Water Resources Governance Dynamics: A case of Rwamuthambi Sub-Catchment, Kenya

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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. In addition, 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 a 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.

Keywords: *conservation; enforcement; governance; public participation; sub-catchment; water resource.*

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 has usually perceived wetlands as useless

(Mathews 1993), a nuisance and 'wastelands' (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 include 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 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 involvement of grass root stakeholder. 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 seven 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; 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. At the upstream there was farming, livestock rearing and occasional human wildlife conflict 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 (Specific, Measurable, Achievable, Relevant, Time-bund) 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 argument 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 makers of possible strategies to promote governance and hence sustainability of Rwamuthambi sub-catchment.

Material and methods

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 1 (MEMR, 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 projects 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).

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 seasons; the long rains between mid-March – May and short rains between mid-October to December, with 800-1200 mm annual

precipitation. The rest of the months are dry (CGK, 2013; Jaetzold *et al.,* 2007)

The sub-catchment study areas lie within a number of Agro- Ecological 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).

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 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.

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 assistant 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 also inquired on awareness of relevant water resources laws, social behavioural 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.

There was a population of 19,800 households (HH) within Rwamuthambi sub-catchment. This included the households of some WRUA committee members since the committee should comprise of representatives from within the sub-catchment (GOK, 2002)
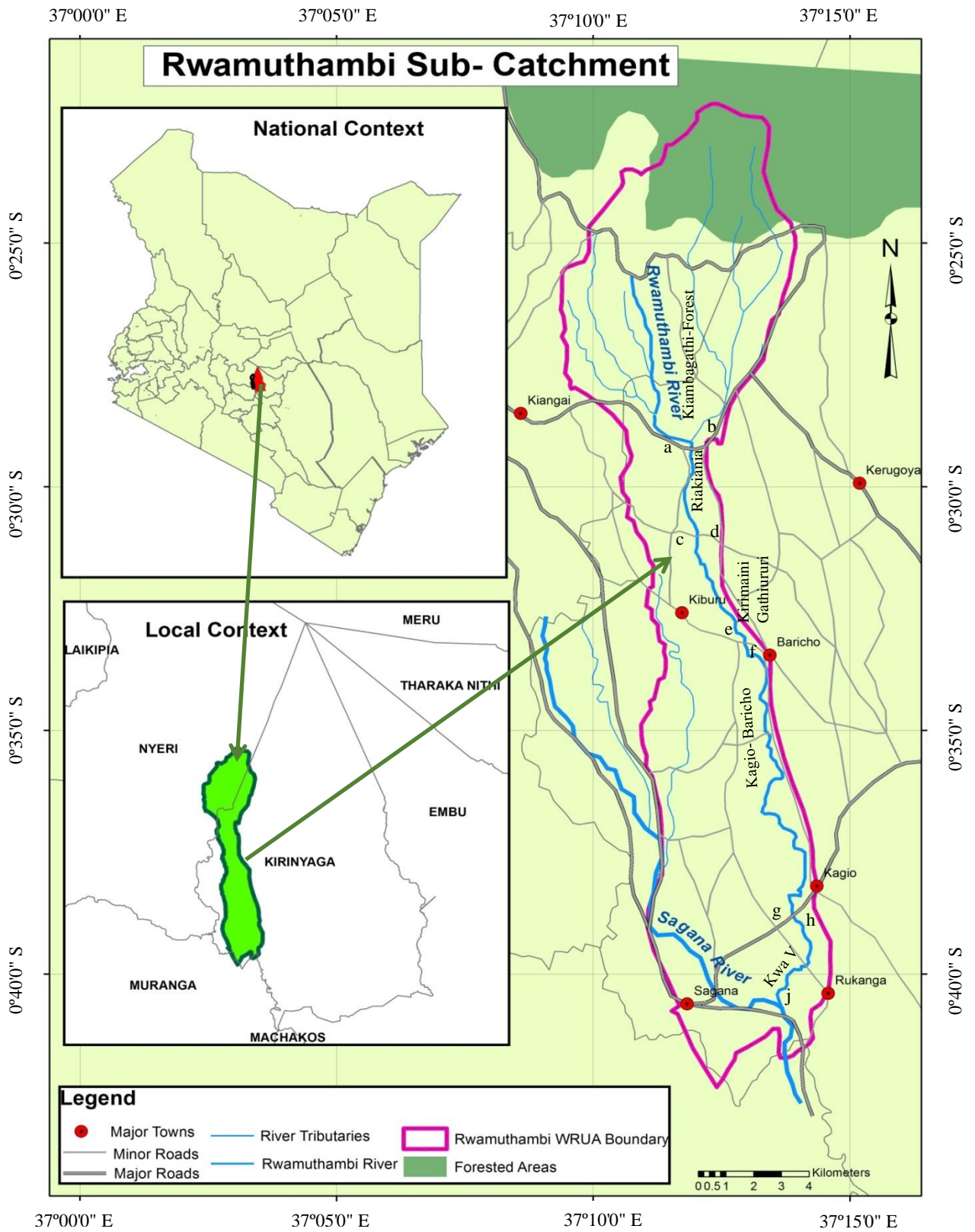
Figure 1: Map showing the location of the study area: Source RSCMP, 2015
(a-b): Kiangai- Kagumo road; (c-d): Kabonge- Riakiania road; (e-f) Kiburu- Baricho road; (g-h); Sagana- Kagio road

((a-b), (c-d))- Upper Midland-I, ((c-d), (e-f))- Upper Midland-II, ((g-h), (j))- Upper Midland-III

The sample size n_o =196 was obtained through Cochran's formula (Horse, 2018; 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 pre-test 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 were 203. These comprised 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).

Results

Overview of governance in 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 pre-treatment. 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 which 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 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.

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).
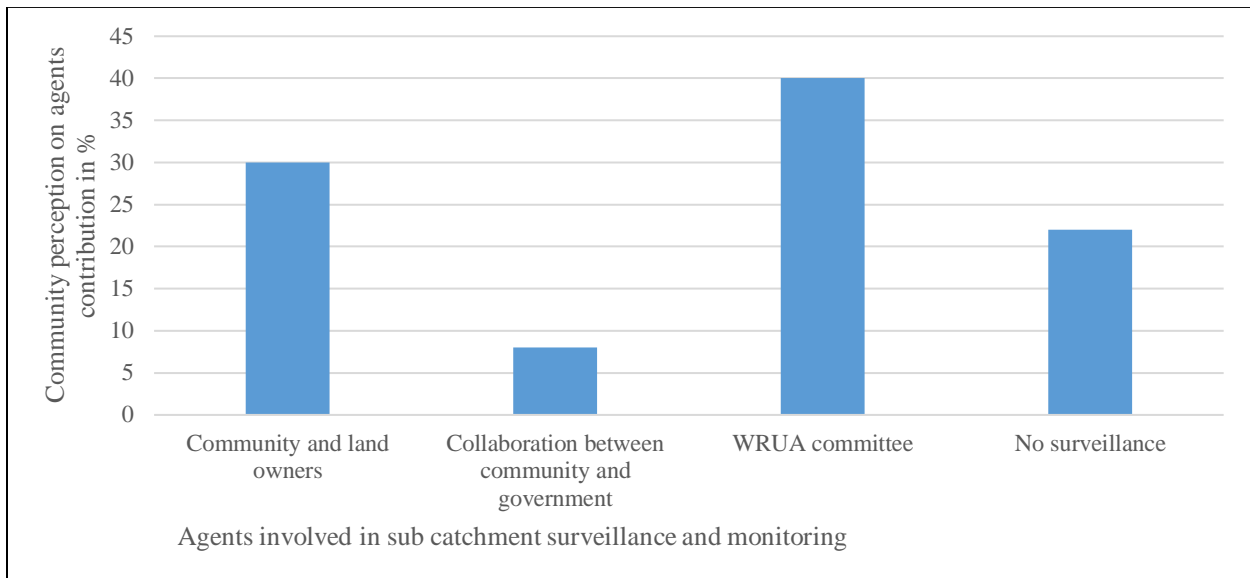

Figure 2: Surveillance and monitoring of Rwamuthambi sub-catchment area in percentage (%)
Source: Field survey 2018

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 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 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 wellbeing. 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 chiefs and assistant chiefs, yet there was 99% compliance.

Nonetheless, 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.
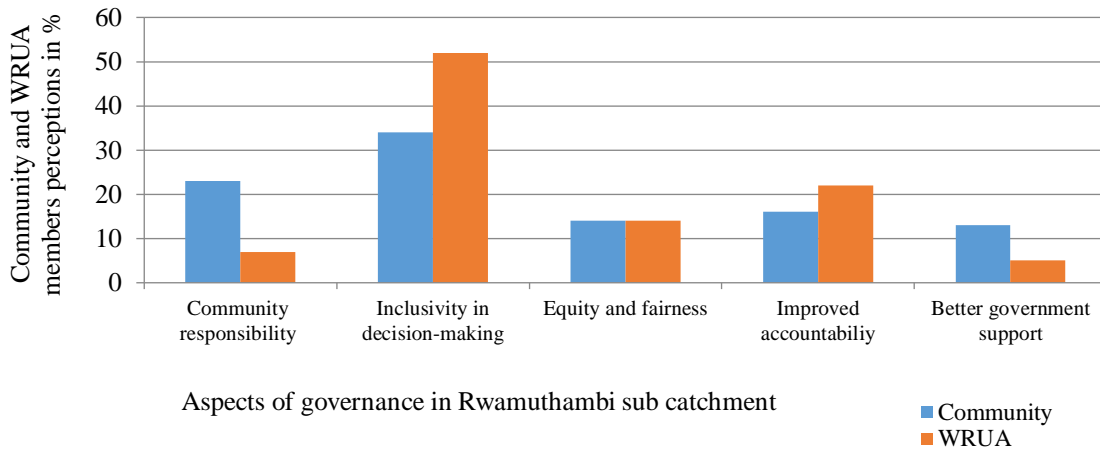

Figure 3: Perception (%) on various aspects of governance by the community members and WRUA officers in Rwamuthambi sub-catchment area
Source: Field survey 2018

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. However, 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 nongovernmental organizations and Agro-

Based companies operating within the catchment had penetrated the area through community-based organizations (CBOs). The CBOs marketed farm in puts and services and in return offered the farmers extension services and also marketed the farm produce. The community ranked public participation in wetland management and decision making as effective (32%) while 28% of the community conferred that it was least effective. Provision of incentives towards wetland conservation was ranked as moderately effective (30%).

Table 1: Ranking of perception of various government activities within the sub-catchment in percentages (%)

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

Source: Field survey 2018

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 sort 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 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 2: Ranking of effectiveness of various government services by the community within Rwamuthambi sub-catchment area per Likert scale

Government activities	Raters Most effective (5)	Very effective (4)	Effective (3)	Moderately effective (2)	Least effective (1)	Total
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

Source: Field survey 2018

Discussion

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) in 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.

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.

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.

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 behaviour of individuals resulted from preferred 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.

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 nature 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.

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.

Compliance with ethical standards

The research was carried out under WMI of the University of Nairobi, Kenya. 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

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