, P., Lim-Applegate, H., & Scoccimarro, M. (2002). The adaptive decision-making process as a tool for integrated natural resource management: focus, attitudes, and approach. *Conservation Ecology*, *5*(2).

Liu, B.M., Abebe, Y. McHugh, O.V. Collick, A.S., Gebrekidan, B., Steenhuis, T.S. (2008) Overcoming limited information through participatory watershed management: Case study in Amhara, Ethiopia. *Physics and Chemistry of the Earth, Parts A/B/C* 33 (1–2): 13-21

Longpichai, O. (2013). Determinants of Adoption of Crop Diversification by Smallholder Rubber Producers in Southern Thailand: Implications on Natural Resource Conservation *Kasetsart J. (Soc. Sci) 34: 370 - 382*

Luangduangsitthideth, O., Limnirankul, B., Kramol, P. (2019). Farmers' knowledge and perceptions of sustainable soil conservation practices in Paklay district, Sayabouly province, Lao PDR. *Kasetsart Journal of Social Sciences 40 (2019) 650–656*

Makango, A. T., & Reddy, R. U. (2014). *Assessment of Farmers' Awareness about Land Degradation and Their Attitude towards Land Management Practice: A Case of Ezha Woreda in Gurage Zone Snnpr* (Doctoral dissertation, Haramaya University).

Maneveska-Trasevska, G. (2013). Farmers Knowledge Attributes contribute to attaining higher farm Technical Efficiency: A Transitional Economy Case. *The Journal of Agricultural Education and Extension Vol 19 (1): 7-1*9.

Martignago, G. (2011). A comparative analysis of Sava, Tisza, Dniester transborder water river basin management agreement and cooperative policies and their impact on the enhancing of mutual understanding and the well being of people involved.

Matthews, T. D., & Kostelis, K. T. (2011). *Designing and conducting research in health and human performance*. John Wiley & Sons.

Mautner, M. R. L. (2018). Urbanization and Groundwater Management: Modeling the feedbacks between land use change, infiltration, and withdrawals in the Mexico City Metropolitan Area (353311). In 2018 Fall Meeting.

Mengistu, F. & Assefa, E. (2019) Farmers' decision to adopt watershed management practices in Gibe basin, southwest Ethiopia. *International soil and water conservation 7: 376-387.*

Michaels, S. (2001). Making collaborative watershed management work: the confluence of state and regional initiatives. *Environmental management*, *27*(1), 27-35.

Mitchell, N. (1990). *Cult and Controversy: The Worship of the Eucharist Outside Mass* (Vol. 4). Liturgical Press.

Moldan, B., Janoušková, S., & Hák, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. *Ecological Indicators*, *17*, 4-13.

Mugenda, O. M. (1983). *The impact of bankruptcy on the Iowa petitioner* (Doctoral dissertation, Iowa State University of Science and Technology).

Neubert, S. (2007). Poverty oriented irrigation policy in Kenya: empirical results and suggestions for reform.

Ngari, L. (2013). A contribution to the peopling and environmental changes in the Upper Tana River Basin (Kenya) after the introduction of farming and iron: A multi-disciplinary approach. *International Journal of Innovative Research & Studies*, *2*(5), 75-107.

O'Donnell, T.K., Baffaut, C., Galat, D.L. (2008) Predicting effects of best management practices on sediment loads to improve watershed management in the Midwest, USA *Intl. J. River Basin Management* 6 (3): 243–256

Ostrom, E. (1994). Institutional analysis, design principles and threats to sustainable community governance and management of commons. In *ICLARM Conf. Proc.* (No. 45, pp. 34-50).

Owuor, P. (2015). The disaster profile of Kenia. *Emergency and Disaster Reports, 2 (3)*.

Oyama, N., Nair, J., & Levitan, J. (2012). Africa's Water Crisis: The Miracle and the Mirage: What Policy Mix, Strategies and Institutional Steps are Vital?. In Rethinking Development Challenges for Public Policy (pp. 201-233). Palgrave Macmillan, London.

Pereira, J. S., & Chaves, M. M. (1995). Plant responses to drought under climate change in Mediterranean-type ecosystems. In *Global change and Mediterranean-type ecosystems* (pp. 140-160). Springer, New York, NY.

Pritchett, L. (1999). *Where has all the education gone?*. The World Bank.

Pugel, K., Javernick-Will, A., Linden, K. 2019. What is a collective action approach and what makes it effective? - a desk review. All systems go! WASH systems symposium, The Hague, The Netherlands, 12-14 March 2019.

Rao, M., & Gupta, V. (2014). Sustainability Beyond Buildings. Architecture+ Design, 31(3), 60.

Ritter, W. F., & Shirmohammadi, A. (2000). Agricultural nonpoint source pollution: watershed management and hydrology. CRC Press.

Rushemuka, N.P., Bizoza, R.A., Mowo, J.G., Bock, L. (2014). Farmers' soil knowledge for effective participatory integrated watershed management in Rwanda: toward soil-specific fertility management and farmers' judgmental fertilizer use Agriculture, *Ecosystems & Environment* 183: 145-159

Selhausen, F.M. (2016) What Determines Women's Participation in Collective Action? Evidence from a Western Ugandan Coffee Cooperative. *Feminist Economics*, 22, (1), 130–157,

Sekaran, U. (2009). Bougie. *M," Research Methods for Business: A Skill Building Approach". UK: John Wiley & Sons*.

Seperteladze, Z. K., Davitaia, E. F., Alpenidze, M. D., Aleksidze, T. I., & Rukhadze, N. E. (2013). Nature management zoning of Upper Svaneti geographical environment. *Annals of agrarian science*, 11(2), 9-12.

Sseguyaa, H., Mazurb, R. E., Wellsb, B. and Matsikoa, F (2015) Quality of participation in community groups in Kamuli District, Uganda: implications for policy and practice *Community Development, 46, No. 1, 14–25*

Shiene, S. D. (2012). *Effectiveness of soil and water conservation measures for land restoration in the Wello area, northern Ethiopian highlands* (Doctoral dissertation, Universitäts-und Landesbibliothek Bonn).

Shimele, A. Janekarnkij, P. and Wangwachara, V. (2011) Analysis of Factors Affecting Adoption of Soil Conservation Measures among Rural Households of Gursum District, Ethiopia. *Kasetsart J. (Soc. Sci) 32: 503 – 515*

Singh, S. (2013). Local governance and environment investments ln Hlware Bazar, lndla. Ecological Economics from the Ground Up, 191.

Singh, V. P., & Frevert, D. K. (2003). Watershed modeling. In *World Water & Environmental Resources Congress 2003* (pp. 1-37).

Smith, L. E., & Porter, K. S. (2010). Management of catchments for the protection of water resources: drawing on the New York City watershed experience. *Regional Environmental Change*, *10*(4), 311-326.

Sondaal, A.A.E.C, Tumbahangphe, K.K.M., Neupane, R.R., Manandhar, D.D.S, Costello, A.A., Morrison1, J.J. (2019). Sustainability of community-based women's groups: reflections from a participatory intervention for newborn and maternal health in Nepal. *Community Development Journal 54 (4) pp. 731–749*

Sonwa, D. J., Nkem, J. N., Idinoba, M. E., Bele, M. Y., & Jum, C. (2012). Building regional priorities in forests for development and adaptation to climate change in the Congo Basin. *Mitigation and Adaptation Strategies for Global Change*, *17*(4), 441-450.

Stangor, C., & Walinga, J. (2010). 7.4 Early and Middle Adulthood: Building Effective Lives. *Introduction to Psychology-1st Canadian Edition*.

Steins, N. A., & Edwards, V. M. (1999). Platforms for collective action in multiple-use common-pool resources. *Agriculture and human values*, *16*(3), 241-255.

Stuiver, M. Leeuwis, C. & van der Ploeg, J.D. (2004). The power of experience: Farmers knowledge and sustainable innovations in agriculture. In Wiskerke, J.S.C. & van der Ploeg, J.D. (eds). *Seeds of transition.* Essay on novelty of production, niches, and regimes in agriculture. Koninklije van Gorwin BV. The Netherlands.

Susatyo, M. O., Marsono, D., Kusumandari, A., & Supriyanto, N. (2017). Identification and Analysis The Role of Stakeholders in Sustainable Ngrancah Sub Watershed Management (Case Study in Ngrancah Sub Watershed–Kulon Progo Regency). JURNAL WANA TROPIKA, 5(1).

Tacca, M. (2011), "Commonalities between perception and cognition", Frontiers in Psychology, 2, November, pp. 5-10.

Taena, W., Kolopaking, L. M., Juanda, B., Barus, B., & Boer, R. (2016). An Institutional Model of Transboundary Watershed Management toward Sustainable Development. Jurnal Manajemen Hutan Tropika, 22(1), 35-46.

Tidd, J., & Bessant, J. R. (2018). *Managing innovation: integrating technological, market and organizational change*. John Wiley & Sons.

Tiffen, M., Mortimore, M., & Gichuki, F. (1994). *More people, less erosion: Environmental recovery in Kenya*. John Wiley & Sons Ltd.

Trochim, W. M., Cabrera, D. A., Milstein, B., Gallagher, R. S., & Leischow, S. J. (2006). Practical challenges of systems thinking and modeling in public health. *American journal of public health*, *96*(3), 538-546.

Van Asten, P. J. A., Kaaria, S., Fermont, A. M. & Delve, R. J. (2008). Challenges and Lessons When Using Farmer Knowledge in Agricultural Research and Development Projects in Africa. *Expl Agric. 45, pp. 1–14*

Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P. & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, *467*(7315), 555.

Wachira, B., & Wambui, S. (2013). Evaluation of potential sustainable land management practices to enhance watershed ecosystem services in upper tana catchment: a case study of Kirurumwe River, Ena Basin in Embu County, Kenya. *Research paper submitted in partial fulfilment of requirements, for the degree of Master of ArtS in Environmental Planning and Management, University of Nairobi*.

Wade, W., McCollister, G. M., McCann, R. J., & Jones, G. M. (1988). Estimating recreation benefits for instream and diverted users of waterfowls of the Sacramento-San Joaquin rivers watershed. *Western Regional Research Publication W-133, Benefits and Costs in Natural Resources Planning, Monterey, CA.*

Walle, T., Rangsipaht, S. and Chanprasert, W. (2011). Natural Resource Conservation Practices of Resettlers in the New Resettlement Areas of Amhara Region, Ethiopia. Kasetsart J. (Soc. Sci) 32: 297 - 307

Weekes, C. E. (2013). Agricultural and Domestic Waste Contamination in Chilibre Panama and Potential Low-Cost Best Managament Practices.

Wily, L. A. (2011). 'The Law is to Blame': The Vulnerable Status of Common Property Rights in Sub-Saharan Africa. *Development and change*, *42*(3), 733-757.

Willis, R. M., Stewart, R. A., Panuwatwanich, K., Williams, P. R., & Hollingsworth, A. L. (2011). Quantifying the influence of environmental and water conservation attitudes on household end use water consumption. *Journal of environmental management*, *92*(8), 1996-2009.

Wilson, G. (2012), Community Resilience and Environmental Transitions, Milton Park, Routledge.

WWAP (United Nations World Water Assessment Programme), 2015. *The United Nations World Water Development report 2015: Water for a sustainable world. Paris, UNESCO.*

Zaharia, L., Ioana-Toroimac, G., Catana, S., Minea, G., & Delporte, C. (2012). River lateral dynamics and floods in relation to human communities. Case study: Moara Domneasca Village (On Lower Teleajen River). Aerul si Apa. Componente ale Mediului, 119.

Zimale, F. A., Tilahun, S.A., Guzman, C.D., Hoang, L., Schneiderman, E. M., Langendoen, E. J. & Steenhuis, T. S. (2017) Improving watershed management practices in humid regions. *Hydrological processes* Volume31, Issue18 Pages 3294-3301

APPENDICES

Appendix A: Research Questionnaire for Households

My name is Janes Chomba Njeru. I am conducting a survey on *Factors Influencing the Intensity of Household Application of Watershed Management Practices within the Upper Ena River Catchment in Embu County, Kenya* for academic purposes. If you allow me, I will be asking you questions around this topic. Your personal identifying information will be kept confidential, and will only be used for the purposes of the coordination of this study. Your responses will remain anonymous in any subsequent analyses and published reports. This survey is completely voluntary and you may stop at any time. Equally, you may choose not to answer any question that you feel uncomfortable with. I will greatly appreciate your cooperation and time.

Guidelines

(i) The purpose of this questionnaire is to obtain information in order to assess the factors influencing the adoption of Watershed Management Practices in the Upper Ena River Catchment Area in Embu County

(ii) Kindly fill all the relevant boxes and blank spaces.

(iii) The information collected will be used solely for research as intended for this study and will remain confidential.

General Information

- Date………………..
- Respondent Number........................
- Village..
- Sublocation…………………………
- GPS Coordinates;
    - N:………………………
    - E:………………………

SECTION A: SOCIAL FACTORS

1. Please tick your Gender
    - ☐ Male
    - ☐ Female

2. What is the size of your household?
   - ☐ 0 – 5 Members
   - ☐ 6 – 10 Members
   - ☐ Above 10 Members
3. Please tick your Age bracket
   - ☐ 15 – 30 Years
   - ☐ 31 – 45 Years
   - ☐ 46 – 60 Years
   - ☐ Overs 60 Years
4. Please indicate the highest level of education attained
   - ☐ Primary education
   - ☐ Secondary education
   - ☐ College/ tertiary education
   - ☐ Never attended school
5. Who are the main owners of land in your community?
   - ☐ Male
   - ☐ Female

SECTION B: COLLECTIVE ACTION

1. Are you a member of a Watershed Association, including any organization/group that is active/involved/interested in the watershed
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
2. If yes in question one above, do you participate in the activities of the group?
   - ☐ Yes
   - ☐ No
3. How frequent do you participate the watershed management group activities?
   - ☐ 0 – 2 times a week
   - ☐ 3- 4 times a week
   - ☐ Above 4 times a week

SECTION C: ECONOMIC CONDITION OF HOUSEHOLDS

1. Please tick the family's major source of income.
   - ☐ Employment
   - ☐ Farming
   - ☐ Business)
   - ☐ Employment/Farming
   - ☐ Business/ Farming
2. Please tick the total size of your land
   - ☐ 0.5-1 acre
   - ☐ 2-5 acres
   - ☐ 5-10 acres
   - ☐ Over 10 acres
3. What portion of this land do you farm?
   - ☐ 0.5-1 acre
   - ☐ 2-5 acres
   - ☐ 5-10 acres
   - ☐ Over 10 acres
4. To what extent does the cost associated with the following watershed management practices affect you?

	To great extend	To lesser Extend	Least extent
Terracing			
Cut off drains			
Afforestation			
Contour planting			
Contouring			
Afforestation			
Grass strips			
Agroforestry			
Re-vegetation			
Grazing management			
Minimum tillage			

5. Do you have any access to credit to finance your CA farming business?
   - ☐ Yes
   - ☐ No
6. What are the main sources of credit?
   - ☐ Bank
   - ☐ SACCO
   - ☐ Cooperative Societies
   - ☐ Others

SECTION D: KNOWLEDGE OF PRACTICES

1. Do you think the following land use practices affect the watershed management in your area?

	Yes	No
Cut off drains		
Afforestation		
Contour planting		
Contouring		
Afforestation		
Grass strips		
Agroforestry		
Re-vegetation		
Grazing management		
Minimum tillage		

2. Do you think or are you aware of Agricultural extension officers within your watershed?
   - ☐ Yes
   - ☐ No

3. Are the following channels of communication used in regards to watershed management in your community?

	Yes	No
Local radio program		
Local television program		
Local newspaper		
Email		
Personal communication with family or friends		
Public meetings		
Meetings of local groups and organizations		

4. Do you think the information received in your watershed is reliable?
   - ☐ Yes
   - ☐ No

SECTION E: ATTITUDES

1. Do you think watershed management is important in this community?
   - ☐ Yes
   - ☐ No
   - ☐ Don’t know
2. Are you willing to participate in watershed management in this community?
   - ☐ Yes
   - ☐ No
3. Whom do you think is mandated to influence watershed management practices?
   - ☐ Land owners

- ☐ Local Government
- ☐ Community based organizations
- ☐ NGO's
- ☐ Don't know

4. How would you rate the suitability of the interventions made by the following in regards to watershed management

	Very Suitable	Suitable	Moderately suitable	Unsuitable
Land owners				
Local Government				
Community based organizations				
NGO's				

SECTION F: ADOPTION OF WATERSHED MANAGEMENT PRACTICES

1. Please indicate the title that best describes your situation
   - ☐ Non-Farm Landowner
   - ☐ Landowner / Farm Operator
   - ☐ Absentee Landowner
   - ☐ Tenant Farm Operator
   - ☐ Landowner / Farm Operator / Tenant Farm Operator
   - ☐ Other (specify)…………………………….
2. Do you make land management decisions for property that borders a stream or river?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure
3. Are you aware of the presence of a Watershed Association in your area?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure

4. To your knowledge has there ever been a watershed plan developed for this area
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

5. How long have you been a resident within this particular watershed?
   - ☐ 0 – 2 years
   - ☐ 3 – 5 years
   - ☐ 5 – 10 years
   - ☐ Over 10 years

6. Please indicate how important the following watershed management practices are to you.

	Very important	Important	Slightly important	Not important
Cropping systems				
Land conservation practices				
Terraces				
Cut off drains				
Planting on contours				
Contouring				
Afforestation				
Grass strips				
Agroforestry				
Re-vegetation				
Grazing management				
Minimum tillage				

7. Please indicate which of the following issues might influence your decision to participate in the watershed management program.

	Strongly influence	Influence	No influence	Don't know
The economic cost is not reimbursed by cost-share programs				
The need for more management information and efforts				
Interference with cropping activities on other land				
My flexibility to change land uses as conditions warrant				
The sale value of my farm				
Restrictions on the person who inherits the farm				
The ability of the plan to reduce soil erosion				
The ability of the plan to improve water quality				
The ability of the plan to reduce flooding				
The ability of the plan to improve wildlife habitat				
My interests not being represented by the watershed management plan				

Appendix B: ANU Research Ethics Approval

AFRICA NAZARENE
UNIVERSITY

26th May 2020

RE: TO WHOM IT MAY CONCERN

James Chomba Njeru (18JO1DMEV006) is a bonafide student at Africa Nazarene University. He has finished his course work and has defended his thesis proposal entitled: - ***"Assessment of Household factors influencing the adoption of watershed management practices in the Upper Ena river catchment in Embu County".***

Any assistance accorded to him to facilitate data collection and finish his thesis is highly welcomed.

Rodney Reed, PhD.
DVC Academic & Student Affairs.

Appendix C: NACOSTI Permit

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR
SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **870061** Date of Issue: **05/July/2020**

RESEARCH LICENSE

This is to Certify that Mr.. James Chomba Njeru of Africa Nazarene University, has been licensed to conduct research in Embu on the topic: ASSESSMENT OF FACTORS INFLUENCING THE ADOPTION OF WATERSHED MANAGEMENT PRACTICES IN THE UPPER ENA RIVER CATCHMENT AREA IN EMBU COUNTY, KENYA for the period ending : 05/July/2021.

License No: **NACOSTI/P/20/5510**

Appendix E: Watershed Management Structures and Vegetation Cover

Figure 5: A Raised Earth Bund for Soil Erosion and Water Conservation

Figure 6: An Agroforestry System within the Ena River Catchment

Figure 7: A Contour Vegetated Strip Planted With Perennial Bushes

Figure 8: Tea Bushes Planted on a Slope

Figure 9: Grass Strip planted with Napier Grass along a Field Boundary