 J Hum Ecol, 35(3): 143-154 (2011)

Impact of Socio-economic Activities around Lake Victoria: Land Use and Land Use Changes in Musoma Municipality, Tanzania

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KEYWORDS Wetland-Ecosystems. Land-Use-Type-Change. Anthropogenic-Activities

ABSTRACT Wetlands are amongst the most productive ecosystems of the Earth. Despite its potential in supporting people's livelihood in Tanzania, Lake Victoria is being converted into other land uses. This paper evaluates the impacts of main socio-economic activities on Lake Victoria in Musoma Municipality. Primary data were gathered by administering the questionnaire to a sample of 220 households. Participatory rural appraisal techniques, participant observation and checklist were employed in data collection. The land use types and land use changes was examined through analysis of satellite imageries. This was attained by making use of ArcGIS10 and ERDAS Imagine 9.1. The socio-economic data were analysed using Statistical Package for Social Sciences. The land use/cover identified were Lake Victoria, CBD, infrastructures, Kitaji swamp, fishing areas, settlement, farms, industrial areas, tarmac road and recreational areas. Findings show that there is a strong relationship (r =91.3%; p=0.001) between the anthropogenic activities and land use type/changes. These activities have caused the deterioration of wetland area along with its values at the average rate of 6.5 hayr^{-1} which was observed in 2001 to 2008. Lack of awareness on the role of wetlands was found to impede the participation of local people to Lake Victoria conservation. Thus, this study recommends that, natural resources management (including wetlands) should be integrated in the curriculum of all education levels to foster awareness raising campaign on role of wetland benefits to local people's livelihoods.

1. INTRODUCTION

Wetlands are amongst the most productive ecosystems of the Earth (Emerton and Bos 2004). Tanzania is the largest country in East Africa that is well-endowed with natural resources with an area of 94.5 million ha, of which 6 million ha is covered by water bodies. Based on 2002 national census, the country has a population of more than 35 million people that keeps on growing at the rate of 2.5 percent per annum (URT 2003). However, considering the growth rate of 2.5 percent, the current population in Tanzania is more than 42 million people who need the land and other resources for their survival. Tanzania's wetlands provide a wide range of environmental services from which people benefit, and upon which all life depends (McCartney et al. 2004; URT 2007). The importance of wetlands is not only accounted by being highly productive, biologically rich and providing many ecological services, but also their support to both biodiversity and the economy. They are natural assets which make significant contributions to the Tanzania's national economy (Munishi et al. 2003; URT 2007).

Despite its potential in supporting people's livelihood, Lake Victoria is being converted for other land uses (Munishi et al. 2003; URT 2003, 2007). This has led to a decline of wetland benefits to communities. However, while most of the benefits of wetlands are public goods, the costs of their conservation often fall on local land holders. Human behaviour within their specific environments differs with respect to their rationality, intentions and perceptions, which results in different decisions and thus different impacts on the dynamics of the system of which they are part (Emerton and Bos 2004). Thus, most of the wetlands have been lost completely whilst the ability of many of those that remain to provide valuable benefits has reduced significantly. This paper examines the socio-economic activities, land use and land use changes and their consequences on the Lake Victoria in Musoma Municipality to provide enriched information for decision making with regard to wetland uses and land use plan.

2. METHODOLOGY

2.1 Description of the Study Area

Lake Victoria is the second largest freshwater lake in the world that is shared by three countries namely: Tanzania occupying 49% or

33700 km^2 of the lake, Kenya occupying 6% or 4 100 km^2 and Uganda occupying 45% or 31 000 km^2. It is the largest Lake in Africa with a surface area of 68,800km^2 and a catchment area of 193 000km^2. The main rivers flowing into the lake from the Tanzanian catchment are Mara, Kagera, Mirongo, Grumeti, Mbalageti, Simiyu and Mori. Lake Victoria stretches 412 km from north to south, between latitudes $0^0$30' N and 355 km from west to east between longitudes $31^0$37' and $34^0$53' E (URT 2002). Musoma Municipal is a bay with the total area of 6 300 ha and the elevation ranging from 1 140m to 1 320m above the sea level[1]. Based on national census (URT 2003), Musoma Municipal has a population of 190 000 people with a population growth rate of 2.6%. From this information, the population in 2011 was projected to be 243 304 people. Majority of the people are subsistence farmers of maize, small scale tomato growers, fishermen and businessmen and few are employees.

2.2 Data Collection

Primary data were collected from seven hamlets namely: Kigera, Mwisenge, Mwigobero, Mkendo, Nyasho, Nyakato and Bweri. Combination of techniques such as Participatory Rural Appraisal (PRA) methods, participant observation and structured questionnaires (both closed and open questions) were deployed in collecting both qualitative and quantitative data (Table 1). A checklist was used to solicit information from key informants. About 15 key informants knowledgeable about the study area were interviewed. These included ward elders, environmental committee members, district agriculture and livestock officer and natural resource committee members, Wildlife Officers and Forest Officers. Furthermore, questionnaire was administered to a sample of 220 (Table 1) to elicit the relevant information across the selected hamlets/wards along with the consideration of gender representation. Main Participatory Rural Appraisal (PRA) tools that were used in this study included resource mapping which helped to tap information on resource condition; Venn diagram was used for identifying different stakeholders and the roles played by them in wetland resource management. Furthermore, PRA assisted to identify relevant variables, their cause-effect relationships and the importance of each variable through participatory communication and analytical techniques. Such variables include stakeholders in utilization and management of wetland resources, their interests, resource use benefits and conflict management strategies. The land use types and land use changes data was extracted from satellite imageries by using GIS software (ERDAS Imagine 9.1). The combination of methods used enabled researchers to compliment limitations by one technique to allow cross checking and verification (Olsen 2004).

Table 1: Distribution of respondents in the surveyed villages in Musoma Municipality, Tanzania

Ward	*Total number of households*	*Number of sampled households*	*Sample size (%)*
Mwisenge	315	35	11
Mkendo	135	15	
Kigera-bondeni	279	31	
Nyasho	207	23	
Nyakato	496	55	
Bweri	405	45	
Mwigobero	144	16	
Total	1981	220	11*

**Indicates sampling intensity which was 11%*

2.3 Data Analysis

Socio-economic data analysis was performed using Statistical Package for Social Sciences. Descriptive statistics, charts, frequencies tables and graphs were used to present the results. The land use types and land use changes was examined by using GIS software for processing and analysing satellite imageries. The image classification, ortho-rectification, image mosaicking and image blocks triangulation was done by ERDAS Imagine 9.1. The visual interpretation of land use type/change and the alignment of satellite imageries to map coordinate system were done by making use of ArcGIS10 and to display the histograms. Moreover, regression analysis was done to determine the level of impact of main economic activities in the study area and the role of education on the respective impacts (Equation 1).

2.3.1 Satellite Image Acquisition, Processing, Interpretation and Land Use Data Extraction

Preliminary information to form a variety of land cover themes in a GIS was extracted from the acquired topographical maps with a scale of 1:50000. Moreover, using map control points the maps were scanned and geo-referenced in Arc GIS 10. The digital maps were used to identify potential land use type and sites as well as to locate them during the reconnaissance survey. The topographic maps, Landsat 5 TM, Landsat 7 ETM+ and Landsat 5 TM images (1994, 2001, 2008) were used in the analysis for evaluating the temporal and spatial characteristics of land use type and land use change. The GARMIN 76 GPS was used to record the coordinates of sites visited in the study area (Table 2). In order to detect wetland changes accurately, the images used for this study were acquired on 12th day of May in each year of interest (that is, 1994, 2001 and 2008) which is a dry season with low or zero cloudy. The images were then subsets in ERDAS imagine 9.1 to focus and cover only the area of interest.

Table 2: Coordinates for some visited sites in the study area

Ward	*Coordinates*
Mwisenge	01^{0}29.677'S; 033^{0}47.473'E
Mkendo	01^{0}28.530' S; 033^{0}48.091'E
Kigera-bondeni	01^{0}30.866'S; 033^{0}48.124'E
Nyasho	01^{0}30.491'S; 033^{0}48.374'E
Nyakato	01^{0}30.723'S; 033^{0}49.065'E
Bweri	01^{0}31.366'S; 033^{0}49.676'E
Mwigobero	01^{0}29.550'S; 033^{0}48.615'E

According to Lu et al. (2004) and Canty and Nielsen (2006), well-timed and accurate change detection of features provide the base for better understanding of the relationships and interactions between human and natural phenomena to better manage and use resources. Thus, to understand how land use change affects Lake Victoria, information is needed on what changes occur and when they occur, the rates at which they occur, and the socio-economic and physical forces that drive those changes.

Figure 1 shows the flow chart of image analysis and data extraction. In the context of this paper, wetlands changes were considered to be a function of land use type and land use change. Therefore, this paper employed the Landsat images for the range of seven years to ascertain land use changes whereby the Landsat 7 Enhanced Thematic Mapper Plus (ETM+) of 2001 and Landsat 5 Thematic Mapper (TM) of 1994 and 2008 (WRS 2 path 170 row 61) were used (Table 3). The images were georeferenced to the UTM (Universal Transverse Mercator) map coordinates and then mosaicked the scenes. In order to guarantee consistency and accuracy of data processing, the classification of land use type and land use change was done through visual interpretation. The fieldwork survey was used to support interpretation of the images whereby it provides data for the accuracy assessment. To accomplish the objective of this paper, the processed satellite images (Fig. 1) were then interpreted to determine the land use type and land use change whereby the Land use data in respective time series were extracted (Figs. 3, 4 , 5). The following land use/cover were classified: Water (Lake Victoria), Central Business District (CBD), infrastructures, Kitaji swamp, fishing areas, marshland, settlement, farms (including paddy, non-paddy and dry farming land), open up areas, industrial areas, tarmac road and recreational areas (Figs. 3, 4, 5 and Table 5).

The statistics were extracted from different land cover types in optical data, specifically the LANDSAT scenes and topographical maps. However, the diversity of land uses and wetlands was captured by carefully selecting samples and distributed them evenly. The samples were later saved as shape files in ArcMap (Fig. 1) and then exported to ENVI as region of interest in order to calculate the statistics of each land use type and land cover class. These data were then exported to excel for visualisation and for wetland change detection (Table 5).

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics of the Respondents

Results indicate that majority (84%) of respondents were engaged in various economic activities such as fishing, tourism, crop produc-

Table 3: Sources of satellite images

Date	*Type of imagery*	*Instantaneous field Of View (IFOV)*	*WRS Path/ Row*	*Source*
12/05/1994	Landsat 5 TM	30m x 30m	170/61	http://glovis.usgs.gov
12/05/2001	Landsat 7 ETM+	30m x 30m	170/61	Ardhi University and http://glovis.usgs.gov
12/05/2008	Landsat 5 TM	30m x 30m	170/61	NSMD and http://glovis.usgu.gov

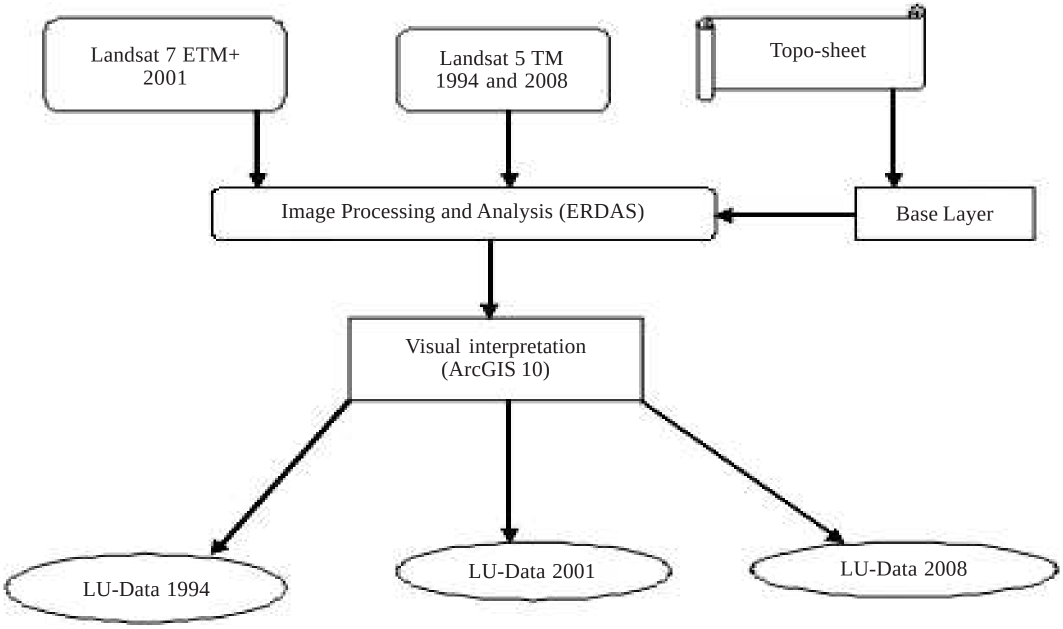

Fig. 1. image analysis flow chart to extract land use data (1994-2008) in Musoma Municipality

tion, livestock production and formal employment but only a small (16%) proportion of old age people were engaged in economic activities in the study area (Fig. 2 and Table 4). These results give insights that there is a high demand for wetlands goods and services by various sectors (fishing, tourism, crop production, livestock production) of which may call for the wise use of wetland benefits. This implies that decision made by majority (84%) in the course of land use and other economic activities can affect water quality and other wetland values. This argument is similar to observation made by Falkenmark et al. (1999) who portray that, exploitation of land resources has undesirable effects on the ecosystems, thus it is essential to understand how humans interfere with the landscape systems.

3.1.1 Land Size and Duration of stay in the Study Area

Findings revealed that, 28.6% of the respondents have stayed in Musoma Municipality for about one to five years, about 38.6% are six to ten years of residence and 32.7% have stayed for more than ten years. The overall average time ($_{d}$) of residence is 5.59 years per household (Table 4). This indicates that the respondents are knowledgeable enough in terms of time and space to provide useful information with regard to the use of wetland resource in study area. These results are in line with Giliba et al. (2011) who emphasize that, people who live in a certain area for a longer period of time accumulate experience and knowledge, on various matters with regard to respective area of interest. Paradoxically, it may also indicate that people may have enough time to cause significant impacts (positive or negative) at the study area.

Findings show that 45% of the respondents owned 0.1 ha to one hectare of land, 37% owned 1.1 ha to 1.6 ha, and 14% owned 1.7 ha to 2.2 ha of land while only three percent and one percent of the respondents owned 2.3 ha to 2.8 ha and more than 2.8 ha of land respectively. The average land size ($_{L}$) per household in the study area was 1.16 ha (Table 4). Furthermore, the average household size ($_{HS}$) was 7 people (Table 4) which is above the district average size of 6 people (URT 2002). Moreover, about 34% of the respondents had acquired land through renting. Some of them acquired it through inheritance (30.6%) and by purchasing (28.6%) while only few (6.8%) of them have been located the land by government (Table 4). The results imply that perhaps people may be able to use their land for various socio-economic activities thus increasing the ability to sustain their lives. It can also be

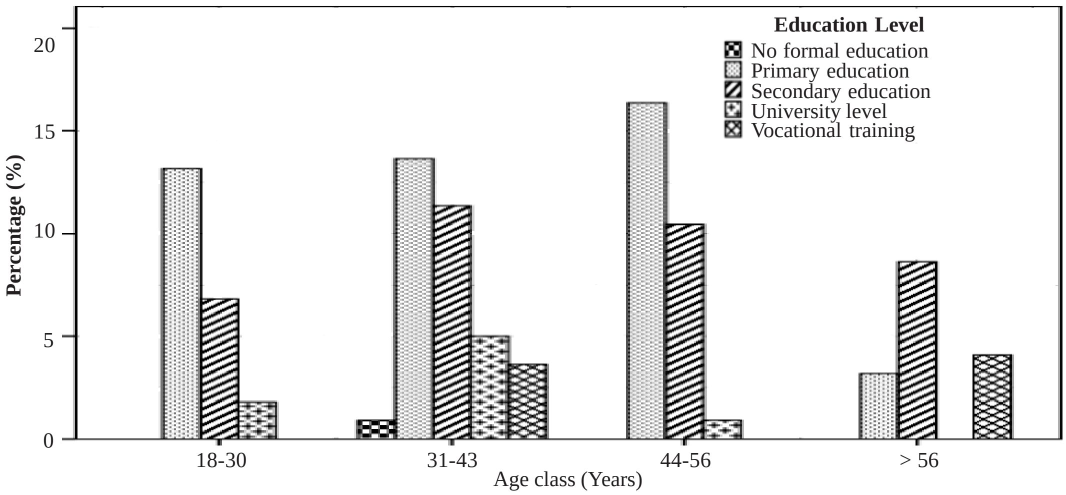

Fig. 2. Distribution of respondents by age and level of education

Table 4: Main economic activities, land size and means of acquisition in Musoma Municipality

Variable	*Variable information*		
	Mean	*Frequency*	*Percent-age (%)*
Residence Duration (years)			
1 - 5	0.86	63	28.6
6 - 10	3.09	85	38.6
>10	1.64	72	32.7
Total	$_d$ = 5.59	220	100
*Average Size of Land (ha)**			
0.5 - 1.0	0.34	99	45
1.1 - 1.6	0.50	81	37
1.7 - 2.2	0.27	31	14
2.3 - 2.8	0.08	7	3
>2.8	0.01	2	1
Total	$_L$=1.16	220	100
Means of Land Acquisition			
Inherited	67	30.6	
Allocated by government	15	6.8	
Bought	63	28.6	
Renting	75	34	
Total		220	100
Land Adequacy			
Adequate	35	16	
Not adequate	185	84	
Total		220	100
*Main Economic Activities***			
Crop production	65	29.5	
Fishing	84	38.2	
Livestock keeping	15	6.8	
Tourism (Recrea-tional activities)	16	7.4	
Small-scale business	21	9.5	
Formal employment	19	8.6	
Total		220	100

Pearson Chi-square (χ^2 = 61.9); Degree of freedom (df = 14); Sig. (p =.000*<5%); $_d$ and $_L$= Overall mean of duration of residence and average land size per household respectively *1ha=2.54 acres; $_{HS}$=6.5 mean household size

established from the results that people can apply for land lease certificate and use land as an asset to borrow money from banks and other institutions for establishing enterprises.

About 84% of respondents reported that the land is inadequate to meet their household demand and only 16% of the respondents considered their land to be enough to meet their household needs (Table 4). This indicates that, majority (84%) household needs more land to produce food for their family. Given this situation in this case, wetland exploitation of natural resources and conversion of wetland to other land uses such as crop production seems as the cheapest way for local people to meet their basic needs. These findings imply that unless land productivity is improved to meet the food demand, wetland conversion in the study area will continue which may also trigger the release of greenhouse gases to the atmosphere. Adhikari et al. (2009) and O' Connor et al. (2010) argued that wetlands provide a potential sink for atmospheric carbon but if not managed properly, they become a source of greenhouse gases. Wetlands release carbon both through natural, seasonal changes and, more drastically, when their equilibrium is affected by human interference. Conversions of wetlands to other land uses have resulted in a net flux of carbon to the atmosphere. Findings of this study revealed that land is in the hands of majority (66%) while some (34%) people in the surveyed wards can access land through renting (Table 4). Since results of this paper show that majority of households own land and depend on it for their livelihood, thus, any decision made by majority regarding use of their land may have positive or negative impact on wetland values in the study area to a great extent. This implies that good land management can have positive impact on wetland management.

3.2 Main Economic Activities

Findings show significant differences of economic activities of respondents in the study area (χ^2 = 61.9; p<0.05) which ranged from fishing (38.2%), crop production (29.5%), small-scale business (9.5%), formal employment (8.6%), tourism activities (7.4%) and only 6.8% of respondents were livestock keepers (Table 4). The diversity of economic activities in the study area indicated the need for more land to accommodate various land uses and the need for space to dispose wastes generated from these economic activities. This may increase the chances of wetland degradation (likelihood ratio=73.4) as a result of pollution from these economic activities. This implies that the degradation of wetland (water) quality due to a certain land use type in upstream parts of a watershed can have negative effects on users in downstream parts of the watershed and the degradation affects flow through the watershed. These findings are similar to the study conducted by Baur et al. (2000) and UN (2009) who argued that different land use systems may have different impacts on wetland values direct or indirectly as a result of land use practices of the stakeholders (upstream or down-stream). Results of this paper is similar to the studies by Copeland et al. (2010), Kangalawe and Liwenga (2005) and Ramsar (2009) who assert that poor farming practices have led to land degradation along with negative impacts on wetlands.

3.3 Land Use Types and Changes around the Lake Victoria

Results indicate that, the main land use types were fish landing areas, farms, commercial areas, industrial areas, infrastructures, settlements, area for recreation and spiritual activities (Table 5). Likewise, observation shows there is diversity of land use types in the study area (Table 4) which have been changing since 1994 to date (Figs. 3, 4, 5). The analysis of satellite imagery (Landsat 5 TM image of 2008 with Path 170 and Row 61) revealed that in 2008 of 65% (4 093.9 ha) of total land (6 300 ha) in the study area was considered in land use plan, whereby about 16.2% of total land was occupied by water, 4.6% of total land accounts for CBD while 1.2% of total land was for fish landing sites and other fishing activities. Farms and settlements accounted for 2.6% and 26.3% of the total land respectively (Table 5). About 4.8%; 2.7%; 2.4%; 1.8%; 1.2%; 1%; 0.1% and 0.09% of the total land accounted for industrial areas, marshland, recreation area, tarmac road, open up areas, transport and communication, Kitaji swamp and airstrip respectively (Table 5).

These results (Table 5) have dissimilarities with the analysis of satellite imagery (Landsat 5 TM image of 1994 and Landsat 7 ETM+ image of 2001 with Path 170 and Row 61) of the same study area whereby 54.42% (3428.18 ha) and 54.43% (3429.1 ha) of total land (6300 ha) was accounting for different land uses respectively which were less than that of 2008 (65%) (Figs. 3, 4, 5 and Table 5). This indicates that more land was used for various types of land use in Musoma Municipal in 2008 of which might be attributed to conversion of wetland areas to some land use type such as settlement and farms. This can be confirmed by the observed overall decrease (temporal and spatial) in wetland area at the average rate of 6.45 ha per year (2001 to 2008) while areas of farmlands and settlements were increased by 12.85% and 32.76% respectively (Table 5). Yet, results portray that there was a slight increase of wetland area between year 1994 and 2001 (Table 5), with the rate of increase ranges between 0.93 ha/year to 1.9 ha/year which was probably attributed to El Niño in 1998 which also destroyed some farms and buildings which were closely to the shorelines of Lake Victoria particularly at Nyasho ($01^0$30.491'S; $033^0$48.374'E); Nyakato ($01^0$30.723'S; $033^0$49.065'E); Mwisenge ($01^0$29.677'S; $033^0$47.473'E) and Bweri ($01^0$31.366'S; $033^0$49.676'E) (Tables 2 and 5). This implies that, there was a significant change in land use with increase in wetland areas and decrease in some other land use types such as farmland, settlement and infrastructure. Conversely, there was a dramatic decrease in wetland area which was observed between years 2001 and 2008 with the estimated rate of decrease

Table 5: Land use type and land change in the study area (1994-2008)

Land use type/Land cover	*Time series*			*Change in percentage (%)*	
	1994	*2001*	*2008*	*(1994-2001)*	*(2001-2008)*
	Coverage (Ha)				
Water	1068.21	1081.37	1019.74	1.23[a]	5.70*
CBD	178.47	147.235	289.98	17.5*	96.95[a]
Kitaji Swamp	3.24	7.84	7.21	141.98[a]	8.04*
Fishing	133.29	17.248	75.96	87.06*	340.40[a]
Marshland	36.69	143.942	167.04	292.32[a]	16.05[a]
Mixed urban(built up and farms)	1433.97	0	0	F*	F*
Farms	0	147.9	166.9	N**	12.85N[a]
Settlement	0	1248.54	1657.617	H**	(H**) 32.76[a]
Tarmac road	76.68	72.4416	112.86	5.53*	55.79[a]
Open up area	86.04	80.8	75.8	6.09*	6.19*
Recreational area	0	106.83	150.842	N**	41.20N[a]
Industrial area	360.63	332.00	300.00	7.94*	9.64[a]
Airstrip	5.9544	5.9553	5.96	0a	0[a]
Transport and communication	45.0	37.0	64.00	17.78*	72.98[a]

*Indicates % area decrease, a=Indicates % area increase; N[d]=Decrease in % of new land use; N**=New land use; F*=Separation of farms from settlement; H*=Area occupied by settlement only. Fishing areas considered landing areas and fish processing industries. 1ha of LV occupied mean volume of 0.0003997 cubic kilometre of water. Total land area of Musoma = 6300 ha

ranges between 4.2 ha/year and 8.7 ha/year (Table 5).

Thus, the decrease in wetland area was in line with decrease in its values such as ecological values (breeding sites for fish and birds). Besides, this may also reduce the number of fish catch in the respective period (temporally and spatially) and increase the costs of fish catch effort which

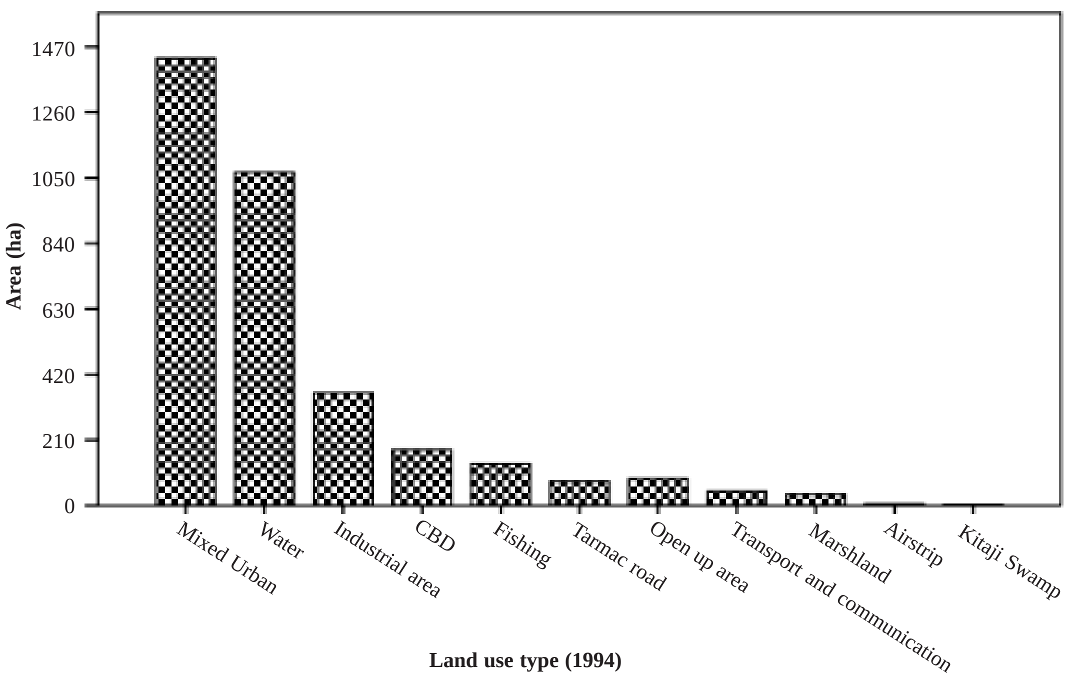

Fig. 3. Size of various land use types in year 1994 in Musoma Municipality

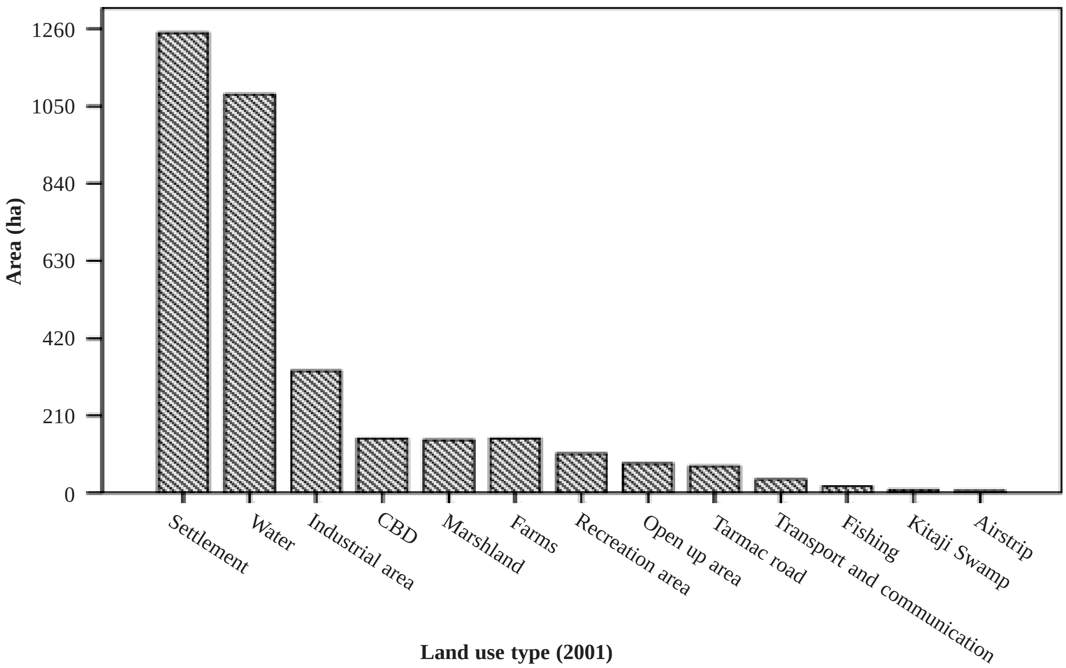

Fig. 4. Size of various land use types in year 2001 in Musoma Municipality

affected economic returns in fishing activities and the multiplier effect might spread to other households. Results of this study can be compared with the study conducted in Vedaranniyam by Prabaharan et al. (2010) who found that coastal zones are most vulnerable for land use changes in rapid industrialization and urbanization aeon mainly influenced by various anthropogenic activities. These results (Table 5 and Figs. 3, 4, 5) imply that wetland was converted into other land use type which led to loss of its area in line with wetland values. The conversion of wetlands to other uses might be due to rapid population growth in the study area which increases pressure and the demand for natural resources and wetland benefits to meet people's basic needs. It can also be attributed to negative attitude of local people towards wetlands as a wasteland. Results of this study are in line with some previous studies (Kashaigili 2006; Kirsten 2005; URT 2007) which argued that wetlands have been converted to other uses such as agriculture, settlement and infrastructure. While some wetland conversions no doubt have been in the best interest of society, wetlands have too often been lost for very limited benefits and even costs to society (Munishi et al. 2003; Turner et al. 2000).

3.4 Impacts of Main Socio-economic Activities on Lake Victoria

Results portray that, there is a strong linear relationship (Pearson correlation: r= 0.913) between the impacts on Lake Victoria and anthropogenic activities such as fishing activities, level of education of the respondents, crop production, settlement and livestock keeping. According to Hill and Lewicki (2007), regression analysis is a statistical tool for the investigation of relationships between variables whereby the investigator seeks to ascertain the causal effect of one variable upon another.

The regression analysis to predict the level of impacts on Lake Victoria caused by socio-economic activities, revealed that the regression model was significantly able to predict the impact on Lake Victoria (R^2=86.7%; p<5%) with 6.07 as the error (SE) of prediction which was accounted by the remaining 13.3%. The error (SE) signifies the unobservable factors in predicting the impact on Lake Victoria. De Groot et al. (2006) argued that, anthropogenic activities such as urban development in terms of various infrastructures, housing and agricultural management, have caused significant impacts and loss

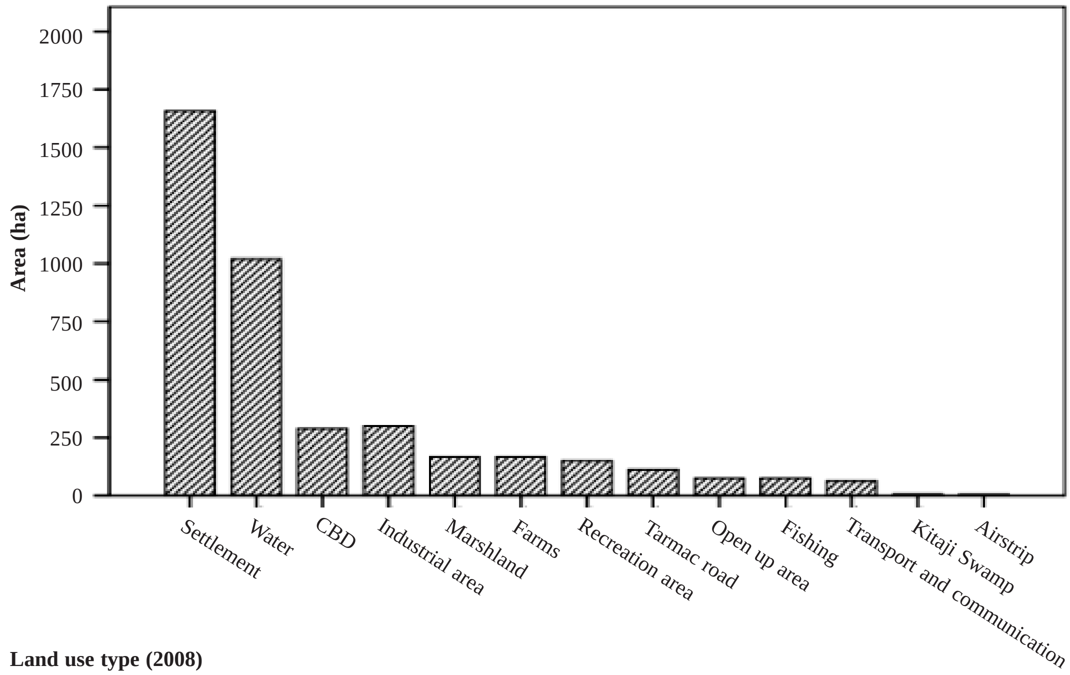

Fig. 5. Size of various land use types in year 2008 in Musoma Municipality

of wetland in many areas around the world. However, the regression analysis shows that, when the exogenous variables (predictors) are held constant, there was a minimum impact on Lake Victoria at the additional factor of 5.53 (Equation 1). This implies that the sum impacts of unobservable parameters such as natural phenomena (drought, water hyacinth, floods), some out-boundary anthropogenic activities (effluents from mining industries) can raise the impact on Lake Victoria by an additional factor of 5.53. Considering " y " as the impact on Lake Victoria then, let $y = LV_{\text{inf}}$, thus:-

$$LV_{\text{inf}} = 5.53+0.04X_0-0.71X_1+0.27X_2+0.05X_3+0.03X_4 \qquad (1)$$

3.4.1 Fishing Activities in the Study Area (X_0)

Observation revealed that there was substantial increase in fishing efforts on the lake. The increase in number of fishing efforts such as fishing crafts using outboard engines may cause pollution which has negatively impacted the biodiversity (loss of habitat) and the ecological integrity of Lake Victoria. It has also increased the number of fish landing site along with infrastructure development for easy access of these sites. This may increase the chances for pollution by oil leakage from the boats and from other sources of pollution. Regression analysis shows that, fishing activities has negatively impact the Lake Victoria by a multiplicative factor of 0.04 ($p=0.027$) (Equation 1). This factor can also be attributed to the increase in number of fish landing sites by 340.4% in the years 2001 to 20008 (Table 5). This implies that, a marginal increase in fishing may impact the Lake by 4% along with the degradation of wetland values. Likewise, the use of illegal fishing gears (small meshed nets) also might have detrimental effect on wetlands. The direct observation and PRA revealed that, some fishermen were using illegal ways of fishing in line with illegal fishing gears which have destroyed some breeding sites of fishes.

3.4.2 Education Level (X_1)

Level of education was observed to be significant on the prediction of impacts on Lake ($p=0.00$) and negatively correlated with the level of impact on Lake Victoria. Results portray that marginal decrease in education level has impacted the lake negatively by a multiplicative factor of 0.71. This implies that, a marginal decrease in level of education may hind-back the efforts of awareness raising programmes on the role and importance of Lake Victoria to local people. This has negatively affect the wetland by 71% by making its values unknown which led to negative attitudes of local people towards wetlands (Equation 1). In addition, this has subsequently act as disincentive to local people of which its effects were the wetland pollution, poor land use practices, poor participation of local people on wetland conservation programs, over-exploitation of wetland resources, wetland encroachment and conversion of wetland into other land uses. It can be established that, loss of wetland values and misuse of wetland resources is the consequence of making wetlands values unknown due to a marginal decrease in level of education.

3.4.3 Crop Production (X_2)

Crop production has intensified over the last 20 year since 1987 whereby apart from increasing production the process has caused severe effects on many African wetlands (Kangalawe and Liwenga 2005; Munishi et al. 2003). Findings of this study revealed that crop production was significantly ($p=0.039$) affecting the wetland by a multiplicative factor of 0.27 (Equation 1). This indicates that a marginal increase in crop production characterized by poor land use practices has affected Lake Victoria by 27%. This can be attributed to the increase in household size (Table 4) at the surveyed area which implies that there was high demand for food and other household sustenance needs. Furthermore, the increase in household size marks the increase in demand for land along with the use of agrochemicals to produce enough food to feed the growing population. Nevertheless, this implies increasing stress on the wetland resources to assure people's basic needs. Since cultivation is the major economic and social activity for the majority of the communities (Tables 4) adjacent to wetlands is a confirmation that pressure on the natural resource base is high. Thus, findings have revealed that, poor land use practices and pressure from anthropogenic activities (*in situ and external actions*) on Lake Victoria has jeopardized its values. Lack of capital to invest in different social economic undertakings; poor farming practices leading to land degradation; and other factors have been pointed out by previous studies (Kangalawe and Liwenga 2005; Kansiime et al. 2007; McNeely and Mainka 2009) as the underlying causes which affect the sustainable utilization of many wetlands.

3.4.4 Settlement (X_3)

Human settlement significantly impacted the Lake Victoria by a multiplicative factor of 0.05 with p-value equal to 0.002 (Equation 1). This impact can be attributed to increase in the area of housing in the study area driven by increased household size (Tables 4 and 5), urbanization, and sewerage discharge from these human settlements along with the increase in hotels close to shorelines of the Lake. This implies that the marginal increase in settlement has caused impact on Lake Victoria by 5%. These results are in line with Rebelo et al. (2010) and Wang et al. (2008) who portray that land reclamation and wetland conversion for human settlement and other land uses has cause wetland fragmentations together with their values.

3.4.5 Livestock Keeping (X_4)

Equation 1 show that livestock keeping insignificantly ($p=0.136$) affect Lake Victoria by a multiplicative factor of 0.028. This indicates that, the marginal increase in livestock size has caused impact on Lake Victoria by 2.8%. This can be attributed to small number of livestock in the study area. Although results show that, livestock grazing has insignificant impact on wetland, yet it can damage reproductive habitats (nests, burrow trampling, exposing spawning sites to desiccation and removal of mating perches sites which may reduce habitat diversity. Mwakubo and Obare (2009) asserts that the ecological health of Lake Victoria has been weakened profoundly as a result of increase in land demand for material production such as raw materials and food as a consequence of rapidly growing population, clearance of natural vegetation along the shores for agricultural and livestock production.

4. CONCLUSION

Main socio-economic activities examined by this study were fishing, agricultural production, recreation and livestock production. Findings show that majority (91.4%) of local people depend on these socio-economic activities to sustain their day to day life. The main six land use types which directly or indirectly impact the Lake Victoria and the associated wetland values in the study area were: agricultural activities, human settlement, fishing, infrastructure development, recreational sites (beaches, lodges and hotels) and processing industries. Consequently, there was a strong relationship (r=91.3%) between land use type/changes and the anthropogenic activities. This was due to the increase in demand for wetland resources to sustain the rapid grown population and infrastructure development which was the underlying cause for conversion of wetland to other land use type and loss of wetland values. Despite its great potential in supporting local people's livelihood, the wetland was found to be decreasing at a rate of 6.5ha per year due to various socio-economic activities.

5. RECOMMENDATIONS

This paper recommends that, unless emphasis is put on the awareness raising campaign on the role and wise use of Lake Victoria resources, the wetland will continue to be degraded and its impact will affect people in a vicious cycle. Good land use practices should be promoted so as to reduce the impacts that has been caused on the Lake Victoria due to poor land use practices

ACKNOWLEDGEMENT

Glory be to the Almighty God for he has made this work to come to its completion. We are grateful to VLIR (Flemish Inter-University Council) for financing this study. We would also like to extend our sincere gratitude to those who in one way or another have contributed to this study. We are indebted to Vicent Kashabo, Water Authorities and Ward Natural Resources Committees in Musoma for providing essential information for this study to you all we say *"mkor're-bhuya"*, *"ero-kammaanoh"*, *"ahsanteni sana"*, *"Dank U"*, *"Merci beaucoup"*, *"Optime"*, *"Vielen Dank"*, "thank you very much".

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