WANGARI MAATHAI INSTITUTE FOR PEACE AND ENVIRONMENTAL STUDIES

Journal of Sustainability, Environment and Peace

Homepage: http://www.jsep.uonbi.ac.ke

ISSN: 2663-4627

Towards a Framework for Monitoring and Communicating Water Resources Sustainability: A Case Study of Rwamuthambi Sub Catchment Area, Kenya

Eunice Muthoni Kumunga[1], Titus Chemandwa Ndiwa[2], Nzioka John Muthama[1]

[1] Wangari Maathai Institute for Peace and Environmental Studies, University of Nairobi, Kenya

[2] Department of Clinical Studies, University of Nairobi

Article history:
Received: 30 July 2019
Received in revised form: 25 January 2020
Accepted: 30 January 2020
Available Online: 06 February 2020

Corresponding Author
Eunice Muthoni Kumunga
Email Address: eunicem.kanoti@gmail.com

Key words:
conservation
education
Indicators
sensitization
sustainability
utilization

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.

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 & Cosselink, 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; EMCA, 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) (Water Act 2002) currently known as Water Resources Authority (WRA) (Water Act 2016).

Please cite this article as: Kumunga E. M., T. C. Ndiwa, and N. J. Muthama (2020). Towards a framework for monitoring and communicating water resources sustainability: A case study of Rwamuthambi Sub Catchment, Kenya. *J. sustain. environ. peace 3 (1) 21–33*

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 (2015) 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) avered that communication increased acceptability of sustainability culminating to positive adaptation to sustainable behavior.

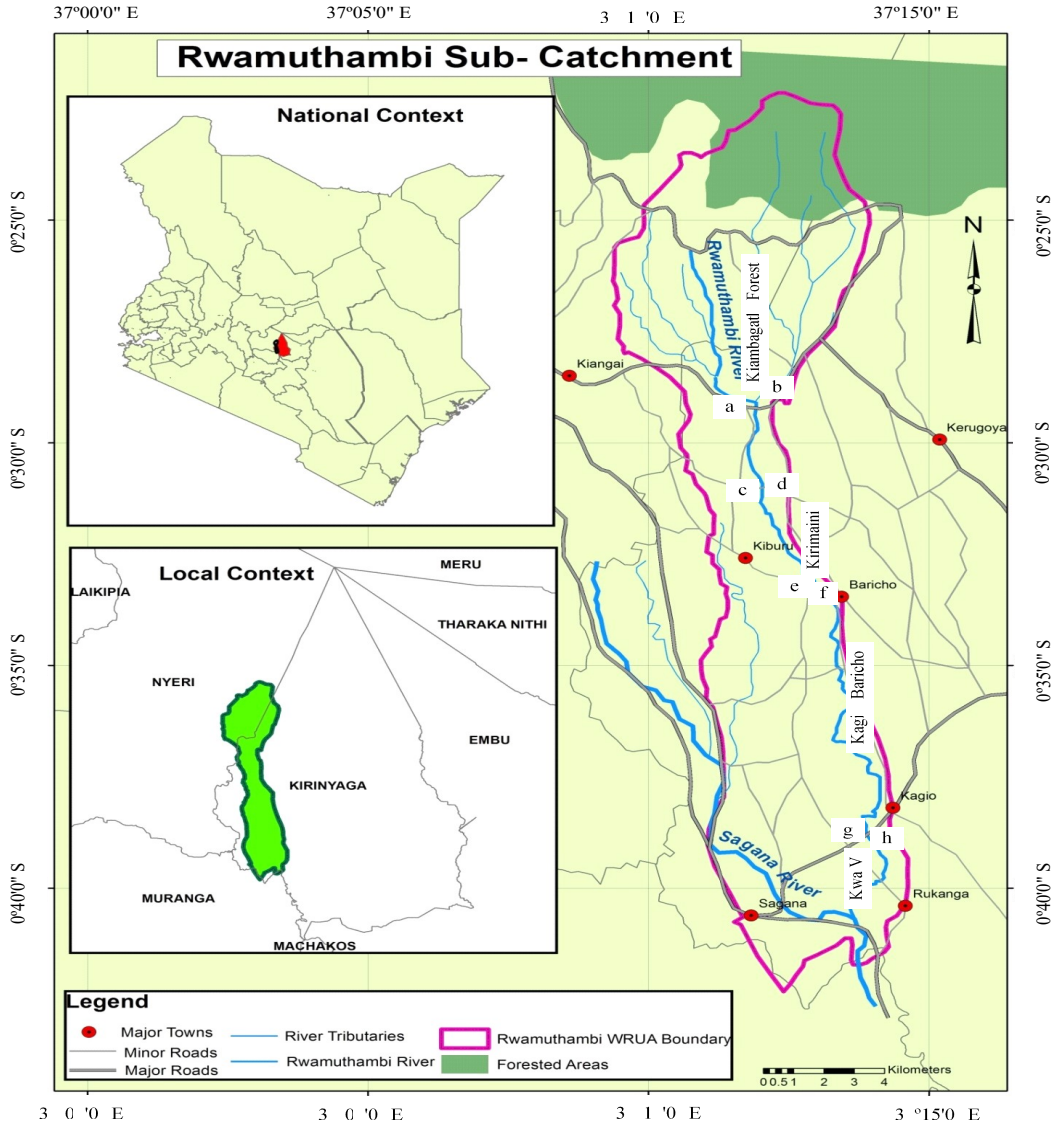
2. Methodology

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, 2012). 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 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).

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 (Farm Management Handbook of Kenya, 2010). 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; Farm Management Handbook of Kenya, 2010).

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 (Farm Management Handbook of Kenya, 2010).

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 1.



a-b: Kiangai- Kagumo road; c-d: Kabonge- Riakiania road; e-f Kiburu- Baricho road; g-h: Sagana- Kagio road

Figure 1: Rwamuthambi Sub Catchment

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) (Water Act 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 et al., 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 1 and 2.

Table 1: List of topographical maps

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

Table 2: List of laws and policies

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 Management 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.

3. Results

3.1 Social economic characteristics and sub catchment utilization

The study administered a total 223 questionnaires to respondents consisting of 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.

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 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.

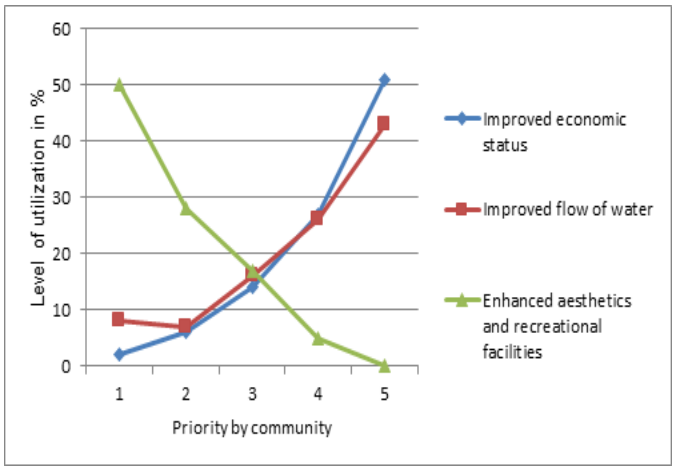


Figure 2: Outcome of utilization of sub catchment resources by order of priority
Source: Field data analysis by Author

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 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 3: Factors affecting utilization of Rwamuthambi sub catchment

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

Source: Field data analysis by Author

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.

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 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 4: Factors affecting sensitization in Rwamuthambi sub catchment

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

Source: Field data analysis by Author

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.

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 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.

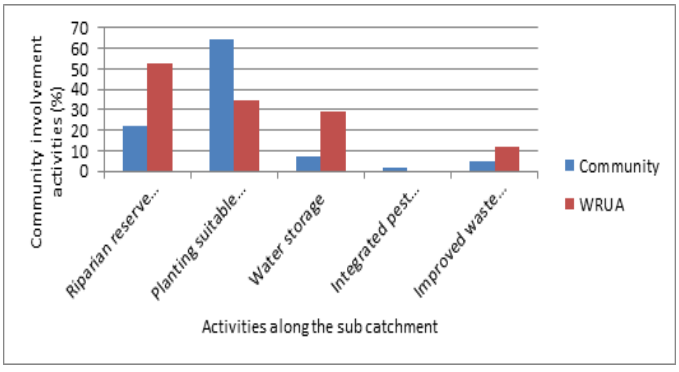


Figure 3: Perception on activities along Rwamuthambi sub catchment
Source: Field data analysis by Author

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 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 5: Factors affecting conservation of Rwamuthambi sub catchment

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

Source: Field data analysis by Author

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 5.

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.

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), Renias & Remigios (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 Rafia *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 *et al*. (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 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.

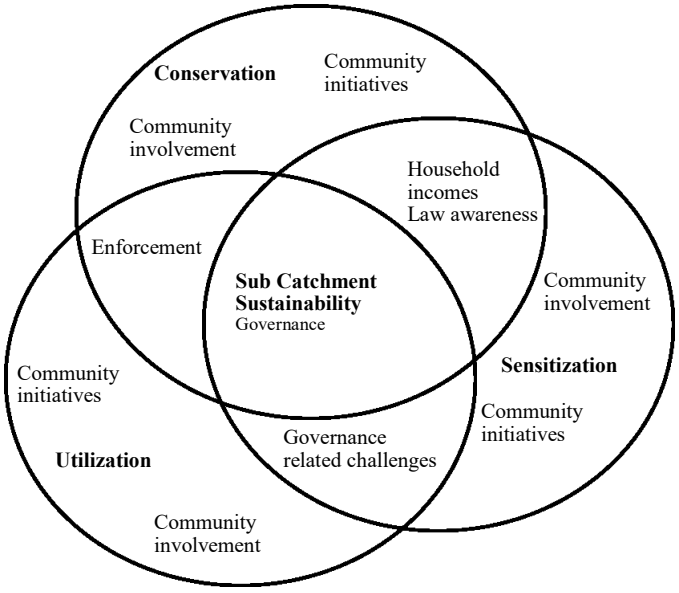


Figure 4: Enhanced illustration and communication of sustainability;
Source: Adopted from (Ravikumar et al., 2014)

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.

Acknowledgement

The authors are grateful to institutions and individuals who provided data and information towards this research. These include Kirinyaga County WRA office led by James Maina Kanai, Rwamuthambi WRUA committee members. Much gratitude also goes to research assistants and Mr. David Ndwiga for assistance in data analysis. We also thank our colleagues from WMI who provided insight and expertise that assisted the research.

Compliance with ethical standards

The research was carried out under Wangari Maathai Institute of Peace and Governance of the University of Nairobi. Consent of participants in interviews and questionnaire survey was sought before each individual participant. Permission was sought and granted by National Commission for Science, Technology and Innovation (NACOSTI) Ref: No. NACOSTI/P/18/10767/23007.

References

Adams WM, Aveling R, Brockington D, Dickson B, Elliott J, Hutton J, Roe D, Vira B, Wolmer W. (2004). Biodiversity conservation and the eradication of poverty. Science Vol 306 (5699) pp 1146–1149 DOI: 10.1126/science.1097920 Accessed on 20-12-2019

Agriculture Act Cap 318, Laws of Kenya, Government Press

Alyson C. Flournoy (1997) Preserving Dynamic Systems: Wetlands, Ecology and Law, Duke Environmental Law and Policy Forum, Vol. 7 pp 105-132, available at http://scholarship.law.ufl.edu/facultypub/441

Rafia Afroz, Muhammad Mehedi Masud, Rulia Akhtar and Jarita Bt Duasa (2014) Water Pollution: Challenges and Future Direction for Water Resource Management Policies in Malaysia Sage Publications Environment and Urbanization Asia Vol. 5(1) pp 63–81 DOI: 10.1177/0975425314521544 Accessed on 19-11-2019

Andresen T. & Curado M. J. (2005) Sustainability of Wetlands: Nature Conservation and Agriculture in Baixo Vouga Lagunar WIT Transactions on Ecology and the Environment, Vol 81 DOI: 10.2495/ECO050491 Accessed on 24-7-19 https://www.witpress.com/elibrary/wit-transactions-on-ecology-and-the-environment/81/14814

Arto O. Salonen and Mauri Ahlberg (2011) Sustainability in Everyday Life Integrating Environmental, Social, and Economic Goals Sustainability Vol. 4 (3) DOI: 10.1089/sus.2011.9693 MARY ANN LIEBERT, INC. Accessed on 27-12-19

Ashton P.J. (2007) The Role of Good Governance in Sustainable Development: Implications for Integrated Water Resource Management in Southern Africa. In: Turton A.R., Hattingh H.J., Maree G.A., Roux D.J., Claassen M., Strydom W.F. (eds) Governance as a Trialogue: Government-Society-Science in Transition. Water Resources Development and Management. Springer, Berlin, Heidelberg https://doi.org/10.1007/978-3-540-46266-8_5

Ashton, P.J. & H.M. MacKay (1996). The Philosophy and Practice of Integrated Catchment Management: Implications for Water Resource Management in South Africa. A Discussion Document. Water Research Commission and Department of Water Affairs & Forestry, Pretoria. 128 pp.

Ayaa Dominics Dan, Waswa Fuchaka (2016) Role of indigenous knowledge systems in the conservation of the bio-physical environment among the Teso community in Busia County-Kenya African Journal of Environmental Science and Technology Vol. 10(12), pp. 467-475 DOI: 10.5897/AJEST2016.2182 Accessed 27-6-19

Baker C, Lawrence RL, Montagne C, Patten D. (2007) Change detection of wetland ecosystems using Landsat imagery and change vector analysis. Wetlands Vol 27 (3):610-619 DOI: 10.1672/0277-5212(2007)27[610:CDOWEU]2.0.CO;2 Accessed on 12-8-2019

Bakkes, J. A., van der Born, G. J., Helder, J. C., Swart, R. J., Hope, C. W., and Parker, J. D. E. (1994). An Overview of Environmental Indicators: State of the Art and Perspectives, Environmental Assessment Technical Reports. United Nations Environment Programme, New York, USA

Booth, D. E. (2004). Hooked on growth: Economic addictions and the environment. Lanham, MD: Rowman & Littlefield https://pdfs.semanticscholar.org/e61a/b0689a545df5083502c1e1ae40e74025777c.pdf Accessed on 19-11-2019

Brouwer, R., Crooks, S. and Turner, R. K. (2003). Environmental indicators and sustainable wetland management. In Turner, R. K., Van Den Bergh, J. C. J. M. and Brouwer, R. (eds.). Managing wetlands: An ecological economics approach. Edgar Edward Publishing Limited, Cheltenham, UK and Massachusetts, USA

Clare Shari, Krogman Naomi, Foote Lee, Lemphers Nathan (2011) Where is the avoidance in the implementation of wetland law and policy? Springer-Wetlands Ecology and Management Volume 19, Issue 2, pp 165–182 https://link.springer.com/article/10.1007/s11273-011-9209-3#citeas Accessed on 21-7-19

Constitution of Kenya (COK) (2010)- Laws of Kenya, Government of Kenya, Government Press

County Government of Kirinyaga (CGK) (2013) County Integrated Development Plan (CIDP) Government Printers

Demnati Fatma, Allache Farid, Ernoul Lisa, and Samraoui Boudjema (2012) Socio-Economic Stakes and Perceptions of Wetland Management in an Arid Region: A Case Study from Chott Merouane, Algeria, Springer Ambio Vol 41(5): pp 504–512 doi: 10.1007/s13280-012-0285-2 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3390579/ Accessed on 20-7-19

Environmental Management and Coordination Act (Amendment) of (EMCA) 2018 Laws of Kenya, Government Press

Environmental Management and Coordination Act (Amendment) of (EMCA) 1999 Laws of Kenya, Government Press

EPA (United States Environmental Protection Agency) (2017) Wetlands; Why are wetlands important? https:// www.epa.gov/wetlands/why-are-wetlands-important Accessed on 5-7-19

ePLANETe Blue (2015) A Multi-Faceted Approach to Sustainability, University of Versailles Saint-Quentin-en-Yvelines, https://proxy.eplanete.net/galleries/ broceliande7/1-four-spheres-sustainability Accessed on 20 -7-19

Evans, K., Velarde, S.J., Prieto, R., Rao, S.N., Sertzen, S., Dávila, K., Cronkleton P. and de Jong, W. 2006. Field guide to the Future: Four Ways for Communities to Think Ahead. Bennett E. and Zurek M. (Eds.). Nairobi: Center for International Forestry Research (CIFOR), ASB, World Agroforestry Centre. p.87. URL: http://www.asb.cgiar.org/ ma/scenarios Accessed on 15-1-19

Farm Management Handbook Of Kenya (2010) VOL. II – Natural Conditions and Farm Management Information – Annex: – Atlas of Agro-Ecological Zones, Soils and Fertilizing by Group of Districts – Subpart B2 Central Province Kirinyaga County

Faulkner Stephen, Barrow Wylie Jr., Keeland Bob, Walls Susan, Telesco David (2011) Effects of conservation practices on wetland ecosystem services in the Mississippi Alluvial Valley Ecological Applications Conservation of Wetlands in Agricultural Landscapes Ecological Society of America (esa) journals Vol 21 (sp1) https:// doi.org/10.1890/10-0592.1 Accessed on 12-9-19

Freebairn J. (2011). Allocating Limited Water. Australian Economic Review, Vol 44 (2), 225-232. https:// doi.org/10.1111/j.1467-8462.2011.00635.x. Accessed on 2 -7-19

Gallopín, G. C. (1997) Indicators and their Use: Information for Decision-making. Sustainability indicators: A Report on the Project on Indicators of Sustainable Development. Eds: Moldan, B., Billharz, S., and Matravers, R., John Wiley & Sons, Chichester, UK

Ghorab MA, Khalil MS (2016) The Effect of Pesticides Pollution on Our Life and Environment. J Pollut Eff Cont Vol 4 (2) pp 159. doi:10.4172/2375-4397.1000159 Accessed on 12-9-19

Gouzee, N., B. Mazijn, and S. Billharz. 1995. Indicators of sustainable development for decision-making. Federal Planning Office of Belgium, Brussels, 34pp

Griggs D, et al. 2013. Policy: sustainable development goals for people and planet. Nature Vol 495 pp 305–307. doi:10.1038/495305a Accessed on 20-10-2019

Guo M, Li J, Sheng C, Xu J, Wu L. (2017) A review of wetland remote sensing. Sensors Vol 17(4):777 doi: 10.3390/s17040777 Accessed on 12-8-2019

Horse Theme (2018) Statistics How To Theme http:// www.statisticshowto.com/probability-and-statistics/find-sample-size/ Accessed on 12 January 2018

Hulme M, Doherty R, Ngara T, New M, Lister M. (2001) Africa climate change: 1900–2100 Climate Res. Vol 17 pp145-68 https://www.int-res.com/articles/cr/17/ c017p145.pdf Google scholar Accessed on 12-10-2019

International Institute of Topical Agriculture (IITA). Annual report for 2004. Ibadan, Nigeria: International Institute for Tropical Agriculture; 2004 Google Scholar

Junhong Bai, Baoshan Cui, Huicong Cao, Ainong Li, and Baiyu Zhang (2013) Wetland Degradation and Ecological Restoration The Scientific World Journal Volume, ArticleID523632, 2pages Hindawi Publishing Corporation http://dx.doi.org/10.1155/2013/523632

Kaffashi Sara, Shamsudin Mad Nasir, Radam Alias & Rahim Khalid Abdul (2015) Socio-economic reason to save an international wetland, Journal of Integrative Environmental Sciences, Vol 12:1, pp 67-83, DOI: 10.1080/1943815X.2014.998685

Kecha Aron, Ochieng Griffins, Lekapana Paul and Macharia Geoffrey (2006)(, ir-library.ku.ac.ke/…/Status% 20of%20Wetlands%20in%20Kenya%20and% 20Implications.....%20(2).pdf, Status of wetlands in Kenya and Implications for Sustainable Development, Environment and Sustainable Development, A guide to higher Education in Kenya, Kenyatta University Accessed on 2 June 2017

Kenya Wetlands Forum (2012). Why conserve wetlands? http://kenyawetlandsforum.org/index.php? option=com_content&view=article&id=1:welcome-to-kenya-wetlands-forum Accessed on 10-8-19

Khahil MS, Kenawy A, Ghorab MS, Mohammed EE (2012) Impact of microbial agents on Meloidogyne incognita management and morphogenesis of tomato J Biopest Vol 5 pp 28-35

Lake Naivasha Catchment Area Protection Order No. 171, Legal Notice (2012)

Lalika C.S. Makarius., Meire Patrick, Ngaga Yonika M. (2015) Exploring watershed conservation and water governance along Pangani River Basin, Tanzania Land use policy Elsevier Vol 48 pp 351-361 https://doi.org/10.1016/ j.landusepol.2015.06.010 Accessed on 11-9-19

Leedy, Paul D. and Jeanne Ellis Ormrod (2013) Practical Research: Planning and Design. Tenth edition Boston. Accessed from http://libguides.usc.edu/writingguide/ researchdesigns, on 28 February 2018

Ma C., Zhang G.Y., Zhang X.C., Zhou B., Mao T.Y. (2011) Simulation modeling for wetland utilization and protection based on system dynamic model in a coastal city, China Elsevier Procedia Environmental Sciences 13 pp 202 – 213

Marambanyika Thomas and Beckedahl Heinz (2016), Institutional Arrangements Governing Wetland Utilization and Conservation in Communal Areas of Zimbabwe. Review of social sciences, [S.1.], v.2, n. 1p.01-17 ISSN 2378-8550. Available at <https:// www.socialsciencesjournal.org/index.php/site/article/ view/71> Accessed 1-2-2018 doi; http:// dx.doi.org/10.18533/rss.v2i1.71, Accessed 1 Feb 2018

Marambanyika Thomas, Beckedahl Heinz, Ngetar Njoya Silas (2016) Community strategies to promote sustainable wetland-based food security in rural areas of Zimbabwe Springer GeoJournal Vol 81 No. DOI 10.1007/s10708-016 -9724-0 https://www.researchgate.net/ publication/303740605 Accessed on 12-4-19

Marc A. Rosen (2018) Issues, Concepts and Applications for Sustainability Journal of culture, politics and innovations Issue (3) DOI: 10.12893/gjcpi.2018.3.40 ISSN 2283 – 7949

McInnes RJ. 2013. Recognizing ecosystem services from wetlands of international importance: an example from Sussex, UK. Wetlands. 33:1001–1017. doi:10.1007/s13157-013-0458-1

Mitsch William J., Bernal Blanca & Hernandez Maria E. (2015) Ecosystem services of wetlands, International Journal of Biodiversity Science, Ecosystem Services & Management, 11:1, pp 1-4, DOI: 10.1080/21513732.2015.1006250 Accessed on 4-4-19

Mitsch WJ, Gosselink JG. 2000. The value of wetlands: importance of scale and landscape setting. Ecol Econom. 35:25–33. doi:10.1016/S0921-8009(00)00165-8

Momanyi Mironga John (2005) Conservation Related Attitudes Of Wetland Users In Kisii District, Kenya Ajeam-Ragee Volume 10 pp14-25

National Land Use Policy (NLUP) Sessional paper No. 1Ministry of Lands and Physical Planning (MLPP) (2017), Government Press, Kenya

Ostrom, E. (1990) Governing the Commons: The Evolution of Institutions for Collective Action. New York: Cambridge University Press

Pandey Deep Narayan (1994) Traditional Knowledge Systems for Biodiversity Conservation, World Conservation Union. http://www.infinityfoundation.com/mandala/t_es/t_es_pande_conserve.htm Accessed on 18-6-2019

Pearson Vogt MA, W. Paul, Dianna C. Gardner, and Lynne M. Haeffele (2012). When to Use What Research Design. New York: Guilford. Accessed from http://libguides.usc.edu/writingguide/researchdesigns, on 28 February 2018

Physical Planning Act Cap 286 (PPA) (1996) Laws of Kenya, Government Press

Ravikumar Ashwin, Gonzales Tovar Jazmin, Kowler Laura, Larson Anne M. (2014) Building future scenarios: Governance, land use and carbon management at the landscape scale, Center for International Forestry Research (CIFOR), Bogor, Indonesia https://www.cifor.org/library/5360/ Accessed on 15-1-19

Renias Ngara and Remigios V. Mangizvo (2013) Indigenous Knowledge Systems and the Conservation of Natural Resources in the Shangwe Community in Gokwe District, Zimbabwe", International Journal of Asian Social Science Vol 3(1): pp 20-28, page 20. Available at http://www.aessweb.com/pdf-files/20-28.pdf [Accessed on 18/06/2014].

Robertson Margaret (2018) Communicating Sustainability Taylor and Francis group, London Routledge https://www.taylorfrancis.com/books/9781315659015 DOI https://doi.org/10.4324/9781315659015, Accessed on 18-7-19

Rucker Mike (2017) How to determine the sample size for your study Category. Research https://unstick.me/determine-the-sample-size-study/ Accessed on 20-2-19

Ruhet Genç (2017a) The Importance of Communication in Sustainability & Sustainable Strategies Elsevier ScienceDirect 14th Global Conference on Sustainable Manufacturing, GCSM 3-5 October 2016, Stellenbosch, South Africa Procedia Manufacturing 8 pp 511 – 516 Available online at www.sciencedirect.com Accessed 27-5-19

Rwamuthambi Sub Catchment Management Plan (RSCMP) 2015, WRMA

Saadati S., Motevallian S. S. , Rheinheimer D. E. , and Najafi H. (2013) Indicators for Sustainable Management of Wetland Ecosystems Using a DPSIR Approach: A Case Study in Iran Conference Paper DOI: 10.13140/2.1.2350.5921 https://www.researchgate.net/publication/234034593 Accessed on 18-7-19

Sachs et al. (2009) Biodiversity conservation and the millennium development goals. Science Vol 325(5947) pp 1502–1503. DOI: 10.1126/science.1175035 Accessed on 20-12-2019

Saunders, M., Lewis, P., & Thornhill, A. (2003) Research method for business students, 3rd edition. New York: Prentice Hall.

Schoenbach, V.J. (2004). Data analysis and interpretation; mconcepts and techniques for managing, editing, analyzing and interpreting data for epidemiological studies Accessed from http://www.epidemiolog.net/evolving/DataAnalysis-and-interpretation.pdf on 7 Jan 2018

Schreiner Barbara & Barbara Van Koppen (2001) Catchment Management Agencies for poverty eradication in South Africa 2nd WARFSA/WaterNet Symposium: Integrated Water Resources Management: Theory, Practice, Cases; Cape Town http://www.iwmi.cgiar.org Accessed on 16-10-19

Schuyt Kirsten D. (2005) Economic consequences of wetland degradation for local populations in Africa Ecological Economics, vol. 53, issue 2, pp 177-190 https://econpapers.repec.org/article/eeeecolec/v_3a53_3ay_3a2005_3ai_3a2_3ap_3a177-190.htm Accessed on 20-7-19

Shahzalal Md., Hassan Azizul (2019) Communicating Sustainability: Using Community Media to Influence Rural People's Intention to Adopt Sustainable Behaviour Sustainability Vol 11(3) Special Issue Psychology of Sustainability and Sustainable Development, 812; https://doi.org/10.3390/su11030812, https://www.mdpi.com/2071-1050/11/3/812 Accessed on 17-7-19

Shrestha Ustala (2013) Community Participation in Wetland Conservation in Nepal; The Journal of Agriculture and Environment Vol 12, Pp 140-147 DOI: http://dx.doi.org/10.3126/aej.v12i0.7574 Accessed on 18-4-19

Smith E.G., Eiswerth M.E., and Veeman T. S. (2010). Current and emerging water issues in Agriculture: An overview. Canadian Journal of Agricultural Economics/Revue Canadienne D 'agroeconomie, 58(4), pp 403-409. DOI 10.1111/j.1744-7976.201O.01202.x. Accessed on 2-7-19

Sullivan, C.A. and Fisher, D. E. (2011) Managing wetlands: integrating natural and human processes according to law. Hydrological Sciences Journal, Vol. 56 (8) pp 1640–1655 https://doi.org/10.1080/02626667.2011.630318 Accessed on 16-7-19

Survey Act, Cap 299, - Laws of Kenya, Government Press

Todd H. Votteler, Thomas A. Muir (2002) Wetland Management and Research Wetland Protection Legislation, National Water Summary on Wetland Resource United States Geological Survey Water Supply Paper 2425 https://water.usgs.gov/nwsum/WSP2425/legislation.html Accessed on 3-2-19

Tomas M. Koontz (2006) Collaboration for sustainability? A framework for analyzing government impacts in collaborative-environmental management, Sustainability: Science, Practice and Policy, Vol 2 (1) pp 15-24 DOI: 10.1080/15487733.2006.11907974 Accessed on 19-9-19

Turner Kerry (1991) Economics and Wetland Management Environmental Economics Ambio Springer on behalf of Royal Swedish Academy of Sciences Vol. 20, No. 2, pp. 59-63 https://www.jstor.org/stable/4313777?seq=1#page_scan_tab_contents Accessed on 19-7-19

UN. (2015). Millennium development goals report 2015. New York, NY: United Nations. [Google Scholar] Accessed on 20-10-2019

Von Meyer H. (2000) Territorial indicators for sustainable development. Why? And how? Pages 150–157 in Organization for Economic Co-operation and Development, frameworks to measure sustainable development. OECD, Paris

Walmsley Jay, Mark Carden, Carmen Revenga, Frank Sagona and Malcolm Smith (2001) Indicators of sustainable development for catchment management in South Africa - Review of indicators from around the world Water SA Vol. 27 (4) pp 539-550 ISSN 0378-4738 http://www.wrc.org.za Accessed on 15-10-19

Walmsley R. D. & Pretorius J. P. R. (1996). Environmental Indicators. State of the Environment Series No. 1. DEAT. Pretoria. 76 pp Department of Environmental Affairs and Tourism

Water Act (2002) Laws of Kenya, Government Press

Water Act (2016) - Laws of Kenya, Government Press

Water Act Cap 372 Laws of Kenya, Government Press

William R. Stewart, Virginia Carter and Paul D. Brooks (1980) Inland (Non-Tidal) Wetland Mapping U.S. Geological Survey Reston, VA 22092 pp 617-628 https://www.asprs.org/wp-content/uploads/pers/1980journal/may/1980_may_617-628.pdf Accessed on 25-9-19

Xuehua Liu & Yan Sun (2010) Evaluating and structuring indicators for wetland assessment, Front. Environ. Sci. Eng. China 4: 221. Higher Education Press and Springer-Verlag Berlin Heidelberg, https://doi.org/10.1007/s11783-010-0029-0 Accessed on 19-7-19