Assessment of effects of sub-catchment governance on management of water resources: - A case of Rwamuthambi Sub-catchment, Kenya

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Eunice Muthoni Kumunga

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Wangari Maathai Institute for Peace and Environment Studies

University of Nairobi

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DECLARATION

This thesis is my own original work and has not been presented for award of a degree in any other University.

Sign: ……Date:……15th November 2021……

Eunice Muthoni Kumunga

This thesis has been submitted with our approval as university supervisors

This research has been submitted for examination with our approval as university supervisors

Sign: ……..... Date: 16th November 2021……

Prof. Nzioka John. Muthama

16th November 2021

Sign: ……..... Date: ……

Dr. Titus Chemandwa Ndiwa

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To God be the glory.

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ABSTRACT

Degradation of sub catchments has been a major global challenge. Kenya has experienced a similar situation in spite of water sector reforms of 2002 that assigned every wetland to a sub catchment, separated water service delivery from water resources management and decentralized management of water resources. This study was carried out in Rwamuthambi sub catchment with an aim to assess the status of governance, effectiveness and challenges of WRUA committees and explore indicators and strategies involved for sustainable utilization that would curb experienced degradation even after the reforms. The study employed exploratory descriptive research design. Data was collected through questionnaires, semi-structured interview augmented by observations and review of secondary data. Data analyses was by Kendall's coefficient of concordance (W) for ranking, t-test for ratings, Chi square, regression analysis and descriptive analysis using Stata and excel software. The results revealed that only 15% of WRUA committee members understood water resources management while 35% were aware of relevant legislations. The study found that 82% of the community members were involved in sub catchment utilization activities. In addition, degradation had no significant association with existence of WRUAs $\chi 2$ (4, N=180), $p< .01$, and WRUA contributions were perceived differently per agro-ecological zone $\chi 2$ (8, N=147), $p>.05$. The level of household incomes influenced level of sub catchment conservation and sensitization ($p< 0.05$), enforcement had a significant positive influence ($p< 0.05$) to the economy and environment components and community involvement and community initiative had a strong significant influence ($p< 0.05$) on utilization and sustainability. Further, there was significant agreement by the community regarding wetland government support services ($W = 0.05$, $p<.05$). Challenges unearthed included inadequate financial and human resources, lack of understanding, poor collaborative governance, inadequate support from county government and private tenure of

riparian land reserve. The study improved the framework to monitor and communicate the effects of sustainability indicators. It was recommended that for effective conservation of wetlands, WRUAs should embrace collaborative governance and pursue integration of sub catchment management plan with county land use plans through policy review. Further, since conservation was revealed as a function of utilization the study also recommended a systematic follow-up the tipping point of utilization-driven conservation.

ABBREVIATIONS AND ACRONYMS

CBD- Convention on Biological Diversity

COK- Constitution of Kenya

COPs- Conference of Parties

EMC- Environmental Management and Co-Ordination

EMCA- Environmental Management and Coordination Act-1999

EPA- Environmental Protection Agency

GMR- Global Monitoring Report

GOK- Government of Kenya

GWP- Global Water Partnership

GNF- Global Nature Fund

IEBC- Independent Electoral and Boundaries Commission

IUCN- International Union for the Conservation of Nature

IWRM- Integrated Water Resources Management

MEMR- Ministry of Environment and Mineral Resources

MDG- Millennium Development Goals

NWMP- National Water Master Plan

RSCMP- Rwamuthambi Sub- catchment Management Plan

RWBG- Regional Wetlands Biodiversity Group

SDG- Sustainable Development Goals

UNDG- United Nations Development Group

UNEP- United Nations Environmental Programme

US EPA- United States Environmental Protection Agency

UTaNRMP- Upper Tana Natural Resources Management Project

WRA- Water Resources Authority

WRMA- Water Resources Management Authority

WRUA- Water Resource Users Association

WRUA-MCM- Water Resource Users Association Management Committee Members

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CHAPTER ONE:

INTRODUCTION

1.1 Background of the study

Kenya has many laws dealing with environmental conservation, management, sustainable land use and wise use of wetlands, but the laws are sector-oriented with each concentrating on a particular sectoral related issue with the objective seldom connected to environmental protection. Hence, despite the many policies and laws the country still experiences environmental degradation (Odote *et al*., 2007).

However, a preview of the countries land historical background explained the source of the quagmire. Before Kenya was declared a British protectorate in 1895, wetlands like other natural resources were controlled and managed by a council of elders who ensured their communal use and sustainability through imposition of sanctions and fines (Castrol, 1991). During the colonial era, policies were prepared geared towards containing the Africans in settlements (Caroline, 2014). There was control on where it was permitted land for cultivation and grazing depending on the location, topography, proximity to water catchments and wetlands, besides clear guidelines over the types of crops to be grown. The government officers had authority to control the size of stock and where to be grazed (Peter *et al.,* 2013).

Colonial Kenya was governed by the colonial masters without the Africans having much say or leeway to hoist their views towards governance of resources. At the same time, independent Kenya being a capitalist economy had the first Constitution of Kenya (1963) offering some limited if not full control of land. Each individual had the right to accumulate wealth through their own effort without much regard to the economic status of their neighborhood. Additionally, by the time Kenya gained its independence in 1963, the population was charged with an urge to own their own

property and at least a parcel of land for that matter registered in their favor. This could not have been entrenched better than owing to the desire heightened from discrimination and lure for economic independence created when the nation went through the oppression of British colonial administration (Bruce, 1996). In the post-colonial Kenya, the first Constitution of Kenya was based on the Lancaster House template thus most of the laws were borrowed from the colonial system. It was based on central government and local authorities that were classified from City Council, town councils, urban councils and county council authorities over areas that were rural in nature (GOK, 1998).

Thus, during demarcation, land rights registration and classification were geared towards promoting and safeguarding individuals and the state (GOK, 1968; Nathalie *et al.*, 2006). Land was classified into three tenure systems that is private, government and trust land (CoK 1963, Kecha *et al*., 2006). There were no areas set aside exclusively for wetlands whether natural or artificial. These were actually deemed as natural wastelands, barring infrastructural and physical development, besides causing security risk, harboring pests and disease vectors which endanger human health (Kecha *et al.*, 2006; Gardner 1996). As noted, there were no records of any spatial plan or land use plan which would form the basis for demarcation. The Preliminary Index Diagrams (PIDs) produced in 1975 by Survey of Kenya were based on mosaics formed using photographs following photography of the area. Preparation for clear visibility of the high resolution camera launched on low flying aircraft photography was through authority issued to the people to physically mark out their boundaries using hedges or heaped soil as a mark along the boundary. Worth noting was that this was done long after demarcation was finalized in the late 1960s.

GNF (2002) noted that poor identification of wetlands and understanding of the causes of degradation and how they relate were major causes of degradation. To identify various types of wetlands, wetland classification was based on their origin and character as provided for in the guidelines developed by Regional Wetlands Biodiversity Group (RWBG) with the technical assistance by the International Union for the Conservation of Nature (IUCN) in collaboration with the institutions dealing with biodiversity (NWMP, 1999; NEAP, 1994; MEMR 2012b). The wetlands were thus classified as marine, estuarine, sodic and or saline water, fresh water and human-made wetlands. The human made wetlands include aquaculture, agriculture, salt production, urban and industry (borrow pit, mining pools, quarries, road impoundments, brick pits) and water storage (waste water treatment facilities, ponds, dams, reservoirs).

However, in Kenya characterization and classification of wetlands has been sectoral-based and on government agencies whose mandates coincide with wetlands (NEAP, 1994). The wetland classification is mainly influenced by the varying mandates of the particular institution. Therefore, the effort for conservation was driven by the goals and aspirations of the institution depending on whether conservation is aimed at biodiversity or the water catchment (NWMP, 1992).

In 2012, the Kenya Wetland Atlas was published, with emphasis on the need to promoting sectoral integrated planning for wetlands and wetland biodiversity in an effort to ensure that their effects would be taken into consideration when implementing capital projects. In as much as some wetlands are under private ownership, Section 40 of the constitution deals with the protection of right to property whereas Article 42 of the same constitution postulates that every person has the right, either individually or in association with others, to acquire and own property (COK, 2010a). MEMR (2012b) noted, that legislation in Kenya cuts across the board including through the privately owned property and the owners must comply with the provisions of the law on how to

utilize their privileges against conservation and management of the natural resources in general and the environment.

According to USAID, (2007) Wetland loss and degradation has resulted to over 2.6 million people in Kenya facing water shortage due to insufficient wetlands upon which to retain the storm water. Therefore, the country is already suffering from the effects of degraded lakes and wetlands. UNEP (2013) stated that the fresh water per capita was projected to reach $235m^3$ by 2025 unless the challenges were identified and addressed accordingly. An estimation of wetlands coverage in Kenya as recorded by the Kenya Wetlands Forum report of 2012 was 3-4% of the total Kenyan land mass. This coverage surges up to 6% during high precipitation.

In spite of degradation emanating from varied origins when combined, complex interrelationships manifest. Proper identification of the causes and understanding how they relate would lead to developing an amicable solution to their restoration. In general, there lacks enough funding to deal with all the degradation challenges while at the same time, lack of concern and poor public participation by the stakeholders lead to failure in conservation and restoration whereas in other instances, conflict of interest may hamper progress (GNF, 2002). Wetland conservation aims at protection and preservation of the resource.

In the 1963 manifesto, Kenya committed to conserve natural resources for posterity and eliminate the initial belief that viewed them as valueless (Gichuki, 1992). The first wildlife conference for Eastern Africa which targeted conservation of natural resources in general was organized in 1969. Meanwhile, water resources conservation received a lot of attention globally with the formulation of Ramsar convention in 1971 (Ramsar Convention Secretariat 2006).

A study in 1983 recommended separating of operations and maintenance. It also advised towards decentralization (Nyanchaga 2011). There followed preparation of a National Water Master Plan in the 1980s.

Later, in the 1987 proceedings of the 3rd conference of contracting parties (COP) of the Ramsar convention was held in Regina, Canada, Kenya became one of the countries that took up the initiative to conserve catchment areas and wetlands (Njuguna and Howard, 1992). A National Water Policy was prepared in 1999. Kenya was among the member countries considered for Millennium Development Goals of 2000 whose target 6 promoted access to safe drinking water and proper sanitation, through international regulations, awareness creation, and guidelines development, policies and legislations (Ramsar Convention Secretariat 2006). As a follow up the 10th meeting of the Conference of Parties of 2010 held in Nagoya, Aichi Prefecture- Japan, devised and upheld a strategic plan meant to guide achievement of the set goals for conservation of diversity and set 20 Aichi targets on biodiversity that would determine time limits and determine the level of achievements COP meeting (Herkenrath an Harrison 2011). Target five addressed habitat loss and degradation while target nine discussed introduction and destruction of indigenous species by exotic for whatever reason, both areas concentrating on ecosystems which the study focuses on.

MDGs were replaced by Sustainable Development Goals of 2012 born in Rio de Jeneiro. SDG target 6.3 and 6.5 deals with ecosystem health and quality while SDG target 6.5 is ecosystem health and quality as well as Integrated Water Resources Management (IWRM).

Borrowing from IWRM model and guided by the 1999 National Water Policy Kenya water was reviewed in 2002. The review aimed to ensure that pro-poor and human rights-based approaches were incorporated in the water sector.

Water Act Cap 372 0f 1974 was also reviewed in 2002 The revised act entrenched public participation and involvement of water resource management and introduced new water management and governance institutions which included Water Resources Authority (WRA) (GOK, 2016) and Water Resource Users Authorities (WRUA).

Rwamuthambi sub catchment was a creation of the amended law (RSCMP, 2015). There was a plethora of un-authorized water abstractors, a notable depletion of land cover, encroachment and anthropogenic activities along the riparian. WRUA was therefore mandated to oversee management of the sub catchment through provision of an interface to provide equitable and rational allocation of water resource, water quality monitoring, ensuring compliance with water quality standards for various uses effluent discharge and mapping including preparation of catchment plans besides taking an inventory of underground water resources and flood prone areas (Moraa *et al.* 2012) and provide linkage between the community, civil society and relevant government institutions (GOK, 2016).

The current study carried out an assessment of the how sub catchment governance affected the management of water resources in Rwamuthambi sub catchment area

1.2 Statement of the problem

According to Kenya Vision 2030 Kenya's economy, society and environment depend on ecosystems which must therefore be protected in order to revive the country's economy (MEMR, 2012b; Kenya Vision 2030). Further curbing degradation of wetlands is envisaged in order to meet the 2010 Constitution article 42 goal on the right of every person to a clean and healthy environment and 43 (1) (d) on the right to sufficient clean and safe water.

Environmental Management and Coordination Act (EMCA) was established in 1999 (GOK, 1999) and became effective in 2002 and reviewed in 2018 (GOK, 2018a) aimed at overall coordination

of environmental governance and maintenance in Kenya. Although it had not accomplished, it was expected to harmonize environmental related legislations that were initially disjointed and also establish a framework for integrated environmental management (Nathalie *et al.*, 2006). In addition, the law considered recommendations for a wetland policy by the Ramsar convention Conference of Parties (COPs) of 1990. Kenya being a signatory was committed to introduce a holistic national environmental policy which would deal with the myriad problems facing wetlands including but not limited to over-extraction of water, subdivision of land into uneconomic or un-ecological sizes and deforestation of catchment areas (MEMR, 2012; UNEP, 2013)

The repeal of the Water Act cap 372 of 1974 in 2002 designated every wetland to a sub catchment and separated the water resources from the provision of water service (GOK, 2002). Water resources are classified under state department of water and irrigation whose mandate is to create institutions that would be responsible for management of water resources and water services provision. (GOK, 2002: GOK, 2016). The proposed institutions in 2002 included Water Resources Users Association (WRUA) whose functions were inter- alia formulation and enforcement of standards, procedures and regulations for the management and use of water resources, create accountability for local wetlands and ensure equitable utilization of the local water resources. WRUA also provide the linkage between the consumers and Water Resources Management Authority.

In addition, Water Resources Management Authority (WRMA) later renamed Water Resources Authority (WRA) (GOK, 2016) was required to maintain an inventory of all wetlands (local or small catchments and wet lands) and should cause preparation of Wetland Management Plans necessary for protection and control of degradation. The Water Act of 2002 was later revised in 2016 (GOK, 2016). Worth of noting was that EMC (2009) regulations permitted use of wetlands

including harvesting of papyrus, medicinal plants, cultivation where the cultivation area would not pose adverse effects, including hunting. This therefore meant that wetlands and catchment areas should be utilized sustainably.

Nevertheless, the country has continued to lose a lot of biodiversity coupled with accompanying socio-economic benefits in the local wetlands. Although, Kenya has 581,751km2, of which 97.8% is dry land while 2.2% is water surface. Of the dry land 80% is semi-arid and arid and only the balance being arable for agriculture (George 2017), which consequently presents the reliability for boosting their food production by substituting its production through irrigation. Thus, many people have turned into cultivation on the wetlands in order to increase food production during dry spells as a way of adapting to degradation brought by climate change (Were *et al.*, 2013). In addition, Kenya vision 2030 predicted that the county's water resource index could decline from 1093m^3/capita/year in 2010 to 586m^3/capita/year by 2025.

In an effort to remedy, the Constitution of Kenya 2010 established parks and reserves, in a move to conserve wetlands and biodiversity, this move only considered only 20% of the delicate and ecologically sensitive areas leaving out 80% of sub catchments (MEMR, 2012b), Rwamuthambi sub catchment area being amongst the left out. Agwata (2005) who researched on Tana catchment area in Kenya exposed episodes of degradation caused by uncontrolled anthropogenic activities which resulted to droughts and floods the latter being attributed to 70% of the highly precipitated upper basin (UTaNRMP, 2014).

Rwamuthambi sub catchment WRUA has been in existence since 2005. Nevertheless, the sub catchment has experienced substantial degradation, extreme decline in availability of surface water mostly during dry spells and poor quality of water especially caused by siltation during rainy season (RSCMP, 2015). A study conducted in Upper Tana Basin by Agwata et al. (2015) sustained

the existence of degradation in the Tana basin. Later, another study conducted in Upper Tana catchment in the counties of Embu and Kirinyaga by Oritogun *et al.* (2018) revealed that degradation was rampant with the most affected being wetlands, springs and rivers whereby cultivation was done up to the eye, with others being drained for land reclamation whilst others were affected by growing of trees that were not ecologically compatible to water and wetland resources.

A clear indication was that the sub catchment's degradation persisted since there was no other available literature in regard to reversal of the sub catchment degradation. Subsequently, the current study embarked on assessment of effects of governance on Rwamuthambi sub catchment governance as a way to eliminate or inhibit degradation within the sub catchment and also contribute to understanding and resolving similar challenges in other sub catchments.

1.3 Research Hypothesis

The study sought to test acceptance or rejection of the following hypothesis

H_0: There is no agreement by the stakeholders on efficiency of government provision of wetland civic education towards wetland conservation

H_1: There is agreement by the stakeholders on efficiency of government provision of wetland civic education towards wetland conservation

H_0: There is no agreement by the stakeholders in regard to efficiency in delineation of wetlands as public conservation areas by the government in order to conserve wetlands

H_1: There is agreement by the stakeholders in regard to efficiency in delineation of wetlands as public conservation areas by the government in order to conserve wetlands

H_0: There is no agreement by stakeholders on efficiency of government provision of agricultural extension services to stakeholders for improved wetland conservation

H_1: There is agreement by stakeholders on efficiency of government provision of agricultural extension services to stakeholders for improved wetland conservation

H_0: There is no agreement by stakeholders on efficiency of government encouragement towards public participation in conservation of wetlands

H_1: There is agreement by stakeholders on efficiency of government encouragement towards public participation in conservation of wetlands

H_0: There is no agreement by stakeholders on government efficiency in provision of incentives towards conservation of wetlands

H_1: There is agreement by stakeholders on government efficiency in provision of incentives towards conservation of wetlands

H_0: There is no relationship on perceptions of contribution of WRUA services amongst the three ecological zones of Riakiania- Kiambagathi- Forest, Kirimaini- Gathiuriru and Baricho- Kagio- Kwa V.

H_1: There is a statistically significant relationship on perceptions of contribution of WRTUA services amongst the three ecological zones of Riakiania- Kiambagathi- Forest, Kirimaini- Gathiuriru and Baricho- Kagio- Kwa V.

1.4 Purpose of the study

The purpose of the study is to assess effects of governance on management of Rwamuthambi sub catchment area. Subsequently the study considered public participation, decision making, accountability and transparency, efficiency and effectiveness, equity and effectives, inclusiveness and consensus oriented elements of governance.

1.5 Objectives of the study

1.5.1 General objective

The main objective is to assess the effect of sub catchment governance on management of water resources in Rwamuthambi Sub Catchment- Tana Basin, Mount Kenya region.

1.5.2 Specific objectives

1. To assess status of governance in Rwamuthambi Sub catchment.
2. To evaluate the influence of governance by Water Resource Users Association on the Sub catchment.
3. To evaluate monitoring and communication of Sub catchments sustainability.

1.6 Research questions

The study focused on answering the following research questions based on the objectives.

i. How is the status of governance of Rwamuthambi Sub catchment?
ii. To what extent have WRUA influenced governance system in the Sub Catchment?
iii. What is the framework for monitoring and communication of Sub catchments sustainability?

1.7 Justification of the study

Kenya Vision 2030 blueprint of 2007 cited water resources ecosystems as major elements for spanning the flagship projects like tourism, agriculture, industry, urbanization, energy production etc., for economic growth. But wetland degradation in Rwamuthambi sub catchment has been increasing over the past years in spite of review of the water act in Kenya which established local based water resource users' associations to oversee wetland governance and management

improved management of the sub catchment could enhance the livelihood of the community and by extension propel the country to industrialization and urbanization.

Furthermore, the study interrogates the adherence of the Constitution of Kenya 2010 (10) (2) on principles of governance and national values including but not limited to good governance, public participation in decision making, accountability, transparency, efficiency and effectiveness, equity and fairness and sustainable development.

In addition, the sub catchment traverses three agro-ecological zones ranging from Upper Midland-I humid climate, Upper Midland-II sub humid through to Upper Midland-III which is semi-arid conditions (Jaetzold *et al.,* 2007). This agro-ecological zone variation presents varied scenarios, strategies and approaches during interaction with the sub catchment as the community ekes out their livelihood, agriculture being the economic main stay. Therefore, the findings of this study can apply to a wide spectrum of sub catchment. The results of this study has potential for comprehensive information to interest groups and stakeholders including researchers, policy makers and the local community on governance of water resources within the sub catchment and to those sub catchments which are similar or face related challenges.

1.8 Scope of the Study

Rwamuthambi Sub Catchment which is the area of study is formed by Rwamuthambi River and its tributaries. This is one of the major rivers flowing from Mount Kenya forest into Nyeri County on the upper side before flowing constantly through Kirinyaga County up to its confluence with River Sagana which lies within the Upper Tana basin. Downstream River Sagana is later known as River Tana when it falls within Lower Tana Basin. Geographically, the study area is bounded by the limits of the drainage system that flow to River Rwamuthambi by gravity.

Further, the study was restricted on assessed of only some of good governance elements which included accountability, public participation, equity and fairness, efficiency and effectiveness and decision making. The respondents in the study included selected, household heads, relevant departmental heads within the sub catchment, sampled national government administrators with the jurisdiction of the study area and WRUA management committee members.

1.9 Limitations of the study

The study is limited to the extent that it did not involve other WRUAs within Upper Tana Catchment area or from other catchments from different geographical areas but only concentrated on Rwamuthambi WRUA. This was due to limitation in finances and time constraints for the study. Whereas this created a generalization of the useful lessons identified, the study area traverse through of three agro-ecological zones thus providing a wide spectrum for application. Thus the results could apply to a myriad of water resources governance issues in the tropics and beyond, that are typical with Rwamuthambi sub catchment area.

Carrying out household interviews involved physical visits to the sampled home steads which lay along difficult, winding terrain which could only be accessed on foot. This meant that more time was invested in covering the area of study, thus more resources employed. This was overcome by adding the number of days for data collection. Analysis data which was mainly qualitative was through use of Stata software (Stata Corp LLC, USA) which enabled easy data management and visualization. In addition, the study employed exploratory descriptive design in order to establish most of the information owing to shortage of literature and prior studies for the sub-catchment. To eliminate bias, the questions were designed to interrogate same issue from different perspectives.

CHAPTER TWO: LITERATURE REVIEW

This section presents literature review on governance of water resources including causes of degradation and various ways degradation has been addressed, community involvement in management, relevant policy issues, institutional framework, inter- sectoral collaboration and decentralization. Through literature review gaps which informed the study were identified. A conceptual framework was formulated revealing strategies that would be used to attain a sustainably managed sub catchment.

2.1 Catchments, wetlands and water resources

The well-being of human life and existence on earth depends on the many ecosystem benefits especially from wetlands that are healthy. Nathalie *et al*. (2006) and MEMR (2012b) highlighted water resources as one of the key factors for future development and as fundamental to economic productivity and social well-being. It is notable that of all the ecosystems wetlands have received the highest impact evinced by degradation and loss caused by land use changes, development of infrastructure and increased water diversion and abstraction, (Lao 2013; Munishi *et al.*, 2012). Ironically, Waarde *et al.* (2005) averred that one of the ways of averting poverty is through provision of access to safe and clean water for drinking. The main threat to water resources include water scarcity (only one third of 3% of global water which is fresh is found as ground and small amounts on the surface and in the air), water pollution (mainly from sewage) water conflict and climate change. Therefore, increased population is directly related to need for more water resources especially to the poor in society and should be involved in conservation and wise use of wetlands.

2.1.1 Catchments

A catchment is an area of land often bounded by hills where the surface water from rainfall (mainly in the tropics) or precipitation flow into a lower elevation collected by the natural landscape to form a single body, which could surface water (reservoirs, rivers streams, lakes), wetlands and all groundwater beneath and any activity occurring within a catchment affect the entire catchment (Aglanu, 2014). Every point of land on the surface of the earth forms part of a catchment. It forms an ecosystem thus becoming the standard functioning unit of a landscape which provides a linkage between water, soil and living things (Georges River. n.d). A catchment is also known as a watershed or a drainage basin. It therefore comprised of all land and water areas which contribute run-off to a common point. Large catchment areas may contain many sub catchments (USGS.gov 2019).

A sub catchment is formed by a collection of tributaries or several wetlands (Aglanu, 2014) connecting to a larger river that flows through a valley (Dunne & Leopold 1978). Rwamuthambi River is an example of a sub catchment which is formed of several tributaries and wetlands and demarcated by natural structuring of the topography (RSCMP, 2015)

2.1.2 Wetlands

Wetlands are found everywhere on the continent apart from in the Antarctica. Varied factors determine the type of wetlands. Some wetlands exist in ecosystems consisting of hydrophytes which could be on rock shores or in could be in other areas regarded as wetlands just because of their seasonal flooding like for the case of tidal flats and gravel beaches. Therefore, soils are not necessary condition for wetlands (Tiner 1997). The functioning of wetlands is influenced by hydrological factors which include geomorphological settings, hydrodynamics, micro and soil type (Brouwer, 2003).

There has been a challenge in coming up with a universal definition of wetlands (Flournoy, 1997 Finlayson et al., 2011; Copeland 2010). Wetlands may be referred to as ecosystems that integrate terrestrial and aquatic (water, soil and vegetation) environments (Lathrop 2011). Wetlands may also be described as waterlogged places where there's a high-water table covering the landscape with depth less than six meters permanently or seasonally flooded (Hejney *et al.,* 1998).

Although a wetland may experience extended dry spells, the water table is at or near the surface to support aquatic ecology. The water logging causes particular characteristics in the soil development and attracts plants, animals and microbial adapted to live in such biogeochemistry.

Wetlands may be classified according to the region (tundra or tropics), soil types, topography, climate hydrology, vegetation type or type of water (Yates 1998, Kecha *et al*. 2006). Wetlands could be fresh, brackish or saline water. They may occur in isolation or as an immediate place between land and water (Tiner 2012). In Kenya, wetlands are defined as man-made or natural areas that are permanently, seasonally or intermittently waterlogged with fresh, saline, brackish or marine water and supports characteristic biodiversity (Kenya National Museums, 1999).

Generally, there are two broad categories of wetlands, coastal or tidal wetlands and inland or non-tidal wetlands. Coastal or tidal wetlands occur at estuaries and consist of saline water arising from the mixture of sea water and fresh water due to tides emanating from the sea. Inland or non-tidal wetlands occur on flood plains and riparian areas, in depressions and margins of lakes and ponds where ground water or precipitation saturates the soil (EPA, 2018a).

However, there are several generalized types of wetlands as explained by Mitsch and Gosselink (2000), Tiner (1998) and reiterated by Collins (2005), Wood (2013). Marshes are wetlands that are flooded throughout or only during high precipitation and are found mainly at the edges of rivers, lakes, ponds or streams. Wet meadows have permanently or almost permanently saturated

soils. Peatland are formed by accumulated decaying plants. Fens and seeps are wetlands mainly sustained by underground water whether alkaline or fresh water respectively. Bogs rely on precipitation as their only source of water and tend to be acidic and low with nutrients and oxygen. Swamps and Marshes are similar to lakes but are shallow permitting vegetation to grow up to the surface. Whereas swamps are dominated by trees or woody plants tolerant to water, marshes being shallower than swamps support grasses, reeds and are dominated by aquatic animals, usually found along rivers and slow-moving streams.

2.1.3 Water resources

The major relationship between wetlands and water resources is that wetlands act as capacitors buffers and connectors (Bergkamp *et al.*, 2000). Water resources are sources of water that are beneficial or potentially beneficial to humans which include household, agricultural, industrial, recreational and environmental activities. According to UN et al. (2005) environmental acticvities include those activities that lower or abolish pressures to the environment with an intention to create efficiency in the use of natural resources.

As capacitors, wetlands regulate the water quantities, the water cycle, supply of water and water quality (Bergkamp *et al.,* 2000). For similar reasons wetlands are thus known as the "earth's kidneys" (Momanyi (2005), Junhong *et al.* (2013), Mitsch *et al. (*2015) and "natures supermarkets" (Momanyi 2005, Mitsch *et al.,* 2015). The comparison to kidneys is because wetlands receive water filters waste and clean pollutants as the water flows downstream; mitigate floods, droughts and recharge water aquifers. Subsequently, wetlands provide livelihoods to the local communities as they rely on controlled flooding which maintain the water table and recharge of surface water (Bergkamp *et al* 2000). The term biological supermarkets was implied because wetlands form a food chain-like over and above supporting a broad biodiversity, provide habitats and in addition act as a global carbon sinks and creates climatic stability (Momanyi 2005, Mitsch *et al.,* 2015).

As buffers wetlands conserve the landscape. In the upper catchments, wetlands are important in conservation of water in a drainage basin allowing time for infiltration and quality maintenance. Moreover, wetlands contain surface run-off hereby minimizing soil erosion. The water held and cleaned here is then used downstream for variety of activities depending on its purity. In the lower floodplains and catchments, wetlands play a similar role and also act as buffer along river banks, tributaries and around lakes (Bergkamp *et al.,* 2000).

Wetlands as connectors between habitats, biomes, ecosystems and communication for residents and provide migratory routes and also provide components necessary for biological diversity conservation besides the functions of flood mitigation, filtration and water quality regulation. The connectivity is multi-directional (longitudinal and lateral) sustaining a catchment ecological stability. This allows movement up and down along say a river corridor or along estuaries and interaction between terrestrial and aquatic organisms by providing a gradual gradient of water level (ibid).

2.2 Global and local overview of water resources governance

According to Global Monitoring Report (GMR) of 2009, governance refers to power relationships which include formal and informal processes of policy formulation and resources allocation, processes of decision-making and mechanisms for holding governments accountable. Water resource governance operates on the premise of consensus which transcends beyond government to reach out to society for enhanced effectiveness (Stoker, 1998; Terry, 1998; Peters *et al.*, 1998) including the principles of managing power, and incorporates non-state actors for the well-being of the citizens and utilization of resources for improved public life and social up-lift. Water resource governance includes political, economic, social and administrative processes formulated

for development and management of water resources and delivery of water services (GWP, 2002, Rogers and Hall, 2003).

Wetland governance is premised within the water resource governance whereby wetlands are viewed as natural water infrastructure inherent to management of water resources at the catchment level (UNDP, 2004). Wetlands have been ascertained as the main source of ecosystem services including supporting, provisioning, regulating and cultural attributes. These services are the constituents of human wellbeing transcending through security, basic material for life, health, good social relations and freedom of choice and action (Saito, 2015). At some stage there were negative views about wetlands. For instance, Mathews (1993) stated that wetlands had been regarded as useless while Gardner (1996) and Kecha *et al.* (2006) added that they were referred to as nuisance while Ndaruga and Irwin, (2003) revealed that wetlands were viewed as 'wastelands' and areas that harbored diseases and dangerous animals. Such negative perception may have led to large scale pollution, drainage and modification into alternative uses without regard to ecological and socio-economic values resulting to high wetland degradation as experienced in the study area.

2.2.1 Causes of degradation

Water resources degradation occurs when wetlands undergo negative alterations to their natural status due to anthropogenic activities which include agriculture, industry, disorderly urbanization and increase in population (GNF, 2002). Globally, water resources degradation was attributed to a myriad causes. The main causes of degradation arise due to unsustainable management of the ecosystem services. These include agriculture due to eutrophication (Galloway *et al.* 2008, Harper 1991), pesticides and chemical inputs (Hamilton, 1993) human activities on wetlands which include tourism and related activities like infrastructure destruction of flora and fauna, urbanization, water extraction- over abstraction (Acreman *et al.*, 2000), dredging and encroachment into wetland (Paul *et al.,* 2011), sewage caused by inefficient treatment works (Moss

et al., 1996), garbage (Sunlu, 2003) and organic pollution (Mason, 2002). The study area faces similar challenges and the study envisage to establish how governance was applied as a remedy

A study conducted in Kenya Upper Tana catchment area by Agwata (2005) revealed that the catchment degradation was due to reclamation of wetlands for farming, clearing of forests for grazing and charcoal burning, growing of ecologically unfriendly tree species like eucalyptus culminating to increased floods and drought. The study only proposed institutional frameworks necessary for an integrated and sustainable management of water resources in Tana basin. The current study bridges the gap through analyses WRUA influence to the governance of water resources in Rwamuthambi sub catchment, which is a tributary of Upper Tana basin.

One of the main causes was citizen related factors. For instance Hartter and Southworth (2009) established that increased population growth culminated into encroachment of ecologically fragile land due to demand for agricultural land as witnessed in Western Uganda due to diminishing wetlands, forests resources and landscape fragmentation as a culmination to land subdivision on sub catchment areas. This study however did not provide a solution to the dwindling water resources but only highlighted their plight and extent. The current study analyses conservation management of water resources by WRUA.

Bakema and Iyango, (2001) and Streever (2012) indicated that degradation was caused by lack of awareness regarding benefits and functions of wetlands while Robb (2002) and Brown and Lant (1999) stated that degradation was due to individual's failure to relate their isolated actions as a cause to cumulative negative consequences including pollution. For instance a study of Yangtze River in China by Yang and Muller (2009) posited that the main challenge of water resources management was effluents released into the river from domestic and industries posed a challenge in water resources management affecting mostly downstream. This study only highlights

application of Integrated Water Resource Management (IWRM) but does not evaluate local institutions like WRUA for a solution which the current study addresses.

Other contributors to degradation are policy related. This category include undecipherable land tenure and unclear ownership of wetlands as exposed in a research conducted by Le bel et al. (2011) on human-wildlife conflict in Mozambique and Zimbabwe. The findings established that where land was held with uncertain land rights, those utilizing the wetland had negligible inclination towards wetland conservation concluding that unclear ownership of wetlands contributed to degradation. This current study thus sought to establish why degradation occurred in Rwamuthambi sub catchment area despite the wetlands being under secure land tenure.

Finally, institutional challenges were another major factor of degradation. Doremus (2009) research in CALFED Bay-Delta Program of California blamed degradation as a consequence of institutional fragmentation whereby regulatory responsibilities within a single political jurisdiction get divided amongst multiple institutions (like at the federal level, there were different institutions to oversee water quality, water allocation, licensing of hydropower, protection of wildlife, farming, urban development, flood control etc.), irrespective of whether the activities target the same water resource.

Kalikoski et al. (2002) in the case of the Estuary of Patos Lagoon on fixing institutions to ecosystems in artisanal fisheries management unearthed that failure of institutions was a cause to degradation. This finding was supported by Ostrom *et al.* (2007) during the United States proceedings of National Academy of Sciences, and also by Pahl-Wostl *et al.* (2008) on a study on theoretical explanation for global water system governance concept that the problems faced in resource management did not emanate from the resource base but were more associated with failures in institutions fitted in the environment they managed. Additionally, a study in Northwest

Cameroon by Bikwibili and Danny (2018) on challenges and potential of community-based water resource management established that water resources challenges mainly emerged from insufficient institutional frameworks leading to lack of coordinated development policies due to top-down approach to resource management and deficient capability for maintaining water systems. The study addressed the gap by assessing how Water Resource Users Associations can transform a wetland

2.2.2 Community-based approach and community involvement in water resources management

Various studies conducted came up with different ways for community to resolve degradation challenges. For instance, a study by Dawson et al., (2003) in UK and Ireland on impacts of climate change on freshwater wetland habitats and another by Chuma et al. (2008) on Southern Africa inland wetlands similarly revealed poor policy implementation on areas requiring community involvement. The findings further provided that concerted effort in ensuring a balance between utilization and conservation was required in order to improve the community livelihood considering the diverse habitats of an ecosystem. The current study analyzed policy implementation and concerted efforts needed for a balanced utilization and conservation.

Mathenge *et al.* (2014a) and Mathenge *et al.* (2014b) in a study on Ngaciuma- Kanyaritha basin of Tana catchment area in Kenya indicated that Community Water Management Systems (CWMS) were instrumental to water security and that they required recognition by WRUA as contributors to water resource supply. Maconaiche *et al.* (2009) in another study conducted in Ethiopia and Sierra Leone that investigated devolution and local institutional arrangements argued that in spite of policies being formulated with a target of including communities and multi-stakeholders' participation in natural resource management, there was insufficient discussion on incorporation of existing local institutional efforts in wetland management especially in developing countries.

The study noted that there were various institutions relevant to water resources that still had a stake in sub catchment management rather than inclusion of local communities as provided for in various policies. The current study sought to address this gap

DeCaro and Stokes (2008) on community-based programmes for natural resources conservation and motivation towards conservancy conducted in developing nations both stated that water resource degradation could be controlled through offering relevant education regarding functions and benefits including training on wetland conservation to stakeholders. The current study interrogated this by evaluating correlation between level of education and relevant water resources related knowledge.

Goldman (2003) in the study of Tarangire–Manyara ecosystem in Tanzania on Community Based Conservation (CBC) models established that introduction of community-based conservation and emphasis on devolution was mere rhetoric because governance approach was still top-down with local indigenous knowledge featuring only at the periphery, despite the premise that the local wetland knowledge would reflect better on social and ecological goals of a wetland. This study does not highlight on the role of water resources management institutions. The current study incorporates collaborative governance theory in community based institutions through WRUA.

Crow & Sultan (2002) noted that the ability of the community to be able to manage the water resources effectively and ensure equitable access to water services is hampered by corruption by individuals who compromise on proper use of water, finances, development activities and own governance. The study addressed this gap by evaluating the influence of WRUA to governance of water resources.

2.2.3 Relevant policies for water resources governance

Different studies where wetlands were under varying terms of ownership and tenure portrayed a pointer on direction of conservation. For instance, studies by Hartter and Ryan (2010) on

management of natural resources, decentralization and usufruct rights in regard to Forests and Wetlands of Western Uganda and Timmer (2004) on community-based conservation and leadership in the Tropics both concluded that where communities had secure usufruct rights to wetlands, degradation was minimal as there was responsibility in conserving the resource base.

Similarly, a study conducted in Uganda by Barakagira and de Wit, (2019) on how wetland management agencies in the community would promote wetlands conservation revealed that there was negligible or no degradation of wetlands where local community was permitted to farm at the riparian since they observed set wetland boundaries. In addition, the findings supported the earlier argument by Schwartzman et al. (2000) in the study on Tropical forest conservation that local people are instrumental to long term conservation and dispenses the notion of viewing rural people and local residents as enemies of nature. The study strived to address this gap through a framework to monitor and communicate sustainability of water resources.

Oruma et al. (2007) conducted a study in Kenya on Mau catchment area and recommended preparation and implementation of sub catchment management plans as a solution to enhance wetland sustainability. Additionally,

.Similarly, Rwamuthambi sub catchment area had a WRUA management committee in place and a sub catchment management plan prepared in 2015 (RSCMP, 2015). Regardless, Agwata *et al.* (2015) posited that Tana catchment area still faced flooding and prolonged dry spell, while RSCMP, 2015 stated that there were challenges arising from land tenure system and poor collaboration from relevant institutions. Furthermore, a research by Pahl- Wostl *et al.* (2015) posited that impact of change in governance approach could only be realized in time scales of decades and not in years, of which the sub catchment was slightly over 15 years since its

establishment. A research by Oruma *et al.* (2007) recommended preparation and implementation of sub catchment management plans as a solution to enhance wetland sustainability

2.2.4 Institutional framework

Kalikoski *et al.* (2002) posited that institutions would offer solutions to wetland degradation through governance. In addition, there was need to understand water resource management institutions in governance to enable resolve prevailing environmental problems since the institutions are formed by people. Further, Pahl-Wostl et al. (2008) advocated that sub catchment-level water-related issues, could be handled best in the sphere where it occur, that is locally. In review of suggestions on how institutions would address wetland resource degradation and conflict, Doremus (2009) supported the local intervention idea and alluded that this would be through creation of institutions which had authority and responsibility to match the scope and geographical extents of a resource noting that environmental problems are best resolved through fragmented governance institutions braced with strong leadership and necessary tools to resolve inter-agency conflicts.

The works of Cronin et al. (2015) in Asia on water, sanitation and hygiene policy agenda argued that equitable, sustainable and quality universal access to water resources could only be achieved through institutional and policy reforms in order to make data available and improvement of cross sectoral integration at national and local levels. Bassia et al. (2014) in the study of wetland status in India concluded that wetland conditions are a factor of institutions socio-economy and physical environment. The current study bridged this gap by reviewing the status and dynamics of Rwamuthambi sub catchment area governance

2.2.5 Inter-sectoral collaboration

Swatuk (2003) in the study of application of Ramsar convention guidelines on wise-use in Botswana's Okavango Delta System noted that when disjointed decision-making came from

various departments and agencies, no common goal would be attainable. In furtherance to institutional involvement in eradication of degradation Pahl-Wostl et al. (2008) posited on the need for multileveled designed water resource governance but preferred prominence of global approach as opposed to local approach. A later study by Pahl-Wostl (2015) on review of water governance against global change revealed that emphasis had been placed on inter-sectoral policy integration and vertical and horizontal coordination in water governance and management. In support, Duit et al. (2010) and Gupta et al. (2013) postulated that institutions would resolve degradation challenges through multilevel governance and management, coordinated inter-sectoral and involvement but across all government levels. Ironically, most decisions including land use, hydro power generation and infrastructure development that affect water resources did not emanate from water sector (Pahl-Wostl et al., (2020). Furthermore, Joshi and Bhandari (2016) in the study on shaping and reshaping conservation and paradigm shifts in wetland governance in Nepal noted that it is therefore not unusual that in spite of existence of the established institutions for resource governance and management there are notable challenges from the roles each played. The current study evaluated inter-sectoral collaboration and management of a sub-catchment.

2.2.6 Decentralization of water resources governance

Maconaiche et al. (2009) from the study on devolution and arrangements of local institutions for wetland management in an Ethiopia and Sierra Leone-based study established that decentralization hampered development of mature local institutional arrangements caused by political intervention. Furthermore, a study conducted in Columbia River basin by Vogel (2012) involving catchment parceling out and reorganization of basin-based territory management injected some caution revealing that introduction of another level of decision-making be it local could exacerbate unequitable distribution of power rather than guaranteed improvement in resource management. Moreover, Pahl-Wostl and Kniepe (2014) argued that in spite of reforms in governance systems in

support of decentralization, the main challenge was lack of coordination which made devolution cause more fragmentation. This current study focused on transformation of wetlands through WRUAs that are elements of decentralization.

2.2.7 Summary of literature review and Research gap

Subsequently, the works of Hartter and Southworth (2009) on effects of land subdivision to sub catchment areas and works of Goldman (2003) combined with DeCaro and Stokes (2008) together with Goldman (2003) on conservation through wetland functions training and awareness, effects of land rights to wetland conservation by Timmer (2004), Le bel *et al*. (2011) and Barakagira and de Wit (2019) and the role of institutions in governance and wetland management by Doremus (2009), Kalikoski *et al.* (2002), Gupta *et al.* (2013) and Duit *et al.* (2010) laid foundation for this study. Regardless, authors Ostrom *et al.* (2007) injected a note of caution that due to the varied preferences and perceptions of resource users, all problems of governance cannot be resolved through a panacea presented in a simple set of model expected to offer a blueprint to either, government ownership governances system, privatization governances system or community property governances system for instance to apply to all environmental problems. Therefore as postulated by DE Stefano et al. (2014) based on research undertaken in Middle East and North Africa countries on concepts and approaches for water governance, it is critical to undertake regular assessment of status of existing governance frameworks and come up with alterations when needed. This finding requiring regular studies governance status is addressed through the current study

In addition, Lao (2013) and Munishi *et al.,* (2012) postulated that wetland governance is attained when there is interaction amongst policies and legislations together with institutions and systems through which the community exercises power and shares out responsibilities for making and implementing decisions that affect wetlands and wetland decisions and how the decision makers

are held accountable. This meant that coordination and setting of rules would be based on negotiations and interactions as opposed to imposition, ideally from the top usually by one actor (Young, 2010; Huntjens *et al.,* 2011; Plummer *et al.,* 2013). Thus, this current study approached the problem of degradation from several angles through assessment of dynamics of governance in management of Rwamuthambi sub catchment area, evaluation of how WRUAs could transform a sub catchment area and also evaluated of monitoring and communicating sustainability of the sub catchment.

2.3 Theoretical Framework

The concept of collaborative governance involves making processes and structures which involve multi-organizational, inter-sectoral and multi-leveled stakeholders in managing public purpose programs or implementation of public policy which could otherwise not have been resolved by a single organization (Emerson 2018; Ansell and Gash, 2008; Emerson *et al* 2012; Agranoff and McGuire 2004). According to Bingham and O'leary (2015) success in collaborative governance is attained when there's a nexus between public and private sector. Generally, collaborative governance is viewed as a non-state dimension of participation (Ansell and Torfing, 2015; Bartelli and Faciolli 2016; Torfing and Ansell, 2017). It is noted to be influenced by several variables which include leadership, existence of prior cooperation or conflict, power sharing and resource inequalities, incentive for stakeholder participation and institutional design. Collaborative process also depend on the following factors that include dialogue, building trust and dedication and fostering a common understanding which can be engraved through focusing on small wins (Ansell and Gash, 2008).

According to Sun, (2017) and Tomo et al. (2018) collaborative governance provides cooperation for public and private sector through formal and informal interactions. The initial use of

collaborative governance theory was in 2004 (Donahue 2004) and later in 2006 in public collaboration by Donahue and Zeckhauser (2006). Sun (2017) has described three theoretical characteristics of Collaborative governance. The first is diversity implied as broad-based to include government, non-state actors, enterprises, public and other subjects who participate in managing social activities. This operates under the notion that collaboration between two or more actors synergize to yield greater results than what the entities would achieve separately. The second theoretical characteristic is order in the functions of various subsystems. Order is crucial to achievement of overall functions say, through exchange of resources and information sharing but also accomplished due to compliance of set rules. The last basic theoretical characteristic of the theory is purpose. Purpose is usually construed to be established by government mainly with an aim to improve achievements and elevate public interests.

In view of collaborative governance theory, the study interrogates the extent to which WRUA have impacted on wetland sustainability in line with public participation, utilization and sensitization. This study is a research that assessed degradation and how governance is used in conservation of a sub catchment. It took into consideration that the drainage basin forming the catchment runs through privately owned parcels of land while still the catchment area is under the jurisdiction of WRUA and that besides the land owners, there were other stakeholders, enterprises and non-state-actors who came into play

Further, the study focused on application of bottom-up approach stated to provide insights into organizational review and consensus in decision making while reviewing equity and fairness which promoted governance structures geared towards sustainable catchments. Just as the theory provides, the study focused on inter-sectoral synergy achievement rather than individual entity achievement. The study supports collaborative governance theory and what Rogers (2014) stated

that social change can only be attained through organizations incorporating the community and public participation.

Collaborative governance theory lines with modern society's expectation in pursuit of rationality and commitment to realize a balance between government and social forces. It's pivoted for supereminence and emphasizes on balanced efficiency and fairness.

2.4 Conceptual framework

This study looked at the effects of governance on management of Rwamuthambi sub-catchment area by espousing the fact that Water Resource Users Association (WRUA) are the institutions mandated to oversee water resources conflict resolution and collaborative management (GOK 2016). The study assumed that control of degradation depended on the effectiveness of WRUA. This assumption was supported by collaborative governance theory that sustainable sub catchments can be attained through engaging formal and informal collaboration and cooperation between private and public institutions.

The study conceptualized (Figure 2-1) that by establishing the status of governance of the sub-catchment, the information would provide governance strategies pre and post WRUA which would form a basis for lessons and improvement of the system. Similarly, the contribution of WRUA and challenges encountered during policy implementation would inform a preferred approach. Through stakeholder involvement, attributes to factors of sustainability were analyzed and how monitoring and communication the same affected the sub catchment. The concept envisaged that through public participation, sensitization, training, inter-sectoral resources management and addressing the issue of land tenure, the sub catchment would experience improved conservation and sustainability

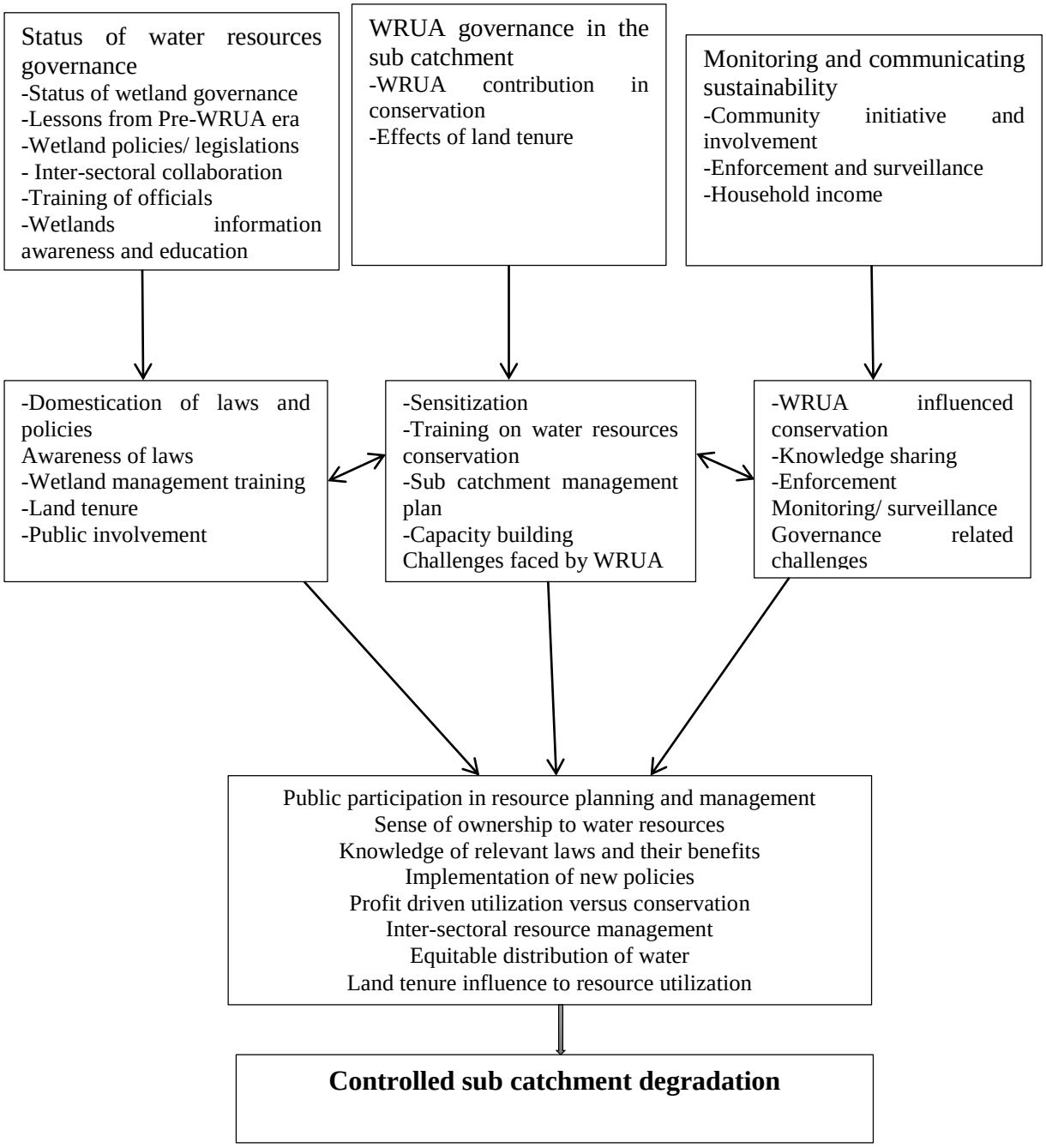

Figure 2-1 Conceptual Framework on variables in the study

(Source: Kumunga E.M, 2018)

CHAPTER THREE: MATERIALS AND METHODS

3.1 The study area-

The study was conducted in Rwamuthambi sub catchment in upper Tana basin, Mt Kenya region. It is situated within Kirinyaga County and partly in Nyeri County. The sub catchment covers approximately 168 km^2 of which 20 km^2 is under Mount Kenya forest while 148 km^2 is under human settlement with a density of 544 persons per square kilometer (GOK, 2010b). The settled area of the sub catchment traverses through the following locations Inoi, Mukure, Mwiirua, Kariti, Mutira, and Kinyaga. Within this settled area there are urban areas and market centres which include Muragara, Kagumo, Kabonge, Riakiania, Baricho, Kiandangae, Kagio, Kathaka, Sagana and Kwa V. The total river network stretch within the sub catchment is Tabout 80km. The study area was selected following noticeable change in sub catchment characteristics and size over time. The sub catchment comprises of streams (perennial, intermittent and ephemeral), swamps, irrigation projects and water pans, but the study concentrated on Rwamuthambi River which is the main drainage channel of the sub catchment. The altitude range is 2026.5-1140 meters above sea level over a running distance of 36kms. It lies within 0° 37' 6" S, 37°14' 57" E; 0° 37' 6" S, 37° 24' 34" E and 0° 69' 9" S, 37° 14' 57" E and 0° 69' 9" S, 37° 24' 34" E. The catchment area was delineated against adjacent sub catchments by use of GIS system through automated river overlay and consideration of drainage patterns as captured in satellite imagery through generation of Digital Elevation Model (DEM) (Sekulin *et al.* 1992, Bertolo 2000). Figure 3-1 shows the location map of the area of study.

Rwamuthambi River is a tributary of River Sagana also known as River Tana in its old stage falling within Lower Tana Basin. River Tana (Sagana) is one of the largest wetlands in Kenya (CGK, 2013, MEMR, 2012b; (Geertsma *et al.,* 2009). It flows through several sub locations of Mukure, Mwerua, Kathaka, Gacharu, Kariti and Kiine, before joining River Sagana.

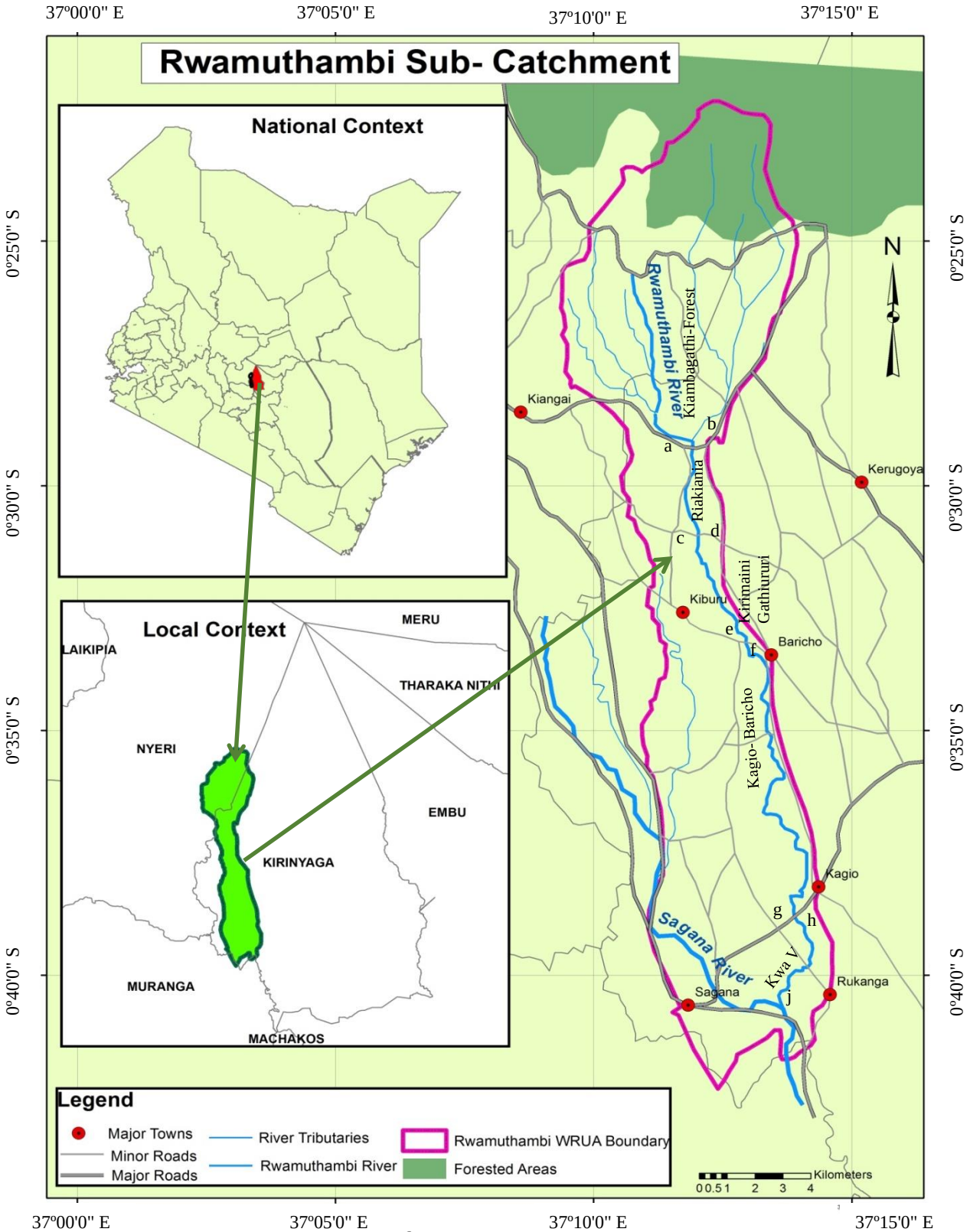

Figure 3-1 Map showing the location of the study area Source (RSCMP, 2015)

(a-b): Kiangai- Kagumo road; (c-d): Kabonge- Riakiania road; (e-f) Kiburu- Baricho road; (g-h); Sagana- Kagio road;
((a-b), (c-d))- Upper Midland-I, ((c-d), (e-f))- Upper Midland-II, ((g-h), (j))- Upper Midland-III

The area of study experiences tropical climate as a result of its close proximity to the Equator. It's on the windward side of Mount Kenya with annual temperatures ranging between 17°- 20°celcius mean annual. It is characterized by two rainy seasons; the long rains (mid-March – May) and short rains (mid-October- December) with an annual precipitation of 800- 1200mm. The rest of the months are dry (CGK, 2013; Jaetzold *et al.,* 2007).

The sub catchment study lies within three agro-ecological zones ranging from tea growing through coffee, Macadamia, fruits horticultural crops, maize to semiarid (UTaNRMP 2014b). It has well drained soils which are extremely deep, dusky red to dark reddish brown, friable clay, with acid-humic topsoil: humic nitisols (Jaetzold *et al.,* 2007). The area is mainly dominated by the Kikuyu community.

3.2 Research design

The study was based on exploratory- descriptive research design. Exploratory design focus mainly used for gathering insights and familiarizing with the area and problem of study and also to enable explain occurrence of some phenomenon and in deduction of effects following adoption of the new wetland policies that established WRUA. Through this design, review of previously published literature and personal interviews were incorporated. The narrated stories knit around the study area were collated with some forming the basis for questions include in the questionnaire (Cuthill, 2002; Taylor *et al.,* 2002). Descriptive design was used to reach objectives and test hypothesis that emerged from exploratory research so as to obtain status and describe what existed with respect to variables and conditions (Anastas, 1999).

3.2 Sampling

A stratified systematic sampling method was used for data collection. The strata were based on the proximity to the sub catchment and the immediate influence to the river. The study considered

different categories of respondents who included the land owners abutting both sides of the main Rwamuthambi River which forms the sub catchment basin selected through stratified systematic sampling over the area which was subdivided into five portions with the demarcations marked by tarmac road crossings. Every 5^{th} household on both sides of the river was subjected to the questionnaire (Gorard 2013, Leedy and Ormrod 2013, Pearson *et al.* 2012).

Water Resource Users Association Management Committee Members (WRUA-MCM) were considered following their pre-selection through purposeful sampling. The committee members had been identified based on three agro-ecological zones defining the sub catchment where each zone was represented by seven democratically elected members from within itself. The government officers were identified from relevant departments while local administrators considered had jurisdiction over the study area. Focused group discussions were also organized with WRUA-MCM. Key informants were identified purposively.

3.3 Pre-testing of questionnaire

Pre-test was done in the month of June 2018 to establish that the questions worked as intended and were understood by the respondents (Hilton, 2017). In addition the pretest ensured that the questions were asked accurately to reflect the information desired by the research and also gauge the reaction of the respondents towards the interview. Pretesting was done on a small sample of the target population (Grimm, 2010). The study conducted a pretest on 30 respondents. Through interrogating the interviewers and respondents the duration expected in filling a questionnaire was established and also managed to get preliminary data for analysis that was to determine and gauge the understanding of the questions and answers given, duration taken to fill a questionnaire. The feedback was used to improve on questionnaire design and ensure that objectivity is sustained (ibid).

To conduct the pretest the data collectors were trained and questionnaire administration similar to the real one conducted. Perusal of the pretest questionnaires, compilation and preliminary analysis was performed. This exercise led to review to some of the questions that were open ended into guided answer questions and inclusion of a rating system in the answers in order to deduce trend of issues and their frequency during data collection. .

3.4 Sample size

The latest population census of 2009 GOK (2010b) registered the sub catchment area to have 46,031 House Holds (HH). Out of this 19,800 HHs parcels abutted the main channel based on Water Resource Authority (WRA). Sample n was obtained Cochran's formula for large populations Horse (2018), Rucker (2017).

Computation of sample size

The Cochran's formula provides that;-

$$n_o = \frac{Z^2 pq}{(e_p)^2}$$

n_o =Cochran's sample size recommendation

Z = Z value (i.e. 1.96 for 95% confidence level)

p =Proportion of the population abutting Rwamuthambi River provided by RSCMP, (2015) as the sub-catchment area was not exclusively gazetted as a census zone (GOK, 2010b)

e_p = Desired level of precision-confidence interval ±7% = (±0.07))

q= 1- p (0.5)

n_o =1.96^2 *0.5*0.5/ $(0.07)^2$= 196

Out of the total sample of 196 households, 58 households abutting Rwamuthambi River who formed the first strata and 134 households within the sub catchment but not touching on the river channel comprising the second strata. 27 officers were also targeted who included 21 WRUA management committee members, 4 government officers (County Government department of Physical Planning, Department of Agriculture, Kenya Forest Service (KFS), WRA and 2 local administrators (a senior chief and an assistant chief). 15 key informant interviews were conducted and three focused group discussions held.

The total target sample was therefore 223 questionnaires.

3.5 Data collection

Data was collected between the months of July and September 2018. Various techniques and tools employed included interviews by questionnaires; transect surveys, observations, key informant interviews, focus group discussions (Nyumba, 2018) and review of documents and records (Pearsman 2014). Secondary information that was used for the study was mainly from topographical and registry index maps, relevant literature from publications, journals and books in the relevant field. Satellite imagery were also used. Relevant local policies, laws and legislations mainly environmental related like water act and land acts and international conventions formed part of the study materials.

The questionnaire comprised of four parts. The first three parts each represent the research objectives while the fourth and last part targeted the general bio-data of the respondent. Precisely, Part one of the questionnaire inquired available information in regard to status of governance of the local wetlands and information within the public domain in regard to legislations, institutions, community involvement sensitization and capacity building. Issues of monitoring surveillance and enforcement were inquired.

Part two interrogated effects of existing governance on management of Rwamuthambi Sub Catchment, inquired on causes of degradation, factors of wetland destruction, social impacts attributed to governance contribution of WRUA to governance of the sub catchment and inter-sectoral involvement and specific elements of governance as appreciated by the respondents. Land tenure was investigated and its effect to utilization of the sub catchment and community involvement and participation in matters of the sub catchment.

Part three investigated scenarios of governance that would influence sustainable utilization of the sub catchment. This section investigated on community best practices that ensured wise use of the sub catchment, governance related challenges and how they could be addressed, effects of government involvement to the utilization of the sub catchment and dimensions of governance as well as opportunities gained through embracing initiatives fronted by good governance besides community initiatives for sustainable conservation of the sub catchment. Existence of Rwamuthambi sub catchment management plan and its contribution through its implementation was also sought. Respondents were also requested to provide views on how to improve good governance.

Part four was on respondents bio-data which was necessary for supplementing information availed in the first three sections. This part investigated on age, gender, level of education, level and sources of income and residence.

3.6 Data Analysis methods

The collected data was cleaned in order to remove any unnecessary information and eliminate redundancy. Errors were checked through screening, examining spelling mistakes, and identifying missing data. The errors detected were corrected, variables rectified and a field verification carried

out in order to fill in the missing data. The clean data was coded according to various categories ranging from variables, names, types of measurements and missing variables (Schoenbach, 2004). The cleaned data from questionnaires were analyzed using various methods and software. These included Stata software (Stata Corp LLC, USA), regression analysis at 95% confidence level, (Youssef 2012) MS Excel software and SPSS (Coolican, 1994; Schoenbach, 2004),Chi square at 95% confidence level (Cohen 2010; Kao *et al.,* 2007), Kendall's coefficient of concordance (W) (Jeevanand (2020), Legendre, 2010; Mattson, 1986) and Spearman's rank correlation (R_s) (Lovie, 1995). A five scale agreement or disagreement was determined using Likert scale (Likert, 1932; Jameison, 2004; Elaine and Christopher, 2007). Analysis Of Variance (ANOVA) was used where several variables needed to be divided into distinct components and determine the significance based on the null hypothesis against alternative hypothesis and the difference between (Cohen, 2010; Kao *et al.,* 2007). Conclusion and way forward was arrived at through interpretation and discussion of the results.

3.7 Quality assurance

Quality assurance was introduced in order to ensure that the methodology employed was not biased as well as to determine the authenticity of the results arrived at during analysis. This was done by preparing interview questions framed such that they would act as checks and balances for each other in such a way that they would interrogate the same thing in a different perspective (Saunders *et al.,* 2003). This assisted in establishing authenticity of answers given in a particular matter. For instance, the respondents were asked regarding the mechanisms that govern wetlands in question 1b of Part I and at the same time inquired on who conducted surveillance and monitoring of wetlands in question 8 of Part I. Both questions yielded answers that followed the same perspective.

In addition, question 3 of Part I inquired on contributions of Water Resource Users Association (WRUA) to governance of Rwamuthambi Sub-catchment in order of priority and at the same time in question 4 Part III inquired on how government involvement affected the community in regard to sustainable utilization of Rwamuthambi Sub-catchment. There was an inquiry on traits of good governance and accountability and these were met in Rwamuthambi sub catchment in question 5 of Part I. This compared to question 4 of Part II which was about social impacts that had arisen as a result of the current state of governance. The answers given by the respondents to these questions were expected to follow the same trend.

3.8 Compliance with ethical standards

The consent of participants in interviews and questionnaire survey was sought before each individual participant. Ethical clearance for the research was sought and granted by National Commission for Science, Technology and Innovation (NACOSTI) Ref: No. NACOSTI/P/18/10767/23007

CHAPTER FOUR:

Dynamics of governance in management of water resources; A case of Rwamuthambi sub catchment, Kenya

Abstract

Integrated water resource management in sub-catchment areas is imminent in Kenya since the review of Water Act in 2002. Subsequently, this research analyzed the water resources governance dynamics of Rwamuthambi sub-catchment and made key recommendations for sustainability. An exploratory descriptive design was adopted. Data was collected through 203 questionnaires, 15 key informant interviews, semi structured interviews and observations. Spearman's rank correlation (R), Kendall's coefficient of concordance (W), Likert scale and descriptive statistics were used to analyze the data. 32% of the local community respondents ranked public participation as most effective in wetland conservation while 33% indicated that the WRUAs improved wetland sustainability through civic education and sensitization. The results revealed that stakeholder sensitization on sub-catchment conservation was the least important while public participation ($W= 0.1$, $p< 0.05$) was the most important consideration. It also emerged that pre-WRUA enforcement strategies were effective. Also there was a strong negative correlation between poor enforcement of policies and poor institutional capacity ($R (23) = -0.77$, $p= 0.03$) in sub-catchment activities. Therefore, there is need to promote land owners' participation and technical and financial capacity building for WRUA committee members. The study recommends domestication of policies to address intrinsic sub-catchment matters and adoption of pre-WRUA era conservation strategies of enforcement as ways to promote sustainability through governance.

Key words: conservation, enforcement, governance, public participation, sub-catchment, water resource

4.0 Introduction

Wetlands are key subjects of sub-catchments which form the main source of water. The services are the constituents of human well-being transcending through flood control, eutrophication, water cleansing and improvement of water quality by absorption of pollutants, and source of food and recreational facilities (Dise, 2009; Saito, 2015; Masifia and Ole Sena 2017). All economic sectors ranging from agriculture, energy, transport and industry including tourism rely heavily on ecosystem services (Bertule *et al.* 2018), which are dependent on continued and timely availability of water and its ecosystem services (Finlayson *et al.*, 2005). This notwithstanding, the society have usually perceived wetlands as useless (Mathews 1993), a nuisance and 'wastelands' (Kecha *et al.*, 2006; Gardner 1996), as sources of waterborne diseases, pests, and foul smell and habitats for dangerous wild animals such as snakes (Ndaruga and Irwin, 2003). Streever (2012) attributed such understanding to lack of or limitation in awareness on the importance of wetlands. In addition, Robb (2002) and Brown and Lant (1999) cited predictions of individual wetland decisions on wetland ecosystem functions to be hampered by knowledge gaps about consequences of cumulative effects that arise from such decisions that are made independently and separately.

Globally, many countries during early stages of development are highly centralized, bureaucratic and concentrate mainly on water. This is generally referred to as first-order which is mostly about supply of water (Turton *et al.* 2007). This first order is also termed as the hydraulic mission phase (Waterbury 1979; Reisner 1993) in which the economic base is provided by water resource infrastructure (Turton *et al.*, 2004). This scenario is also replicated in Africa where wetlands are

important for basic survival (Schuyt 2005) where many countries have faced the challenge of sustainable and equitable allocation and utilization of water resources (Conway *et al.* 2009; Speed *et al.* 2013). A study conducted in Northwest Cameroon showed that the main challenges of water resources included national development policies that lacked coordination, weak institutional frameworks, top-down approach resource management and lack of capability to maintain water system (Bikwibili and Danny, 2018). Water governance is the system of management that influence allocation of water resources encompassing basic provision of water and sanitation services (Bayu *et al.,* 2019) through policies that highlight intended direction and laws which provide the official and informal terms for service delivery under which an institution steer policy implementation (DE Stefano *et al.,* 2014)

Subsequently, increase in human population and other competing interests of water users has been the main contributor of water resources governance challenges (MEMR 2016). Other factors that affect water governance include economic growth, energy generation agricultural production, management paradigms, social attitudes and perceptions (Tortajada, 2010). In general, governance of water resources refers to governing with and through established decentralized networks (Rhodes, 2007; Ostrom, 2009). Water resources governance resonates around scale, polycentricism and cultural norms. It is contextual with high dependence on physical factors, economic levels, social development and ever evolving political and cultural norms (Woodhouse and Muller, 2017). According to Montenegro and Hack (2020), other factors of water resource governance as social interests, administrative capacity and legal arrangements while Huitema *et al.* (2009) postulated that there needed to be collective responsibility, improved institutional structures and adoption of functional and viable power sharing. Nevertheless, Suhardiman *et al.*

(2017) added that of importance is the action of how people join together for collective action and the impetus behind the motivation.

Kenyan wetlands are no exception to these situations. Earlier, many strategies were imposed without consideration of effects vested onto the supporting ecosystems. For instance, in the 1920s water supply was placed under the Department of Public Works and later moved to the Ministry of Agriculture in the 1950s under the Swynnerton Plan in order to intensify peasant agriculture (Nyanchaga 2011; Sunman 2017). After Kenya's independence in 1963, a water development plan which incorporated a water supply plan that aimed at full cost recovery was prepared. Although there was a manifesto during the same year that had committed Kenya to wetland conservation measures (Gichuki 1992), the perception on utilization and conservation of wetlands did not transit from traditional approach.

Later, following a 1983 study which recommended separation of operations, maintenance and also advocated for decentralization, attention towards water resources management and governance gained prominence (Nyanchaga 2011). Thereafter, a National Water Master Plan was prepared and launched in the 1980s followed by the National Water Policy of 1999 which aimed at addressing water allocation issues, enforcement of management decisions including prescriptions for dealing with degradation and encroachment into catchments. This policy formed the basis for Water Act of 2002 (GOK,2002) and the Water Act No. 43 of 2016 (GOK, 2016) which brought forth the water reforms acknowledged as Africa's most comprehensive in terms of institutional framework and overall sector governance (Rampa 2011). The repealed Water Act of 2002 initiated the Integrated Water Resources Management (IWRM) model in Kenya for promotion of economic and social welfare for sustainability (ibid) as a second-order resource management system which adopted decentralization approach which incorporates the social capital through stakeholder

involvement (Ohlsson 1999; Turton 1999) and institutional development (Turton *et al.*, 2007). IWRM was meant to defy the sectoral approach initially employed in Kenya and many other countries.

Kenya has embraced the IWRM model since 2002. The model through recognizes water resources governance and its connectivity with provision of water services. The 2002 Water Act separated water provision services from management of water resources and set guidelines for decentralization of governance of water resource management up to the grass root level which included collaboration between the government and grass root stakeholder involvement. This was accomplished through establishment of the Water Resources Authority (WRA) and the Water Resource Users Association (WRUA) (MEMR 2016).

Rwamuthambi WRUA was established in 2005 comprising of 21 committee members who were elected democratically from the community as per provisions of Water Act of 2002. To ensure fair and equitable distribution of the members through the sub-catchment, Water Resource Management Authority (WRMA) currently renamed as WRA had divided the sub-catchment area into three based on the prevailing Agro-Economic Zones. Each zone was represented by 7 members.

Despite this positive effort, many sub-catchments around the country have continued to experience watershed degradation and water pollution (Aglanu, 2014; MEMR, 2012). For instance, the three sub-streams namely Ngong, Nairobi and Mathare that pass through the city of Nairobi in Kenya are evinced with lots of encroachment by informal settlements and pollution from untreated effluents from the human settlements and industries (Kiithia 2012). This is a scenario typical to market centre through which Rwamuthambi River flow. Further, Yang and Muller (2009) in China's Yangtze River revealed that noted occurrences of domestic and industrial effluents

draining into the river channel reduced water quality downstream for other uses and users posing another challenge in management of water resources. According to Global Water Partnership (GWP) (2000), GWP (2003) and Organization for Economic Co-operation and Development (OECD) (2011), the main causes of the continued water sector crisis were identified to be governance related while Bertule *et al.* (2018) added that water scarcity arose from resource mismanagement. The second World Water Forum of 2000 declared that the crisis over water was not about its adequacy but rather about the strategies available for water resources management including protection of critical catchment areas, effective governance and adaptive management (Gokce, 2018). It was noted that IWRM had elevated water resource governance, although it did not emphasize on lessons to handle uncertainties (Akamani, 2016) which deter formulation of water resources management strategies (der Keur *et al.*, 2008). Uncertainties vary from scenario uncertainties which arise from policy analysis, to statistical uncertainties based on some known outcomes to qualitative uncertainty in situations where outcomes could not be determined statistically (Brown, 2004).

Rwamuthambi sub-catchment is located in Kirinyaga County of Central Kenya which is associated with the Mount Kenya watershed. It has been used for micro hydropower production, food production, and as a source of water for domestic, industrial and urban use (RSCMP, 2015). Nevertheless, it has faced destruction and degradation since 1970s arising from increased demand for ecosystem consumptive goods (including water, timber, pasture agricultural crops) and services including recreation, water, agricultural crops and pasture leading to human encroachment and catchment conversion into rice and horticultural farmlands, excision of government forest for agriculture expansion, illegal logging, grazing in the forest and charcoal burning. These effects were experienced depending on the locality within the sub-catchment; farming and livestock

rearing on wetlands, occasional human wildlife conflict, upstream, while downstream water resource conflicts and charcoal burning was rampant (ibid). Subsequently, Yang and Muller (2009) indicated that water resource governance must balance such conflicting interests whereby in the upstream water is drawn for agriculture, domestic and industrial use while in some instances hydro power production and recreational facilities that require continual flow rely on the same water.

According to Turton *et al.,* 2007 insufficiencies were registered in the first-order phase when there was sectoral resource management. Similarly, in Rwamuthambi sub-catchment there was notable active but disjointed sectoral involvement before establishment of WRUA. Nevertheless, there were positive achievements to water resource management that contributed to modern economy (RSCMP, 2015). The work of DE Stefano *et al.* (2014) laid foundation on the critical need to regularly assess status of prevailing water governance structures and practices to establish suitability and make amends where necessary. It is against this backdrop that the dynamics of the sub-catchment's governance are evaluated through a study of status of Rwamuthambi sub-catchment before and after establishment of WRUA.

Building on the concept of Tait (2016) that evolution of social institutions is necessary so as to auger with new values of the agents that operate within them and drawing from Lu *et al.* (2015), who argued that policy targets and institutions that are meant to achieve them are supposed to be SMART but are not due to the complexity of social processes and diversified relations to natural processes, then the work of Tait (2016) laid foundation that due to the complexity of social processes and diversified relations to natural processes, SMART goals is only idealistic since it is not possible to determine the relevant tasks a priori but are learnt through experimentation, social learning processes and adaptation. Building on this the objectives of the study were as follows: - 1) review the current water resources governance status in Rwamuthambi sub-catchment area, 2)

analyze issues on conservation and degradation of the sub catchment area and finally, 3) make key recommendations for improvement of the sub-catchment governance and management. The outcome of this research is intended to inform policy possible strategies to promote governance and hence sustainability of Rwamuthambi sub-catchment.

4.1 Material and methods

4.1.1 The study area

The study was conducted in Rwamuthambi Sub-catchment (RSC) area in Kirinyaga County (0°37'6"S, 37°14'57"E; 0°37'6"S, 37°24'34"E and 0°69'9"S, 37°14'57"E and 0°69'9"S, 37°24'34"E) as shown in Figure 4-1 (RSCMP, 2012). The sub-catchment is part of the larger Upper Tana catchment area whose source is Mount Kenya. Rwamuthambi River basin is a major tributary to Tana River also known as River Sagana in its young stage. The sub-catchment system consists of several perennial and ephemeral streams, swamps, irrigation activities and water pans. It flows through several sub locations from Mukure to Kiine, and undulates through various market centres including Muragara, Kabonge, Riakiania, Baricho, Kagio and Kwa V who rely on its water resources. The catchment traverses from the forested and wet Mount Kenya to the almost semi-arid area of the county (CGK, 2013).

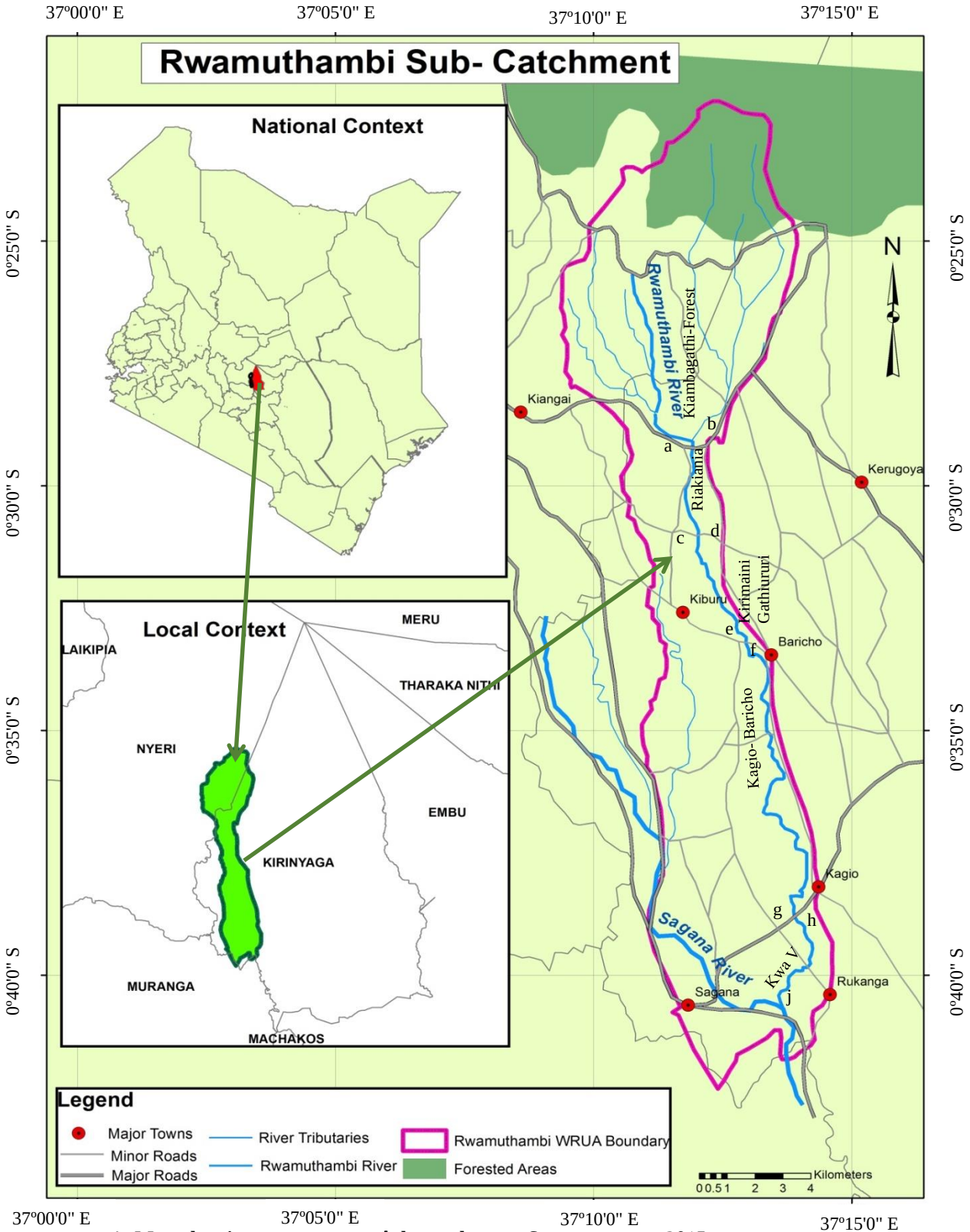

Figure 4-1: Map showing the location of the study area Source RSCMP 2015 (a-b): Kiangai- Kagumo road; (c-d): Kabonge- Riakiania road; (e-f) Kiburu- Baricho road; (g-h); Sagana- Kagio road; ((a-b), (c-d))- Upper Midland-I, ((c-d), (e-f))- Upper Midland-II, ((g-h), (j))- Upper Midland-III

The area of study is on the windward side of Mount Kenya, at close proximity to the equator and has a tropical climate with annual temperatures ranging between 17° and 20°Celcius. Rainfall is characterized by two rainy seasons; the long rains (mid-March – May) and short rains (mid-October- December) with 800- 1200mm annual precipitation. The rest of the months are dry (CGK 2013; Jaetzold *et al.*, 2007)

The sub-catchment study areas lies within a number of agroecological zones (AEZs), namely, Upper Midland-I (UMI) - Kiambagathi- Forest, Upper Midland-II (UMII)- Kirimaini- Gathiururi and Upper Midland-III (UMIII)- Kagio- Baricho (UTaNRMP 2014). The area has well drained dusky red to dark reddish brown soils which are extremely deep and dominated by friable clay, with acid- humic topsoil- nitisols. The land use is dominated by small scale farming involving the production of tea, coffee, macadamia, avocado, maize, beans, bananas, some types of fruits, horticultural crops and zero-grazing especially dairy farming (Jaetzold *et al.*, 2007). Coffee farming had been overtaken by irrigation horticultural production (RSCMP, 2015) which could be attributed to continued low coffee prices (ICC, 2019).

4.1.2 Data collection

Field data was collected in the months of July to September 2018 from primary sources through field visits, administration of questionnaires and key informant interviews. Secondary data was acquired through literature review of records, documents and journals. The target respondents for the study questionnaire were divided into two broad categories, namely, the local community, the grass root sub-catchment management group comprising of the WRUA-MCM (Management Committee Members) and other government agencies officers.

The study area was divided into five sections through delineation according to the tarmac road river crossings. A stratified systematic sampling method was employed for data collection. The strata were defined by separating land abutting the river channel and the rest of the community

within the sub-catchment area as shown in Figure 4-1. Using road transect lines, every 5th household was subjected to the questionnaire (Pearson *et al.,* 2012; Gorard, 2013; Leedy and Ormrod, 2013). The questionnaires were filled by the household heads or if absent, the eldest available person within the homestead who had attained 18 years, this being the age of consent.

4.1.3 Sampling procedure and data analysis

WRUA- Management Committee Members (WRUA-MCM) were adopted as respondents representing each of the three Agro-Ecological zones. The committee members had been recruited by Water Resource Management Authorities (WRMA) as provided for in the Water Act (GOK, 2016). Government officers were selected from relevant departments while the local administrators (chief and sub chief) considered are those whose areas of jurisdiction was within the study area. The questionnaire inquired on status of governance between former and current management of the sub-catchment. The questionnaire inquired on awareness of relevant water resources laws, social behavioral factors that affected water resources, social impacts experienced following WRUA governance, public participation, accountability /transparency, decision making mechanisms and community voice, sensitization, governance related challenges and role of stakeholders in conservation.

Key informants were purposively and randomly selected (Cochran, 1977; Fei, 2015). Interviews were conducted by the researcher to selected respondents who were above the age of 50 years having been in existence before and after establishment of WRUA.

This study targeted a population of 19,800 households (HH) within Rwamuthambi sub-catchment which included the households of some WRUA committee members since the committee should comprise of representatives from within the sub-catchment (GOK, 2002)

The sample size n_o =196 was obtained through Cochran's formula (Horse 2018 and Rucker 2017).

$$n_o = \frac{Z^2 pq}{(e_p)^2}$$

where

- n_o =Cochran's sample size recommendation;
- Z = Z value (i.e. 1.96 for 95% confidence level);
- p =Proportion of the population with direct impact to the sub-catchment governance adopted from RSCMP, (2015) because the sub-catchment was not a gazetted census zone (GOK, 2010)
- e_p = Desired level of precision-confidence interval ±7%

The questionnaire questions were transcribed into the local language for a clear understanding by the respondent without contorting the meaning. A pretest of the tool was conducted as to establish the duration it would take to fill a questionnaire besides acquiring familiarity to the instrument and evaluating any problems arising when responding. The information obtained was used to modify the tool accordingly.

The total number of questionnaires subjected to analysis was 203. These comprised of 180 from the households community and land owners who abutted the river channel. The questionnaires also targeted the officials who comprised of 21 WRUA committee members of who only 17 responded four relevant government departmental heads and a chief and sub chief. The collected data was subjected to Kendall's coefficient of concordance (W) in assessment of agreement between ranked raters derived from computation and range from zero to one where zero is no agreement and one is perfect agreement (Legendre, 2010; Mattson, 1986).

Spearman's rank correlation (R_s) was applied to measure linkage between two sets of data where one is perfect positive correlation and negative one is perfect negative correlation (Lovie, 1995). Likert scale was used to determine agreement or disagreement on a five point scale (Likert, 1932;

Jameison, 2004; Elaine and Christopher, 2007). The study set the threshold for significance as $p \leq 0.05$. Descriptive analysis was by Office Excel (Coolican, 1994).

4.2 Results

4.2.1 Overview of governance Rwamuthambi sub-catchment area

An assessment of water governance indicated that 98% of community members used portable water from the rivers before establishment of WRUAs in 2005. Results from the responses on the situation of water abstraction before establishment of WRUA indicated that at that time, water abstraction was exclusively by coffee factories and public institutions like schools and health centres. Irrigation and encroachment into water resources were completely banned and upheld. Further, the study revealed that pollution into the river channels was minimal as more than 99% of the community relied on potable water directly drawn from the rivers. The respondents revealed that until late 1990s there was only one water supply project whose intake was at Kiambagathi-Forest area which served the lower areas through gravitational flow. In spite of this project the informants disclosed that individual household connection to piped water supply was less than 2% because of prohibitive connection fees and project maintenance expenses. The findings showed that the project did not last due to various challenges. The government officials alluded that the main reason for failure of the project was lack of collaboration from the various government ministries concerned with water resources conservation as each one had different approach and goals towards the sub-catchment. More than 94% of the community informants posited that the water supply project failed due to political interference and poor public ownership leading to equipment vandalism.

It was also noted that before establishment of WRUA, governance instructions originated from different government entities including Ministry of Agriculture (MoA), Ministry of Energy (MoE),

Ministry of Environment and Natural Resources (ME&NR) and Ministry of Health (MoH). Nevertheless, there was adherence to the set rules and guidelines. According to the respondents, the entire sub-catchment area witnessed over 90% surveillance to individual farms by either the area agricultural extension officer from MoA, ME&NR, MoH or surveillance officers deployed by farmers' cooperative societies. For instance, in Kirimaini-Gathiururi and Kagio-Baricho areas surveillance was carried out by agricultural extension officers in order to control cultivation on riparian reserve, irrigation or diversion of water while Public Health Officers monitored use of agro-chemicals as well as handling of effluents from light industries like abattoirs and coffee factories to ensure that it was not released into the water channels without pretreatment. More than 98% key informants specifically from Kiambagathi-Forest area alluded to efficient surveillance by MoE who monitored diversions of water for local mini-hydro power generation. Majority of the respondents posited that there was better conservation in the areas where there was local hydro energy generation because the community had realized that when water in the channel increased, domestic energy supply was maintained. Those found defying the set instructions were subjected to stringent penalties. The penalties included prohibition of sale of tea or coffee produce which were the main stay of local economy and at times denial of agro-chemical allocation for the cooperative society was the only supplier.

According to the results, surveillance and monitoring was on until the early 1990s when the services from agricultural extension officers ceased and at the same time coffee farming was dwindling following poor and delayed payments. An alternative to coffee farming was horticulture and food crop production. There was also increased demand for arable land as this was the period when there was pressure for parents who were the beneficiaries of first adjudication to be inherited by adult children as per the cultural requirements. More than 86% of the respondents indicated that

need for more land and high yields led to land reclamation and abstraction of water for irrigation. In addition, more than 80% of key informants indicated that some parts of the catchment experienced low agricultural productivity due to increased soil erosion and low yields from the farms. Low yields were also attributed to over cultivation and excessive use of chemical fertilizers as a way to boost yields on the land whose sizes had diminished. Most farmers preferred use of organic manure mainly from livestock but stocks had gone down substantially owing to reduced parcel sizes and pasture

According to key informants there was no surveillance or enforcement in the late 1990s to 2004. It was established that enforcement and surveillance was supported by coffee industry through the field officers whose strategy was through sanctions imposition denying coffee sale to the factory. This strategy also failed when coffee farming was at the verge of collapse. Key informants from WRUA also contended that during its tenure a lot of abstraction was witnessed upstream which denied those living downstream adequate flows especially during dry spells culminating into water related conflicts. More than 95% of those abutting the river encroached the riparian reserve for cultivation. Those in the middle and lower AEZs practiced horticultural farming for local and export market, while the community living in the upper AEZ engaged in growing of fast maturing exotic eucalyptus which had ready market in the tea factories as fuel wood and Kenya Power and Lighting Company as electricity distribution poles. More than 70% of the farmers at close proximity to Rwamuthambi River who engage in irrigation started the practice during this period. The study interrogated surveillance and monitoring along the riparian reserve since WRUA was established. The results as illustrated in Figure 4-2 revealed that 6% of the community indicated that surveillance was through collaboration between the community and government and 30% opined that it was through combined effort of the community and land owners'. Most of the

community (42%) stated that surveillance and monitoring was predominantly by WRUA while 22% of the respondents indicated that there was no surveillance.

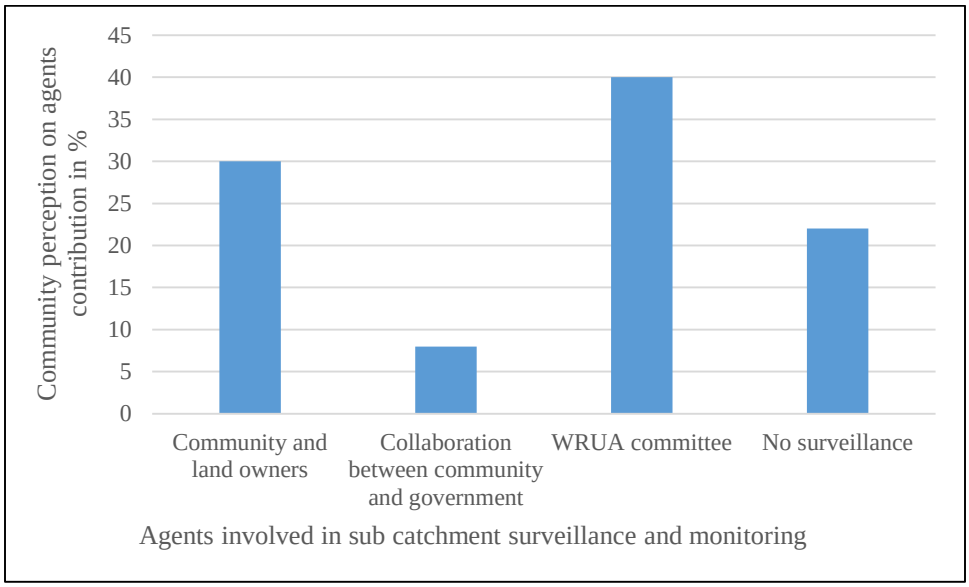

Figure 4-2: Surveillance and monitoring of Rwamuthambi sub-catchment area in percentage (%) (Source: Kumunga E.M, 2018)

Generally, more than half of the community (65%) indicated that hydrological conditions had changed since the introduction of cultivation along the riparian reserve. A similar number pointed out that there was very poor enforcement since the establishment of WRUA. Poor enforcement was also cited as a major challenge faced in implementation of the sub-catchment management plan which WRUA had prepared as per its mandatory requirement for its operation. Spearman's rank correlation coefficient was subjected to 23 officials' responses in regard to challenges faced in implementation of the sub-catchment management plan. The results revealed that there was a significant correlation between poor enforcement of wetland policies and poor institutional framework (R_s (23) = -0.77, p = 0.03). There was a significant correlation between poor knowledge of negative sub-catchment utilization tendencies and land tenure system (R_s (23) = -0.65, p = 0.04).

A correlation was also registered between land tenure and community participation in sub-catchment activities (R_s (23) = -0.5, p= 0.05).

4.2.2 Status of governance in Rwamuthambi sub-catchment

The study sought to establish what was deduced to be governance towards Rwamuthambi Sub-catchment in the last five years when WRUA was in charge. The community and WRUA-MCMs had different perceptions as illustrated in Figure 4-3. Improved accountability was rated at 16% and 22% by community and WRUA-MCMs respectively. The WRUA key informants stated that the funding was mainly from Water Services Trust Fund (WSTF), who based the release of funds on balanced and audited books of accounts thus requiring WRUA to enhance accountability. Other sources of revenue included water tariffs, subscription from members and labor-equivalent of charges in cases where a community member could not pay in monetary terms. However, WRUA committee informants alleged that the funding was inadequate and the committee members lacked basic financial management skills.

Perception on governance of Rwamuthambi sub-catchment was sought and the results presented in Figure 4-3. Equity and fairness in wetland related projects were rated equally by both WRUA and community at 14%. In addition, the results showed that (23%) of community took responsibility in sub-catchment conservation but only 7% of WRUA-MCMs were in support. The community took responsibility by providing information and data required for making wetland inventory and condition of resources. The interview sought to establish wise use of the sub-catchment by inquiring on what choices the community made in regard to utilization of the sub-catchment advancing well- being. Community key informants indicated that the entire community would embrace sub-catchment wise use if there was adequate awareness creation by WRUA. Simultaneously, key informants from WRUA intimated that only legitimate land owners portrayed keenness in conservation activities along the riparian area. In addition, the informants mentioned

that before promulgation of a new constitution in 2010 (GOK,2010), the community was not aware of any specific laws that guided conservation, but viewed everything as directives controlled by local administration comprising of chief and assistant chief, yet there was 99% compliance. Nevertheless, there was more inclusivity in decision-making since the establishment of WRUA as acknowledged by more than half (52%) of WRUA committee members and slightly above a third (34%) of the community. Only 5% of WRUA committee members and government officers compared to community (13%) acknowledged that there was government support. The variation in grading of support from relevant government institutions was attributed to lack of distinction by the community between roles played by various government agencies.

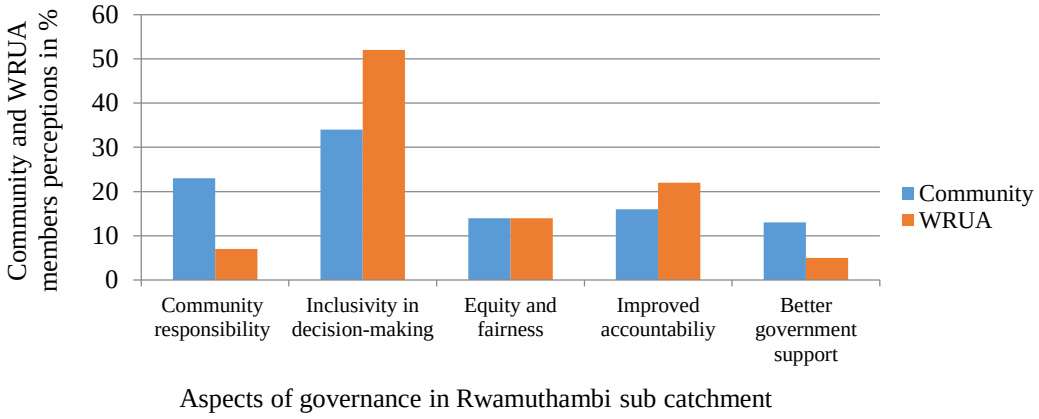

Figure 4-3 Perception (%) on various aspects of governance by the community members and WRUA officers in Rwamuthambi sub-catchment area (Source: Kumunga E.M, 2018)

4.2.3 Public awareness, education and funding

The government engaged in some sub-catchment rehabilitation activities which included provision of civic education and sensitization on wise use of wetlands and water conservation through construction of water pans and rain water harvesting, delineation of water resources as public conservation areas, provision of agricultural extension services on modern farming methods and improved methods of irrigation, encouraging public participation in wetland management through decision making and provision of incentives towards wetland conservation. Nevertheless, WRUA committee members conceded that although most had attained above secondary education, there was limited know-how related to water resources to sufficiently educate the local community on wetland governance and management. The study further interrogated whether the community accorded equal importance to each of these activities through ranking the level of effectiveness from the greatest to the least on a 5 Likert scale with the following perception indices; 1= least effective: 2= moderately effective: 3= effective: 4= very effective: 5= most effective. The results as illustrated in Table 1 divulged that most of the communities (33%) affirmed that provision of civic education and sensitization on wise use of wetlands and water conservation was most effective. WRUA officials however stated that there were no guidelines or by laws available that were specific to the issues affecting Rwamuthambi sub-catchment. Delineation of water resources as public conservation areas was graded narrowly as least effective (28%), and most effective (26%). Provision of agricultural extension services on modern farming methods was rated as very effective. Key informants pointed out that non- governmental organizations and Agro- Based companies operating within the catchment had penetrated the area vide community-based organizations (CBOs). The CBOs marketed farm in puts and services and in return offered the farmers of extension services and as well as marketed

the farm produce. The community ranked public participation in wetland management and decision making as effective (32%) while 28% of the community conferred it was least effective. Provision of incentives towards wetland conservation was ranked as moderately effective (30%).

Table 4-1 Ranking of perception of various government activities within the sub-catchment in percentages (%); (Source: Kumunga E.M, 2018)

Government activities	Likert scale ratings					
	Most effective	Very effective	Effective	Moderately effective	Least effective	Total
Provision of wetland civic education	33	22	21	14	10	100
Delineation of wetlands as public conservation areas	26	11	16	19	28	100
Provision of agricultural extension services	13	28	18	21	20	100
Encourage public participation	14	11	32	15	28	100
Provision of incentives towards wetland conservation	12	24	11	30	23	100

The study further analyzed the results in order to establish how much agreement there was on the responses in regard to effectiveness of the government activities by the community. Through Kendall's coefficient of concordance test a null hypothesis was that with the ranking (1= least effective: 2= moderately effective: 3= effective: 4= very effective: 5= most effective) responses were independent of each activity. The Kendall's coefficient of concordance (W) measured extent of agreement or disagreement amongst the community based on rankings. The research had sought to establish how government involvement affected the community in regard to sustainable utilization. The community rankings were based on factors of governance ranging from provision of civic education, delineation of wetlands as public conservation areas, provision of agricultural extension services, encouraging public participation to provision of incentives. The most disagreed upon factor was on provision of wetland civic education #1 and the best agreed upon, #5 was to encourage public participation. There was less agreement on the intermediaries as reflected in Table 4-2. The results revealed that there was a high level of disagreement on the government sub-catchment rehabilitation activities that ($W = 0.1$, $p < 0.05$). Thus, the rankings of government activities were not independent of one another therefore the null hypothesis could not be accepted.

Table 4-2: Ranking of effectiveness of various government services by the community within Rwamuthambi sub-catchment area per Likert scale; (Source: Kumunga E.M, 2018)

Government activities	Raters					
	Most effective (5)	Very effective (4)	Effective (3)	Moderately effective (2)	Least effective (1)	Total weight
Provision of wetland civic education	59	40	38	25	18	637
Delineation of wetlands as public conservation areas	46	20	29	35	50	517
Provision of agricultural extension services	24	50	32	38	36	528
Encourage public participation	26	20	57	27	50	485
Provision of incentives towards wetland conservation	22	44	20	52	42	492

4.3 Discussion

4.3.1 Inter-sectoral sub-catchment management and Pre-WRUA era experiences

The study results indicated that before establishment of WRUA the local community had adopted the system imposed by the various government sectors that took role in ensuring conservation of the sub-catchment. During this period, there was limited pressure to the sub-catchment as the local economy was supported by coffee and tea growing in the upper Agro-Ecological Zones, and maize and beans in the lower Agro-Ecological Zones. Utilization and water abstraction were highly controlled and monitored through sectoral efforts surveillance. In support to this finding Lalika *et al*. (2015) a study along Pangani River basin in Tanzania established that inadequate collaboration and connection at the local level was a factor that can deter smooth management and success in

watershed management while Barczewski (2013) noted that lack of a working consensus between different actors affected the status of a water resources. In a related research conducted on status of wetlands in India by Bassia *et al.* (2014) condition of a wetland is influenced by institutional, physical and socio-economic factors. However, further results revealed that before establishment of WRUA sectoral catchment area management was undertaken in a top-down approach. In the post WRUA era which commenced in 2002, the water relevant sectors no longer came into play. Most of these sectors acted independently without a set out structure for interaction with WRUA who were mandated by the law to oversee the sub-catchment management through involving the community and stakeholders. This finding seems to confirm what Lalika *et al*. (2015) alluded that there was need to substitute the existing system of water resources governance which is focused on water alone with one that has a broader perspective sector wise and within ecosystems. In addition, it is imperative that the new governance system incorporates contemporary top-down reforms, a finding also supported by Saravanan (2009).

Similarly, Msuya (2010) noted that the sectors donned different management structures leading to poor inter-sectoral coordination. Therefore, the study advocates for recognition of some of the pre-WRUA water resource management structures that had effectively sustained water resources sustainability for incorporation into a coordinated integrated Rwamuthambi sub-catchment management system.

When WRUA commenced the sub-catchment management, the other water related sectors did not feature much in matters of sub-catchment conservation apart from Ministry of Environment and Natural Resources (ME&NR) through its Forestry Department. Subsequently, the sub-catchment witnessed increased wetland farming and water abstraction for irrigation and domestic use especially in the upstream areas at the expense of those living downstream. Interruption of the

river capacity flow caused unfair water distribution and water conflicts from diverse stakeholder interests. These results were consistent with Msuya (2010) that fragmented management structures could lead to poor integration of upstream and downstream water needs. Similarly, Garces Resprepo (2007) opined that water distribution rules culminated to upstream users getting more water than downstream counterparts. In addition, the findings were consistent with those of Kabogo *et al.* (2017) who argued that controlled abstraction could increase downstream water flows.

4.3.2 Effects of water allocation plan and enforcement to sustainable water flow

Further, the results showed that equity and fairness was rated low but rated equally by both the community and WRUA committee members. Hence, there was need for a water allocation plan prepared by WRUA through inter-sectoral consultation to uphold equity throughout the river channel. This observation was supported by Regner (2006) who asserted that concerted effort by WRUA was required in order to restore trust between upstream and downstream disparities in water allocation and abstraction.

This study thus affirms the finding by Tropp (2007) that a sustainable water flow could be achieved based on the understanding how sub-catchment governance works which would call for avoidance of poor governance usually portrayed through failed management of human activities and related impacts and unresolved water resource conflicts. Thus, a balance between improvement of flow of hydrological services and welfare improvement of local community who are the first beneficiaries is necessary.

During the pre-WRUA era the results revealed that enforcement through imposition of sanctions and systematic monitoring was very effective and would need consideration during post WRUA era where enforcement was a major challenge. . This finding agrees with Ostrom (2000) who alluded that enforcement mechanisms could be in form of sanctions and by a surveillance team to

monitor agreed activities and penalties for non-compliance. A related finding on application of lessons learnt was posited by Srinivasan *et al.* (2012) and Gondhalekar *et al.* (2013) that experience in a particular context could also be transferred to another. Similarly, Huitema *et al.* (2009) argued that it was necessary to reconsider traditional practices to deal with increasing issues related to water supply and quality.

During the post WRUA period the results indicated that enforcement would improve if there was enhanced institutional framework, a scenario that was also confirmed statistically using Spearman's correlation coefficient. This finding was supported by Ostrom (2010) who posited that it was the responsibility of institutions to ensure that the rules that appeared on paper were implemented as a guide to activities on the ground. These results were also consistent with Weber *et al.* (2017) who argued that the general challenges of water resources included lack of agreed policy objectives, low repercussions for noncompliance and disjointed policy enforcement which culminated into wetland encroachment. Thus, imposition of sanctions and agreed penalties against the sub-catchment degradation would improve its conservation.

4.3.3 Training of WRUA-MCMs in wetland management

Sensitization and wetland information awareness conducted by WRUA and private agricultural extension officers (since there were very few government agricultural officers) was rated as very effective. Nevertheless, riparian encroachment was on the rise most probably due to low understanding of wetland information. Masanyiwa *et al.* (2019) established a similar challenge on the low numbers of officers available but differed on cause in that while (Ibid)'s study findings blamed the central government for not mandating the local government to recruit, in Kenya's scenario, the county governments have the entire mandate following full decentralization of department of agriculture.

Further, the finding by Liambila (2017) was perceived to support the fact that although WRUA is mandated to safeguard downstream biodiversity and ensure basic human requirements while at the same time increasing utilization of water resources for economic and social improvements, the committee generally lacked technical capacity towards integrated river basin management. This finding was affirmed by Njonjo (2002) that most WRUA committee members lacked formal skills for conducting monitoring and evaluation of water resources. In what appeared to be an extension to this finding Mumma *et al.* (2011) posited that desired objectives can only be achieved through monitoring, evaluation and applying relevant practical interventions. This study also revealed that the sub-catchment area no longer received government extension officer services from ministry of agriculture. This finding was confirmed by Msuya and Wambura (2016) who noted that extension services were demand driven and where it was provided extension agents lacked frequent in-service or professional development training to ensure delivery on up to date information. It was therefore noted that WRUA committee needed basic training on wetland planning and management. This was further explained by Lalika *et al.* (2015) that if WRUAs and extension officers' capacity was built, watershed conservation and water governance would yield a positive outcome.

The results further demonstrated that WRUA sensitization on water resources information and conservation was rated the best of the services provided by government, thus creating awareness on consequences associated with wetland utilization and its regulation. This finding was supported by Matiru (2000) who argued that obstacles in enforcing water laws could emanate from lack of consensus on facts about water resources or due to misinformation on what the community perceived as facts. The finding that WRUA being a government entity was directly involved in dissemination was contrary to what was established by Mutua *et al.* (2017) that most of the county

policies were disseminated by the private sector and there was lack of involvement of government in sensitization and implementation of policies which resulted to minimal impact.

4.3.4 Effects of land tenure to sub-catchment conservation and public participation

According to the Constitution of Kenya (GOK 2010) all wetland belongs to the state while the Water Act (GOK, 2002) provided that every wetland was under a specified sub-catchment area. However, the results showed that almost the entire of Rwamuthambi sub-catchment riparian reserve was privately owned. This tenure system contributed to the sub-catchment degradation similarly to what Akech (2001) and Sullivan and Fisher (2011) alluded to that individual tenure contributes heavily to eroding of indigenous conservation systems and influence activities. Through Spearman's rank correlation the study confirmed that awareness of consequences of negative wetland utilization increased with land tenure while community participation reduced proportionally with land tenure. In contrast to this finding Price (2007) stated that the driving force for conservation management was land tenure rather than insufficient knowledge. However, this finding was supported by Katusiime and Schütt (2020), who stated that sustainability would be attained when that land tenure acts as a driver of change, influencer of decision making and as a motivation to encourage take up of new practices. Hence, the study finding seem to agree with Gallardo *et al.* (2013) who emphasized on the need for attention to land tenure for collaborative engagement in sub-catchment management.

The results of this study further demonstrated that modes of the sub-catchment utilization changed when the community reverted to relying on wetland farming as a way to increase the arable land without being abated by the authority in spite of the environmental law being in force. The land demand was enhanced by population increase which depended on the wetlands for basic needs and as a main support to the local economy development. This finding was similar to what Schuyt (2005) noted that modification and reclamation of wetland is mainly motivated by financial and

economic factors. A similar observation was given by Were *et al. (*2013) and George (2017) that more pressure to the resources occurred when the rural communities predominantly relied on irrigation whilst others turned into cultivation on the wetlands in order to boost food production especially during dry spells. Further, the results ascertained that before establishment of WRUA, water abstraction was well controlled. There was only one community water supply project then which failed due to vandalism blamed on lack of community ownership. This finding was similar to Abdelhadi *et al.* (2004) that only projects under community ownership got protection against destruction and wastage as a safeguard to the resources and a control to conflicts.

The results also postulated that as a consequence of reclamation there was reduction of area covered by wetlands and subsequent loss of habitat for wild life and other wetland products like fuel wood, animal fodder, traditional medicine food resources and water, which were important to the local community. These results seem to confirm the findings by Brown and Lant (1999) that wetland utilization brings about conflict from inherent ecosystem services of wetlands and land owners whose major objective is to maximize profits through conversion of the water resource driven by economic demand ranging from agriculture, real estate development and industrial uses. But the finding contrasted that of Savenije (2002), Rampa (2011) and Day (2013) who argued that there was need to switch from the earlier notion over traditional water resource management that treated water resources as a public good into embracing water resources as an economic good and a social good. Hence, this study agrees with the definition of water resource management by Gilman *et al.* (2004) that it's the effort to plan and control human utilization of fresh water ecosystems or provision of related services including any anthropogenic activities that alters the hydrological or biological function of fresh water ecosystems.

In addition, Kendall's coefficient of concordance results revealed that although provision of civic education on water resources was rated the most effectively offered support by government it was also a perception that was most disagreed upon by the community. The community nonetheless perceived public participation as the activity most agreed upon. This study results also seem to agree with the observation by Johnson (2002) and Price (2007) that when resource users have sufficient awareness and capacity about wetland issues, there is improved participation and involvement in decision making. But in contrast, Lamsal *et al.* (2015) averred that although people maintained a positive attitude toward wetland conservation, participation in conservation efforts was inadequate. Therefore activities along the sub-catchment were determined by the perception held towards governance initiatives.

The results also indicated that the community gauged responsibility in the sub-catchment conservation highly. This was a similar finding by Masifia and Ole Sena (2017) who asserted that social interactions and behavior of individuals resulted from preffered decisions and collectively created social responsibility which affects wetlands either positively or negatively. Consequently, there should be a balance by the community such that public participation issues are integrated as essential rather than a distraction from farm activities that seemed to yield immediate benefit to the individual. In another related finding Theesfeld and Schleyer (2013) established that public participation should be linked with existing legal decision-making structures which gets complicated when decision making power is integrated with responsibilities. Therefore, as Parker *et al.* (2007) observed land tenure is a factor that could limit local participation which Stoll-Kleemann and Welp (2008) affirmed as fundamental in conservation and management of water resources.

4.3.5 Domestication of water resources policies

In addition to the effort in dissemination of wetland information by WRUA, the results also indicated that national policies and guidelines were too generalized to address the challenges faced at the local sub-catchment. This finding was consistent with Leidel *et al.* (2012) who established that sustainable and effective measures for resolving water resources issues could only be arrived at when the solutions are generated from intrinsic information in regard the concerned region. Contrary to this finding Stringer *et al.* (2007) noted that undue concentration is accorded to the local level ignoring explicit relationship to the wider socio- economic and political settings in which the locality is situated and often pays inadequate attention to the broader structures which also affect the local level. Turner *et al.* (2001) also alluded that area-based approach to wetland conservation proved to fail in conserving wetland functions. But in support of this finding Butterworth *et al.* (2010) noted that although policies are made at a large and comprehensive scale, its implementation is always done at the local level.

In addition, a similar allegorical argument by Raustiala (1995) averred that focusing on implications of international commitments to a nation without domestication could lack meaning at the point of implementation. Further, Were *et al.* (2013) had a similar view that there was conflict when local level activities had to be guided by decentralization demands derived from international level. Accordingly, this study supports findings by Sullivan and Fisher (2011) that water resources can be managed through integration of the law with natural and human hence the need to translate policies and domesticate sub-catchment regulations in order to respond to rooted specific sub-catchment matters.

Insufficient funding was a major drawback in the sub-catchment protection. This was the result registered from WRUA committee members who also revealed that there were limited revenue sources. This finding was similar to Mollinga (2008) who opined that poor institutional capacity

hinders utilization and mobilization of funds. The results showed that committee members concurred that there lacked basic training on both wetland governance and financial management. In a similar finding, Parker and Oates (2016) recommended that WRUAs required training in governance and financial management for effective delivery of stipulated mandates. The results additionally indicated that there was improved general accountability by WRUA and thus improved management. This finding was supported by (Lalika *et al.* (2015) who noted that water resource governance challenges existed due to ineffective structures and insincere management of finances which could be controlled through capacity building of water users' associations.

The study results showed that pollution was controlled through soil conservation methods that reduced soil erosion, pre-treatment of industrial effluents before release into the river, proper disposal of chemical containers and reduced usage of fertilizers. This finding was supported by Nadir *et al.* (2019) who implied that in order to minimize pollution on land soil and water, mitigation measures should be undertaken at the sub-catchment level.

4.4 Conclusions

The results show that WRUA being the mandated body for management and governance of water resources should incorporate other relevant sectors for focus on entirety of the ecosystem. At the same time there was evidence of notable conservation through guided utilization and control of pollution of the sub-catchment during pre-WRUA regime which was attained through synergy of different agencies and sectors. Therefore, inter-sectoral collaboration and incorporation of enforcement based on past experiences adopted in pre-WRUA era should inform strategies preferred by WRUA. For instance, there was relative compliance through invocation of sanctions and penalties coupled with surveillance and monitoring of sub-catchment activities. The adopted enforcement strategy should be agreed upon in order to ensure maximum compliance. In addition,

a water allocation plan was necessary for effective balance between sustainable flow of water and development of wetland based local economy. Land tenure was noted to be a major factor of conservation and public participation. Whereas land owners were keen to reap high profits from improved sub-catchment utilization practices there was need to impart requisite knowledge on best practices. Subsequently, community sensitization and information dispensation which was crucial for wetland conservation could be attained through capacity building WRUA committee members and agricultural extension officers to brace them with requisite know-how on water resources governance and management. Basic technical training on wetland governance and basic financial management course to WRUA committee members is essential in order to offer informed sensitization and skills on sub-catchment conservation and prudent funds management. The local community alluded that public participation was necessary for sub-catchment management and that success of projects depended on community ownership but land owners were not eager to dedicate time to public fora since these were viewed to consume valuable time which otherwise would be used more productively in economic activities which were mainly tagged to water resources. Consequently, the adopted public participation strategy should be sensitive to local community needs. The study recommends domestication of national laws in order to address the local intrinsic challenges.

CHAPTER FIVE

Wetland transformation through Water Resource Users Association; The case of Rwamuthambi Sub Catchment area, Kenya

Abstract

Many studies conducted in Kenya regarding water resource governance have focused on the mandate of Water Resource Users Associations (WRUAs) with less attention being accorded to their effectiveness in conservation of wetlands. This study assessed the effectiveness of WRUA committees, and challenges faced in conservation of Rwamuthambi Sub-catchment. The study employed exploratory descriptive research design. Data was collected through questionnaires, semi-structured interviews, observations and review of secondary data. Chi square and descriptive statistics was used to analyze the data. The survey results revealed that only 15% of WRUA committee understood water resources management while 35% were aware of relevant legislations. Factors of wetland degradation showed significant association with existence of WRUA ($\chi 2$ (4, N=180) = 20.46, $p < .01$) where ($\chi 2$- chi square (degrees of freedom, N = sample size) = chi-square statistic value, p = p value), although WRUA contributions were perceived differently per agro-ecological zone ($\chi 2$ (8, N=147) = 15.51, $p > .05$). Challenges unearthed were inadequate financial and human resources, lack of understanding, ineffective collaborative governance, poor support from county government and private ownership of riparian land reserve. There is need for WRUAs to embrace collaborative governance for effective conservation of wetlands. Integration of sub catchment management plan with county land use plans and policy review is also required.

Key words: - Collaborative governance, Degradation, Integration, Non-revenue water, Private land, Rehabilitation.

5.1. Introduction

The quality of water is highly associated with the character of a catchment area conditioned on inter alia land uses and the climate (Sidoruk and Skwierawski 2006). Globally, sub catchments have a potential to provide a variety of benefits to society including supporting major livelihood activities and economic sectors such as food-energy-water security which contribute in poverty alleviation. These benefits are however dependent on the health of the sub catchment. Sub catchments health is influenced by its condition based upon several factors that include size, hydrology and land and animal species diversity (Cobbaert *et al.,* 2011), catchments processes and their management (Parker and Oates 2016). In spite of their importance, health of wetland ecosystems is drastically getting worse due to deterioration of environmental quality, decrease in biotic diversity, loss of habitats and over-harvesting of wetland resources (Gokce, 2018; Lao 2013; Chapungu, 2013; Kingsford, 2011; Dudgeon *et al.,* 2006). River degradation ranks highest amongst all other world ecosystems (MEA, 2005) causing a toll on biodiversity (Vo¨ro¨smarty *et al.,* 2000) and communities that depend on them (Lemly *et al.,* 2002)

Sub catchment degradation is attributed to natural limitations of availability of freshwater which include effects from natural and biological processes (Khatri and Tyagi 2014), inadequate financing and inappropriate technologies leading to excessive abstraction, pollution from industries and agricultural activities (Loucks and van Beek 2017). However, recent studies have associated failures in water governance with water crisis across both developed and developing countries (Pahl-Wostl & Kranz 2010; UNDP 2004). Kenya in particular has experienced

mismanagement of water resources and wanton destruction of catchment areas besides universal challenges including inadequate water, poor water quality, increase in population and climate change (NLUP, 2017).

Kenya managed its water resources under Water Act Cap 372 for 28 years (1974-2002) (GOK, 1974). The act centralized all water resource management operations and depicted a top-down approach where the stakeholders were not involved (Richardson, 1996). This legislation emphasized on water services to the expense of water resources management. Its review in 2002 separated service provision and water resources management, and decentralized water sector operations. According to Beyene and Luwesi (2018), the desired outcome of the separation of policy and regulation from service provision and water resources management was to improve the mechanisms of accountability and transparency in the water and sanitation services and resources management subsectors.

The new act also classified all wetlands in Kenya regardless of their sizes and assigned each of them to a particular sub catchment area. It also established Water Resource Users Associations (WRUAs) through Water Resource Management Authority (WRMA) amongst other supporting institutions (Yerian *et al.* 2014; Baldwin *et al.* 2015) in order to foster public participation in the water resources affairs (K'akumu *et al.,* 2016; McCord *et al.,* 2017; GOK, 2002). A WRUA consists of water resource users, land owners abutting the riparian reserve, government and non-state actors who share a common water resource such as a sub catchment and elected committee members from within the sub catchment area (Dipeshi 2016) and are mandated to provide services and interact directly with water users and consumers. The committee recommended applications for water abstraction, ensure cleaner and reliable water supply, work with community to promote integrated water resource management, resolve disputes among water users, and provide storage

facilities like water tanks construction of water pans. WRUAs are also expected to provide linkage between the community and regulatory arms that dwelt on policy and customer care.

Management of water resources got more impetus in 2007 when Kenya prepared Vision 2030 plan, which was anchored on political, economic and social pillars. The plan placed water as key requirement that will enable the country to achieve industrialization and urbanization through universal access to water. This was in harmony with UN's 2030 sustainable development goals (SDGs) (UN, 2015) (Chepyegon and Kamiya 2018). The role of water resources management and governance was further emphasized in the Constitution of Kenya promulgated in 2010, (GOK, 2010a) which provided for access to water as a basic human right. In order for Kenya to achieve the anticipated development agenda envisaged in Vision 2030, there was need to face the water resource governance and management challenges (Kibuika and Wanyoike 2012).

This paper is premised on the collaborative governance theory which according to Tomo *et al.* (2018) was intended for policy implementation between private and public actors so as to formulate new ideas to deal with obstacles that occur to both private and public administrations. The theory emphasis on efficiency independent of hierarchical structure (Sun, 2017) and stresses on government to consider multi-agencies (Lan, 2015) including social entity which incorporates collaborative mechanisms of operation geared towards achieving a common public purpose (Sun 2017; Emerson *et al.*, 2012).

Drawing from the theory's ability to provide solutions through negotiations and joint implementation of policies (Cooper *et al.*, 2006), the study views WRUA as the fulcrum that provides the leadership and forum through which support is experienced by identification of the policy problems and their solutions. Ansell & Gash (2008) stressed that for effective collaborative governance, there has to be forum leadership and support. Corroborating with Ansell (2012) the

best approach to dig about stakeholder satisfaction and understanding of procedures would be for WRUA to foster negotiations of regulations in order to assist stakeholders arrive to a consensus towards the sub catchment transformation.

Integrated Water Resource Management (IWRM) combined with public participation was the foundation of sub catchment management upon which WRUAs were formed (Richards and Syallow, 2018). Rwamuthambi sub catchment WRUA was still at its formative stages having operated without registration for more than 15 years until its official registration in 2017. Even though WRUA had prepared a management plan in 2015, the basin was still facing challenges of degradation, population increase (GOK, 2019) leading to water shortage during dry spells and flooding (Mati *el al.,* 2008), land tenure system and poor collaboration amongst relevant grass root institutions (RSCMP, 2015). Therefore, the study investigated efficiency and challenges faced by WRUA in the process of implementing their mandate as decentralized units anchored in public participation. It provides strategies for sub catchment transformation and informs policy review that can apply in other sub catchments

5.2. Materials and Methods

5.2.1 Site description

The study was conducted in Rwamuthambi Sub Catchment area which runs across Kirinyaga and Nyeri Counties, and borders Mount Kenya (Figure 6-5). It is a constituent of larger Upper Tana River Catchment which lays North West of Nairobi (UTaNRMP, 2014b). The catchment comprises of Sagana River, also known as Tana River downstream (Geertsma *et al.,* 2009). River Tana is one of the five main water basins in Kenya, beside River Ewaso- Ng'iro, Athi River, Rift Valley and Lake Victoria Basins. Rwamuthambi River is a major tributary to River Sagana (CGK, 2013).

Rwamuthambi Sub Catchment covers an area of about 170km^2, and stretches from Mount Kenya forest through four districts; Mathira East in Nyeri County, Kirinyaga central, Kirinyaga west and Mwea west in Kirinyaga County. Rwamuthambi River is about 80kms long from its source in Mount Kenya to its confluences (j) with River Sagana at Kwa V (Fig 6-5). The sub catchment is geographically bound within 0° 37' 6" S, 37°14' 57" E; 0° 37' 6" S, 37° 24' 34" E and 0° 69' 9" S, 37° 14' 57" E and 0° 69' 9" S, 37° 24' 34" E (RSCMP, 2015), as shown in Figure 5-1.

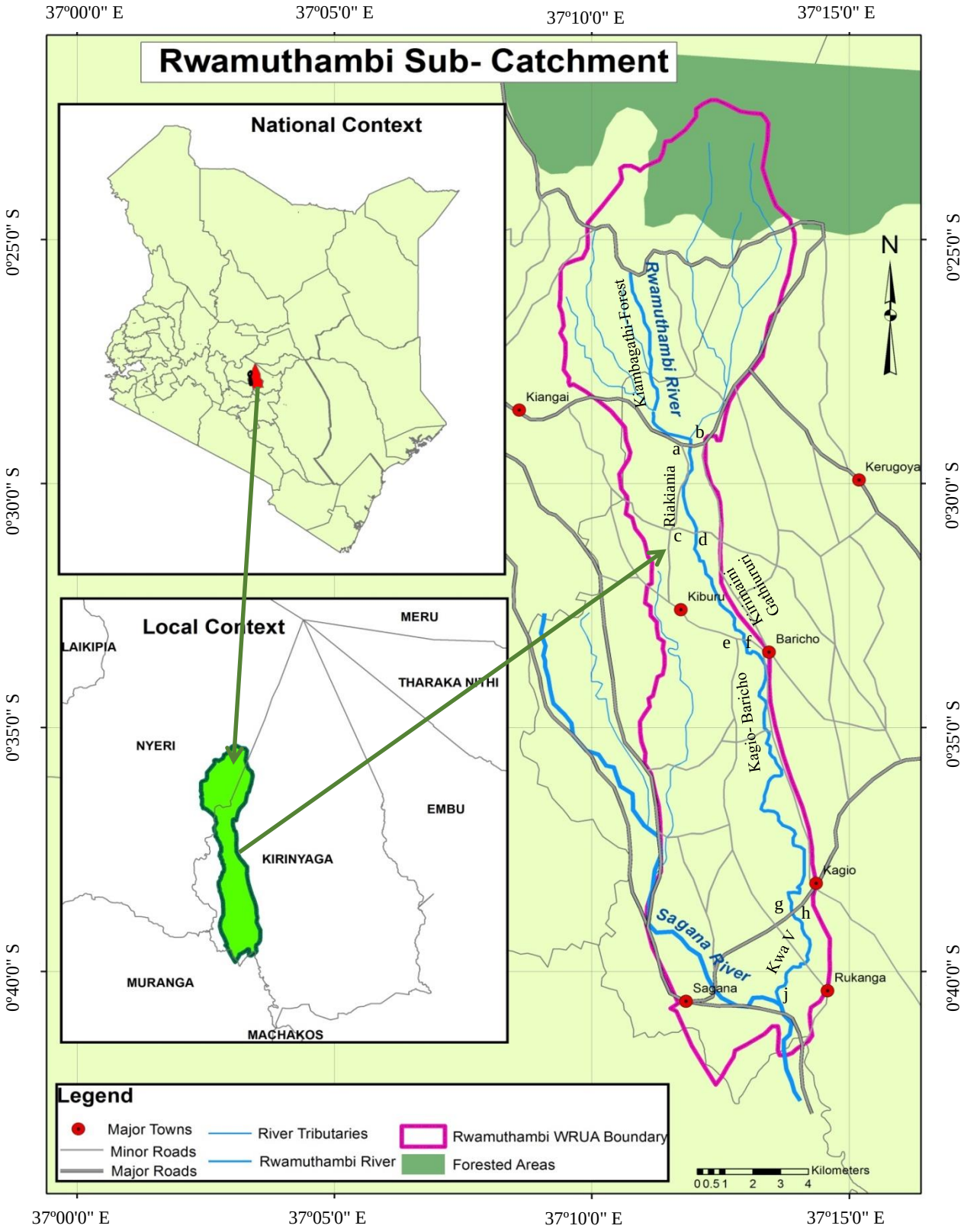

Figure 5-1 Map showing the location of the study area: Source (RSCMP, 2015)
(**a-b**): Kiangai- Kagumo road; (**c-d**): Kabonge- Riakiania road; (**e-f**) Kiburu- Baricho road; (**g-h**): Sagana-Kagio road; (**(a-b)**, **(c-d)**)- Upper Midland-I, (**(c-d)**, **(e-f)**)- Upper Midland-II, (**(g-h)**, **(j)**)- Upper Midland-III

Study area being on the windward side of Mount Kenya and at close proximity to the Equator experiences tropical climate. Its annual temperatures range between 17°- 20°celcius and has two rainy seasons. Long rains occur from between mid-March to May, and while the short rains between from mid-October to December. Outside these rainy seasons, with dry spells are experienced during the rest of the year. Annual precipitation ranges from 800 - 1200mm (Jaetzold *et al.,* 2007). The sub catchment lies within three agro- ecological zones as indicated in Figure 5-1; Upper Midland-I which is humid suited for tea and dairy farming (Riakiania- Kiambagathi-Forest), Upper Midland-II with sub-humid conditions supporting maize, beans, coffee, irish potatoes (Kirimaini- Gathiururi) and Upper Midland-III an area which is semi-humid ideal for pulses, maize, cotton and cassava (Baricho- Kagio; Kwa V) (Ibid). It has well drained soils which range from extremely deep, dusky red to dark reddish brown, friable clay, with acid humic topsoil (CGK 2013; Jaetzold *et al.,* 2007). The local livelihood is supported through small scale farming where the main cash crops are coffee, macadamia nuts, avocado and horticultural crops, while substituting it with zero grazing cattle farming. Food crop farming includes maize, beans, bananas, arrow roots, amongst others.

5.2.2 Sampling

The three ecological zones were crucial to the study as they formed the basis for management of the sub catchment based on natural conditions and also provided the frame for equitable distribution of WRUA- Management Committee Members (WRUA- MCMs) within the sub catchment (RSCMP, 2015). For ease of this study's data collection coordination and in respect to the ecological zones the study area was further divided into five sections labelled as Kiambagathi Forest, Riakiania, Kirimaini- Gathiururi, Kagio- Baricho and Kwa V shown in Figure 6-5. The demarcation was marked by the tarmac road crossing Rwamuthambi River channel as it drains to River Sagana. Two of the river crossings (c-d) and (e-f) also marked the extent of agro- ecological zones stated above. Primary data collection targeted the community, WRUA-MCMs relevant

departmental heads including local administrators. Sample size for the community n_o was obtained through Cochran's formula (Horse, 2018; Rucker, 2017) based on a population of 19,800 households (RSCMP, 2015).

$$n_o = \frac{Z^2 pq}{(e_p)^2} = 196$$

$where\ n_o$ =Cochran's sample size recommendation

Z = Z value (i.e. 1.96 for 95% confidence level)

p =Proportion of the population with direct attribute to the SC Governance

e_p = Desired level of precision-confidence interval ±7% = (±0.07))

The respondents also included 21 WRUA-MCMs, 6 government officers; 4 departmental heads and 2 administrators (the senior chief and assistant chief from the area). The total target sample was therefore n=223 questionnaires. However, data analysis was based on 203 questionnaires comprising of 180 questionnaires that were filled and returned from the community, 17 from WRUA committee and 6 questionnaires from government officials. A pretest was conducted over a small sample. The results assisted the research in refining the final question based on the information and comments gathered during the trial survey, besides familiarizing with the tool instrument (Marambanyika and Beckedahl 2016; Saunders *et al.*, 2003).

5.2.3 Data collection and analysis

The questionnaire collected information on the status of governance in local wetlands, effects of existing governance on the sub catchment, governance scenarios that influence future sustainable utilization of the sub catchment, and bio-data of the respondents. Questions were framed with answers provided on a numeric scale whereby the respondent ranged based on priority, weight or order of preference and an option a space for an additional opinion.

The questionnaires were administered to the household heads or in their absence, the senior most adult available. Stratified systematic sampling procedure was applied whereby transects were

drawn and every 5th household considered Gorard, 2013; Leedy and Ormrod 2013; Pearson et al., 2012). There were two strata formed by identifying and segregating the land owners along the riparian from the rest of the community within the catchment area. 24 key informants were purposely selected whereby 7 community opinion leaders and a WRUA-MCM represented each agro-ecological zone. The identified were subjected to open ended questions including management and utilization scenarios before establishment of WRUA, matters of surveillance, involvement of land owners and role of politicians. Generally, the questions were meant to validate data collected from the questionnaire (Jawuoro *et al.,* (2017). These interviews were conducted in person at points convenient to the interviewee. Relevant observations were recorded through transect walks.

Primary data was collected during the dry season in the months of July and September, a time when river water consumption was at its peak and most farming was irrigation dependent. This data aimed at gathering raw relevant information that explored into the research question. Field work was conducted after seeking and being issued with a research permit. This ensured compliance with research ethics principles and participants rights. Secondary data was obtained through review of varied documents in order to establish what existed in relation to the area of study in order to justify the gap being filled by this study. The documents included relevant local legislations, journals, books, authorised publishers from the internet and relevant international conventions.

The data that required ranking was analyzed through Stata software (StataCorp LLC, USA) for comparison between variables and between groups and plotting frequency distribution (Youssef 2012). MS Excel software was also used (Schoenbach, 2004) and at 95% confidence level chi square test of independence was applied to test differences in distribution of responses based on null hypothesis against alternate hypothesis (Cohen, 2010; Kao *et al.,* 2007).

5.3. Results

The respondents consisted of 62% males and 38% females. The total responding rate was 91% for the community and WRUA-MCM (17 questionnaires were returned out of 21). Being an agricultural zone, many homesteads were busy in the fields thus vacant during morning hours thus, 42% questionnaires were conducted in the morning and 58% in the afternoon.

WRUA management committee membership was such that for one to qualify to be a committee member, one must be above 18 years, fully paid up member of the society and elected at an annual general meeting as provided for in the water act of 2002 (GOK, 2002) and the WRUA constitution. The level of education or technical orientation was not an attribute for qualification. More than two thirds of WRUA-MCMs (82%) had post-secondary certificate, while the rest held primary certificate. 88% of the interviewed committee members were aware of existence of laws related to wetland governance. The selection of WRUA membership was fairly distributed throughout the sub catchment and ideally elected democratically based on the three agro-ecological zones (Figure 5-1). To ensure equity, each of the three ecological zones has a representation of 7 members making a total membership to 21.

5.3.1 Governance issues since establishment of WRUA

The community got involved in activities that supported conservation and sustainability through the intervention of WRUA-MCMs. The main activities accorded priority was soil erosion control (46%) and re-afforestation (33%). Field transects evinced planted bamboo and other wetland friendly vegetation along the riparian reserve. This study established that WRUA committee collaborated with Community Forest Association (CFA) to provide and plant ecological friendly seedlings along the riparian reserve especially in the areas of Riakiania- Kiambagathi- Forest and Kirimaini- Gathiururi areas (Figure 5-1) which lay at a higher altitude. This was achieved either through engaging the land owners or at most times without the land owners' consent. The results indicated that 35% of the land owners destroyed the seedlings.

Three out of every five members of WRUA-MCM against two out of every five members of the community indicated that the riparian reserve was set apart from the title deed and survey maps. A reference to both the title deed and the survey map in the land office however indicated that the riparian reserves were not detached from private parcels during demarcation. More than two thirds of the key informants owning land abutting the riparian reserve alluded that WRUA committee was fully involved in riparian reserve rehabilitation and conservation activities in spite of the reserves being part of their private land. Furthermore, regardless of lack of a clear format on delineation of the riparian reserve in Rwamuthambi sub catchment management plan (RSCMP), WRUA jointly with CFAs had demarcated and set apart 85% of the riparian reserve. This was followed by planting Bamboo, *Vitex keniensis* (Muhuru), *Calodendrum capense* (Muraracii), *Prunus Africana* (Muiri), *Wurbagia Ugandensis* (Muthiga) and *Vernonia auriculifera* (Muthakwa) seedlings amongst others. During this exercise the committee members recommended extirpation of Eucalyptus trees. Key informants compared this approach to the former river management system that was before establishment of WRUA which did not involve the public. The community asserted that land demarcation conducted by Survey office used the centre line of the river as the boundary and subsequently granted the beneficiaries the right to the riparian reserve. In light of this more than 50% of the community stated that this approach by WRUA was tantamount to trespass since the land was private. Consequently, the land owners uprooted the seedlings while others absconded WRUA meetings in reiteration. WRUA asserted that there lacked a laid-out procedure on ensuring that their recommendations were adhered to. However, most of the community (65%) indicated that there was improvement in rehabilitation of the riparian reserve since establishment of WRUA in spite of their approach.

The study found that the community was barely consulted during project identification or implementation in the sub catchment. There was evidence that WRUA held meetings. However, such meetings were random and deliberations tailor-made without giving the community a chance

to deliberate on agenda projects. Yet the proposed wetland conservation programs still got underway. It was on this backdrop that the research inquired on how community in Rwamuthambi sub catchment would sequence measures towards improvement of governance in the sub catchment. The results were as illustrated in Figure. 5-2. 31% indicated that governance would be enhanced by giving the locals a voice during project implementation and expenditure. 23% suggested that taking responsibility to monitor and evaluate project outcomes would improve on the sub catchment governance. The least proposed strategy (9%) for governance improvement was on scrutiny of proposals suggested for consideration.

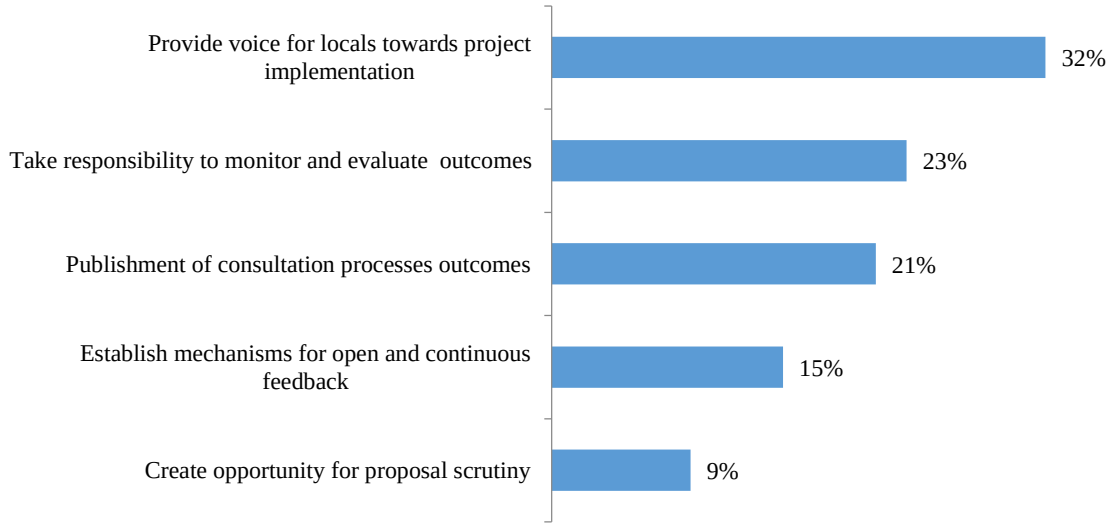

Figure 5-2 Community preferred sequence of strategies for governance improvement in percentage (%); (Source: Kumunga, E.M, 2018)

In some cases, the local community received information regarding wetland degradation from WRUA. Degradation had adverse effects on wetland management. Interrogation was done on perceived causes of degradation. At a significant value (p) of 5%, a chi square test of independence was done to determine the relationship between community responses and that of WRUA in order to rate the level of understanding gained from sensitization. The relationship was significant ($\chi 2$ (4, N=180) = 20.46, p< .01) as shown in Table 5-1 where 4 are the degrees of freedom and N is the sample size. Notwithstanding, the study revealed that 77% of the community was not aware of

RSCMP While 23% confessed to know of its existence but not its contents. Besides the county department of physical planning which is mandated to prepare and guide implementation of physical development plans admitted that there lacked incorporation of RSCMP into their land use plans and the county government did not consider this plan as part of their projects. The sub catchment area had no water allocation plan.

The study also interrogated the understanding of the community and land owners towards the main causes of degradation. Although overexploitation of wetland resources and unsustainable use of wetland resources were very close factors leading to degradation, responses were sought so as to establish whether the community interpreted them as interrelated. The responses had a big disparity. Key informants indicated that overexploitation was not fully associated with unsustainable utilization.

Table 5-1 Perception on factors affecting wetland degradation in percentages (%); (Source Kumunga E.M, 2018)

Social and behavioral factors	**Community and land owners**		**WRUA and government officers**		**Chi square test of independence**
	Frequency	Per cent	Frequency	Per cent	
Overexploitation of wetland resources	50	28%	2	9%	$\chi 2(4) = 20.46a$ $p<.01$
Unplanned and haphazard implementation of development	42	24%	5	22%	
Land fragmentation/ subdivision	39	22%	6	26%	
Persistent use of organic pesticide	31	17%	3	13%	
Unsustainable use of wetland resources	18	10%	7	30%	
	180	100	23	100	

a:-2 cells (20%) have expected count less than 5. The minimum expected count is 2

The study further established that WRUA committee engaged in selected community projects such as provision of branded water tanks to institutions for water conservation, installation of master meters and construction of water pans. WRUA managed these activities through funding from Water Services Trust Fund (WSTF) substituted by revenue collected from water supply projects. WRUA-MCMs (Management Committee Members) stated that these finances were inadequate to support all essential conservation activities. It was also alluded that there was hardly any support from other relevant government sectors save for Community Forest Association (CFA) who contribute seedlings and sometimes labor. According to WRUA- MCMs there was neither financial nor technical support received from the county government, while the input from other departments including departments of agriculture, energy and survey were dismal. The community asserted that monitoring of water resources from agriculture extension officers and public health officers as it used to be previously before introduction of WRUA was no longer witnessed. This was supported by 25% of WRUA- MCMs who confirmed that there was low to very low

monitoring and enforcement compared to what was experienced before WRUA took office. WRUA key informants blamed poor surveillance and monitoring to in adequate staffing and lack of support from relevant sectors.

More than 98% of water abstraction was tapped from upstream. This was most viable as it took advantage of gravitational flow to individual farm lands and to those reservoirs constructed through projects funded by WRUA or non-state actors. The main areas that relied on such projects were within Upper Midland-II (Kirimaini) and Upper Midland-III (Kagio-Baricho; Kwa V). The study observed that WRUA community-based water project abstractors, who had benefited from the master water meters paid for water services as per their consumption. More than 95% of the 48 stand-alone water legal abstractors had neither meters nor taps on their pipes thus leaving water unattended to run throughout into their farms. But the effect of this scenario of water wastage was mostly felt during the dry spell when there was clear scarcity of water for those downstream. WRUA explained that although flat rate charges were introduced for those without meters, these consumers evaded all payment with an excuse that river water was God given and therefore should be free of charge.

Besides the water meters, WRUA had made other contributions to the sub catchment area. The study sought to gauge how the community and land owners categorized based on the three ecological zones; Upper Midland-I (Riakiania- Kiambagathi- Forest), Upper Midland-II (Kirimaini- Gathiururi) and Upper Midland-III (Baricho- Kagio- Kwa V) prioritized each contribution. The response options were sensitization and education on functions of wetlands, provision of incentives to those members of the community involved in conservation, uniting resource users and water Resource Management Authority, provision of funds to improve water infrastructure and creation of a sense of ownership to wetlands and their products as shown in Table 5-2 and 5-3.

A chi square test of independence at a significance level of 5% was used to test the distribution of responses across the three ecological zones. The general null hypothesis was that the responses from the zones were dependent or related. Responses in regard to sensitization and education on wetlands functions rendered the null hypothesis false ($\chi 2$ (8, N=147) =1.19, p>.05) thus rejected. For instance, while Riakiania- Kiambagathi- Forest area and Baricho- Kagio- Kwa V region registered high priority of 29% and 33% respectively Kirimaini- Gathiururi area had only (17%) towards WRUA provision of information about the catchment through education and sensitization. Kirimaini- Gathiururi sub catchment area engaged the most in irrigation.

Similarly, the perception towards provision of incentives to those who were involved in conservation was varied ($\chi 2$ (8, N=147) = 5.77, p>.05). Riakiania- Kiambagathi- Forest area and Kirimaini- Gathiururi area had 31% and 22% responses as essential priority while Baricho- Kagio- Kwa V area had only 18%. WRUA provided community with incentives especially free seedlings which were distributed equitably in the ecological zones and offered assistance in planting them. However, the survival rate of seedlings at Riakiania- Kiambagathi- Forest was high owing to its high altitude while Kirimaini- Gathiururi viewed every activity from an economic value thus considering tree growing along the riparian as a waste of highly productive agricultural land. This was different from Baricho- Kagio- Kwa V where tree planting required special attention as the climate was tending to semi- aridity. Those from Baricho- Kagio- Kwa V an area prone to floods during the rainy season stated that in the 1980's and early 1990's incentives were offered in monetary form, farm equipment and even recognition for participants who led in soil conservation famous known as "kuzuia mmonyoko wa udongo".

Further, the response on uniting resource users and water resource management authority also failed the null hypothesis as differences were portrayed through the zones ($\chi 2$ (8, N=147) = 6.24, p>.05). While 30% of the responses in Kirimaini- Gathiururi area indicated that this was essential priority, only 19% and 12% supported it from Riakiania- Kiambagathi- Forest area and Baricho-

Kagio- Kwa V area respectively. Key informants from Kirimaini- Gathiururi area were concerned about restrictions imposed on water abstraction. Responses in regard to provision of funds for water infrastructure also showed independence in the zones ($\chi 2$ (8, N=147) = 1.85, p>.05) thus rejecting the null hypothesis. Further interrogation showed that Kirimaini- Gathiururi who had 30% as moderate priority were the areas that relied most on horticultural production as a source of livelihood, therefore most of the water pans were personal initiative. Riakiania- Kiambagathi- Forest area and Baricho- Kagio- Kwa V area both gave only 13% and 18% respectively as moderate priority. More than 90% of the community-based water supply projects were self-sponsored. Further, responses on rating of priority on creation of a sense of ownership was also independent ($\chi 2$ (8, N=147) = 4.75, p>.05) against the null hypothesis that the responses were related. For instance, while 25% responses from Kirimaini- Gathiururi registered moderate priority, Riakiania- Kiambagathi- Forest area and Baricho- Kagio- Kwa V area both tied at 16%.

Table 5-2 Comparison of preferred priorities by community and land owners; (Source Kumunga E. M, 2018)

WRUA contribution	Ecological zone	Essential priority	High priority	Moderate priority	Low priority	Not a priority	Chi square test of independence
Sensitize and educate on wetlands functions	Riakiania- Kiambagathi-Forest	14	15	11	7	5	$\chi 2(8) = 1.19a$ $p>.05$
	Kirimaini- Gathiururi	13	8	12	8	5	
	Baricho- Kagio- Kwa V	12	16	10	6	5	
Provide incentives to conservators	Riakiania- Kiambagathi-Forest	16	8	7	12	9	$\chi 2(8) = 5.77b$ $p>.05$
	Kirimaini- Gathiururi	10	11	12	7	6	
	Baricho- Kagio- Kwa V	9	11	11	12	6	
Uniting water users and management authority	Riakiania- Kiambagathi-Forest	10	15	13	7	7	$\chi 2(8) = 6.24a$ $p>.05$
	Kirimaini- Gathiururi	14	13	8	6	5	
	Baricho- Kagio- Kwa V	6	9	9	12	13	
Provide funds for water infrastructure	Riakiania- Kiambagathi-Forest	5	6	7	16	18	$\chi 2(8) = 1.85a$ $p>.05$
	Kirimaini- Gathiururi	5	6	14	11	10	
	Baricho- Kagio- Kwa V	5	6	9	13	17	
Create a sense of ownership	Riakiania- Kiambagathi-Forest	12	8	12	10	10	$\chi 2(8) = 4.75b$ $p>.05$
	Kirimaini- Gathiururi	14	11	8	6	7	
	Baricho- Kagio- Kwa V	15	8	7	8	11	

a, b 0 cells (0%) have expected count less than 5. The minimum expected count is a=5; b= 6

Table 5-3 Responses on priorities over WRUA contributions in percentages (%); (Source Kumunga E. M, 2018)

WRUA contribution	Ecological zone	Essential priority	High priority	Moderate priority	Low priority	Not a priority
Sensitize and educate on wetlands functions	Riakiania- Kiambagathi-Forest	27%	29%	21%	13%	10%
	Kirimaini- Gathiururi	28%	17%	26%	17%	12%
	Baricho- Kagio- Kwa V	25%	33%	20%	12%	10%
Provide incentives to conservators	Riakiania- Kiambagathi-Forest	31%	16%	13%	23%	17%
	Kirimaini- Gathiururi	22%	24%	26%	15%	13%
	Baricho- Kagio- Kwa V	18%	23%	23%	24%	12%
Uniting users and water management authority	Riakiania- Kiambagathi-Forest	19%	29%	26%	13%	13%
	Kirimaini- Gathiururi	30%	28%	17%	13%	12%
	Baricho- Kagio- Kwa V	12%	18%	18%	24%	28%
Provide funds for water infrastructure	Riakiania- Kiambagathi-Forest	10%	12%	13%	30%	35%
	Kirimaini- Gathiururi	11%	13%	30%	24%	22%
	Baricho- Kagio- Kwa V	10%	12%	18%	26%	34%
Create a sense of ownership	Riakiania- Kiambagathi-Forest	23%	16%	23%	19%	19%
	Kirimaini- Gathiururi	30%	25%	17%	13%	15%
	Baricho- Kagio- Kwa V	31%	16%	14%	16%	23%

5.3.2 Challenges encountered by WRUA

Although WRUAs were established through the guidance offered by Water Resource Management Authority (WRMA), all the WRUA Management Committee Members (MCMs) agreed to have inadequate capacity and technical background on water resource governance. None of them had training oriented to environmental and natural resources fields or had prior experience in wetland conservation. This was in spite that from the survey all WRUA-MCMs were literate with 6% and 35% having attained university and college levels respectively. Only 35% of WRUA-MCMs were aware of existence of water management legislations like Forest and Conservation Act, Agricultural Act and Physical Planning Act of which 21% knew the contents of water related various policies like water policy. The study also noted that 6% WRUA-MCMs were aware of the water act while 13% were privy to Environmental Management and Coordination Act

(EMCA). Only 15% of WRUA-MCMs knew the basic content on water resources management. However, the committee played an effective role in dispute resolution.

5.3.3 Prevailing dimensions of water governance in the sub catchment

A large number of activities in the sub catchment area were orchestrated towards income generation since the main economic base for the area was agriculture. The community reverted to irrigation for market production of horticultural crops following slump in coffee prices during mid-1990s. Based on census reports, the study area had experienced an increase of more than 50% in household population since 1990s. Consequently, this increased demand for food and other water resource-based services leading to changes in the ecosystem. The substitute crops included among others tomatoes, French beans, kales, gorget capsicum and fruit crops. More than 85% of the respondents were self-employed and mainly engaged in farming generating monthly incomes ranging from 50-200 USD. The study established that most of the stakeholders (41%) perceived the sub catchment governance from an economic dimension (Figure 5-3).

Another 30% of the respondents indicated that the dimension for sub catchment governance was institutional. This was supported by the existence of civil societies who collaborated with Community Based Organizations (CBOs) to construct water pans which would act as storage of storm water and source of water for irrigation during the dry spell. The system was embraced by 15% of farmers. Most of the key respondents (63%) indicated that the selection of the leaders was not democratic since the entire community within the sub catchment was not involved. It was alleged that committee members were hand-picked rather than the choice of the people being represented. Further, WRUA lacked institutional capacity for proper management of the sub catchment. WRMA officials indicated that the office was under-staffed to adequately serve all the 6 sub catchments that are in Kirinyaga County side of the larger Upper Tana Catchment area adequately. In addition, training offered by WRUA-MCMs to the community was limited to farmers abutting the river and those engaged in water projects.

Although 24% of the respondents gave the sub catchment area governance dimension to be political, local sub county and ward representatives were not involved in management matters. More than 90% of the key informants asserted that politicians did not play any role in influencing policy formulation. In Rwamuthambi sub catchment area, politicians only featured during launch of tangible items like water tanks or commissioning water pans. This was attributed to fear of losing popularity by the politicians if involved in controlling or stopping activities hurting water resources against the wish of potential voters. 5% of the respondents did not align the sub catchment governance to any dimension.

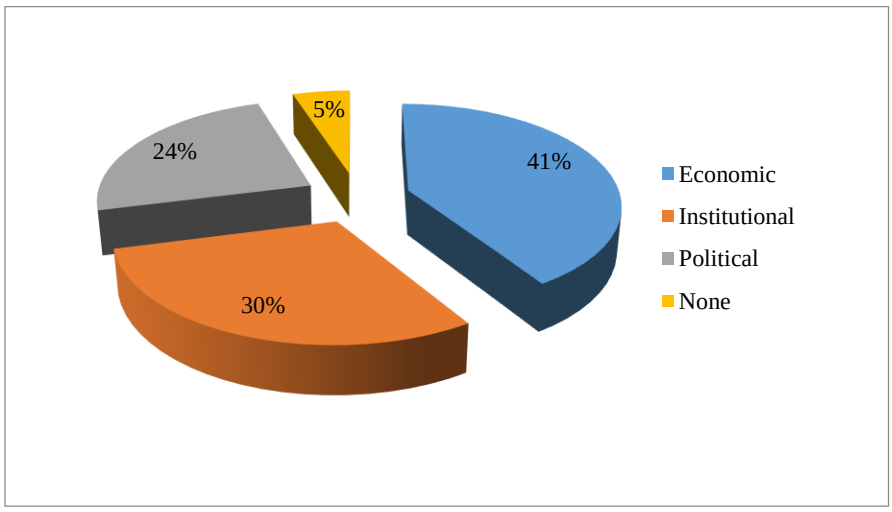

Figure 5-3 Prevailing dimensions of governance in Rwamuthambi sub catchment area; (Source Kumunga E. M, 2018)

5.4. Discussion

5.4.1 Effect of capacity building WRUA-MCMs to community wetland perception and attitude

More than 15 years have passed since the establishment of Rwamuthambi WRUA and over two years since its official registration and before conducting this study. It emerges that WRUA-MCMs have encountered challenges in handling technical matters and also educating the community on best practices which are some of the activities under their mandate. This could not be attributed to illiteracy as most of members had attained secondary education level and above, surpassing the country's 7.8% overall documented average of population with similar level of education (CGK,

2013). In a similar finding Rebelo *et al.* (2010) indicated that one of the major restrictions against sustainable use of water resources for food production was lack of information on benefits and strategies that can be employed to achieve sustainability. WRUA-MCMs admitted that there was need for requisite know-how in regard to contents on relevant legal frameworks and information related to water resources conservation. This finding as corroborated by Omolo, (2010) emphasized upon policy implementers to beware of rights and responsibilities besides getting armed with an understanding on how to exercise them. If WRUA-MCMs managed to drive appropriate local conservation measures and uphold effective institutional structures then the sub catchment cannot get degraded through cultivation as was confirmed by (Marambanyika *et al.*, 2016). Another study by Oremo *et al.* (2019) also revealed that when the community is knowledgeable on issues of water management, it has effect to their attitude and practices. Thus, for there to be a shift towards wise use of wetland resources WRUA therefore needs to educate the community on benefits and sustainable use of wetland resources.

5.4.2 Water conservation through introduction of water tariffs

Rwamuthambi WRUA encouraged the community to account for water drawn and tried to reduce water wastage by imposing payment for water abstraction though standing charges or metered charges as one way to regulate water abstraction. The move was meant to control and minimize the looming water scarcity exacerbated by ever reducing water quantities from being wasted. This finding was supported by Ukumu (2019) that for sustainability, human abstraction of renewable resources should be systematically planned. Wastage of the resource was abated through reduction of Non-Revenue Water (NRW). The revenue collected was used to supplement the sub catchment funding that WRUA received from Water Sector Transfer Fund (WSTF). This finding was similar to Mati and Mugo (2018) that the main objective for financing the water sector should be to maximize the public investment's social return and make the institutions sustainable. However, the benefits of charging water resources were minimal based on the high rate of payment defaulters

due to unwillingness to pay since water was viewed as a free public resource. A similar finding was also arrived at by Noga and Wolbring (2013) that in water abundant areas water is regarded as a human right and thus could not be equated to monetary worth. This perception and attitude could however be changed through educating the public on water resources issues and promoting management for sustainability. This conclusion is supported by Chee *et al.* (2015) that NRW can be reduced by teaching the public and promoting interest on benefits of reducing NRW through community led strategies. Notwithstanding, a related finding by Rampa in 2011 revealed that increase in financial resources and technical support are not short-term solutions to improved governance. WRUA required support from the community and the county government in order to monitor and reduce non-revenue water. This explains why there is need for empowerment of WRUA-MCMs in technical and conservation skills so that capacity gained could trickle to the community as custodians of the sub catchment.

As an additional way to conserve water, the study evinced that WRUA used the funding received from Water Sector Trust Fund (WSFT) to provide water tanks for roof rain water harvesting and construction of water pans with the latter achieved through collaborative governance with Non-Governmental Organizations (NGOs). This is in congruence with the findings by Mati and Mugo (2018) that government resources invested in public goods like water resources could attract private funding.

5.4.3 Effects of land tenure policies to wetland governance

The study results further established that the entire riparian reserve was adjudicated under freehold tenure which is absolute proprietorship that accords the holder unlimited rights of use, abuse and disposition (GOK, 2016). But the Constitution of Kenya (GOK, 2010a) provides that water resources are held in trust for the people by the National Government (GOK, 2016). Ogolla and Mugabe (1996) and KLR (2006) reiterated that the state holds power in regulation of private land use and may revoke any land rights in an effort to ensure conservation of the environment. These

facts did not resonate well with the findings from the study on matters of rehabilitation and conservation of the riparian reserve as the study established that the land owners along the riparian reserve were not in acceptance of dominance over their presumed private land which was used mainly for farm produce, considering that it was held under absolute ownership rights registered during land demarcation process of 1960s. The rights included sub division of land and from the results the community views on degradation were not influenced by the existence of WRUA. In a related finding Johanna *et al.* (2015) stated that there was a strong historical linkage of ecosystem degradation to land demarcation and lost commonality whose consequence culminated to its privatization resulting into preference towards agricultural production against wetlands and rivers conservation. In addition, Manzungu (2004) noted that stakeholder participation without restructuring ownership and access rights run the risk of tokenism. Furthermore, Babcock (1991) attested that in as much as the economic benefits for wetland conservation cuts across the entire society, the land owners endures the conservation cost through lost opportunities for investment making most property owners abutting the wetlands form attitudes against their conservation. In addition, Oremo *et al.* (2019) unearthed that attitudes and practices were determined by land tenure and distance of the farm to the water resource. In the face of these findings, there is need to review the issue of riparian reserve ownership as legislated against the current private land interest for sustainability in posterity.

5.4.4 Sub catchment area sustainability through public participation

Further, more findings portrayed WRUA to be applying an approach that was near top- down in the process of riparian reserve rehabilitation and conservation. This faced resistance from the land owners which manifested through defiance and uprooting of tree seedlings planted by WRUA jointly with CFA. In a similar finding Rambonilaza *et al.* (2015) established that most of individuals imposed with compulsory maintenance ended up defaulting. But in contrast to this finding Huntington *et al.* (2017) noted that when faced with any form of change communities join

with others to form collaborative response space which therefore calls for consideration of local responses as a basis for adaptive policies which would be supportive to the community instead of pressing limitations. Most of the community stated the need to get a voice in project implementation and responsibility to monitor and evaluate sub catchment projects. This portrayed the willingness of the community to participate in sub catchment area management projects. This finding supports what Alexiu *et al.* (2011) posited that reduced community participation inhibits community involvement in social activities with citizens perceiving it not for their individual benefit but for the benefit of WRUA as a government agency. Thus, it is the collaborative actions of WRUA and the community that yields to improved economic status and availability of clean water amongst other wetland relate benefits.

The study established that WRUA worked closely with CFAs through provision and planting of ecologically friendly seedlings. In a similar finding by MCPFE (2009) indicated that there was need for integrated approach and cooperation amongst water and forest authorities since forests contribute to water supply by maintaining high water quality through minimizing erosion by soil stabilization and regulating flows. But contrary to this finding Mamoon (2018) asserted that rather than upland forests serving as sponges, forests retain more water than other surfaces therefore their clearing would reduce the surface area that contribute to over 80% evapotranspiration which returns the excessively absorbed water to the atmosphere, instead of adding this water to the stream flow. In addition to this contrast, Mamoon was also supported by Salih (2001) that conservation and re-vegetation caused displacement. This claim was disputed by Luwesi and Barder (2013) and Mathenge *et al.* (2014b) who reported success in rehabilitating degraded wetlands in Kenya through planting of trees. Further, Parker and Oates (2016) averred that an interdisciplinary approach was required for a sustainable management of a river ecosystem so that the ecosystem is viewed as water security rather than as consumers of water. According to GOK (2017) this is an

area of dilemma for Kenya on how to balance the ever-expanding agriculture as the main stay to the economy yet it flourishes best in catchment areas compared to forest conservation.

The sub catchment was being utilized extensively by the community for cultivation and other activities through incorporating some conservation measures promoted by WRUA committee during sensitization as confirmed by the Chi square results from level of understanding acquired through sensitization. In support of this finding Yang *et al.* (2006) alluded that consistent provision of information from science and ideas regarding environmental protection compared to economic development removes contrasts in adjustment and attitudes toward using water for agriculture or other economic activities. This was also consistent with what Marambanyika *et al.* (2016b) outlined that wetland sustainability can only be achieved if there was a simultaneous focus on protection of the environment, promotion of socio-wellness and effective institutional structures under a wetland committee. Also, Boschet and Rambonilaza (2015) noted that some decisions towards conservation could be torn between preservation of peripheral natural landscape and protection of farming activities.

The results established that conservation activities undertaken by the land owners were voluntary and benefit driven purely from an economic angle. This conclusion was attested by (Liniger *et al.*, 2011) and Stringer *et al.* (2007) who proffered that success of conservation depended on local socio-economic benefits and household specific goals. WRUA provided conservation incentives equitably and generally rehabilitated the reserves across the ecological zones but these were rated differently by the community. The responses were related to prevailing activities practiced along the riparian reserve. For instance, it emerged that the community from these upper zones noted issues involving blocking the river channels by individuals denying downstream neighbors from getting sufficient water or at times dykes constructed by some farmers upstream would overflow to other farmlands destroying their crops. This finding was consistent with Ngowi & Mwakajea (2018) that incentive policies and implementation can improve conservation and livelihood.

Therefore, as long as the dimension of conservation was economic, adoption of the strategy was likely to be easy.

5.4.5 Sub catchment area management through inter-sectoral collaboration

The study also demonstrated that there was a challenge of sectoral integration as each related ministry was confined to its territorial and operation boundaries with each sector developing its plan without considering integrating with the others. The relationship between agriculture and irrigation water usage cannot be ignored yet the department of agriculture was not much concerned with riparian encroachment since agriculture act permitted only a reserve of 3m (GOK 2012c). A similar finding by Yang *et al.* (2006) inferred that effects of irrigation to rivers, and ecosystems could only be remedied through rehabilitation. At the same time the department of survey sustained that the centre line of the river was the parcel boundary (GOK 1969). The ministry of energy was concerned only when issues related to hydro power generation along Rwamuthambi River arose but was distance on matters of sustainable utilization of the water resources. Oremo *et al.* (2019) conveyed a similar finding that sub catchment area governance is influenced by varied multi-level actors whose interests were varied, conflicting and had arrangements that were not context-specific leading to lost synergy in governance. This explains why Johanna *et al.* (2015) advocated for enhancement of inter sectoral management while Carlsonn and Berkes, (2005) and Folke *et al.* (2005) indicated that the complexity of environmental governance required co-management by multi-level governance institutions and embracing adaptive, flexible strategies to deal with change and uncertainties. A similar suggestion is stipulated in Water Resource Users Association Development Cycle (WDC) in that water resources management could only be achieved through multi-sectoral collaboration and coordination of integrated institutional capacity, technical knowledge and stakeholder participation (WSTF, 2009).

The success of a county government is attained through working with grass root institutions like WRUAs who had direct interaction with the community which was the essence of devolution. An

observation from the study area indicated that county ward representatives seldom involved themselves with riparian reserve conservation activities and WRUA operations. The local representatives kept at bay in regard to riparian reserve affairs which were mainly privately owned as the politicians were wary over any unpopular decisions that would reduce their prospect for re-election when their term lapsed. On the same note, the same effect could be transferred to WRUA committee members off whom Water Resources Management Authority (WRMA) regulations provided that in order for the committee to meet institutional framework threshold, it was mandatory to select committee members through fair elections. This finding was consistent with Giordano *et al.* (2005) that political uncertainty may have ramifications to institutions managing resources. Additionally, WRMA regulation should set out a performance evaluation so that there are thresholds for WRUA committee members once elected to keep them in office, rather than by expiry of their term. In this regard it is concluded drawing from Jorge and Ignacio (2015) that new policies are not panacea to water resource management but there's need to adopt collaborative governance and take into account common practices, inertia and hysteresis in order to develop new practices.

The study unveiled that Rwamuthambi WRUA had managed to prepare a Sub Catchment Management Plan (SCMP) which more than two third of the community had declared were unaware of. This was the same plan from where the activities by WRUA were derived. But based on the study results the main factors leading to degradation in Rwamuthambi sub catchment were mainly unsustainable use of wetland resources and their over- exploitation which arose from unplanned development and chaotic implementation of development activities as was asserted by (Zuquette *et al.,* 2002). Implementation of RSCMP did not receive any funding or technical support from the county government since the plan was not integrated with county physical and land use development plan, whose mandate and authority for preparation is vested with the county government (GOK, 2019). This finding was similar to Rodríguez *et al.* (2015) who stated that

effective water resource management could only be achieved through coordinated strategies established between land use planning and water resource management in order to generate land use scenarios which would limit the uncertainty, mitigate impacts of water infrastructure, guide in decision-making and cater for deviations from the envisaged proposal. Boschet and Rambonilaza (2015) corroborated that there exists a powerful political component in the process through which a local government makes a decision whether to support or ignore a sub catchment plan.

Furthermore, Patrick and Heymans (2015) stated that there was need for county governments to take up the role of sector specific policy making under the new governance dispensation of devolution including the water sector in order to ensure proper legislative framework and institutional operations. As such, WRUA committee should also take the initiative to establish a working relationship with the members of the county assembly because any proposed policies or budgetary allocation for WRUA could only be ratified through the county government assemblies because politicians are instrumental in driving policy review. These findings therefore show that WRUAs require supported from the county government through adoption of the sub catchment management plans for integration with the county land use plans and consequent funding for their implementation.

Although WRUA had not prepared a water allocation plan, the committee managed to solve conflicts of water allocation and others between land owners' utilization and value of conservation towards wetland resources. This finding was supported by Henle *et al.* (2008) and Guzman Ruiz *et al.* (2011) that conflicts can be resolved through integration of water organizations to the benefit of socio economic and ecological reasons. In addition, Namvua (2019) reported that land use planning could holistically address resource management by ensuring sustainable resource utilization and conflict control. The study finding agrees with Saleth and Dinar (2008) that successful resolution of conflicts is an indication of genuine institutional reforms while Masifia

and Sena (2017 asserted that the greatest concern for water resource governance is their sustainability for current and future allocations.

5.5. Conclusion

Public participation and education on the benefits of wetland conservation especially on control of wastage of water through imposing tariffs on water consumption is crucial for sustainability of a wetland. Economic benefits were motivational to sub catchment conservation. Further, WRUA needed to embrace collaborative governance amongst stakeholders and other water related government sectors and non-state actors. The challenges include inadequate financial and human resources, low participation from water related government sectors and elected leaders, dismal support from the county government and management of the riparian reserve while it is under private tenure. For a transformation of the sub catchment area, the study therefore recommends multi-sectoral collaboration and cooperation, empowerment of WRUA management committee members, integration of the sub catchment management plan with county land use plans and review of policy in order to unravel the question of management of riparian reserve still registered under private tenure.

CHAPTER SIX:

Towards a framework for monitoring and communicating water resources sustainability: A case study of Rwamuthambi Sub Catchment area, Kenya

Abstract

Wetlands degradation in terms of biodiversity and ecosystem health has been experienced especially from wetland vegetation loss due to unsustainable usage of natural resources. This study explores the indicators involved and various strategies the local community employs in utilization and conservation of Rwamuthambi sub catchment, the role played by Water Resource Users Association (WRUA) to influence the sub catchment area management and how these strategies can be used to monitor and communicate sustainability. Data was collected using field surveys, questionnaires, key informant interviews and direct observations. This data was analyzed through descriptive statistics and regression analysis using Stata software. The results indicated that level of household incomes influenced level of sub catchment conservation and sensitization ($p< 0.05$). Enforcement had a significant positive influence ($p< 0.05$) to the economy and environment components. Community involvement and community initiative had a strong significant influence ($p< 0.05$) on utilization, conservation and sensitization which are the components of sustainability. The study revealed that sustainability was mainly about people and their wellbeing. The study found that 82% of the community members were involved in sub catchment utilization activities. Though profit driven, their involvement subsequently improved the sub catchment conservation. However, community levels of education did not influence sub catchment sustainability. The study adopted and improved the illustration of sustainability pillars as the framework to monitor and communicate the effects of these indicators. Based on the

findings, the study concluded that conservation was a function of utilization and recommended a systematic follow-up by practitioners on the tipping point of utilization-driven conservation.

Key words: conservation, education, indicators, sensitization, sustainability, utilization

6.1. Introduction

Although wetlands sustainability ensures human survival on earth both at present and in the future, it is unfortunate that the concept of sustainability has not been regarded by many individuals as crucial to their daily lives (Robertson, 2018; EPA, 2017). In order to efficiently provide these critical services to humanity, wetlands need to be healthy so that they carry out their functions such as receive water, filter wastes, clean pollutants, mitigate floods and droughts, and recharge water aquifers (Junhong *et al.,* 2013; Momanyi, 2005; Mitsch and Gosselink, 2000). Additionally, wetlands support a broad range of biodiversity by providing suitable habitats. They also act as global carbon sinks and climate stabilizers (Momanyi, 2005, Mitsch *et al.,* 2015, Mclnnes, 2013). However, irrespective of their typology or nature wetlands are faced by some common threats. The most common is as a result of human activities and their effect on decision making which impact on wetland resources (Brouwer *et al.,* 2003; Saadati *et al.,* 2013). For instance, more than half of the global wetlands have been reclaimed for agricultural use, while others have been cleared to pave way for infrastructural development (Schuyt, 2005; Demnati *et al.,* 2012). Such numerous wetland loss and alarming pace of their destruction raised the world focus on the need for their conservation (Ma *et al.,* 2011).

Kenya is no exception to these challenges as its wetland discharge rate dropped from $647M^3$ to $200M^3$ between 1992 and 2012. Although there is evidence of wetland degradation and encroachment, the actual extent of wetlands is unknown due to lack of proper wetland inventory (Kenya wetlands forum, 2012; GOK, 2012). However, through use of satellite imagery information, dwindling spatial areas of wetlands are observable including development activities

and state of vegetation cover (Stewart *et al.,* 1980; Baker *et al.,* 2007; Guo *et al.,* 2017). Rwamuthambi sub-catchment area in particular has experienced pressure from economic development, lack of information and failure of conservation interventions leading to deterioration, encroachment and lack of sustainability of its wetlands (RSCMP, 2015).

Water Resource Users Associations (WRUAs) were established by the Kenyan government under Water Resources Management Authority (WRMA) (GOK, 2002) currently known as Water Resources Authority (WRA) (GOK, 2016). They are meant to regulate, formulate and enforce standards and procedures for management and utilization of water resources and other related functions. A WRUA is local community based organization meant to create collaboration in management and conflict resolution in matters that concern water resources use. According to Andresen & Curado (2005) healthy wetlands can be sustained through balancing conservation objectives with farming practices, irrespective of whether they are traditional or modern intensive agricultural methods. Robertson (2018) indicated that much of environmental stress was as a result of lack of information and understanding of interrelationships of the spheres of sustainability and how they could be monitored. Seddon *et al.* (2016) also noted that for effective conservation, restoration and sustainability there must be clear understanding of biodiversity in science and policy spheres. Xuehua & Sun (2010) concluded that socio economic indicators for wetland sustainability of all environmental resources are the most threatened.

Even though the term sustainability is used often, the community and wetland related institutions may not associate it to their activities and behaviour over the sub catchment. This is contributed by lack of systematic exploration on the relationship between human wellbeing and biodiversity as integral to sustainable development agenda (Griggs *et al.,* 2013; UN, 2015; Sachs *et al.,* 2009; Adams *et al.,* 2004). According to ePLANETe (2015) and Gouzee *et al.* (1995), sustainability is viewed in three dimensions that include economic, environmental and social aspects which overlap in a logical way. And as Marc (2018) asserted, in order to attain sustainable development there

must be a connection and a balance of the three elements since they are usually in conflict. Economic sphere which is profit driven should balance with environmental and social systems since long term economy depends on the latter. At the same time, social stability is a sub set of environmental sphere where people and their culture operate within the environment. Similarly, these arguments apply to the environmental sphere when viewed against economic and social spheres (Ibid).

This study employed sustainability indicators as tools to monitor and assess wise use application and interaction (Von 2000) with WRUA in Rwamuthambi sub catchment. Relevant information was analyzed and communicated through use of identified indicators (Walmsley *et al.,* 2001; Gallopín, 1997), which are essential for measuring sustainable development (Walmsley *et al.,* 2001). Before adoption of indicators in explaining environmental systems sustainability as per Chapter 40 of Agenda 21, they have since been used by economists for expounding economic trends (Bakkes *et al.,* 1994; Gouzee *et al.,* 1995).

By focusing on community socio-economic activities as indicators and on the role played by WRUA in sustainability of Rwamuthambi sub catchment, the study sought to establish where these activities came into play in the overlap of the three spheres of sustainability (economy as manifested through utilization, environment through conservation and social element through sensitization). The aim of the interrogation was to highlight where these attributes affected the pillars of sustainability in order to ascertain what to monitor and also ensure communication of the outcome in a simplified and concise format. Ostrom (1990) suggested that monitoring of a resource by users themselves was a way to foster community collaboration. This was in support to Ruhet (2017) who recommended that there needed to be appropriate technical approaches involving skills in effective communication processes and negotiations through inclusive public participation. Similarly, findings from Shahzalal & Hassan (2019) and Evans *et al.* (2006) averred

that communication increased acceptability of sustainability culminating to positive adaptation to sustainable behavior.

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6.2. Methodology

The study was conducted in Rwamuthambi Sub Catchment (RSC) which traverses from Mount Kenya forest through Nyeri County before entering Kirinyaga County through which it flows up to its confluence with River Sagana. The sub catchment is part of upper Tana River catchment area, one of the major basins in Kenya (MEMR, 2012b). Rwamuthambi River is a major tributary to River Sagana which is known as Tana River in its old stage. A combination of cultural and socio-economic activities led to degradation and encroachment of the sub catchment resources. The sub catchment system consists of several perennial and ephemeral streams, swamps, irrigation projects and water pans. As indicated in Figure 6-1, the area is geographically located along 0° 37' 6" S, 37°14' 57" E; 0° 37' 6" S, 37° 24' 34" E and 0° 69' 9" S, 37° 14' 57" E and 0° 69' 9" S, 37° 24' 34" E (Ibid).

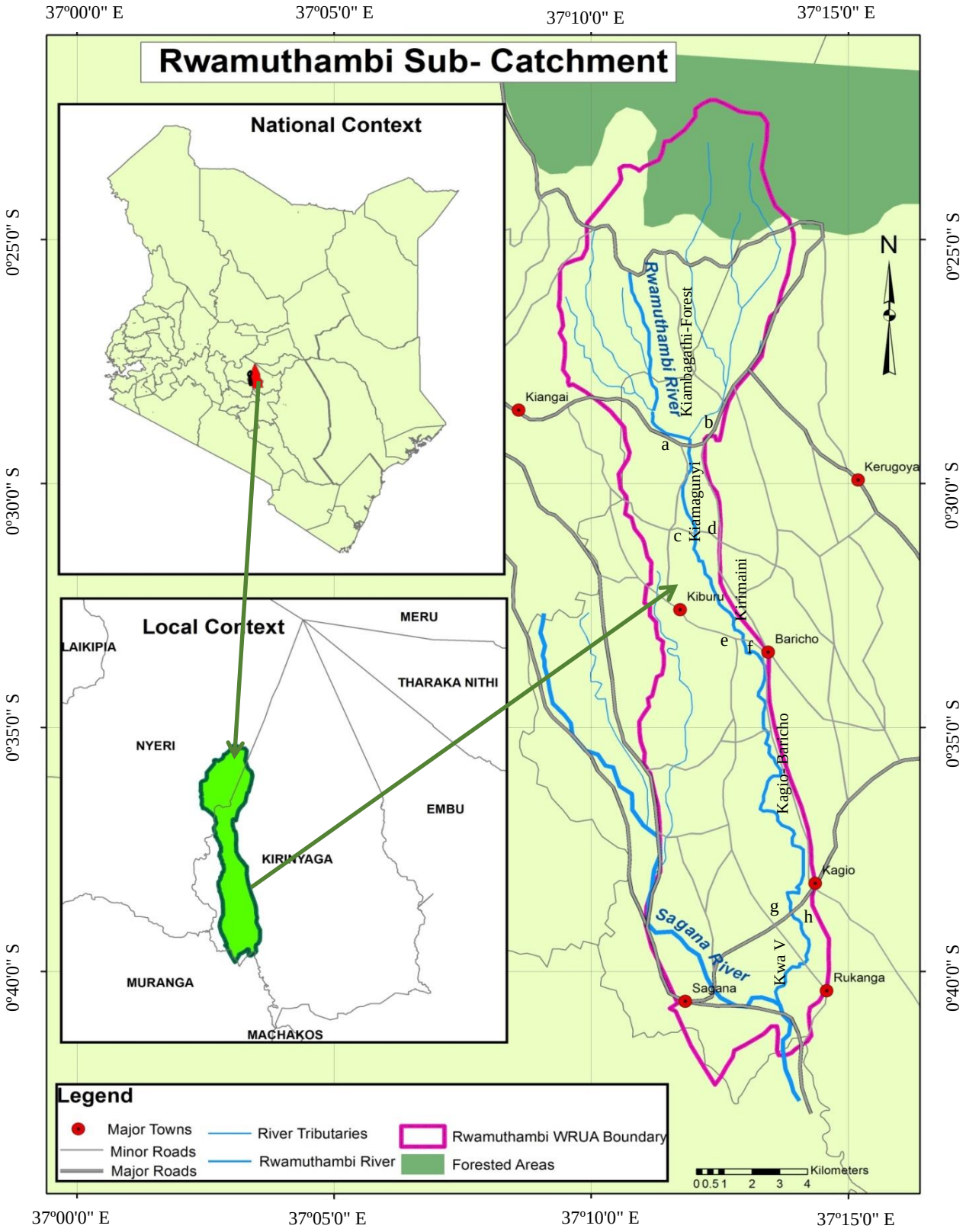


Figure 6-1 Map showing the location of the study area: (Source (RSCMP, 2015)
a-b: Kiangai- Kagumo road; c-d: Kabonge- Riakiania road; e-f Kiburu- Baricho road; g-h: Sagana-Kagio road

The sub catchment lies within Upper Midland-I (Kiambagathi- Forest; Kiamagunyi), Upper Midland-II (Kirimaini) and Upper Midland-III (Kagio-Baricho; Kwa V) agro-ecological zones. The area is endowed with well drained soils which are extremely deep, dusky red to dark-reddish-brown in the upper side and friable clay, with acid- humic topsoil and nitisols (Jaetzold *et al.*, 2007). The area experiences a tropical climate owing to its close proximity to the Equator and being on the windward side of Mount Kenya. Its annual temperatures range between 17°-20°celcius. It experiences two rainy seasons; the long rains occurring from mid-March to May, and short rains from mid-October to December, with an annual precipitation of 800 - 1200mm (CGK, 2013; Jaetzold *et al.*, 2007).

Most of the farming is seasonal based (Ibid) but population pressure, socio-economic needs and climate change has pushed farming to irrigation based (Hulme *et al.*, 2001; IITA, 2014). The main cash crops grown were coffee, tea, bananas and Macadamia. The food crops included maize, beans, and various types of fruits and horticultural crops which also substituted as source of income generated from their sale. The residents also practice zero-grazing dairy farming whereby most of the natural animal feeds are grown along the wetlands (Jaetzold *et al.*, 2007).

The area was subdivided into five sections Kiambagathi- Forest, Kiamagunyi, Kirimaini, Kagio-Baricho and Kwa V with the boundaries created by the points where the tarmac road dissected the drainage channel as it flowed from the source to the confluence as shown in Figure 9-6.

Field data collection was conducted during the dry season in the months of July and September 2018 using a detailed questionnaire, key informant interviews direct observations and review of documents. A total of 196 community respondents sample $n = 196$ of the community stakeholders was obtained through Cochran's formula by Horse (2018) and Rucker (2017) as follows, based on a household population of 19,800;-

$$n_o = \frac{Z^2 pq}{(e_p)^2}$$

$where; -n_o$ =Cochran's sample size recommendation; $Z = Z$ value (i.e. 1.96 for 95% confidence level); p =proportion of the population with direct attribute to the sub catchment governance; e_p = desired level of precision-confidence interval ±7% = (±0.07)) and population proportion= 50%

The questionnaire was also administered to Water Resource Users Association Management Committee Members (WRUA-MCMs), relevant county government heads of departments and selected national government administrators within the sub catchment area. They were representative for the sub catchment area and had been democratically elected by stakeholders vide the guidelines of Water Resource Management Authority (WRMA) (GOK 2002). The targeted government officers were both from relevant county departments and national government administrators in charge within the study area.

The questionnaire targeted household head or the senior most person in the homestead who had attained age of 18 years, which is considered as age of consent in Kenya. A pretest of the questionnaire was conducted to a small sample. The outcome was used to refine the questionnaire and reorder them to ensure that questions were structured in a way that did not alter their meaning or influence the responses. The pre-test data was also used to evaluate the questionnaire administration and get familiar with the instrument (Marambanyika *et al.,* 2016; Saunders *et al.,* 2003). The respondents understanding of the questions and any problems they encountered in answering the questions was also assessed and adjusted to suit the study (Marambanyika *et al.,* 2016).

A stratified systematic sampling method was used for questionnaire administration. The strata comprised of land owners within the sub catchment area and those abutting the river. Data was collected by drawing transects. Every 5th household along transect was considered for interview (Leedy and Ormrod 2013; Pearson *et al.,* 2012).

The questionnaire was divided into four parts. The first part dwelt on information in regard to status of governance within the sub catchment; the second was on effects of existing governance to the sub catchment area. The third part gathered information on scenarios influencing future utilization sustainability while the last part was on biodata. Transect walks were done throughout the sub catchment area upon which observable records were captured.

Key informants were purposively selected within WRUA-MCMs, relevant county heads of departments and village opinion leaders. The interviews were conducted face to face at places agreed with each interviewee. The questions were open ended aimed at capturing information on impacts of projects initiated by WRUA, approach used in sensitization and conservation and the decisions behind utilization of the sub catchment area

Secondary information was mainly from topographical maps which provided a basis for evaluation of change (Stewart *et al.*, 1980). Epochs of satellite imagery was used to establish vegetation cover variations on the wetland (Baker *et al.*, 2007; Guo *et al.*, 2017). Relevant literature from journals, books and authorised publishers from the internet were also perused besides local policies, laws and legislations mainly environmental related and relevant international conventions as shown on tables 6-6 and 7-6.

Table 6-1 List of topographical maps; (Source GOK, 1975)

Topographical maps	Reference no.
Embu	135-2
Ithanga	135-4
Karatina	121-3
Murang'a	135-1

Table 6-2 List of laws and policies; (Source GOK, 2018b))

Law/ Policy	Year of publication
Constitution of Kenya	2010
Physical Planning Act cap 286	1996
Agriculture Act Cap 318	1986, 2012
Survey Act cap 299	1969
National Land Use policy	2017
Rwamuthambi Sub Catchment Mangement Plan	2015
Environmental Management and Coordination Act cap 387	1999, 2018
Water Act Cap 372	1974. 2002, 2016

The data gathered was categorized according to types of information and variables (Schoenbach, 2004). The data was analyzed using regression based on (Stata) software at 95% confidence level in order to establish relationships between variables.

6.3 Results

6.3.1 Social economic characteristics and sub catchment utilization

The study administered a total 223 questionnaires to respondents consisting of $n = 196$ community members, 21 WRUA-MCMs, 4 Departmental heads and 2 local administrators. However, only 201 questionnaires were returned at the end of the study. Focused group discussions were also conducted to WRUA-MCM and some selected community opinion leaders. An evaluation on the level of education of the community established that 63% had gone beyond secondary education (secondary 43%, college 17%, university 3.5 %). 36% had primary school education while 0.5% dropped out of school before completing primary education. Despite high

level of education, 23% of the community members were not aware of Rwamuthambi Sub Catchment Management Plan (RSCMP).

In addition, WRUA key informant interviews asserted that there was increase in flow of water within the sub catchment since the establishment of WRUA. They justified increase in water supply through the argument that in spite of the over 48 legal abstractors, there were a myriad of both illegal abstractors and over abstraction by the legal ones, yet there was still water left in the channel for use downstream. WRUA could not ascertain the exact amount in the alleged variation of flow since the weirs were out of order. The community key informants on the other hand stated that many seasonal rivers dried up soon after the rain which was not the case several years ago. At the same time, demand for land near the river channels increased as dry spell approached because water abstraction channels could also not meet the irrigation water demand as far as it used to. This indication of declining flow of the river water was contrary to that of WRUA-MCMs. In addition, illegal water abstractors used unorthodox methods such as unlined furrows (which use soil and stones filled into gunny bags) to transport the water to distant farms away from the main river though just within the sub catchment. WRUA informants estimated that illegal water abstractors were responsible for more than 70% of the unaccounted water.

It was observed from the community that surveillance on illegal activities was moderate (64%) while 25% stated that it was low. Only 11% stated that surveillance was very low. Key informant interviews confirmed that surveillance had reduced by more than 50% since establishment of WRUAs. RSCMP had no structured information on the modalities of collecting information that related to the sub catchment, monitoring or surveillance.

6.3.2 Utilization of Rwamuthambi sub catchment

Utilization of Rwamuthambi sub catchment was driven by income generation with 51% of the community indicating that they gave priority to activities that improved their livelihoods. Similarly, 43 % of the community gave priority to activities that improved flow of water since it

supported their production initiatives such as farming, fish production, livestock rearing and industrial activities (coffee factories and abattoirs). Aesthetics and recreational facilities were of least priority with 50% of the community indicating that they didn't attach much value to them.

In addition it was also noted that utilization of the catchment varied per the agro ecological zone. For instance, more that 73% of riparian land within Kiambagathi- Forest and Kiamagunyi areas cleared off indigenous vegetation for conversion into tea farming and later growing eucalyptus. The latter had ready market especially sale as fuel wood to tea factories. 80% of riparian land within Kirima-ini area was converted to horticultural crop farming. More than 60% of riparian land within Kagio and Baricho areas had 'Jua kali' (informally cultivated) rice. These activities were meant for production to feed local and export markets. Figure 6-2 based on study results showed that the community had low regard towards reserving the sub catchment for aesthetics and recreational facilities. Conversely, the community indicated more priority towards income generating agricultural production through irrigation. The community perception towards conservation of the sub catchment for recreation facilities as compared to improved economic status and increased flow of water showed an inverse relationship. The preference for recreational facilities along the sub catchment decreased as the community opted for activities that generated income and also gave priority to activities that improved flow of water since they relied on the water for irrigation.

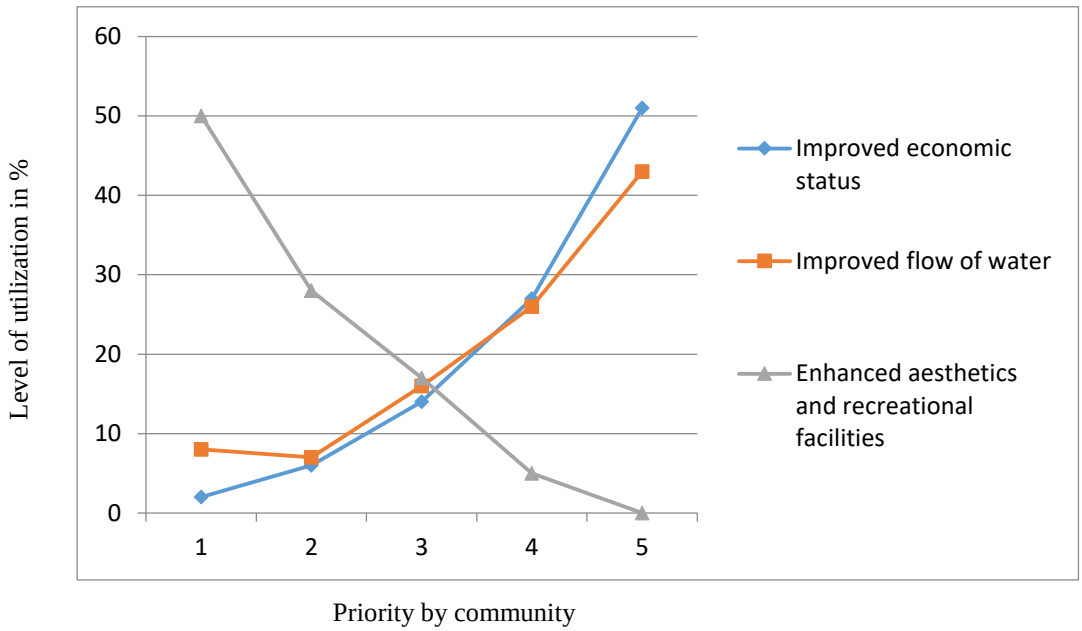


Figure 6-2 Outcome of utilization of sub catchment resources by order of priority; (Source Kumunga E. M, 2018)

Soil erosion by water was linked to some agricultural practices. For instance, the difference in tillage methods was determined by land sizes held by an individual owner and by the terrain. For example, digging was preferred in Kiambagathi- Forest, Kiamagunyi and Kirima-ini because the average sizes of farms were below two acres which is relatively small for mechanization besides the areas having steep topography. The areas of Kagio and Baricho used ox-drawn plough for tilling as they had land sizes above three acres and the terrain is fairly flat. Both of these cultivation methods left the ground bare besides making loose topsoil and prone to erosion.

More than 95% of the farmers used organic and inorganic fertilizers as well as pesticides especially in areas where there was horticulture farming or rice farming. The dominant fertilizers were those rich in nitrates and phosphates which may be washed away into the water bodies during rainy season. From transect walk, it was observed that rice paddy fields got covered by a layer of red water fern which could cause blockage of drains risking flooding during rainy season. The fern also altered the water colour and odour which could reduce the water quality.

Further, it was observed that there were some community members who washed clothes at the river banks especially from Kagio area through to the confluence with River Sagana. Other

activities included washing cars while where water was drawn using animal carts, the animals entered the river while drawing water, polluting water for those downstream.

The study also interrogated factors that affected the sub catchment utilization using regression analysis as shown in table 6-3. The results showed a significance positive influence $p<0.05$ in level of enforcement, community initiative, community involvement and elimination or reduction of governance challenges. These findings showed that there was external influence controlling utilization especially due to the fact that almost all the parcels of land in Rwamuthambi sub catchment area were privately owned and all activities were pegged to profit making. The effort was attributed to sensitization and education by WRUA-MCMs.

Indicators that had no significance influence $p>0.05$ to utilization included community awareness of Rwamuthambi Sub Catchment Management Plan (RSCMP), level of income and knowledge of the law.

Table 6-3 Factors affecting utilization of Rwamuthambi sub catchment; (Source Kumunga E. M, 2018)

Utilization	Coefficient	Std. Err.	t	P>t
Level of enforcement	0.120	0.119	1.01	0.014
Community initiative	0.079	0.075	1.05	0.037
Community involvement	0.014	0.072	0.19	0.048
Governance challenges	-0.117	0.070	-1.59	0.014
RSCMP awareness	0.036	0.221	0.16	0.872
Income levels	0.127	0.102	1.24	0.216
Knowledge of the law	0.072	0.063	1.13	0.058

The existence of RSCMP was a big achievement for the sub catchment as it was adopted as a blue print to guide development and management of the sub catchment management through its implementation. Key informants indicated that RSCMP was lean on details like enforcement

modalities, access to sub catchment information from stakeholders and procedures on how Rwamuthambi WRUA should carry out the stipulated management activities. Only 23% of the community and 47% of WRUA-MCMs were aware of the existence of RSCMP.

6.3.3 Sensitization towards wetland resources

Regression results with sensitization as the dependent factor towards sub catchment utilization at 5% significance level revealed that there was significant difference in the following factors. Wetland sensitization was influenced by stakeholder level of income, community initiative and involvement, level of enforcement and the prevailing governance challenges being addressed. The challenges included poor coordination of institutional structures. For instance WRUA key informants alluded that the institution did not have a formal strategy for communicating with stakeholder. There was no list of contact persons available or programme of events. Engagement with the stakeholders was ad hoc on emerging issues need-bases. Some community key informants alluded that there was also poor financial management with most of the finances being allocated to projects such as purchase of water tanks for schools rather than investing in long term programs. With sensitization as the dependent factor towards sub catchment utilization at 5% significance level regression analysis results were as presented in table 6-4. Enhancement in community initiatives by one unit led to increase in sensitization by 0.008 units holding other factors constant. Similarly, an improvement in the household income levels by one unit increased sensitization by 0.017. The level of enforcement and knowledge of the law were not significant to sensitization.

Table **6-4 Factors affecting sensitization in Rwamuthambi sub catchment;** (Source Kumunga E. M, 2018)

Sensitization	Coefficient	Std. Err.	t	P>t
Level of enforcement	0.145	0.126	1.15	0.250
Community initiative	0.008	0.079	0.10	0.047

Community involvement	0.016	0.076	0.20	0.038
Governance challenges	-0.020	0.078	-1.22	0.024
RSCMP awareness	0.282	0.233	1.21	0.227
Income levels	0.017	0.108	0.16	0.000
Knowledge of the law	0.121	0.067	1.81	0.072

The community (52%) stated that the common method that was used for sensitization was through indigenous knowledge and experience sharing. Only 35% of community respondents indicated that WRUA conducted sponsored short courses for capacity building. Benchmarking was seldom considered due to its high capital intensity. The key informants from WRUA stated that constrained budgetary allocation was a major challenge to improved sensitization. In spite of this challenge 36% of the local community indicated that open communication channels provided opportunities to air their views. 26% stated that WRUA had created opportunities for the community to get involved in monitoring and evaluation of outcomes whilst only 15% were aware of mechanisms for open and continuous feedback.

WRUA-MCMs indicated that in every baraza (public gathering) 50% of the agenda was on sensitization. The two areas of emphasis were; (i) on matters on legalization of water works and economic use of and (ii) on graithing the public to participate in the process of preparation of water allocation plan. This notwithstanding, the key informants from the community pointed out that barazas did not offer sufficient education in regard to importance of wetlands. On the contrary to WRUA-MCMs perception above, the community stated that meetings were dominated by budgetary agenda and proposal of projects whenever there were looming funds. Less than half (41%) of the community, stated that WRUA offered education on wetland functions, their roles or responsibilities. 31% of the community alluded that there was improved sense of ownership which they attributed to sensitization on benefits accruing from community involvement and wise-use of

the sub catchment area. The rest of the community (28%) indicated that WRUA had managed to unite resource users WRA.

6.3.4 Conservation

Before establishment of WRUA, more than 80% of Rwamuthambi sub catchment area suffered from clearing of indigenous vegetation replacing them with eucalyptus because of their fast growth and ready market. Observations from the community however indicated that there was effort from WRUA-MCMs to stop planting of eucalyptus while marking the existing ones for destruction.

Figure 6-3 show that most of the community members (64%) engaged in best practice through planting of ecologically suitable vegetation while 53% of WRUA-MCMs indicated that the community was more concerned in general practices of riparian protection especially those that had economic value. For instance, more than two thirds (82%) of the community admitted that they planted napier grass mainly for their animals and the rest for sale but not out of concern to conserve the riparian area. In relation to the agricultural activities being undertaken, the research inquired on pest management in connection to sub catchment resource conservation. It emerged that none of the WRUA-MCMs viewed integrated pest management as an option while only 2% of the community were aware of it.

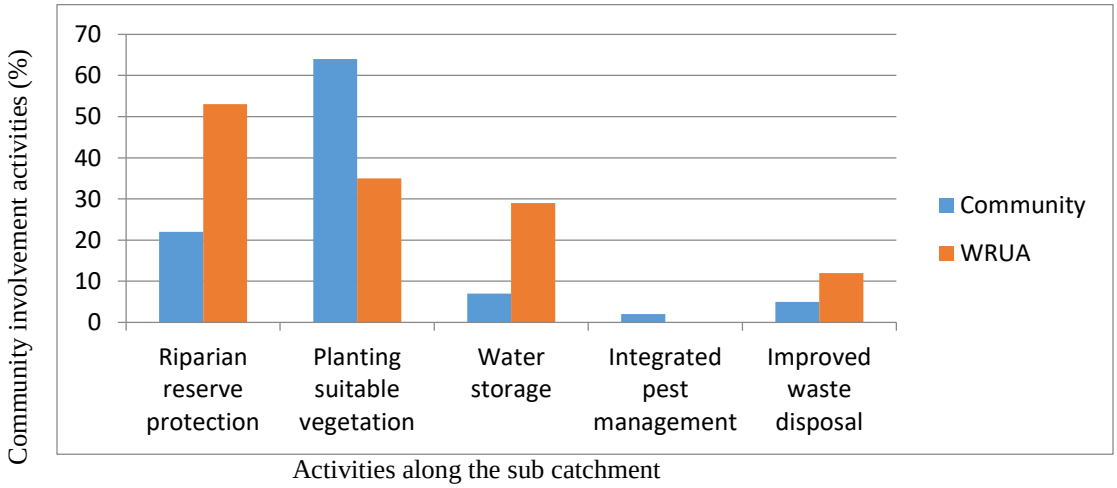


Figure 6-3 Perception on activities along Rwamuthambi sub catchment; (Source Kumunga E. M, 2018)

Sub catchment activities that contributed to conservation undertaken by the community within the sub catchment were in varied intensities. For instance within the riparian reserve 46% of the stakeholders indicated that soil erosion control was of priority followed by re-afforestation (38%) at a Likert scale of 4 and 5 respectively. Nonetheless, there were those conservation activities that the community gave less priority at a Likert scale of 1 and 2. These included wetland rehabilitation (35%) and employing knowledge exchange as a form of enhancing conservation (40%) respectively.

Sustainability is a culmination of many factors and activities. From regression analysis with conservation as the dependent factor, results indicated a positive significant influence ($p<0.05$) in level of enforcement, community initiative, community involvement and level of income as shown in table 6-5. This meant that for instance, an increase in one unit on level of enforcement led to an increase in 0.065 units to conservation. The results also showed no significant relationship ($p>0.05$) from the interrogated governance challenges which included institutional framework and financial management, RSCMP and knowledge of the law. This inferred that conservation was not based on governance strategies, the knowledge of the law or the existence of RSCMP.

Table 6-5 Factors affecting conservation of Rwamuthambi sub catchment; (Source Kumunga E. M, 2018)

Conservation	Coefficient	Std. Err.	t	P>t
Level of enforcement	0.065	0.124	0.52	0.000
Community initiative	0.018	0.088	0.21	0.048
Community involvement	0.020	0.074	-0.27	0.027
Governance challenges	-0.062	0.075	-0.83	0.410
RSCMP awareness	0.013	0.227	0.06	0.953
Income levels	0.063	0.104	0.16	0.046

Knowledge of the law	0.008	0.065	0.13	0.897

The various causes of degradation of Rwamuthambi sub catchment area were interrogated in order to establish the perception of the community on the magnitude of pressure to the environment exuded by each. On average, 29% of the community alluded that the causes of wetland degradation were due to inadequate enforcement mechanisms 28% indicated that it was due to inadequate legislation, while 21% indicated that it was due to lack of information on wetland values. These results tallied to the regression analysis shown in table 10-6.

Other indicators that the community did not find directly contributing to degradation included lack of incentives to the conservators (11%), poor governance (10%) and population increase perceived to contribute only (1%). Almost all parcels of land along the riparian reserve were privately owned. However, 63% of the stakeholders indicated that enforcement on management of the riparian reserve was moderate.

6.4 Discussion

The results of the study found out that community involvement and community initiative coupled with perception and actions were core influencers of conservation. The local community engaged in various activities to increase sub catchment area productivity and subsequently improve their livelihoods. In the process, they adopted some strategies that included terracing, growing ecologically friendly plants and cover crops in order conserve the wetland and enhance soil erosion control. A similar finding was recorded by Lalika *et al.* (2015) that retaining vegetation along the riparian reserve is a suitable strategy for conservation and enhancing flow of water. Further, Faulker *et al.* (2011) observed that the most effective conservation practices are those that hold a direct connection between the activities that are associated to a certain practice and limitations to ecosystem process and related activities. In addition, Shrestha (2013) established that ecological balance in use of water and land resources could only be attained through effective local

participation. Thus the future of conservation of Rwamuthambi sub catchment area lies in positive ecological practices from the local community.

Sensitization on government policies and capacity building towards wetland benefits emerged as another indicator influencing sustainability of the catchment. Improvement in community involvement led to increase in stakeholder sensitization which was essential for the success of the catchment management. Sensitization involved dialogue between stakeholders and WRUA pertaining to the information received upon which views raised would be listened to, discussed and upon consensus, relevant action taken. Nonetheless, the study results did not link knowledge of the law to improvement in community sensitization. Besides, results also showed that most WRUA-MCMs were not conversant with sub catchment principles and prevailing wetland resource legislation. Therefore, although Rwamuthambi WRUA-MCMs organized for short courses, there lacked a structure for public engagement and a clear direction on the process of stakeholder engagement. The blame was laid on budgetary constraints and on the institution's tendency to target more on short term projects. These findings compared with those by Ashton (2007) which concluded that although stakeholder engagement could improve water resource management, there was lack of a clear pathway on the process for their engagement with the community. In a similar finding Booth (2004), asserted that short-term growth may over ride long-term environmental quality and security. It was noted that WRUA required a structure on stakeholder engagement that would outline a program of activities that is agreed over with the community. In addition, WRUA-MCMs once appointed required induction on the institutional framework and nature of responsibilities they would be expected to hold.

Irrespective of these challenges, the results showed that WRUA-MCMs had managed to create a sense of ownership for the sub catchment resource. This was deduced based on the fact that land owners heeded to the guidance of WRUA in spite of the parcels involved being held under private tenure. This finding was similar to Kombo *et al.* (2010) that besides public participation, instilling

a sense of ownership would promote success in water resource management. Nonetheless, this was contrary to the finding by Ashton & MacKay (1996) which implied that there were great strategies for water resource management fostered by the government but failed in representing correct ambitions for its management to the public who were the same party in the resource utilization.

Further, the study finding implied that WRUA-MCMs conveyed some information other than what was wholly contained in the statutes because most of them alluded to be minimally conversant with the contents of relevant laws and documentations. This calls for a need to document the approach adopted by WRUA-MCMs and the nature of information they passed across to the community since through their effort, the community got involved. Furthermore, the study divulged that more than half of the community relied more on indigenous knowledge and experience-sharing for sub catchment utilization and conservation. This finding is supported by Ayaa *et al.* (2016), Ngara &Mangizvo (2013) and Pandey (1994) that indigenous knowledge influenced positive management of the environment necessitating its integration into environmental management plans. Similar findings were also registered by Sullivan & Fisher (2011) who further emphasized that the law could only be used to regulate the behavior of humans towards the environment but it could not dictate how the natural environment reacted. It was on the same argument that Ostrom (1990) called for recognition of local community knowledge in resource management. Besides sensitization in regard to benefits of wetland resources, WRUA should integrate cultural and indigenous knowledge into management of the sub catchment.

Based on the opinion from the community the study revealed that lack of awareness of the contents of the RSCMP was one cause of degradation in sub catchment area due to unharmonious development. Their cluelessness of its contents meant that either they did not participate or were not involved in the plan's preparation. As such then, the community dissociated themselves with priorities that WRUA identified based on RSCMP. This finding was congruous with Clare *et al.* (2011) that failure to involve stakeholders in preparation of wetland use planning led to

uncoordinated development leading to degradation. Rwamuthambi sub catchment area WRUA requires a revision of its management plan to ensure participation from the stakeholders.

In addition, the study established that the community did not view governance challenges as an impediment to sub catchment management. At the same time, WRUA-MCMs consulted the community in budgeting and identification of some projects. In a similar finding Lalika *et al.* (2015) noted that water resource governance challenges existed due to ineffective structures and insincere management of finances. Therefore, collaboration between WRUA and the stakeholders was essential for sustainable management of a sub catchment resource.

Although the community living within the sub catchment was generally literate, the results further revealed that rampant degradation was experienced from clearing of vegetation, encroachment and cultivation along the riparian reserve. This could imply that the high education levels held by the community was not oriented towards environmental resources sustainability and therefore did not directly translate into efficient sub catchment area management. In addition, the study results indicated that the community knowledge of the existing policies and legislations did not have significant influence to utilization, conservation and sensitization. A study by Kecha *et al.* (2006) and Turner, (1991) had contrary findings that sub catchment degradation was attributed to lack of information on their role and poor sensitization in regard to their intrinsic values towards human wellbeing. While Schreiner & Barbara (2001) found that illiteracy, substandard education and poor access to information hampered public decision making. As such, the community in Rwamuthambi sub catchment area could have had an indication of existing policies and laws but not privy to their contents. Similar to this finding Tomas (2006) alluded that there were many government policies that emanated into unsustainable results because the community was not privy to the contents of the law. On a similar argument Arto and Mauri (2011) asserted that though research indicated that sustainability could be achieved through innovative technical solutions these must be collaborated with new policies and community behavioural change. Therefore,

practical transition is accomplished through government integrating citizens in participating in decisions regarding ecological flourishment.

The results further revealed that increase in house-hold incomes led to increased conservation of sub catchment maintenance. This was contrary to findings by Freebairn (2011) and Smith *et al.* (2010) who indicated that high incomes coupled with increase in population caused failure on wetland management. It emerged that increase in household incomes accrued from utilization of the sub catchment through better agricultural practices had a direct influence to increased conservation. A similar finding was ascertained by Kaffashi *et al.* (2015) who found that better conservation was directly related to increase in income levels. In addition, the results evinced that household income was not a factor of sub catchment utilization but a factor of conservation. The income was ploughed back with an aim of boosting production for profit gains. This implied that the driving force for conservation in Rwamuthambi sub catchment area was the accruing economic benefits. Similar findings were established by Marambanyika & Beckedahl (2016) that wetland socio-economic benefits acted as an incentive to conservation and sequentially considered wetland management practices that were sustainable.

The results also indicated rampant use of inorganic pesticides and fertilizers as a method to boost production, with extremely low concern for use of integrated pest management as an option for sub catchment conservation. These findings were similar to those of Ghorab & Khalil (2016) and Khalil *et al.* (2012) that the only solution that could decrease use of pesticides included adoption of integrated pesticide management and sustainable agriculture. Study results also recorded pollution from domestic activities, farm inputs, effluents from factories and light industries. Similar findings were recorded by Afroz *et al.* (2014) that industrial waste and agricultural chemical and fertilizers runoff which may also cause increase in algae populations could lead to low levels of dissolved oxygen. Water quality could be improved through control of pollution and adopting safe use of waste water.

At the same time, it was observed that most water was lost to illegal water abstractors. They used heretical methods to draw and transport the water for irrigation and other activities. RSCMP was not elaborate on matters pertaining to water abstraction, prohibited activities, enforcement or penalties that would apply to those who contravened requirements. These inadequacies were in contrast to a similar plan for Lake Naivasha catchment area protection order of 2012, which was elaborate on procedure of water abstraction, prohibited activities and uprooting of eucalyptus trees and replacing them with ecologically and economically suitable tree species. Further, RSCMP was unclear on matters of surveillance and inspection whereas Lake Naivasha catchment area management plan gave inspectors express access to land, information and documentation.

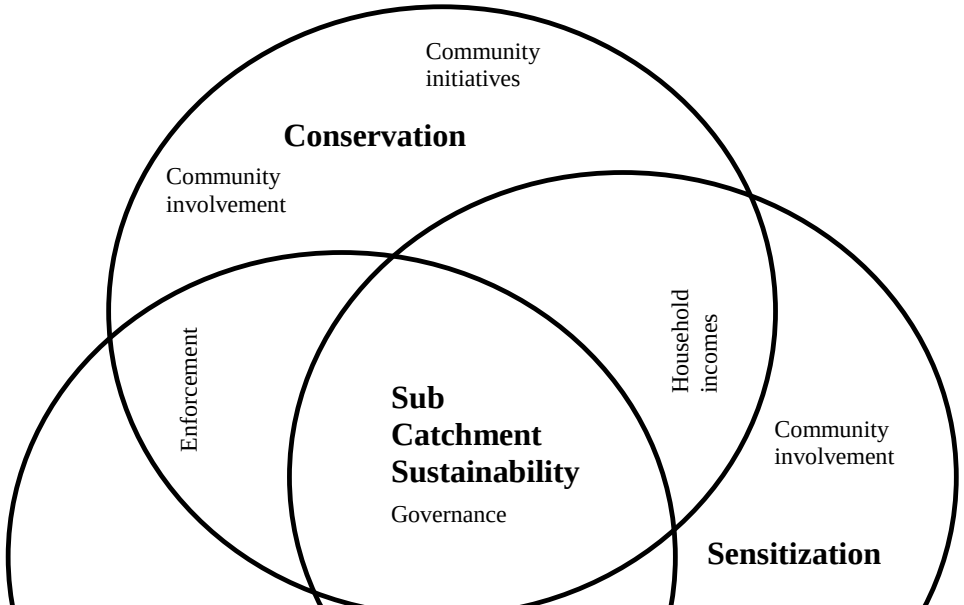
The study also disclosed that the community in Rwamuthambi sub catchment area registered poor enforcement as another cause of degradation. Enforcement was rated as moderate by stakeholders who implied that there was need for its enhancement. From regression analysis results, enforcement was a factor of utilization and conservation. An additional unit in the level of enforcement led to improvement in sub catchment utilization while holding other factors constant. These results concurred with recommendations in the Lake Naivasha catchment area plan, and were also congruent with the study by Todd and Thomas (2002) who reiterated that wetlands were only protected through enforcement of government legislations, policies and programs and educating members of public on the importance and gains of wetlands. Similarly, Sullivan and Fisher (2011) further noted that enforcement of relevant legislation is prerequisite in ensuring successful protection of a wetland ecosystem for the sake of the present community and for the future generations.

The study findings also indicated that conservation of the sub catchment area concerned those abutting the river and the parcel owners within the rest of sub catchment area at varying magnitudes. As the former influenced the riparian directly, the latter adopted improved agricultural methods for soil conservation and planting of trees. This was similar to the findings

by Alyson (1997) that the health of a wetland was affected by activities in the uplands. The abstractors used open canals or pipes which traversed through private parcels of land in order to reach the target plots, free of charge. This gesture was an indication of collaboration within the community. This finding was echoed by Shrestha (2013) that ecological balance for utilization of available land and condition of water resources of a wetland resource was dependent on community participation.

The study results also demonstrated that sub catchment sustainability was attained through utilization, conservation and input from WRUA through sensitization, hence the three pillars of sustainability generally referred to as economic, environment and social pillars. Community initiatives and involvement were the main indicators that affected the three pillars. The level of enforcement affected conservation and utilization while governance related challenges were factors of both utilization and sensitization whereas level of household income and awareness of the law were factors of conservation and sensitization.

Indicators that affect sustainability pillars are communicated by adopting the illustration by Ravikumar *et al.* (2014) as in Figure 6-4. The demonstration was supported by Shahzalal & Hassan (2019) who alluded that change of people's behavior towards sustainability could be effected by including communication elements that targeted attitudes, efficiency and culture. The framework illustrates that relevant issues affecting sustainability can easily be identifiable, interpretable, summarized and reported in congruence to what Walmsley and Pretorius (1996) advocated.



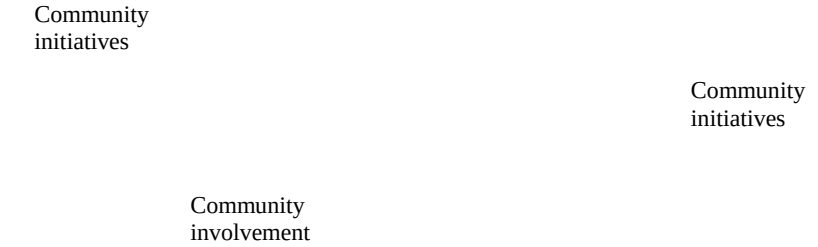


Figure 6-4 Enhanced illustration and communication of sustainability; (Source: Adopted from Ravikumar *et al.,* 2014)

6.5. Conclusion and recommendations

The results of this study revealed that sustainability of the sub catchment area relied more on effective community initiatives, community involvement as well as level of household income and enforcement. Utilization, conservation and sensitization as the three elements of sustainability could only be attained through strategies for stakeholder engagement and communication that ensure recognition of status of wetland ownership and integration of community driven public participation. Level of incomes and awareness of the laws were significant where conservation and sensitization was connected although the stakeholders preferred conservation activities that had short term economic gains.

The stakeholders also insisted on enforcement in order to balance between conservation and utilization. Local people were eager to participate in effective sub catchment management as demonstrated by their voluntary use and sharing of indigenous knowledge. Therefore community participation assisted in rehabilitation and mitigation of negative environmental effects, especially those that were detrimental to production of wetland oriented crops and animals. WRUA policies and initiatives would continue to gain relevance as long as they contributed to quality of life of the people, but there was need to improve the approach and structure of dissemination of information.

The study is essential for management of the sub catchment through communication to local community, besides activists and environmental specialists on effects of activities undertaken. It expresses wetland sustainability in a format which makes it comprehensible and easy to monitor based on the prevailing indicators.

In conclusion, catchment sustainability was not controlled by the community's level of education. In addition, although sustainability was associated with environmental conservation, it was merely about people and their wellbeing. The epitome of utilization would only be short lived if it was not supported by matching conservation measures and enforcement. This work therefore recommends a study to establish the tipping point for utilization driven conservation for sustainable sub catchment development.

CHAPTER SEVEN: GENERAL DISCUSSION

7.1 Introduction

This chapter presents a summary of discussion for this study which sought to assess the effects of sub catchment governance on management of wetland resources in Rwamuthambi sub catchment, Tana Basin, Kenya. The three specific objectives of the study were to assess the status of governance in Rwamuthambi sub catchment, evaluate the influence of sub catchment governance by Water Resource Users Association (WRUA) and to examine monitoring and communication of the sub catchment sustainability.

7.2 General discussion

According to the study findings it emerged that there was organized management of Rwamuthambi sub catchment even before establishment of WRUA in 2002.The sub catchment was managed through a top-down approach which was disseminated through the local administration mainly the chiefs and sub chiefs. In addition the sub catchment was monitored and surveillance conducted against illegal abstractors and unfriendly wetland activities like reclamation and encroachment through inter-sectoral collaboration with the main sectors being agriculture, public health and energy. This finding was consistent with what Lalika *et al.* (2015) alluded that sufficient collaboration and networks at the local level could enhance proper management of a watershed. After WRUA was established in 2002 study findings did not establish collaboration between relevant sectors. During post-WRUA period various sectors have each pursued their own standards and goals. For instance, the Ministry of Agriculture provided for a riparian reserve of 3m (GOK, 1986) while the department of survey advocated for centre line of the river as the boundary for non-tidal river (GOK, 1969) like Rwamuthambi River and the Ministry of Energy concentrated on

sections of the river where there was hydro-power generation. In a related finding, Oremo *et al.* (2019) posited that governance in a sub catchment loose synergy when controlled by multi-level actors who bear contradicting interests and vague contextual arrangements. Similarly, Johanna *et al.* (2015), Berkes (2005) and Folke *et al.* (2005) argued on promotion of inter-sectoral management and involvement by multi-leveled institutions that are adaptive and flexible to approaches in order to achieve environmental governance. This finding is also congruent with WSTF (2009) that management of water resources required multi-sectoral collaboration, technical know-how and stakeholder participation. Further, Jorge and Ignacio (2015) posited that collaborative governance should consider common practices, potentials and delays so as to enable forge new viable practices.

This finding was similar to Barczewski (2013) where blame for poor management was cited to be lack of consensus among sectors. Most of the concerned sectors dealt with the sub catchment independently due to lack of guiding structures which should have been provided by WRUA as per the revised water act. This finding was corroborated by Musya (2010) that poor management structures resulted in poor inter-sectoral coordination. In a related finding Lalika *et al.* (2015) established that there was need to broaden the perspective to include ecosystems and sector inclusion rather than focus on water alone. Hence the current management system should coordinate sectoral involvement and integrate some of the pre-WRUA approaches that proved successful in control of sub catchment degradation.

The study findings further established that only the forestry department was directly involved in wetland conservation during the WRUA era. As a result wetlands within the sub catchment experienced wanton riparian farming and illegal water abstractions mainly in the upstream without much regard to water availability to the downstream community especially during dry season.

These findings were consistent with Garces Respero (2007) that need-based unfair distribution of water between upstream and downstream emanated from poor management structures. Similarly, Kabogo *et al.* (2017) advocated for regulated abstraction as a way of increasing downstream flows. There was need for WRUA to enhance equity and fairness which the community perceived as low. This finding was in congruence with Regner (2006) who averred that as a way of restoring trust between upstream and downstream and eliminating disparities in water distribution, WRUA should uphold their role. Therefore as agreed by Tropp (2007) an understanding of sub catchment governance would enhance sustainable flow of water. This calls for a balance between consumption of hydrological services and improvement of wetland generated welfare to the community.

The study results also implied that wetland degradation could be controlled through enforcement and imposition of sanctions such as denial to deliver produce to the market and surveillance as was the case pre-WRUA. This finding was consistent with Ostrom (2000) that impulsion of sanctions as modes of enforcement and engaging a surveillance team to ensure compliance was effective. According to the results Spearman's correlation coefficient showed that enhanced institutional framework can improve enforcement. This finding was supported by Ostrom (2010) and was also similar to Weber *et al.* (2017) who stated that wetland encroachment was due to disputed policy objectives, inconsistent policy enforcement and low consequences.

The study findings revealed that WRUA committee members lacked relevant knowledge in regard to wetland sustainability. Omollo (2010) revealed a similar finding that it was essential for policy implementers to have understanding of wetland governance and management content and how it should be executed.

Thus it was a necessity to consider offering basin training to WRUA committee members as was confirmed by Lalika *et al.* (2015) that training would improve water governance and wetland conservation. Additionally, the study also concurs with the findings by Marambanyika *et al.* (2016) that protection, conservation and sustainability could only be achieved through a wetland committee. However, this committee should be well trained for the tasks through training and induction pertaining to institutional framework and expected responsibilities.

The study findings also established that sensitization on repercussions of wetland utilization by WRUA was rated highest by the community as was proved through Chi square results which revealed that utilization of the sub catchment relied basically on conservation guidelines promoted by WRUA. In support to this finding, Matiru (2000) posited that enforcement would be more effective if the wetland users were made aware of actual facts and perceived facts in regard to a wetland. Further, Todd and Thomas (2002) similarly observed that conservation could be enhanced through training the community on importance and benefits of wetlands. This was an indication that as long as the community is informed on the policies and other guidelines conservation would be adhered to making enforcement much easier. The finding that WRUA as a government agency took initiative to sensitize the community was contrasted by Mutua *et al.* (2017) who indicated that most policy information was disseminated spearheaded by private sector due to lack of commitment by government agencies.

Although sensitization on wetland awareness by WRUA and agricultural extension officers was rated by the community as very effective encroachment into the wetlands was on the rise. A similar finding was revealed by Masanyiwa *et al.* (2019) that there was low human resource in WRUA and agricultural education officers but the reasons for this differed. The authors (ibid) stated that it was the central government's mandate to employ officers whereas the study findings established

that it was the responsibility of the county government to recruit additional required staff since the functions were devolved. Further, Musya and Wambura (2016) in their study affirmed that agricultural extension officers were demand driven and in some instances those available were not well versed with continuous professional development. Increase in encroachment was attributed to poor understanding of wetland related information.

The study results based on Kendall's coefficient of concordance indicated that the most disagreed upon government support was on sensitization and wetland education, yet it was the most efficiently provided while public participation was the most agreed upon activity. This finding was supported by Johnson (2002) and Price (2007) that sufficient awareness and enhanced wetland capacity improved public participation and embraced decision making. In the same argument, Masifia and Ole Sena (2017) added that individual character determined collective responsibility which affected a wetland in a positive or negative way. Lamsal *et al* (2015) concurred that in spite of positive attitude by community towards conservation, participation was inadequate. Public participation should be balanced with other critical activities but not perceived as a distraction as was implied in the results. This finding was consistent to that by Theesfeld and Schleyer (2013) who revealed that public participation should be integrated with existing legal decision making structures.

The study findings further revealed that policies and guidelines were perceived to be broad, generalized and mostly inapplicable. In contrast to this finding, Springer *et al.* (2007) posited that there was undue attention to the local wetland issues at the expense of broader structures that would address local issues while Turner *et al.* (2001) argued that localized approach cannot succeed in wetland conservation. However, this finding was supported by Liedel *et al.* (2012) who alluded that water resource issues can only be resolved through consideration of localized concerns. In

addition the finding Butterworth *et al.* (2010) as if in support augmented that even if policies were formulated at whatever broad level implementation is always at some specific location. Similarly, Raustiala (1995) also averred that even international commitments undertaken by a nation lacked meaning at the local arenas unless it was stepped down. Even though Jorge and Ignacio (2015) cautioned that new policies may not be a panacea to water resource management challenges, this study agrees with Sullivan and Fisher (2011) that there was need to domesticate policies in order to address intrinsic local matters.

The study found out that almost all the wetlands within the catchment were under private freehold tenure system which made the land owners dominate its utilization. This finding was contrary to Bondi and Mugabe (1996) in the report on systems of land tenure and management of natural resources while relating the same to environment, private property nd provisions of Kenyan Constitution and KLR (2006) in the reports interrogating Kenyan constitutional provisions over rights on private property expressed that the power to control use of any land including private land is vested under the state as a measure to environmental conservation. In addition, Johanna *et al.* (2015) in his study on ecosystems related with water and how they were managed in Taita Hills Kenya associated environmental degradation and neglect of conservation practices to lost commonality that was brought about by adjudication. This finding was further supported by Babcock (1991) in the study on Federal regulatory policy over wetlands asserted that while wetland conservation benefited the entire community, the land owner loses direct opportunities and bears the cost which causes negative attitudes towards conservation. Further, Le bel *et al*. (2011) in the study addressing human wildlife conflicts in South Africa while referring to lessons learn in Mozambique and Zimbabwe averred that land under uncertain rights was utilized with

little regard to conservation. The arguments highlights on the need to revisit the legal provisions and policy guide on riparian reserve under private ownership.

Due to the tenure system WRUA had limitations on control of the riparian as it would be the case of public wetlands. This finding was similar to studies by Akech (2001) during the study on indigenous tenure systems and protection of customary rights to land ownership and Sullivan and Fisher (2011) in the study examining ways of incorporating wetland in legislation as distcind and identifiable water bodies argued that private individual land rights and activities thereon were a major contributor towards failure of traditional conservation systems. In addition Spearman's rank correlation established that there was a direct relationship between awareness of implications from negative wetlands utilization and land tenure. This finding was contradicted by Prince (2007) who established that land tenure was the main driver for conservation rather than insufficient wetland knowledge. Spearman's rank correlation also established that community participation was inversely related to land tenure. A similar study by Katsiime and Schütt (2020) alluded that land tenure drove change and influenced decision making towards new practices while Gollardo *et al.* (2013) posited that sub catchment collaborative engagement was determined by status of land tenure. In addition, Parker *et al.* (2007) concurred that public participation was a factor of land tenure hence the study emphasized that it was crucial in management and conservation of water resources. Thus this study concurs with Stoll KLeeman and Manzungu (2004) that public participation should be associated with land ownership rights otherwise it could risk tokenism.

According to the study most of the community relied on the wetlands for farming especially during the dry seasons. This finding was in agreement with Were *et al.* (2013) and George (2017) that over reliance on irrigation and encroachment into wetlands was greater during the dry spell. It was

also noted from the results that wetland farming continued without intervention from the concerned authorities including WRUA committee but there was control of wetland activities pre-WRUA. Considering that WRUA committee members were democratically elected through a simple majority, it seemed that the members did not want to make unpopular decisions that would make them loose elections. This finding was supported by Giordano *et al.* (2005) that political insecurity could affect operations in institutions in charge of managing resource. Therefore there should be set out performance targets for WRUA to ensure that committee members delivered on their mandate rather than awaiting for lapse of their terms in office. Other results indicated that encroachment into the riparian reserve increased due to demand for more land and resources caused by rising population. There was a lot of wetland encroachment and reclamation as the community harvested fodder, wood, food and water leading to loss of habitat and destruction of the ecosystem. This finding was consistent with Brown and Lant (1999) who averred that there was likely to be conflict between natural ecosystem wetland services and land owners whose main objective was profit driven. However, Saveniji (2002), Rampa (2011) and Day (2013) argued that water resources should be treated as an economic social good rather than the indigenous view as a public good. Thus the study concurs with how authors Gilman *et al.* (2004) defined water resources management that hydrological function or biological function of fresh water ecosystems can be altered through concerted effort to plan and control anthropogenic activities.

WRUA activities could not be achieved due to inadequate financing and lack of basic training in financial management and wetland governance as was established from the study. This finding was supported by Mollinga (2008) while Parker and Oates (2016) further recommended for WRUA training in order to enable them carry out service delivery. Lalika *et al*. (2015) also agreed

with the finding and consequently supported improvement of structures and management of finances which is one way of averting governance challenges

Rwamuthambi sub catchment experienced a lot of illegal water abstraction and uncontrolled water wastage. The study finding implied that the wastage was exacerbated by lack of charging water per consumption. Subsequently, WRUA introduced tariffs so as to abate water scarcity experienced downstream through reduction of Non-Revenue Water (NRW) which also supplemented in raising much needed finances. This finding was corroborated by Okumu (2019) who advocated that abstraction of natural resources should be planned. In addition, Noga and Wolbring (2013) stated that charging of water was unaccepted since most areas where there was a lot of water viewed the resource as a human right. This meant that a lot of water users had to be compelled to pay. Hence, it was prudent to conduct monitoring and surveillance as an effort to reduce NRW.

The study findings established that when WRUA failed to involve stakeholders on conservation measures there was resistance regardless of the nature of activity that WRUA committee was committed to in wetland improvement. For instance, the land owners uprooted seedlings that WRUA committee members jointly planted with Community Forest Association without consulting with the land owners. This finding was congruent to that by Rambonilaza *et al.* (2015) whereby the study asserted that most people forced to compulsory maintenance eventually defaults. However, Huntington *et al.* (2017) revealed that community may embrace changes in collaboration with others through adaptation rather than through inflicting limitations. A further finding revealed that in order for irrigation water to reach the farms away from the main river open channels ran through privately owned parcels without resistance and at no cost. This implied that there was cooperation and collaboration amongst the sub catchment community which could be

utilized positively to achieve WRUA goals. This finding was similar to Shrestha (2013) that ecological balance through utilization of land within the sub catchment and water resources conditions depended highly on community involvement and participation.

The study revealed that WRUA had managed to prepare Rwamuthambi Sub Catchment Management Plan (RSCMP) as was stipulated in the water act upon which WRUA was established. Nevertheless, study findings indicated that most of the activities that caused degradation were preventable through plan implementation. However, it emerged that majority of the community were not aware of the existence of RSCMP and the few who were had no information about its contents. This implied that the community was either not involved or there was no participation in the plan preparation which led to lack of identification of the plan's contents. A similar finding was posited by Clare *et al.* (2011) who argued that when stakeholders are not involved in plan preparation, there was uncoordinated development that led to wetland degradation. A similar finding was also revealed by Zuquette *et al.* (2002) that the main cause of wetland degradation was lack of the resource planning and its implementation. In Rwamuthambi sub catchment the study findings showed that degradation was mainly due to lack of involvement of the community and other relevant government institutions including the County Government in plan preparation.

It was noted that RSCMP was not integrated into any county land use development plan as a basis to guide implementation and get consideration for county funding. It thus emerged that these factors culminated into lack of cooperation during its implementation from both the community and the County Government. This finding was consistent with Rodriguez *et al* (2015) who found that implementation would be achieved through coordinating land use planning and water resource management in order to generate scenarios that would control and mitigate future anticipated

impacts. In addition, Namvua (2019) identified land use planning as a solution to resource management as it offers strategies for utilizing resources sustainability and control of conflicts. This finding also culminated to lack of support from the County Government budgetary allocations (GOK, 2012) since they were based on an integrated development plan. This finding was augmented by Patrick and Heymans (2015) who established that the count government should assume the role of local policymaking as required in the spirit of devolution, especially playing an active role in water resources sector. Further, WRUA committee should establish a working strategy with the County Government in order to get RSCMP integrated into the county plans for it to get budgetary allocation, since all county financial policies must be adopted by the relevant county assembly (GOK, 2012). Thus RSCMP required urgent review in order to bring all stakeholders aboard and also adhere to county plan preparation provisions.

Water abstraction and prohibited activities was not elaborated in RSCMP. The plan was not also clear on penalties or how to enforce when and if the outlined activities were contravened. This finding was contrary to Lake Naivasha catchment area order (2012) which provided that on the process of surveillance, enforcement and extirpation of ecologically unfriendly vegetation like Eucalyptus trees. Further results supported by regression analysis revealed that enforcement was related to sub catchment utilization and conservation. This finding concurred with Todd and Thomas (2002) and Fisher (2011) who asserted that protection of wetlands and eventually sustainability can be achieved through enforcement.

According to the study findings conservation of the sub catchment was influenced by community involvement, community initiative, perceptions and reactions. Most activities undertaken by the local community along the riparian reserve were meant for livelihood enhancement and profit making much less with an aim for conservation. Positive wetland conservation outcomes were also

noted where incentives were offered as a way of encouraging the community to get committed to conservation measures. A similar finding was revealed by Lalika *et al.* (2015) and Faulker *et al.* (2011) that activities that conserve the ecosystem and improve flow of water better are those connected to certain practices while Shrestha (2013) pointed that such activities can only be achieved through local public participation. Similarly, Stringer *et al.* (2007) alluded that conservation was linked to accumulative economic and household benefits. Sensitization was not overly based on contents of the law or technical information on wetland sustainability but shared the local knowledge since it was evinced from the study findings that most WRUA committee members were not conversant with the law or prevailing wetland principles. The study results further indicated that sensitization was affected by public involvement but not knowledge of the law. This finding was agreed with by Sullivan and Fisher (2011) that although legislation control the behaviour of humans, nature could not be dictated. Similarly, Ostrom (1990) alluded that cognition of local indigenous knowledge in management of resources. This finding also seemed to prove what Ayaa *et al.* (2016), Ngara &Mangizvo (2013) and Pandey (1994) posited on the need to integrate indigenous knowledge into environmental management plans as it impacted positively to the environmental utilization and conservation. Hence there was need to document and integrate into policy the indigenous instruments that WRUA employed with the community for improved wetland conservation. It was also noted that the future of Rwamuthambi sub catchment sustainability was based on effective public involvement.

The study findings also revealed that there was no structure or clear direction laid for public engagement which WRUA committee blamed on inadequate finances. This finding was supported by Ashton (2007) who alluded that stakeholder engagement would boost sub catchment management but there lacked a course of action on the process. Thus it was essential for WRUA

to initiate a program and cultivate consensus with the community on the requisite activities upon which a programme could be outlined.

Further findings indicated that WRUA had bestowed a sense of ownership due to the embrace the land owners had over conservation despite of the wetlands being their private property. This finding was similar to a study by Kombo *et al.* (2010) who argued that resource management can be promoted by creating a sense of ownership in addition to public participation. Contrary to this finding Mackay (1996) averred that there were a myriad of ideas cultivated by government but could not auger with the desired outcome of the same community engaged in resource utilization. The study findings also indicated that though governance challenges existed, these did not hamper general sub catchment management. It was also noted that there was consultation between WRUA management committee and the community over identification of projects and budgetary allocations. This finding was similar to Lalika *et al.* (2015) who asserted that in-genuine financial management and structures culminated into water resources management challenges. Subsequently, WRUA needed to lay down structures for stakeholder incorporation in all activities in fulfilment of the law that governs the institution (GOK, 2016).

From the study findings Rwamuthambi sub catchment WRUA faced many challenges including land reclamation, encroachment and wetland farming. This was experienced in spite of the community recording high level of literacy way above the country's average (CGK, 2013). Thus the challenges could not be attributed to illiteracy. This finding was supported by Rebelo *et al.* (2010) who asserted that there were many restrictions over sustainable utilization of wetland resources caused by lack of information and approach required to achieve sustainability. WRUA committee members acknowledged that there lacked requisite knowledge and skill regarding water resources which was necessary to accomplish their mandate. This finding was consistent with

Liambila (2017) and Njonjo and Lane (2002) who agreed that committee members were short of technical capacity and formal skills required to monitor and evaluate wetlands which Mumma *et al.* (2011) attributed to amicable practical interventions. In contrast to this finding Kecha *et al.* (2006) and Turner (1991) failed to attribute degradation to lack of information or poor sensitization but rather blamed it on other factors. However, in support of the finding, Schreiner and Van Koppen (2001) found that substandard education, limited availability of information and illiteracy was a major impediment to decision-making.

From the study findings, Rwamuthambi community was aware of existing legislations but not their contents. This finding was congruent with Tomas (2006) who concurred that most government policies seemed to have failed in attaining their mandate due to lack of understanding of their contents by the community. Similarly, Arto and Mauri (2011) added that innovative technical solutions could boost sustainability if incorporated into policies and community behavioural change. Thus sustainability can be attained through disseminating of policies and relevant information to the community to enable undertaking of informed decisions.

Further findings indicated that in spite of the rising population in the sub catchment, household income was a factor of conservation. However, this finding was contradicted by what Freebaim (2011) and Smith *et al.* (2010) revealed that high household income augmented with rise in population may lead to failed wetland management. In support of the study Kaffashi *et al.* (2015) established that as increase in income levels was directly related to conservation improvement.

Consequently, as portrayed by regression analysis household income was not a factor of utilization but affected conservation. The income accruing from riparian farming was ploughed back in form of conservation measures like soil erosion control and building of water pans as ways of increasing farm productivity. This observation was similar to Marambanyika and Beckedal (2016) that socio-

economic benefits derived from wetland farming act as incentives towards better conservation and cumulatively sustainability.

The study registered use of inorganic fertilizers and pesticides during farming whose effluents ended into to the river system. Integrated pest control was not emphasized as a method of environmental conservation except that based on instructions from WRUA, there was control in handling inputs packaging and cleaning of equipment that was used to administer the chemicals. Pollution was also generated effluents from some residential areas especially around market centres, light industries like coffee factories and abattoirs. This finding was consistent to what Ghorab and Khalil *et al.* (2012) asserted that the remedy to moderate use of inorganic farm inputs would be through adopting integrated pest management control. Similarly, Afroz *et al.* (2014) stated that algae population which reduces levels of dissolved oxygen in water is mainly caused by farm inputs and industrial effluents carried into the water through runoff. The results therefore showed that if the local community is informed on guidelines, they can be custodians of sub catchment pollution control.

The study findings established that the community was not aware of the effects of the cumulative effects of the main factors that contributed to Rwamuthambi sub catchment degradation. The factors emerged to be utilization conservation and sensitization. Analogically, these factors connote the three pillars of sustainability usually described as economic, environment and social. The main indicators for sustainability were community initiatives and community involvement. Other indicators that affected sustainability pillars at different magnitudes included (i) enforcement that was a factor of conservation and utilization (ii) governance challenges was a factor of utilization and conservation (iii) household income and (iv) awareness of the law. Both household income and awareness of the law were both factors of conservation and sensitization. This finding was supported by Yang *et al.* (2006) who averred that when information in regard to importance of environmental protection is elaborated against economic development attributed to attitude change over water for farming in relation to other activities. In addition, this finding was supported

by Shahzalal and Hassan (2019) in the argument that peoples' behavior towards sustainability can be changed through effective communication that depicts effects of attitude, culture and efficiency. Subsequently, the study adopted the illustration by Ravikhumar *et al.* (2014) Figure 13-7 to demonstrate relevant issues that are identifiable, can be interpreted, summarized and reported to show its effect on pillars of sustainability. Similarly, Communication on monitoring of sustainability was also advocated by Wamsley and Pretorius (1999)

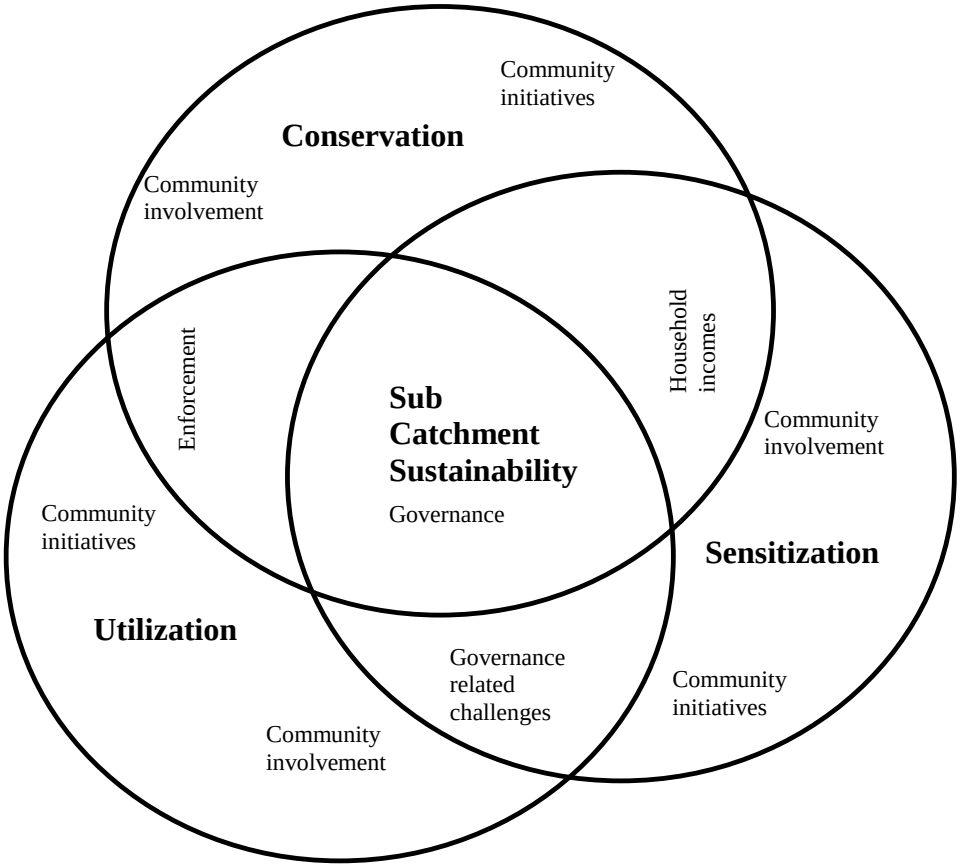


Figure 7-1 Regression analysis results for the three elements of sustainability as factors of sub catchment management (Source: Adopted from Ravikumar *et al.*, 2014)

CHAPTER EIGHT: CONCLUSION AND RECOMMENDATIONS

The study results established that although WRUA was the legally mandated institution to oversee wetland governance and management, there was need for inter-sectoral collaboration and cooperation and stakeholder engagement so as to ensure that focus was on wetland ecosystem as a whole. But WRUA committee needed to build consensus in enforcement strategies to be adopted for compliance of set guidelines. Of the factors affecting sub catchment degradation, land tenure was the highest contributor since the sub catchment was under private ownership yet it should be vested in the state as per the current Constitution of Kenya. In addition, land tenure also emerged as a positive effect for public participation and involvement in sub catchment conservation. Further, the findings established that there was profit-driven utilization that promoted conservation and sustainability. Thus, the land along Rwamuthambi sub catchment was already under private ownership based on land adjudication of the 1950s. But the Constitution of Kenya 2010 vests all wetlands and riparian reserves under public ownership. It is assertive that law does not work in retrospect and the available legal options would be compulsory acquisition or direct purchase to bring back the land to private coffer. Based on the findings therefore the study thus recommends a policy that would enable the sub catchment to be managed as a conservancy.

Other factors that affected sub catchment sustainability included community initiatives and involvement, public participation and level of household incomes. Indigenous knowledge played a major role in conservation since it emerged that high literacy levels of the community that are not relevant to environmental conservation could not suffice. There emerged a need to localize and domesticate wetland laws and ensure that the community was aware of the contents of the relevant wetland policies. The study recommends for integration of the Sub Catchment Management Plan (SCMP) with county land use development plans and other policies that would enable WRUA

activities get consideration in county budgetary allocations. Further, for effective management of the sub catchment, it was recommended that WRUA committee got empowered through training on governance and prudent financial management. The most effective sub catchment conservation activities bore short term socio-economic gains which enhanced community welfare derived mainly from wetland utilization. Subsequently, the study recommends a research on tipping point for a profit-making driven conservation sub catchment. It also emerged that the three pillars of sustainability can be attained through effective communication of issues and activities affecting an ecosystem and by involving the community in monitoring. Degradation and wastage of water can be controlled through introduction of tariffs which would also boost financial base and through sanctions in order to uphold compliance of agreed standards. The findings of this study will improve governance and management of sub catchments through community initiatives, involvement, public participation and inter-sectoral cooperation. More studies need to be conducted as a follow up to implementation of the recommendations of this research.

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APPENDICES

APPENDIX I- QUESTIONNAIRE

Dear Sir/ Madam,

This questionnaire is designed to conduct a survey on the "**ASSESSMENT OF LOCAL WETLAND GOVERNANCE AND ITS EFFECT ON MANAGEMENT OF WATER RESOURCES IN RWAMUTHAMBI SUB CATCHMENT, KIRINYAGA COUNTY**". The study is being carried out as a partial fulfilment for the award of Doctorate Degree in Environmental Management and Governance at the University of Nairobi (Wangari Maathai Institute for Peace and Environment Studies) The information gathered in this study will be treated with strict confidence. The information will not be used for any other purpose other than for this academic exercise.

Your assistance in facilitating the same will be highly appreciated.

Thank you in advance

Please answer all questions and give answers in the spaces provided

PART I- STATUS OF GOVERNANCE OF LOCAL WETLANDS IN KENYA-RUAMUTHAMBI SUB- CATCHMENT (RSC)

Wetland governance mechanisms refers to the inter-relationships amongst policies, laws, culture and norms' including institutions and the process through which power is exercised in the management of economic and social resources for sustainable development besides stakeholder involvement, allocation of responsibilities to make and implement decisions.

1. Do you know the **laws** related to wetlands that **governance**? □ Yes □ No
2. If **yes** kindly choose the ones you are **familiar** with here below**.**
   □ The constitution of Kenya
   □ Environmental Management and Coordination Act 2015
   □ The Physical Planning Act Cap 286
   □ The forest and Conservation Act of 2016
   □ Agricultural Act Cap 318
3. If **no**, what in your opinion are the **mechanisms that govern** the wetlands?
   □ Community initiatives
   □ Private land owners

□ County Government/ National Government
□ Collaboration between community and Government
□ Other (*Specify*)……..

4. How does the **existing legislation** on wetlands support their governance? *Please tick one*
   □ It identifies and includes all users of wetlands
   □ It recognizes that multiple users of wetlands exist
   □ It addresses gaps and limitations in wetland governance system
   □ It provide equitable solutions and more effective mechanisms for dispute resolution
   □ Other (*Specify*)……..

5. What is the **nature of institutions** that are involved in governance of the RSC?

   □ Private □ Public □ Collaboration between Private and Public

6. In your opinion, how effective has the **existing governance** been towards the utilization of RSC? *Please tick one* □ Very Effective □ Effective □ Moderately effective
   □ Less Effective □ Not Effective.

7. Of the following traits of good governance and accountability which is attained in RSC ? *Choose **3***
   □ A commitment to providing a voice for all residents
   □ Transparency and effectiveness in decision making
   □ Encouraging people to become involved and take on leadership
   □ Making information widely available
   □ Availability of a means of feedback of decisions that couldn't change
   □ Other (Specify) …….....

8. How is **community involved** in **conservation** of RSC? (*Please tick appropriately*)
   □ Through participation in planning
   □ Through budgeting for activities and projects
   □ Through collaboration in making and implementing decisions
   □ Through community ownership and management of assets
   □ Through promoting environmentally friendly behavior and sustainable utilization of wetlands
   □ Other (Specify) …….....

9. How is **stakeholder sensitization and capacity building** for wetland utilization and sustainability conducted? (*Please tick appropriately*)
   □ Through experience and indigenous knowledge sharing in public barazas
   □ Benchmarking through organized study tours
   □ Through sponsored short courses
   □ Recruitment and training of trainers on wetland utilization best practice
   □ Other (Specify)

   …….....

10. Who conducts the **surveillance and monitoring** of wetland utilization activities along RSC? *(Please choose and tick)*
    □ NEMA □Water Resource Users Associations □ Water Resource Management Authority
    □ County Government □Community □ Collaboration between community and Government

□ Surveillance and monitoring not conducted
□ Other (Specify) …….....

11. Please rate the **level of enforcement** mechanisms in safeguarding RSC? *Please tick one*
□ Very High □ High □ Moderate □ Low □ Very Low

PART II- EFFECTS OF EXISTING GOVERNANCE ON RUAMUTHAMBI SUB CATCHMENT

Water Act, 2016, Part II article 5 provides that every water resource is vested in and held by the National Government in trust for the people of Kenya. This would be accomplished through the Water Resources' Authority whose functions are defined in the act inter- alia to formulate and enforce standards, procedures and regulations for the management and use of water resources.

1. What is the cause of **degradation of wetlands in** Ruamuthambi Sub Catchment (RSC)? *Please choose according to level of priority 1 to 5 (5-greatest , 1 Least)*
□ Poor governance □ Population pressure □ Lack of adequate legislations
□ Poor enforcement of legislation □ Lack of incentives to the conservators
□ Lack of information on values of wetlands
□ Other (*Specify*)
…….....
2. Who is **in charge of governance** of Ruamuthambi Sub Catchment (RSC)? *(Please choose and tick)*

□ NEMA □ County Government □Water Resource Management Authority

□Water Resource Users Associations □ Water Catchment Associations

□ Community □ Land owners □ Other (Specify)……..

3. What is the **contribution of Water Resource Users Associations** (WRUAs) to governance of Ruamuthambi Sub-catchment? *(Please choose and tick)*
□ Sensitization and education on functions of wetlands
□ Provide incentives to conservationists
□ Uniting resource users and water Resource Management Authority
□ Offers training on best practice
□ Creates a sense of ownership to wetlands and their products
□ Other (Specify)
…….....
4. How have **social and behavioral factors** contribute to wetland destruction? *(Please choose and tick)*
□ Land fragmentation
□ Unsustainable use of water resources
□ Over exploitation
□ Unplanned development and haphazard implementation of development activities
□ Use of persistent organic pesticides
□ Other (*Specify*)……

5. How would you rate **governance** in Ruamuthambi Sub Catchment (RSC) currently as compared to 5 years ago? *Please choose according to level of achievement 1 to 5 (5-Greatest , 1 Least)*
   - □ Improved Accountability
   - □ Democracy in wetland leadership
   - □ Enhanced public participation and inclusivity in decision making
   - □ Heightened equity and fairness in wetland related activities and projects
   - □ Better support from relevant Government institutions
   - □ Greater responsibility vested on the community

6. What are the **social impacts** that have arisen as a result of the **current state of governance** *(Please Tick appropriately)*
   - □ Improved economic status- better income, better livelihood
   - □ Increased flow of water in the catchment
   - □ Enhanced cohesion in project identification and
   - □ Better environmental conditions
   - □ Other (Specify) …….....

7. Have riparian reserves been **set apart** in the title deed and survey maps? □ Yes □ No

8. If RSC is **not set apart** as public land on the title deeds and the survey maps, how then are **government institutions involved** in regulating utilization of these wetlands?.....
   ……

   …….

9. If RSC is **not set apart** as public land on the title deeds and/or the survey maps, how is the **community involved** in these wetlands' sustainability?……..…
   ……

PART III- GOVERNANCE SCENARIOS INFLUNCING FUTURE SUSTAINABLE UTILIZATION OF RUAMUTHAMBI SUB- CATCHMENT

Governance blends responsibility, accountability, participation and statutory authority of all stakeholders. Thus there is need for cooperation from the community besides formulation of supporting legislation

1. What are the **community best practice** in ensuring proper RSC utilization, conservation and sustainability? *Please choose what is applicable according to level of priority 1 to 5 (1-Greatest , 5 Least)*
   - □ Re-afforestation
   - □ Soil erosion control and conservation
   - □ Improved agricultural practices e.g. drip irrigation, crop rotation, no till, cover cropping
   - □ Knowledge exchange and collaboration among stakeholders
   - □ Wetland rehabilitation and conservation

2. What are the **governance related challenges** that affect sustainable use of Ruamuthambi Sub Catchment (RSC)? *Please indicate according to level of priority 1 to 5 (5-Greatest , 1 Least)*
   - □ Poor leadership
   - □ Lack of democracy in wetland leadership
   - □ Poor or lack of public participation in decision making

□ Lack of accountability and transparency in wetland related activities and projects
□ Poor or lack of support from relevant Government institutions

3. In your opinion, how can the **challenges in 4 above** be **addressed**? *Please select **3** below*
□ Initiate training on leadership skills
□ Free and fair selection of local leaders
□ Incorporate public views in implementation and decision making
□ Improved accountability and transparency in wetland related activities and project
□ Enactment of policies that incorporates collaboration with relevant Government institutions
□ Other (Specify) …….....

Wetlands degradation, loss and mismanagement are attributed to lack of information on their role and poor sensitization to the community in regard to their intrinsic values towards human wellbeing.

4. How has **government involvement affected the community** in regard to sustainable utilization of RSC? *Please indicate according to level of priority 1 to 5 (5-Greatest , 1 Least)*
□ Provide civic education and sensitization on wise use of wetlands and water conservation
□ Delineate wetlands as public conservation areas
□ Provide agricultural extension services on modern farming methods
□ Embrace and encourage public participation in wetland management and decision making
□ Provide incentives towards wetland conservation

5. In your opinion, what are the **opportunities gained** by embracing governance initiatives? *Please choose what is applicable and rate them according to importance (5-Most , 1 Least)*
□ Improved livelihood
□ Enhanced aesthetics and recreational facilities
□ Better economic status
□ Improved social structures
□ Availability of adequate clean water

6. Of the following dimensions of **governance,** which one applies to RSC ?
□ Political- those in authority are selected, elected, monitored and replaced.
□ Economic- public resources are effectively managed and sound policies implemented
□ Institutional- citizens and the state itself respect the society's/ public institutions
□ Other (Specify) …….....

7. What are the **community initiatives** towards the sustainable conservation of Ruamuthambi Sub Catchment (RSC)? *Please choose initiatives.*
□ Provide information and data required for making wetland inventory and condition of resources
□ Utilize their knowledge, skill to produce wetlands products and take benefits from them
□ Maintain ecological balances by wise utilization of wetland resources
□ Participation in wetland plan development process
□ Discourage or restrict any activities that exert negative impact on wetlands
□ Other (*Specify*) ……

8. Are you aware of the **Ruamuthambi Sub County Management Plan** (RSC)? □ Yes
□ No

9. If Yes, what are the **challenges** faced in its **implementation**? *Please choose **3** major ones*

□ Lack of appropriate institutional framework
□ Policy failures-lack of and/ or poor enforcement of wetland policies
□ Market Failures- lack of knowledge of wetland values and consequences of negative tendencies
□Land tenure system and type of ownership
□ Inadequate community participation
□ Other (*Specify*) ……

10. What should be done **to improve** the status of governance going forward? *Please choose **3** major ones*
□ By taking responsibility to monitor and evaluate the current outcomes
□By publishing outcome from consultation processes
□ Making it known what decisions were taken and why
□ Provide opportunities to local people to have a say on how money is spent locally
□ Provide opportunities for scrutiny of proposals
□Other (*Specify*) ……

PART IV- RESPONDENTS BIO-DATA

1. Name (*Optional*)……..……..…
2. County of residence…….…….
3. Gender □ Male □ Female
4. Highest level of education attained
□ Primary □ Secondary □ College □ University □ Other (Specify)…….
5. What else do you do to complement your income? *Please state* ……
6. If you work with the government. *Please indicate designation*...……...…….……..
7. Number of years worked with the institution
□ Below 12 months □ 1-5 years □ 6-10 years □ 10-15 years □ Above 15 years
8. Age □ Below 20 years □ 21-30 years □ 31-40 years □ 41-50 years
□ 51-60 years □ 61-70 years □ 70+ years
9. What is your source of income □ Self- employed (specify) □ Business person
□ Employed □ Pension □ Casual employed
10. How much do you earn per month in Kshs.
□ Below 1,000 □ 1,000-4,999 □ 5,000-9,999 □ 10,000-14,999
□ 15,000-19999 □ Above 20,000

APPENDIX II- KEY INFORMANT QUESTIONNAIRE FOR SENIOR RESPONDENTS

1. What was the main source of water before establishment of WRUA?
2. How much water was abstracted for irrigation or other domestic uses?
3. In your own estimation, how much surveillance was conducted?
4. Who carried out surveillance and enforcement?
5. What was being checked?
6. What was the penalty if found flouting the rules?
7. At what point did cultivation along the riparian begin?
8. Who managed the riparian reserve before the establishment of WRUA?
9. Were you aware of laws managing the riparian reserve?
10. What difference has WRUA brought to the sub catchment?

APPENDIX III- SCHEDULE OF FOCUS GROUP DISCUSSIONS

1. Community understanding of elements of good governance and WRUA contribution ti the same
2. Surveillance, monitoring and enforcement of sub catchment management
3. Effects of tenure to wise use of the sub catchment through community involvement and initiatives
4. Sectoral management of the sub catchment
5. Social economic impacts attributed to WRUA