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Full Length Research Paper

Effects of land use practices on livelihoods in the transboundary sub-catchments of the Lake Victoria Basin

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The Lake Victoria Basin (LVB) is experiencing changes in land use due to both anthropogenic and natural drivers which are critical to the sustainability of the resources and livelihoods of the communities. Indeed the resultant land use practices and decisions made by the communities on the use of the land rely on the changes in the basin. This paper presents an analysis of the land use practices in the Lake Victoria Basin using two sub-catchments of Mara River (Tanzania) and Sio River (Kenya-Uganda) as case studies. Collection of mainly socio-economic and environmental data involved in-depth interviews of 679 respondents from the midstream and downstream zones of the sub-catchments. The findings reveal conspicuous changes in community livelihoods as a result of expansion of cultivation, overgrazing on the river banks, increased use of wetlands areas, the disappearance and extreme fragmentation of forest, bush land and appearance and the diminishing of settlements. The hitherto common resources have become scarce forcing farmers to try intensifying and diversifying their farm production with little success due to poor traditional farming practices. Although local initiatives are leading to change, there is need for integrated approaches of indigenous knowledge, technical agricultural research, economic analysis, and policy studies and reforms.

Key words: Land use practices, livelihoods, Indigenous knowledge, Lake Victoria basin.

INTRODUCTION

Background

Lake Victoria is the largest fresh-water lake in Africa and the second largest in the world with a surface area of 69,000 km^2. The Basin (catchment) of the Lake covers a surface area of 251,000km^2 (UNEP, 2006), 44% of which is in Tanzania, 22% in Kenya, 16% in Uganda, 11% in Rwanda and 7% in Burundi (Table 1).

Based on a study by COWI (2002), three quarters of the lake is shallower than 60 meters with the maximum depth recorded at 82 m. The average of total annual flow into the lake from its catchment area is about 20 km^3, about 7.5 km^3 of which comes from the Kagera basin, 8.4 km^3 from the Kenyan forests, 3.2 km^3 from Tanzania and 1 to 2 km^3 from North West Ugandan swamps. The annual rainfall in the basin is estimated at 1015 mm. The annual evaporation rate is estimated at 430 -1350 mm (Okonga, 2001; COWI, 2002) accounting for water leaving the lake. The only surface outlet from the lake is the Nile River with an outflow of 23.4 km^3 (Mott Macdonald, 2001).

Beyond the symbolic significance, the Lake is a resource of great socio-economic potential. The Lake Victoria Basin's potential, lies in the opportunities for investment in fisheries and tourism; transport and communications; water and energy; and in agriculture, trade and industry. Considering the whole basin, the potential is further extended to cover the abundant natural resources in wildlife, forestry, minerals and fertile soils. Recent census reports of the Basin countries indicate

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Table 1. Lake Victoria Morphometric data.

Country	Lake Surface Area		Catchments Area		Lake Shoreline	
	sq km	%	sq km	%	km	%
Tanzania	33,756	49	79,570	44	1150	33
Uganda	31,001	45	28,857	15.9	1750	50
Kenya	4,113	6	38,913	21.5	550	17
Rwanda	0	0	20,550	11.4	0	0
Burundi	0	0	13,060	7.2	0	0
Total	68,870	100	180,950	100	3,450	100

Source: Matsuishi et al., (2006)

that the Lake Victoria Basin has a population of more than 40 million people, approximately 25 million of whom live in the three riparian states (i.e. about 30 % of the total population of the three countries; Kenya, Tanzania and Uganda). More than 80% of the population is engaged in agricultural production. The majority are small scale poor farmers and livestock owners producing maize and cash crops such as sugar, tea, coffee, cotton and meat. The fish resources of the lake directly and indirectly sustain livelihoods for about 3 million people engaged in subsistence, artisanal and commercial fishing. Hence, the Lake Victoria Basin presents many advantages and prospects for East African regional integration and development but also daunting challenges to the planners of the region's economic development (Ogutu et al., 2005). For example, despite its vast potential, investments in the LVB by both local and international entrepreneurs are still low. Although the basin is endowed with rich natural resources of the lake and its environment, approximately half of the total population lives below the poverty line. In a sense, the Lake is something of a paradox: it is a sea of problems, and it is an ocean of opportunities (Brott, 2006). Interventions are required to initiate sustainable development within the LVB to protect the critical watershed areas and the aquatic systems (UNEP, 2004).

Many studies (NEMA, 2001; Isabirye et al., 2001, etc) have shown that encroachment on forest reserves and wetlands, transformation from perennial to annual cropping systems characterises the major changes in land cover and use in the LVB. The sustainability of these changes and their effect on the livelihoods of the local communities and the environmental health of Lake Victoria basin is raising concern. In addition, land use changes in the Lake Victoria region enhanced by population increase, have been associated with land degradation, especially soil erosion and depletion of nutrients, in prime agricultural areas in Uganda (Breyer et al., 1997; Place and Otsuka, 1997; Tukahirwa, 2000; Nkonya et al., 2004). Several studies (Hide, 1999; Lambrecht, 1964; Isabirye et al., 2001) have also shown significant land use changes, including land fragmentation, clearing of natural vegetation for cultivation and fuelwood, within the Lake Victoria Basin in Uganda as has been the case in Kenya (Mahiri, 2003; Swallow et al., 2001; Shepherd et al., 2000; Owino, 1979) and Tanzania (URT, 2003).

Whilst land use practices have been separately studied in the LVB (Lambrecht, 1964; Owino, 1979; Breyer et al., 1997; Place and Otsuka, 1997; Hide, 1999; Shepherd et al., 2000; Tukahirwa, 2000; Isabirye et al., 2001; Swallow et al., 2001; Mahiri, 2003; URT, 2003; and Nkonya et al., 2004;), the linkages of land use practices to livelihoods are lacking. Thus, there is inadequately knowledge on the extent and magnitude of causal relationships between land use practices and income generating activities towards environmental health of the basin. As a result of which the role of income-generating activities in LVB, with respect to poverty and environmental welfare is still vague (Ogutu et al., 2005). Only few of the studies have been linked to the socio-economic conditions of the local communities and the resulting environmental health of the basin. One example is a study conducted by Yanda et al. (2001), using mapping of land use and assessment of erosion hazards methods, in Lake Victoria basin in 22 Districts. In this study different human activities that were considered likely to influence changes on land use/cover were identified. These activities included cultivation, mining, lumbering, charcoal making, livestock keeping and brewing. This is, however, a one-way link of human activities to land use change neglecting the reverse link for describing development-environment interactions taking place in a specific ecosystem. Yanda et al. (2001) acknowledged this shortfall by recommending detailed and regular socio-economic surveys to improve knowledge of the prevailing human activities that are driving changes in land cover and associated processes in the basin.

Therefore, there is a determination to break away from this vicious cycle through regional initiatives such the as Lake Victoria Research (VicRes) Initiative of the Inter-University for East Africa (IUCEA). The East African countries increasingly recognise the importance of the Lake and its basin as a resource that should be managed in a rational manner and exploited on a sustainable basis. This paper is based on an ongoing three-year VicRes

funded study that is assessing land use change and its impacts on the environment and livelihoods in the Mara and Sio sub-catchments of the LVB. The objective of the paper is to highlight how existing land use practices are contributing to land use changes affecting livelihoods and the environmental health of the transboundary river basins.

Conceptual framework

A river basin is a geographical unit that defines an area where various users of the basin's water interact, and where most of them live depending on natural resources (Allen et al, 1995). A basin perspective helps in the analysis of the interactions among various types of land uses and other uses, and in the process, it enhances the understanding of the physical, environmental, social and economic influences that impinge on the productivity of land use systems. Participation of a larger number of stakeholders can be sought, and land use planning can be more effectively carried out. The broader view through a river basin is able to capture dimensions that are not normally included in a land use management approach, such as the causes (and not only the effects) of natural resource degradation, related disputes and livelihood options.

To study these relationships an Integrated System for Knowledge Management (ISKM) research framework (Figure 1) was used as an approach to provide necessary learning environments enabling all those involved a more holistic perspective of sustainable land management, within which they can best make their particular contribution (Allen et al., 1995; Bosch et al., 1996).

ISKM is designed to support an ongoing process of constructive community dialogue and to provide practical resource management decision support for land managers and policy makers (Allen et al., 1995; Bosch et al., 1995, 1996). In this framework, facilitated community dialogue processes are used to structure their knowledge and information on land management issues so as to provide decision support appropriate for different levels (e.g. site, catchment, and region). This approach recognises that natural resource management is increasingly characterised by apparently conflicting social perspectives and emphasis processes to provide those involved with a better understanding of other points of view.

MATERIALS AND METHODS

Study Area

The main rivers feeding the lake are Mara, Kagera, Mirongo, Grumeti, Mbalageti, Simiyu and Mori from Tanzania (LVEMP, 2001); Nzoia, Sio, Yala, Nyando, Kibos, Sondu-miriu, Kuja, Migori, Riaria and Mawa from Kenya; and Kagera, Bukora, Katonga, and Sio (LVEMP, 2003). Kagera River also drains from Burundi and Rwanda. However, the study sites are the basins of two rivers, namely Mara River and Sio River basin (Figure 2) both flowing into Lake Victoria.

The catchment of Mara River is a transboundary basin, more than 65% of which is in Kenya. Mara River originates from an area with high rainfall rate, (1400 mm/year), in South West Mau Escarpment in Kenya and descends from some 3000 m in altitude to below 2000 m, criss-crossing Narok, Transmara, then through the Mosirori Swamp and in the north-eastern part of Tanzania and into Lake Victoria (NELSAP, 2002). This lower portion is a dry plain with annual rainfall of between 500 and 700 mm/year, with high evapotranspiration and considerable water losses. The remaining lower portion flows into Tanzania (ibid). The Sio River catchment is also a transboundary basin more than 65% of which is in Kenya, while the remaining portion is in Uganda. The Sio River originates in Kaujai and Luucho Hills in Bungoma District, Kenya at an altitude of 1800 m and flows into Berkeley Bay in Lake Victoria Basin in Uganda. The drainage pattern of Sio River catchment is dendritic and the drainage density is high. The main stream of Sio river stretches approximately 78 km from the source in Kenya to the mouth in Uganda.

Data was collected using both secondary and primary sources. Secondary data collection involved review of existing reports (unpublished, gray and published reports) from libraries and documentation centres in various institutions in East Africa, the Internet and archival records. Primary data was mainly collected through local community involvement using participatory research methods, which included key informants, in depth and household interviews, to capture the development-environment interactions in the river basins. A total of 679 in-depth questionnaires were administered in the selected study sites and analysed. The questionnaires were administered to randomly selected households on issues relating to sources of livelihoods, land use practices, perceptions of basin resources as well as institutional capacity and community participation in river basin management.

In addition, group discussions were held to describe evolving patterns of livelihood activities in the community and provide interpretations of the reasons for adapted land use practices.

Diagrammatic methods were then used to distinguish groups or household members that are specialising or have specialised in particular income-generating activities in response to land use practices, as well as identifying those that follow mixed strategies.

Data analysis

The analysis of the socio-economic data presented in this paper is with regard to the effects of land use practices on livelihoods. This data was analysed in SPSS using descriptive statistics.

RESULTS

Major Livelihood Strategies in the Mara and Sio Sub-Catchments

The major livelihood strategies identified as per respondents (72, 69.6 and 80.6% for Kenya, Tanzania and Uganda respectively) in the Mara and Sio Sub-catchments is cropping (Table 2). Other livelihood strategies observed were livestock keeping and fishing. In Sio-Kenya and Mara-Tanzania 16.5 and 51.5% of the respondents respectively engage in livestock keeping as well as cultivation and only 19.4% in Sio-Uganda do so. In Tanzania 2.5% of the respondents rely solely on livestock. Other identified livelihood activities in all areas were petty trading especially in weaved items and fish mongering in Sio River; casual labouring mainly in Sio-Uganda; and employment.

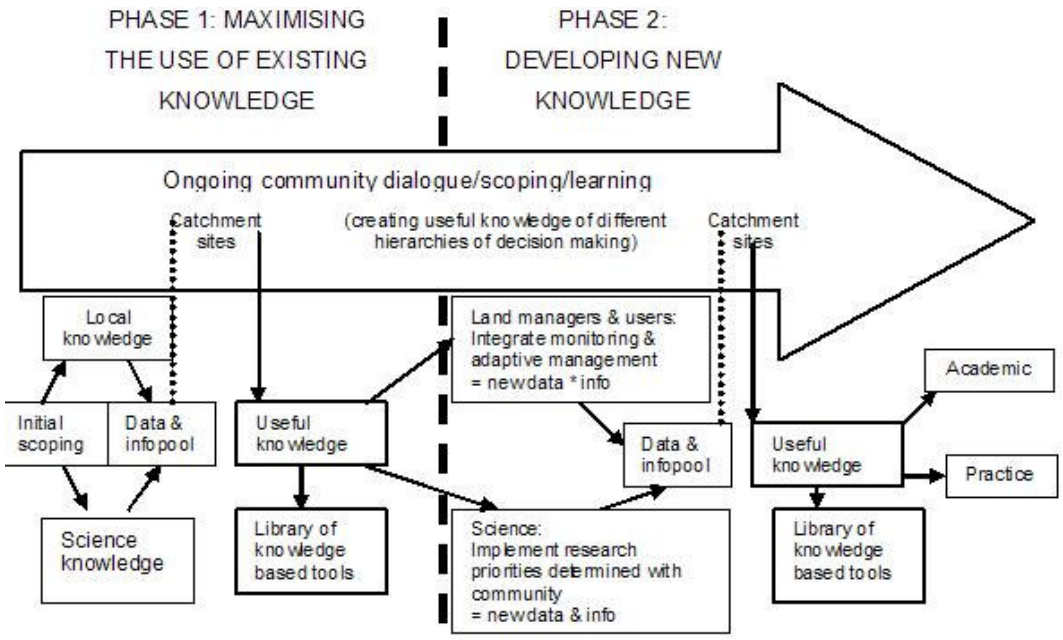

Figure 1. ISKM – A participatory research framework (to facilitate the identification and introduction of more sustainable land management practices. Source: Allen et al. 1995; Bosch et al., 1996).

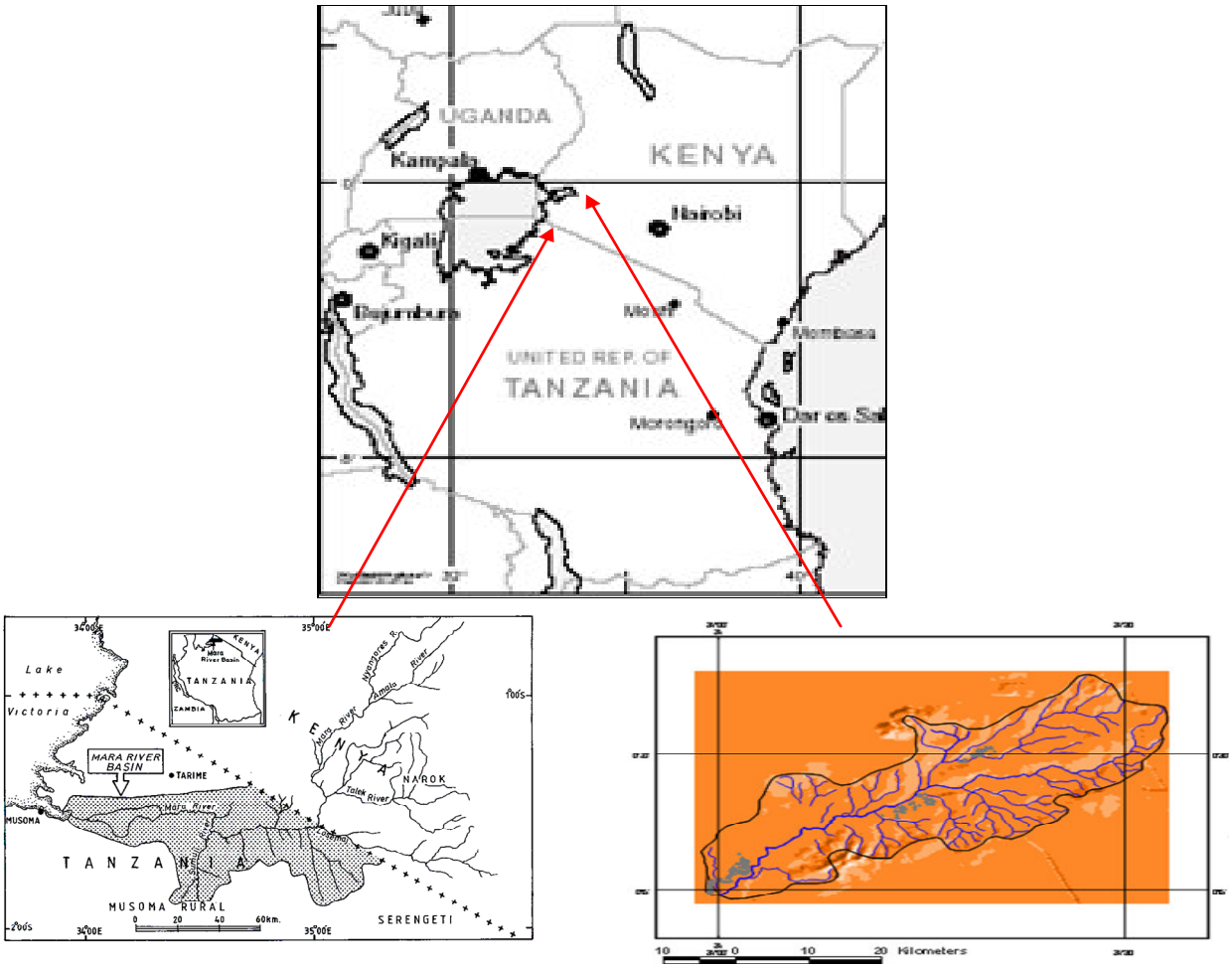

Figure 2. The Mara (lower left) and Sio sub-catchments of the LVB.

Table 2. Major livelihood strategies to household income in the Mara and Sio Sub-catchments.

Activity	Kenya	Tanzania	Uganda
	%		
Cropping	72	69.6	80.6
Livestock	3	1.3	1.5
Fishing	0.5	0	2.5
Others	11	1.3	15.4
No response	13.5	27.8	0
Total	**100**	**100**	**100**

Table 3. Major Land Use in the Mara and Sio Sub-catchments.

Land Use	Kenya	Tanzania	Uganda
	%		
Cultivation	47.5	79.7	59.7
Grazing	1.0	2.5	0.5
Farming and grazing	51.5	16.5	19.4
No answer		1.3	20.4
Total	**100**	**100**	**100**

Table 4. Major crops grown in the Mara and Sio sub-catchments**.**

Crop	Kenya	Tanzania	Uganda
	%		
Maize	62.5	64.6	9.5
Millet	1.5	22.7	-
Banana	-	-	13.0
Potatoes	-	-	27.7
Cassava	7.0	7.6	-
Sugar cane	24.0	-	-
Beans	1.5	-	23.9
Vegetables	1.0	-	-
Other crops	0.5	3.8	-
No answer	2.0	1.3	25.9
Total	**100**	**100**	**100**

Cropping

Since cropping is the major livelihood strategy to the communities in the two sub-catchments, cultivation has become the main land use practice (Table 3). Maize was said to be the major cash and food crop in Sio-Kenya (47.5%) and Mara-Tanzania (79.7%) and potatoes (27.7%) in Sio-Uganda (Table 4). Sugar cane is grown in Sio-Kenya alone as the major cash crop. Other crops include cereals like millet, legumes such as beans. Although the land in question is a wetland where one would have expected rice and vegetables to be predominant cash crops, they are not common crops. It was reported that due to unreliable rainy seasons, vege-tables and rice, which require sufficient water do not do well although they could use irrigation. However, irriga-tion was found not to be popular though the communities live on river banks. Of the three study areas at least more respondents in Sio-Kenya practice irrigation (18.5%) than in Sio-Uganda (4.5%) and Mara-Tanzania (11.4%). In Sio-Kenya irrigation was more for vegetables, while in Mara-Tanzania, it is mainly for rice.

Various farming and tillage practices were found to be employed in the study area. The main cropping method practiced by most respondents is single crop while few of the respondents practice mixed cropping. A handsome number of respondents in Sio-Kenya (81.5%) plant same crop each year but many of them (11.5%) do change crops once in a while. Only a fraction of the respondents practice mixed cropping and these were 54% in Sio-Kenya, 74.6% in Sio-Uganda and only 39.2% in Tan-zania. Fallow is virtually not practiced in all river basins. The very few who practice fallow do not change to other crops then fallow.

Family labour is the main tillage practice in all study sites (21.8, 40.5 and 95% of the respondents in Sio-Kenya, Mara-Tanzania, and Sio-Uganda). While in Sio-Kenya a number of respondents use owned tractors (34.5%), in Mara-Tanzania 15.2% of the respondents use owned ox-ploughs. Most respondents in Sio-Uganda also use family labour.

The widespread use of fire to clear land for farming and land management was also recorded as a common farming practice. There is also burning of the crop resi-due and very few of respondents make use of it as ani-mal feed, for cooking or distributing it on the land as manure. At least 17% of the respondents in Sio-Kenya use the crop residue as animal feed compared to 2.5% in Mara River basin and 3% in Sio-Uganda.

Livestock keeping

As stated earlier grazing is another important land use practice. The major types of livestock kept are cattle, goats and sheep. Communities in Mara sub-catchment keep large sizes of cattle than in Sio River basin. The average size of the livestock is more than 10 in Mara River basin and less than 10 in Sio-Kenya and it is less than 5 in Sio-Uganda. In Mara River basin some res-pondents (3.9%) keep more than 50 heads of cattle. Due to this large size of livestock there is acute shortage of pasture. The critical months of pasture shortage are July to December, characteristically the dry season. During pasture shortage most of the livestock keepers move their livestock for grazing from one place to another or graze along the river banks. For those with a small size of livestock tie them with ropes to control movements. The river is also the main livestock watering point in all study sites.

Table 5. Total average land area owned and cultivated (% Responses).

Land size	Kenya	Tanzania	Uganda
	%		
x<1	34	19	27.9
1<x<2	17	22.8	32.4
2<x<3	20	20.3	19.9
3<x<4	8	12.6	8.0
4<x<5	5	2.5	3.5
5<x<6	3.5	1.3	3.0
6<x<7	2.5	1.3	1
7<x<8	2.5	0	0.5
8<x<9	1.5	0	0
9<x<10	1	2.5	0.5
10<x<20	3	1.3	1
x>20	1	1.3	0.5
No answer		25.1	1.8

Land use changes in the Mara and Sio Sub-catchments

The major land use changes observed in the two sub-catchments are transformation from perennial to annual cropping, encroachment on forest and wetland areas for agricultural purposes. These changes are leading to numerous environmental and economic consequences. According to the respondents' perception on land use changes, the majority in all study areas said land productivity had been declining with time due to various reasons. 42% respondents in Sio-Kenya, 49.4% in Mara-Tanzania and only 5% in Sio-Uganda said land productivity was now lower than 30 years back. However, 73.1% of the respondents in Sio-Uganda contended that land productivity was still good. Since Sio Uganda lies in a deposition area, it is possible that the changes are relatively less when compared to the upstream areas, and besides most communities downstream are engaged in fishing. The main reasons for decrease in land productivity were identified by the respondents as over cultivation because owned and cultivated land is decreasing in Sio River basin and extensive soil erosion in Mara River basin as a result of overgrazing. Other causes of declining land productivity were said to be cultivation techniques in all study areas, use of fire to clear land in Sio-Uganda and Mara-Tanzania, inadequate use of fertilizers in Sio river basin, mono-cropping in all study areas but more in Sio-Uganda, and drought (Figure 3).

Further exploration on the cause of over cultivation, it was revealed that it was attributed to decreasing land for cultivation. Although at individual level community members own land for cultivation, this land is small and has been decreasing with time. The total average owned and cultivated of between 1 - 2 acres (Table 5) is not enough for meaningful socio-economic change and poverty reduction. Respondents in Sio- Kenya have more owned and cultivated land of greater than 5 acres (16%) than in Mara (7.7%) or Sio-Uganda (6.5%).

While in Sio River basin the decrease is due to sub-division because of population growth and extensive soil erosion, in Mara River basin the decrease is also associated with river siltation and sedimentation on the river bank resulting in papyrus reeds growth.

Despite the fact that respondents acknowledge decrease in land productivity and few of them said to be practicing fishing despite of living along the river banks, especially in Mara and Sio-Kenya. Fishing is not widely practiced in Mara and Sio-Kenya for various reasons. These include dangerous wildlife (snakes, crocodiles and hippopotami) along the river banks and limited catch due to poor fishing gear. The common fishing gears are hooks, nets, baskets and spears/harpoons, which is common in Sio River. The fishing catch is less than 10 kg per session per fisherman. The common fish types captured include mud (kambale) and cat (kamongo) fish as well as tilapia (sato). The fishing season is the dry season when fishermen are not engaged in farming.

Poverty levels

The level of poverty at household level, in all study sites has not improved though the countries have been independent for more than 40 years. Housing conditions and characteristics which is often used to assess the level of poverty at household level showed in all site few houses had cemented floors (Sio-Kenya, 17%; Mara-Tanzania, 19%; and Sio-Uganda, 11%) and cemented walls (18, 20 and 11% respectively). As for corrugated iron sheets roofing, Sio-Kenya had slightly higher houses (58%) compared to Mara-Tanzania (22%) and Sio-Uganda (23%). This is also reflected in the type of sanitation used. Some dwellings were found still having no common pit latrines and those having them were located outside the dwellings.

As for education, the number of respondents with primary education in the sites was high in Mara-Tanzania (75%) compared to Sio-Kenya (58%) and Sio-Uganda (50%). The high literacy in Mara-Tanzania is perhaps attributed to 1970s policy on universal primary education and adult literacy. Those attaining secondary education in Mara-Tanzania recorded few respondents who had secondary education (8%) compared to Sio-Kenya (19%) and Sio-Uganda (17%). All sites had respondents who had no formal education with slightly more in Uganda (32%) compared to Mara-Tanzania (14%) and Sio-Kenya (21%).

DISCUSSION

The real problems of land use practices so far identified in the transboundary river basin of Sio and Mara can be summarized to be associated with poverty, inequity

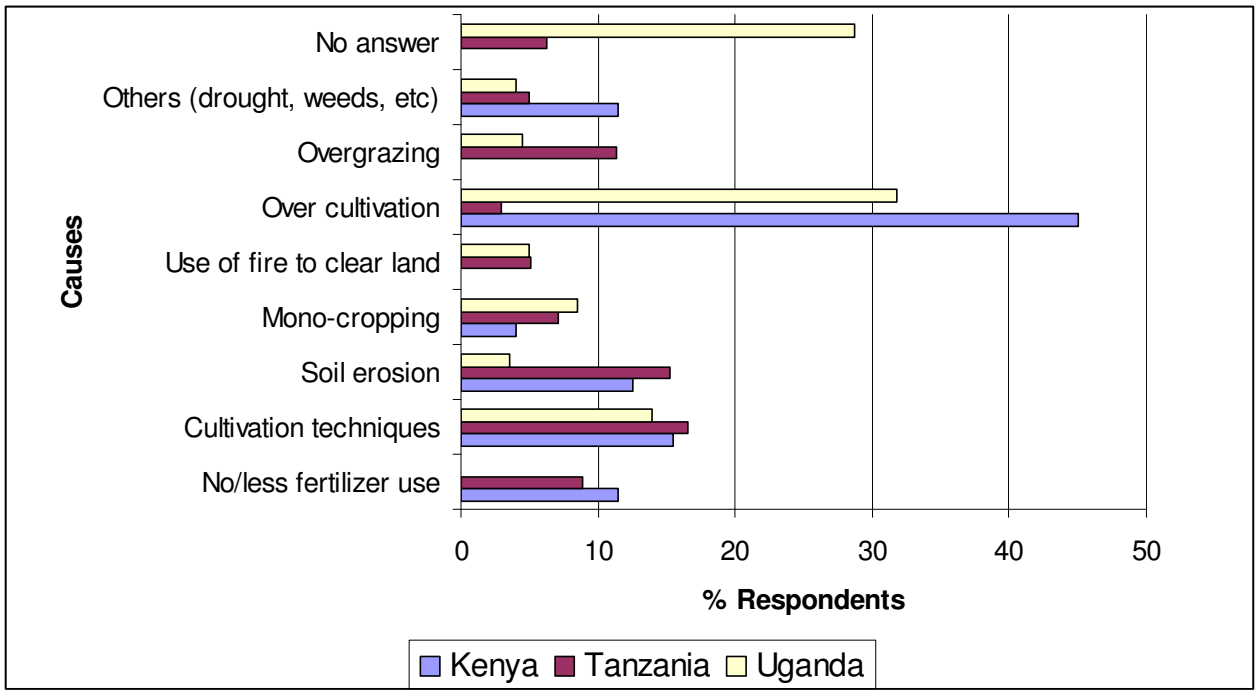

Figure 3. Causes of decreases in land productivity.

among stakeholders in the basins, ineffectual institutions, institutions acting at cross-purposes, poor land management practices and a lack of extension support of farmers, and insufficient knowledge of resource dynamics and ecosystem needs. With rural population growth estimated at annual growth rate of 3.8% in Sio-Kenya, 4% in Mara-Tanzania and 2.5% in Sio-Uganda, the key challenge will be to accommodate it while sustaining and improving the features of the basin that is valued by the communities.

As pointed out in the findings, the conspicuous practices in the two river basins are cultivation in the river bank that is, conversion of wetlands for cultivation shifting from perennial to annual crops and grazing. The overgrazing on the river banks in Mara Tanzania has led to increased erosion and sedimentation, while in Sio Kenya, encroachment on the wetlands and sand harvesting are also having similar effects (Obando et al., 2006). From a landscape perspective the midstream communities generally gave a pessimistic rating of the resource qualities in comparison with the downstream communities. All these dynamics are important in design and development of an integrated management plan for transboundary basins (Obando et al., 2007), which will benefit Lake Victoria basin in totality.

The other issues identified in both transboundary basins related to impacts of land use practices on livelyhoods include a reduction in the lake water levels, siltation, loss of wetlands and reduction in vegetation species. Due to destructive land use practices recorded in both basins, the differences regarding the resources in the basins shows that in the Mara-Tanzania, there is a tendency to under utilize the resources, while in Sio Kenya there is overuse of these resources. The degradation in the areas is also from different sources, sometimes with the communities not taking into considering the implications of the actions mainly because land has decreased and is no longer as productive as before. Although the status is worsened by frequent land use conflict, the downstream communities have a larger variety of livelyhood options particularly in fishing if it can become a dominant livelihood source for the communities.

It is necessary for the decision making mechanisms to take into consideration the differences in the communities in the transboundary basins. This is particularly important since the perceptions on the issues by the local communities are so varied. For instance, as indicated (Bamutaze et al., 2006), the downstream communities in Sio River basin in Uganda are more optimistic regarding the quality of land than those in the midstream in Kenya. In Uganda, the livelihood options of the communities in the basin are more solid due to the fishing activity given the proximity to the basin. Yet this may be seen to be uneconomical due to the decreasing level of fish catches though it can be argued that the decreasing fish catches have led to innovation in the use of fish traps.

What is needed is investigation into how the various river basin stakeholders can be brought together for integrated management. These include programmes/projects in domestic water user in a water supply and sani-

tation for health; small and large-scale agriculture-ranching for food security and income generating; agro-forestry for income generation, business and ecosystem services; tourism for wildlife conservation and earn foreign exchange; mining and other agro-industries to add value to harvested natural resources; fisheries for food security and income generating; and alternative energy sources. These programmes/projects would act as measures to ease pressure on the degraded land and let it recover for present and future generation.

All in all it should be remembered that the local communities in the transboundary basins form the most important stakeholder groups and need to be involved in development of such integrated basin management plans. These communities bear the brunt of the unsustainable use of the resources, and can become more vulnerable where there are limited livelihood alternatives.

Conclusions

From the study, it can be concluded that, land-use practices in the Mara and Sio River basins provide a paramount example of modern or contemporary land degradation. It shows a coupled socio-economic and biophysical process, which is linked to ever increasing land use intensity. The process has multiple, negative impacts upon life-support functions of terrestrial ecosystems (including water resources), human well-being (including health), economic livelihoods, societal development, vulnerability and security. The intensification of economic activities promotes degradation and destruction of soil-vegetation cover, activates erosive processes, and triggers the expansion of land degradation. Due to the differrences in the transboundary basins in terms of land use practices, socio-economic aspects and perceptions, it is imperative that these differences should be considered by the East Africa Community in making decisions and policy that will affect the region. As the research continues, there is need for integrated land use management packages and pathways as well as value chain products that take holistic care of transboundary river basin resource management, production, marketing; and access to markets so as to abate resource degradation and improve livelihoods.

Nonetheless further research is still necessary on the linkages of the environmental processes and uses of the natural resources in these transboundary basins, particularly within the ISKM framework.

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