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Factors influencing adoption of sustainable water resource management practices in upper and middle Mara River Basin, Kenya

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Abstract

Availability of water in desirable quantities and qualities for basic human needs and its use in production is an issue of local, national and global concern. Its availability or scarcity during the prolonged dry spells affects socio-economic wellbeing and environmental sustainability. Increased water demand accompanied with unsustainable use during the dry season has drastically affected the regular flow of many rivers. A study was carried out to understand the adoption of sustainable water management practices in Amalo and Mulot Locations. The influences of community institutions on adoption of sustainable water management practices were assessed. Tree planting, roof catchment and water demand management practices were major water management practices in use. Multiple regression revealed that there was a significant influence of households' membership in Water Users Association on adoption of sustainable water resource management practices ($\beta=0.214$, $p<0.05$). The increasing water abstractions coupled with destruction of the water catchment is in future likely to severely degrade riverine ecosystem and affect human wellbeing. This calls for urgent need for authorities to support water-users groups to optimize local water resources management, develop new and fully enforce existing national water management policies and legislations.

Keywords: sustainable water management practices; community institutions; unsustainable water resources use

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1. Introduction

Water is a critical resource that is not only a finite resource but is also vulnerable and its scarcity and efforts to address and improve its availability has been elevated on national and international development agenda (Connor and Stoddard, 2012; Balaji et al., 2012).

Freshwater resource is a fundamental need for human health and welfare, food security and economic development. Water is very critical in achieving the Global Millennium Development Goals as envisaged by United Nations. The Goal No. 7 where water resources fall is emphasizing environmental sustainability but target 3 of this goal is more specific to water and aims at halving the number of people without access to safe drinking water by 2015 (WHO/UNICEF, 2010). Chapter 18 of Agenda 21 of Dublin Convention highlights the importance of water and indicates the way to secure and sustainable water for the future. It advocates that humans must change the way they manage water so as to achieve sustainable use (WCED, 1987). The use of participatory approach in water resource management is one of the principles of the Dublin Convention (Cosgrove and Rijsberman, 2000). The concept partly reflects the observation that people who inhabit an environment over time are often the ones most able to make decisions about its sustainable use. However, the vast majority of people have become passive observers, and a few people are taking decisions for everyone else leading to misuse, overuse and mismanagement of water resources (McLvor, 2000). Efficient water resource use and management requires engagement of all stakeholders, adoption of water conservation strategies, enhancing diverse water harvesting techniques, and conservation of water catchment areas (Mitchell et al., 2004).

At a global level, Integrated Water Resource Management (IWRM) approach promotes the coordinated development and management of water, land and related resources in order to optimize socio-economic welfare in an equitable manner without compromising the sustainability of vital ecosystems (USAID, 2005). In Kenya, the Water Act of 2002 (GoK, 2002) provides a legislative and institutional framework for effective management and sustainable utilization of water resources leading to the formation of the Water Resource Management Authority (WRMA). Countries are improving water management and governance through developing policies to decentralize decision making to sub-basin and catchment institutions. The Kenya Water Act (2002) recognises Water Resource Users Association as a mechanism of introducing community participation in the management of the river water resources (GoK, 2012). As a mechanism to promote stakeholder participation in water resource management and sustainable use, this Act spells out the need for formation of Water Users' Associations at local levels. This is in view of the need for proper management of this resource in face of continuing scarcity and increased demand. Under the water Act, several policies have been developed to support the implementation of water resource management to maximize benefits. For example, the target of the National Water Harvesting and Storage Policy is to increase national water storage from the current 124Mm^3 to 4.5Bm^3 to that per capita storage can be increased from 5.3m^3 to 16m^3 over the next ten years (WRMA, 2012).

The Constitution of Kenya (GoK, 2010) also recognizes the need to manage water resources and efforts are also underway to review the Water Act 2002 and align it with the two levels of Government that the new constitution WRMA (2012). The Constitution considers water as a human right issue with respect to per

capita use and quality. The national government has been bestowed with the ownership of water resources charged with among other the responsibility of water resource management. Included in these responsibilities is water protection, securing reserve flow and water policy formulation among others (GoK, 2010).

At a national level, water is critical in achieving Vision 2030 which articulates the need for conservation and effective use of water resources for the achievement of the environmental sustainability (GoK, 2007).

Mara River Basin in Kenya is located between (0º 28' S, 33º 47' E) and (1º 52' S, 35º 47'E) and is depended upon by local communities, domesticated animals, and wildlife for their well being. It is a home to 1.1 million people (LVBC and WWF-ESARPO, 2010b; GoK, 2010). The human population in the Mara River Basin has been estimated to be growing at an annual rate of more than 3% (Hoffman, 2007). This accompanied by the associated effects of deforestation, environmental change, increased water abstraction for human and agricultural use, and other activities requires efficient and sustainable water use strategies. For example, river bank cultivation has led to declined water quantity in the main sources during the prolonged dry season. The implications of these environmental impacts on local communities and wildlife include increased poverty, loss of human and animal life and heightened environmental degradation as well as loss of key habitats for species. The Mara River is likely to become severely degraded in the near future due to ever increasing water abstractions, and this will impinge on the most basic ecological and socio-economic needs of the people (Alison, 2010) and wildlife. According to Gereta et al. (2002) previous studies showed that low water flows and subsequent water shortages during the dry season may have significantly affected biodiversity in the Mara River Basin (MRB). An assessment by Lake Victoria Basin Commission and World Wide Fund for Nature-Eastern and Southern Africa Regional Programme Office (LVBC and WWF-ESARPO, 2010a) indicated that there were temporal variations in water demand that created a negative balance between demand and supply during the dry season in Amalo and Mid Mara River.

Since 2000, the Kenyan government has been working to decentralize water management responsibilities to local authorities (GoK, 2000; GoK, 2012). Although the emerging institutions continue to address the effects of water management on quantity in Mara River Basin during the dry spells; a comprehensive approach is needed to address it. The objectives of the study were to assess some of the water management practices which have been adopted in the study areas, the level of local awareness, and effect of participation in the local CBOs including the Water Resource Users Associations (WRUA's) on adoption of water management practices.

2. Materials and methods

2.1. Study area

Amalo location is located in Oleguruone Division of Kuresoi District between (0° 13' S, 35° 28' E) and (1° 10' S, 35° 36' E) whereas Mulot location is located in Mulot Division of Narok South District between (0° 54' S, 35° 28' E) and (1°05' S, 36° 25' E) (GoK, 2009a; 2009b). Climatic conditions in Amalo Location range from

humid to sub-humid with agro-ecological zone II (Pratt et al., 1977). The major crops grown are tea; Irish potatoes and pyrethrum with dairy and sheep farming practiced (WREM, 2008). The rainfall is bi-modal with mean annual rainfall being approximately 1,270 mm (LVBC and WWF-ESARPO, 2010a). Climatic conditions in Mulot are semi-arid with agro-ecological zone 1V (Pratt et al., 1977). The major crops grown are wheat with annual rainfall averaging between 500-1800mm (WREM, 2008).

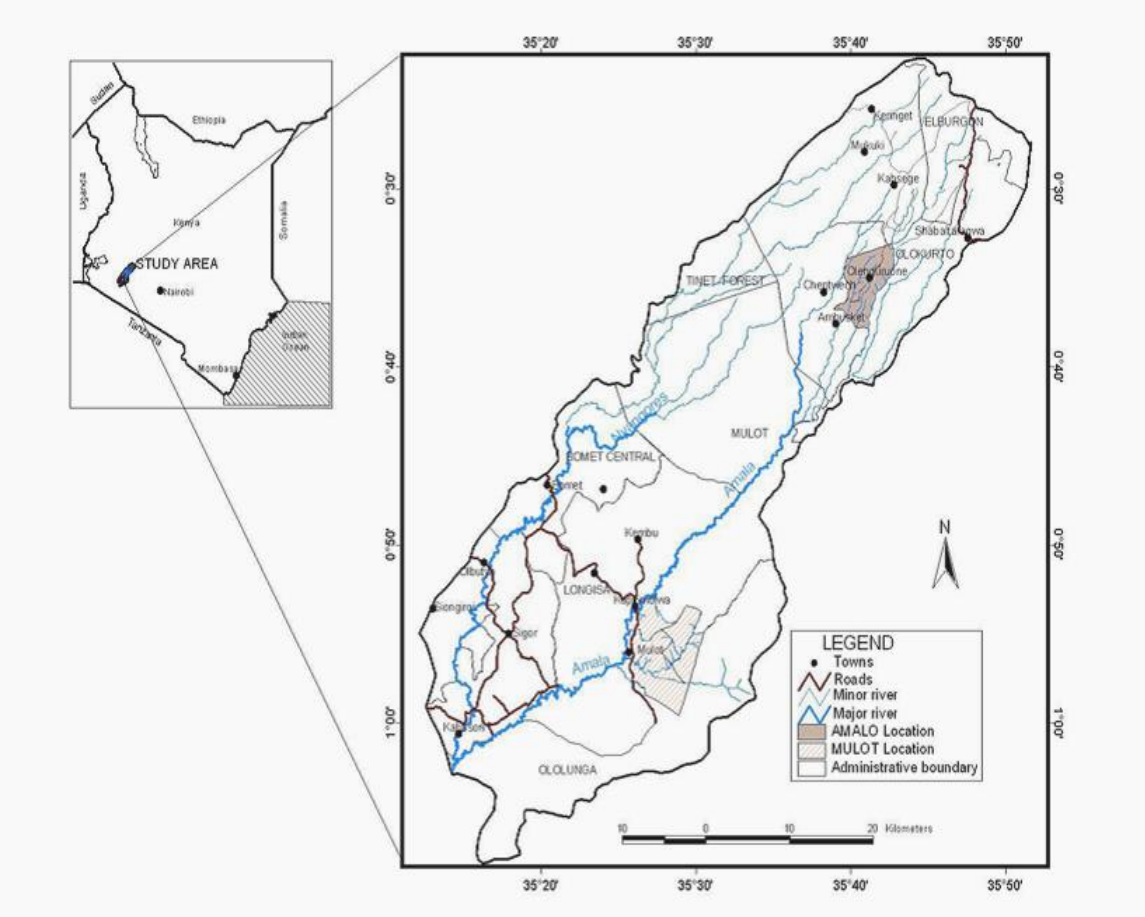

Figure 1. Map of the Amalo and Mulot Locations

Source: Maina, G. M, 2011 (Department of Environmental Science, Egerton University)

2.2. Data collection

The fieldwork was conducted between the months of July and August 2012. Data was collected through administering of questionnaires, focus group discussions, key informant interviews and non-participatory observations. Secondary data was obtained from books, journals, abstracts, internet, reports, theses, dissertations and other publications. Prior to the main study, a reconnaissance survey was carried out to pre-test the research instruments and explore modalities of identifying respondents in the study area.

2.3. Data analysis

Descriptive statistics were used to analyze community institutions parameters. The adoption of the sustainable water management practices was measured by coding 1 for adopting a practice and 0 for non-adopting a practice. In deriving the sustainable water management index, the variables codes were added up. The sustainable water management was a continuous index ranging from 0 to 7. Therefore the higher the value of the index the more the practices the household had adopted. 0 indicated non-adoption of any practice.

Enter and stepwise multiple linear regression models were used to explain variations in adoption of sustainable water resource management practices among respondents. Three independent variables: Number of CBO's participating in water resource use activities and household members registered in the WUAs and other CBOs were fitted in model. Enter approach was used to enter all independent variables one by one and testing them for statistical significance. Cross tabulation was used to show the distribution of adoption of sustainable water resource management practices across the numbers of the CBO's as well as households members registered by the WRUA's and other CBO's.

3. Results and discussion

3.1. Water Resource User Associations (WRUAs)

Mara River Water Users Associations is one of the Community-based Organizations involved in water conservation; in both Amalo and Mulot locations. This WRUA's represented the Mara catchment for both Amala and Nyangores Rivers. However, based on the focus group discussions one WRUA for Amalo sub-catchment was awaiting approval by the time of this study. Despite having the one Water River Users Association only 51.6% knew about it and its involvement in water conservation activities while 48.4% did not know about it (Table 1).

Table 1. Knowledge of WUAs involved in water conservation.

Knowledge of WUAs	Frequency	Percent
Yes	97	51.6
No	92	48.4

3.2. Membership and participation in Water Resource Users Associations (WRUAs)

Most of the respondents (96.3%) were not registered and did not participate in activities of the Mara River Water Users Association while only 3.7% were registered (Table 2).

Table 2. Household members registered and participating in WUA's

Households members in WUA'S	Frequency	Percent
Registered	8	4.2
Not registered	181	95.8
Total	189	100.0

3.3. Number of Community Based Organizations (CBOs)

There were 22 Community Based Organizations involved with water conservation, 21 in Mulot location and 1 in Amalo location (Table 3).

Table 3. Number of the Community Based Organizations involved with water conservation that the respondents were aware of

Location	Community Based Organizations	Respondents Awareness	Percent
Mulot	Implementation youth Group	1	2.2
	Chebinyiny Football Club	1	2.2
	Immanuel Self Help Group	4	8.7
	Salvation Group	1	2.2
	The International Small Group and Tree Planting Program (TIST).	3	6.5
	Faulu Group	1	2.2
	Tuinuane Group	1	2.2
	Saunet Group	1	2.2
	St Mary's Group	3	6.5
	Kelu-emet Group	1	2.2
	Lamayat Women Group	10	21.7
	Mosimowa Group	1	2.2
	Chepoldany Youth Group	1	2.2
	Chepkona Group	1	2.2
	Chemichemi Women Group	1	2.2
	Waves of Light Group	5	10.9
	Sunshine Women Group	2	4.3
	Sessgaa Women Group	2	4.3
Amalo	Implementation Youth Group	1	1.2
Amalo and Mulot	Water Users Association	97	51.6

Note; the percentages do not add up to 100% because the respondents were aware of more than one Community Based Organization.

3.4. Registration and membership in Community Based Organizations (CBOs)

Most (79.9%) of the respondents were not registered while only 20.1% were registered (Table 4).

Table 4. Registration and membership in CBOs

Households members in CBOs	Frequency	Percent
Registered	38	20.1
Not registered	151	79.9
Total	189	100.0

4. Role of community institutions on adoption of sustainable water management practices

All the interviewed respondents had adopted rooftop rainwater harvesting and tree planting. However, only 3.7% and 20.1% were registered and participated in the activities of WRUA's and other CBO's respectively (Table 5). This was an indication that the level of registration and participation in conservation activities in WRUA's and other CBOs was very low. According to the focus group discussions this could have been attributed to the voluntary nature of the associations, lack of awareness on the existence of these CBOs and the legislations guiding local water governance, community participation in water management and use, mandate and membership to WRUAs, lack of incentives and huge logistical and financial challenges facing the Water Resource Users Associations.

The respondents who adopted the maintenance of the riparian buffer zones and water demand management activities and were registered and participated in water users associations and other CBO's were few (Table 5). The riparian buffer zones most observed during the interview were grasses. There were no wooded vegetations which were observed along the riverbanks. Indications are that there were no riparian trees that were managed as part of the riparian zones. The chiefs and community leaders can form community barazas and meetings and encourage the people in these areas to register in the WRUA's as well as actively participate in its activities. The WRUA's would then be used in creating awareness to the community members who are registered and actively participating in its activities on the benefits of growing the riparian trees and other riparian plants along the river banks.

Table 5. Role of community institutions on adoption of water management practices in Amalo and Mulot Locations

		Adoption of water management practices							
Community Institutions		Rain Water Harvesting (%)		Tree Planting (%)		Water Demand Management (%)		Maintenance of the Riparian Buffer Zones (%)	
		YES	NO	YES	NO	YES	NO	YES	NO
Households Registered in	Yes	3.7	0	3.7	0	3.8	3.4	4.5	2.5
WRUAs	No	96.3	0	96.3	0	96.3	96.6	95.5	97.5
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Number of other	0	74.1	0	74.1	0	70	96.6	77.3	69.6
CBOs households are aware of	<1	25.9	0	25.9	0	30	3.4	22.7	30.4
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**
Households registered in other	Yes	20.1	0	20.1	0	23.1	3.4	18.2	22.8
CBOs	No	79.9	0	79.9	0	76.9	96.6	81.8	77.2
TOTAL		**100**	**0**	**100**	**0**	**100**	**100**	**100**	**100**

Source: Fieldwork, July 2012 F= Frequency %= Percent N=189. 0=Not aware
<1= Aware more than one

4.1. Correlation analysis explaining adoption of sustainable water management practices

Correlation analysis of adoption of sustainable water resource management practices shows that there is a positive correlation between adoption of sustainable water management practices and the membership to Water Resource User Associations ($r=0.239$; $P<0.05$). The positive association implies that households' membership to WRUAs and participation in WRUAs increase the adoption of sustainable water management practices and vice versa among households' in Amalo and Mulot Locations. A similar study by Kington and Pannell (2003) showed that membership of organizations such as catchment groups are positively correlated to adoption of sustainable water management practices. The latter findings also concurred with those of Doron et al. (2011), which found out that membership in farmers social networks can facilitate adoption of water conservation activities through information flow and group action (Caviglia, (2003); Bandiera and Rasul, (2006)). Other studies have also found a positive relationship between membership of land care groups and adoption of some conservation practices (Cary et al., 2002; Curtis and De Lacy, 1996; Mues et al., 1998). However, the direction of causality was not clearly established. WRUA's plays a major role in creating awareness in the need to preserve all the other water sources to prevent the overdependence on one source.

Table 6. Correlation analysis among adoption of water management practices and selective variables

Variable	Adoption of water management practices Correlation co-efficient
Numbers of Community Based Organizations households' members are aware of.	0.026
Household's members registered in the Community Based Organizations.	-0.070
Household's members registered in the Water Users Associations.	0.239**

** (P<0.05) and ** (P<0.01)*

4.2. Influences of community institutions on adoption of sustainable water resource management practices

In order to explain variations in adoption of sustainable water resource management practices, stepwise linear regression analysis was used. The combined effect of the three independent variables on adoption of sustainable water management practices had a coefficient of determination (R^2) of 0.057 which was statistically significant (P<0.05). Only 5.7% of the adoption of sustainable water resource management practices was accounted for by the number of the CBOs that the households were aware of as well as household members registered by the WUAs and other CBOs. The other 94.3% of adoption of sustainable water resource management practices was accounted for by other factors which were not under this study. The number of WRUA's though not significant (P>0.05) had slightly higher beta (β=0.126). Household membership to WRUA positively influenced the adoption of the sustainable water resource management practices (β=0.214, P<0.05) as shown in Table 7.

Table 7. Influences of community institutions on adoption of sustainable water resource management practices in Amalo and Mulot Locations

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.322	.113		29.357	.000
	Number of CBO's	-.025	.195	-.010	-.129	.897
	Household members registered by WUA	1.259	.429	.214	2.935	**.004**
	Household member registered by CBO's	-.412	.371	-.149	-1.111	0.268

Dependent Variable: Adoption of water management practices R^2 adj=0.057. P<0.05 N=189

4.3. Regression analysis explaining influences of Water users associations on adoption of water management activities

In order to explain variations in adoption of water management practices, stepwise linear regression analysis was used.

Table 8. Regression analysis explaining variations in adoption of water management practices

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.451	.080		42.926	.000
	Household member registered by WUA's	1.407	.418	.239	3.368	**.001**

Dependent variable: Adoption of water management practices. $p<0.05$ $AdjR^2=0.052$

The results showed that the household's members registered by WRUA could explain 5.2% of variations in adoption of sustainable water conservation practices among respondents (Table 8). The following model could be used to explain respondents' adoption of water conservation practices in the study areas:

Y= 1.407X+ 3.451.

Where Y=Dependent variable representing respondents adoption of water conservation practices and X is the household member registered by WRUA. A unit increase in the membership in WRUA resulted in increase of 1.407 units in adoption of sustainable water resource management practices. This implies that as the registered household members in WRUA increased there was an increase in adoption of sustainable water resource management practices by the households.

Apart from encouraging the formation and membership in WRUA there is need to ensure that users are not only adequately represented but also effectively participate in decision making process as part of increasing the level of local governance in water resource use and management efforts.

Devolved governance system is supposed to provide such opportunity but experience from Uganda shows that users are still left out when it comes to making important decisions (Oosterveer and Vliet, 2010). There is also need to review the Water Act 2002 to align it with this devolved system of government that will also enhance effective management and sustainable use of water resources.

Rural communities are being encouraged to form Water User Associations to help in addressing their water needs. Such associations are often more able to mobilize labor and other resources needed to improve water body management through establishing and enforcing rules of access and duties of the users. One thing that emerges from this study is first, there is lack of awareness on the existing legislative and institutional

frameworks emanating from the Water Act 2002. Secondly, as a result, there is lack of awareness on the governance structures at a local level as well as capacity, potential benefits to local water users, responsibilities and best practices that need to be embraced to facilitate the process of efficient water management and sustainable use of water resources. With a devolved government, results from this study means that the County government has to develop strategies to promote effective management and sustainable use of water resources if these governments are going to achieve economic growth and ensure there is water for all in desirable quantities and qualities. These will necessitate the development of tools and best practices to guide the implementation of integrated water resource management recognising that water is a finite resource which is very vulnerable, is essential social and economic good, stakeholder participation is key to successful management of water resources and the need to mainstream water management in all sectors of economic growth at all levels.

5. Conclusion and recommendations

Deterioration in water quantity in the Mara River during the prolonged dry spells affects the human and ecosystem wellbeing. The analysis of sustainable water resource management practices showed that rooftop rainwater harvesting, tree planting, and water demand management practices like not misusing water and using water pans while watering animals as well as planting of the riparian buffer zones were practiced. The adoption of these water conservation activities was still there but not sustainable. Paying attention to factors which determine sustainable adoption is a priority. Registration and participation of the household's members in Mara River Water Users Association (WRUA) appeared as an important factor due to its positive and significant influence on adoption of sustainable water management practices. These findings provided basis for the following recommendations.

Formation and membership of household and community members in Water User Associations and ensuring that they are all adequately represented and effectively participate in decision making is likely to promote adoption of sustainable water resource management practices. There is also need to empower the community members to unite and register in the already formed associations. Such associations can be able to source funds for development through the financial institutions and organizations. These WRUA's helps to implement and monitor sustainable water resource management practices at local level. However, constraints to adoption of sustainable water resource management practices should be further investigated.

People should be encouraged to adopt tree planting along the riparian zones as a water management strategy.

There is need for county government to support and finance water-users groups to optimize local water resources management; develop new, promote and fully enforce the existing national water management policies and legislations like national water harvesting and storage policy. In addition the water demand should be managed better with appropriate existing strategies like strategic plan for WRMA 2012-2017, national water quality management strategy and water sector strategic plans. This can improve the existing supply-demand balance in water-stressed regions and offer multiple benefits to all stakeholder groups.

The Ministry of Water resources and Irrigation should promote other sustainable water sources and practices like rain water harvesting. There should be vigorous awareness raising campaigns of rainwater harvesting as a by-law in the building guidelines and any new development should be encouraged to explore and apply the rainwater harvesting technologies. Rainwater harvesting should not be taken as a 'free for all' resource. Water management has been only based on renewable water, which is surface and groundwater with little consideration of rainwater. In addition, the communities through the community institutions should be encouraged to build large ferrocement capacity tanks that can store more litres of water for long-term use.

There is also need for synergy between water sector legislations and policies with other related policies such as environmental (e.g. EMCA, Environmental Policy), Agriculture (Agricultural Act, Agricultural Policy), Forestry (Forest Act 2005, Forestry Policy), Fisheries (Fisheries Act), Livestock Act and Policy, Soil and Water Conservation Strategy, Wildlife (Wildlife Management and Conservation Act 2013, Wildlife Policy), and Development (domestication of MDGs, pursuit of Vision 2030).

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