MIGRATION OF AGRO-PASTORALISTS AND WETLAND DEGRADATION IN MBALIKA, SOUTHERN LAKE VICTORIA, TANZANIA

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ABSTRACT

This study assesses the effects of the continued expansion of human and livestock populations in the Mbalika wetland corridor of Lake Victoria in Misungwi district, Mwanza. A sample of 200 respondents comprising agro-pastoralists and indigenous small-holder farmers as a control group was used to gather data from a field survey. Further, the study used GIS and Remote Sensing in quantifying and mapping land use land cover in the study area between 1984/85 and 2012 in order to detect the changes that have taken place between these periods. Subsequently, an attempt was made to project the observed land use land cover in the next 15 years with the help of a transition probability matrix. The study found out that the rapid and excessive in-migration of agro-pastoralists from the drought hit neighboring areas had a more adverse effect on the carrying capacity and sustainability of the wetland as compared to the indigenous small-scale farmers. Consequences determined include a dramatic rate of deforestation and environmental degradation resulting from anthropogenic activities [2,816 (0.77%) hectares of forest and 470 (15.3%) hectares of wetland vegetation were lost over the time period] thus making environmental conservation a daunting task. Projections indicate that the wetland will have been turned into an agricultural land by a probability of 0.5553 by 2027. This study suggests the need for appropriate land rights policies and education to address the existing problems. Among the viable and imperative options include streamlining overstocking, agricultural malpractices, indiscriminate tree felling, extraction of fuel wood and charcoal production, boosting agro-forestry practices and monitoring the threatened wetland areas periodically.

Keywords: Agro-pastoralists; wetland; land/use cover change; remote-sensing; land degradation

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INTRODUCTION

Owing to climate change and variability together with other factors, agro-pastoralists in semi-arid Tanzania encounter numerous hardships with respect to both water and grazing land availability. Consequently, this puts greater challenge to their livelihoods. As a coping mechanism, agro-pastoralists have always opted for migration to new territories in search of pasture and water for their livestock. Most of them have moved to regions occupied by agricultural communities (Antezza, 2008). They have thus been forced to live in new environments with agricultural communities and in some areas there have been cases of conflict as a result of these interactions.

Land and water shortages are currently driving the use of wetland sites in Tanzania environments. Agropastoralists, and indigenous subsistence farmers increasingly compete for limited land and water resources. The principal drivers of continued shrinkage of wetland coverage include increasing population levels, limited livelihood options, and lack of enabling policies or their enforcement. In the rural areas, small but continuous nibbling at the edges has reduced wetlands areas. Wetlands deemed suitable for rice and sugarcane cultivation have been converted to these uses, and in some parts, large areas of wetlands have been converted to dairy farms and cultivation (McCartney, Masiyandima, and Houghton-Carr, 2004).

Studies in several major catchments reveal that between 35% and 60% of the wetlands and the benefits they provide, have already been lost (Swedish Report 2006; Lande, 2008). An increase in the incidence of drought in the region, due to climate change and environmental degradation, as well as the lengthening of the dry season have contributed to the dramatic increase in population size and density, as many inland agro-pastoralists together with their livestock have shifted closer and closer to the lake in search of water, forage and subsistence services offered by the Mbalika wetlands (Hongo and Masikini, 2003; Maitima, Olson, Mugatha, Mugisha and Mutie, 2010)

Despite the existence of policies and strategies, it seems that wetlands continue to be under threat from migrating agro-pastoralists and encroaching small-holder farmers (Kangalawe et al, 2008). In this regard, this study sought to examine the extent of the impact of such communities on the wetlands of Mbalika in southern Lake Victoria.

The general objective of this study was to examine the impact of the burgeoning population of agropastoralists and small holder farmers on the Mbalika wetland of Lake Victoria in Misungwi district. The specific objectives of this study were; to identify the socio-economic profiles of immigrant agro-pastoralists and settled smallholder farmers in Mbalika wetland in Misungwi district, to determine land use types and changes in the Mbalika wetland of Lake Victoria in Misungwi district, to assess the impacts of the intensified over-utilization of wetland resources on Mbalika wetland in Misungwi district and to forecast the future scenario of the Mbalika wetland and its catchments in Misungwi district.

MATERIALS AND METHODS

Study area

The study was conducted in the wetlands lying close to the southern parts of the Lake Victoria Basin in Misungwi district, Mwanza region. Misungwi district is characterized by a high livestock and population density and agro-pastoralism is the principal land use system in the area. Some selected villages located in sampled wards which lie close to the wetlands and which have high concentrations of livestock and population formed the cornerstones of the study. The district is divided into 4 divisions, 20 wards and 78 villages. It lies between 2^0 to 3^0S and 31^0 45'E to $3^0$33'E. The wards lying close to the Lake wetlands include Idetemya, Bulemeji, Igokelo, Sumbugu, Mbarika, Ilujamate and Lubili.

Study Design

The study used cross sectional design (Creswell, 2012) where data was collected at one point in time. The cross-sectional design encompassed causal-comparative since the study attempted to do comparison between migrant agro-pastoralists and small scale farmers as a control group. The study sought to find out differences between the two groups on their effects to the Mbalika wetland. The unit of analysis was a household. The household is preferred here because of its suitability in the sustainable livelihood framework. The study used both qualitative and quantitative data. In qualitative data, focus group discussion and in-depth interviews were used. These tools particularly gathered data on the migration history, value systems and the role of institutions in cementing agro-pastoralists and small scale farmers' bond and conflict resolution.

Population

According to the Tanzania national census of 2002, the population of Misungwi district was 256,133 with 20,604 of those residents living in an urban area (Misungwi Town). The population is growing at a rate of 2.7 per cent per annum. The population density is about 106 per km^2. The number of households is 40,000 with a household size of 6 people.

Sampling and sampling procedures

The sampled study area was drawn from among the wards surrounding the southern shore of Lake Victoria in Misungwi district. The district is divided into administrative units called wards. A list of all those wards surrounding the lake shore was prepared for the sampling exercise. These wards are Idetemya, Bulemeji, Igokelo, Sumbugu, Mbarika, Ilujamate, and Lubiri. This list formed the sampling frame. The wards were arranged serially and alphabetically. The technique used for picking the wards was systematic random sampling. A systematic sample of 4 wards was selected. The wards selected from this technique were Sumbugu, Mbarika, Ilujamate and Igokelo. Populations of each of the selected wards were drawn from the Tanzania Population and Housing Census of 2002 and projected to 2012. The total population for this study was **61,265**

Determination of sample size

The sample size for this study was determined by calculations using the following formula:

$$n = \frac{z^2 . p. q. N}{e^2 (N-1) + z^2 . p. q. q}$$

Where:

N = total number of people in selected wards (61,265); n = sample size of a target population; e = .02 (since the estimate should be within 2% of true value); z = 2.005 (as per table of area under normal curve for the given confidence level of 95.5%); p = .02 (proportion of defectives in the universe); Source: Kothari 2003:219. Using this formula, the sample size determined was **200** respondents.

Operational Design

Variables Investigated in this Study

This study investigated the following variables in connection to the migration of agro-pastoralists and land use degradation in Mbalika wetland of Lake Victoria.

1.Respondent's Profile: Birthplace, age, marital status, household size, production system (Agro-pastoralist/Small holder farmer

2. Environmental Degradation of Wetlands: Awareness of degradation, awareness of relevant national policies, ownership of livestock, household production system, participation in migration and domestic decision making and types of crops grown.

Spatio-Temporal Land Cover Changes

Remote sensing image data sets were applied in assessing the land cover in the Mbalika wetland area of Lake Victoria in order to understand the socio-economic development and changes in the natural environment. Multi-sensor satellite imageries (Landsat 5 Thematic Mapper (TM) and Landsat 7 Enhanced Thematic Mapper Plus (ETM+) were used to assess the temporal changes in the area, namely:

Table 2.5 Date Periods, Satellites / Sensors, Cell Size, and Approximate Locations of the Images used in the Study.

Date	Sensor/mode	Cell size	Location
12/05/1984	Landsat 5 TM	30m	SE quadrant of the Lake (170, rows 61, 62)
12 May 1985	Landsat 7 ETM+	30 m	Eastern third of Lake Victoria (path 170, rows 60-62)
24/June/2012	Lansat 7 ETM+	30 m	SE quadrant of the Lake (path 170, rows 61, 62)

Source: United States Geological Survey, 2006

All data sets are standard products available from the United States Geological Survey through the Institute for Resource Assessment, University of Dar es Salaam. The dates for the data were chosen based on available cloud free imagery and to analyze land cover changes for a longer period of time. To achieve one to one time series mapping and area measurement, the images were geometrically corrected, geo-coded and re-projected to Universal Transverse Mercator (UTM) coordinates on World Geographic System (WGS) 84 Datum, Zone 36N. Visual image interpretation was done to decipher the land cover and the morphological changes along Lake Victoria coastline within the study area. Each sub-scene of the study area was subjected to visual interpretation and the areas where significant land cover/use changes occurred were digitized onscreen using Arc View Version 9 software. Digital Landsat satellite imagery was used for identification and mapping of surface features.

The land cover/use was mapped based on colour hue, textural and structural values identified from the satellite imagery which was also used in delineating the land cover/use boundaries. This describes a method of change detection using the principal component analysis using imagery of two dates. In this study, the false color composites of band 7 (red), band 4 (green) and band 2 (blue) for the Thematic Mapper (TM) and the Enhanced Thematic Mapper (ETM) subset scenes were used for visual interpretation. Edge enhancement was carried on the data to enhance the detection of boundaries and linear features. On the false colour composite images, the green colour hues represent vegetation, whilst the dark blues to bright blue colour hues represent water bodies, depending on the level of siltation. The soils appear in shades of purple and brown and form the background of the image. The bands used for generation of the false colour composites for the Landsat Multispectral Scanner (MSS) data were bands 2 (red), 4 (green) and 1 (blue). In this band combination, silted water appears in purplish color hue. The land cover classification was done based on visually delineated boundaries corresponding to detected changes on the landscape quality, land cover changes and land use patterns. Areas with similar colour hue and texture were grouped into one class. The area under each land cover/use class was then calculated with the help of ERDAS IMAGINE 9.1 Changes in land use pattern were studied based on comparison of the time series data. Visual image interpretation was complemented with ground truth survey and socio-economic data collection from the field during the field survey. Ground truthing was carried out using hand held GPS as a means to obtain base reference for land cover classification and accuracy assessment. This process links ground and image information (Limbe, 2007).

The land use/land cover maps of said period were integrated into GIS. Supervised image classification system (Lillesand *et al.*, 2004; Limbe, 2007) was observed to classify the images in different land cover categories.

RESULTS

Characteristics of Respondents

A total of 200 respondents were interviewed in the selected households from the four wards fringing Lake Victoria basin. Their socio-demographic information is shown in Table 3.1. Of the respondents, 45 were from Sumbugu, 46 from Mbalika, 53 from Ilujamate, and 56 from Igokelo wards. The age of the respondents had a mean of 2.2850 and a standard deviation of 0. 95831. The mean duration of respondents lived around these wards was 39 years (range of 2 to 60 years).

Table 1: Socio-demographic Information of Respondents (n=200)

Socio-demographic variable	Category	Number (%)of Respondents	
		Agro-pastoralists (n=95)	Small holder farmers (n=105)
Age	18-30	23(24.2)	32 (30.5)
	31-43	47(49.5)	58 (55.2)
	44-56	18(18.9)	10 (9.5)
	>56	7(7.4)	5 (4.8)
Gender	Male	57 (60)	40 (38.1
	Female	38 (40)	65 (61.9)
Education	Non formal education	17 (17.9)	11 (10.5)
	Primary education	66 (69.5)	74 (70.5)
	Secondary education	12 (12.6)	16 (15.2)
	Certificate education/Agriculture	0 (0)	2 (1.9)
	Diploma	0 (0)	2 (1.9)
Head of household	Male	32 (44.4)	39 (53.4)
	Female	40 (55.6)	34 (46.6)
Household Size	1-3	7 (3.3)	9 (8.6)
	3-5	33 (26.7)	26 (24.8)
	6-8	47 (52.5)	58 (55.2)
	9-10	8 (17.5)	12 (11.4)
Type of residence	Born in wards fringing the Lake	12 (12.6)	89 (84.8)
	Migrated	83(87.4)	16 (15.2)

Occupation	Crop production and livestock keeping	93 (97.9)	0 (0)
	Entire crop production	0 (0)	93 (88.6)
	Entire patoralists	2 (2.1)	0 (0)
	Farming and petty trade	0 (0)	2 (1.9)
	Fishing and crop production	0 (0)	8 (7.6)
	Formal government employment and farming/livestock keeping	3 (3.2)	2 (1.9)

Source: Mbalika Agro-pastoralists Migration Survey, 2012

Age

The result of the analysis in Table 1 shows the distribution of respondents according to personal characteristics. Majority (49.5%) of the agro-pastoralist respondents had their age range between 31 and 43 years while 24.2% were between 18 years and 30. Those who were between 44 and 56 years of age formed 18.9% and only few (7.4%) were aged above 56 years. Of all the small holder farmers in the sample, 55.2% were aged between 31 and 43 followed by 30.5% who were aged between 18 and 30. Those aged between 44 and 56 formed 9.5%. The aged were only 4.8%. It could therefore be inferred that farming and rearing of animal are predominantly carried out by middle aged people who are energetic and productive in the economic sector.

Gender

The result shows that out of 200 respondents, 53.5% were males and 46.5% were females. Thus the percentage of male respondents was higher than of females. The culture and traditional attitude of the study area, gives men to be the main speakers of their respective families, therefore many of them were available at home during the survey. For agro-pastoralists, many of those aged below 30 years gone out to look after their cattle in grazing areas and for small holder farmers they had gone out for agro activities and since each questionnaire targeted one household many responses came from males aged 30 and above on behalf of their families.

Education

Most of the respondents interviewed had completed primary level of education (70.5%) for small holder farmers and 69.5% for agro-pastoralists while those with no formal education were 17.9%, and 10.5% for agro-pastoralists and small holder farmers respectively indicating that the majority are capable of understanding conservation education. Likewise, such statistics are indicative of the fact that many youngsters are engaged in looking after livestock at the expense of schooling. Those who had acquired secondary education formed 12.6% and 15.2% for agro-pastoralists and small holder farmers respectively while the rest of the respondents comprising experts such as teachers and agricultural extension instructors formed 0% and 3.8% for agro-pastoralists and small holder farmers respectively. The number of agro-pastoralists who migrated close to the Lake's wetlands were fewer (47.5%) than the indigenous small holder farmers (52.5%). An occupational breakdown of these two major groups indicate that those who are engaged in crop production in one way or another are more than agro-pastoralists.

Household size

Table 3.1 results show that, household size of the respondents ranged between 1 and 7 members with the average household size of 6 members, this is above the National level average (NBS, 2003). The majority of the household size in the study area ranged between 6-8 (52.5%) for agro-pastoralists and 55.2% for small holder farmers in all wards. Disaggregated data show that there is very little difference between the household sizes of agro-pastoralists and small holder farmers. Family size and the sustained population growth rate of 2.7 in Misungwi district is important in determining the situation of land cover change because of further extension of farms and other income creating activities.

Economic Activities and Practices in Mbalika Wetland Basin

Several economic activities of the local people revolved around and utilized natural resources in the Lake Victoria wetland corridor. Findings show significant differences of economic activities of respondents in the study area ($\chi^2 = 62.8$; $p<0.05$) which ranged from agro-pastoralism (96.8%), crop production (88.6%), fishing (7.6%), Farming and small scale business (1.9%), formal employment (3.2%) for agro-pastoralists and 1.9% for small holder farmers (Table 1).

Crop Cultivation in the Wetlands

Crop production was the main source of food and means of income generation as it comprised a significantly ($P<0.05$) high proportion (91%) of the agro-pastoralists interviewed. The main crops produced were maize, paddy, banana, vegetables (tomatoes, spinach, egg plants, peppers, green peppers, cabbages, ocra, onions, and carrots), sunflower and cotton. The median farm size was 3 hectares (range 0.25 to 100 hectares per farmer). A high ($P<0.05$) number (75%) of respondents were practicing irrigation farming particularly during dry seasons. Most of the farming systems in the Lake Basin are associated with slash and burn land management practices. Irrigation farming occurs in swamps, marshes and along river mouths particularly in Ilujamate as well as Sumbugu wards by exploiting the well-watered and rich soils from which the floods retreat during the dry seasons. The crops which were grown under irrigation were rice (64%), maize (16%), vegetables (8%), banana (4%), sugarcane (3%), beans (2%), potatoes 2%, and fruits (1%). The farm size under irrigation per household ranged from 0.25 to 3 hectares. Up to 92% ($P<0.05$) of the small-holder farmers reported that water for irrigation was not enough as the lake has continued to retreat over the years. The irrigation efficiency in the area is estimated to be below 60% and is the major water consumer and yet so extravagantly done particularly due to lack of water management procedures and low technologies.

Livestock Grazing in the Mbalika Wetlands

Other common activities included livestock keeping as it compromised 97.9% of all the agro-pastoralist respondents. Immigrant pastoralists formed 2.1%. Domestic animal kept mainly were cattle, sheep and goats. The median number of cattle per household with livestock was 12.0 (range 5 – 500) while median number of sheep and goats was 20.0 (range 2 to 600). Livestock population keeps on increasing from time to time, especially during the dry season due to in-migrating pastoralists with their herds. The in-migration is fueled by availability of pastures and water for livestock during the dry season which frequently causes conflicts between irrigation farmers and livestock keepers. A significantly ($P<0.05$) high number (40%) of the livestock keepers extensively grazed their animals within the Lake Victoria wetland area.

Due to the limited availability of alternative grazing pastures, the communities are compelled to use the wetlands as grazing fields. The wetlands around Lake Victoria (in Mwanza and Mara regions in particular) are traditional dry season grazing areas for livestock from inland districts in Mwanza, Mara and Shinyanga regions, which experience prolonged dry seasons. Most of the wetlands users agreed that the wetlands couldn't accommodate too many livestock. They explained that about 100 square metres is required per 15 cows in order to avoid overgrazing and excessive trampling that leads to gully erosion, which destroys the wetlands. They further reported that, there is intensifying competition for land between the two production systems. The increasing demand for arable land is putting much pressure on the available grazing lands. Fishing was another activity which constituted 7% of the respondents. The common fish available from Lake Victoria are Nile Perch and Tilapia.

Lake Victoria Basin Ecosystem Services

All the respondents reported that Lake Victoria basin was important for their livelihood and supported a vast number of domestic and wildlife. As part of ecosystem services, most respondents (95%) of all agro-pastoralits and small holder farmers reported several benefits they get from the lake namely: get fish, cool weather, good income because of tourism, horticulture, water (for irrigation and domestic animals), freshwater for domestic use, good pasture, timber, firewood, charcoal and cultural values (recreation and ecotourism, ethical values and rituals). Compared with the recent and historical past, respondents reported an increased use of the wetlands resources because of increased demand for settlements, food and grazing lands.

Spatio-Temporal Land Use and Land Cover Changes in Mbalika Wetland

Thematic maps derived from satellite images of 1984, 1985 and 2012 are shown in figures 1 and 2 while their area coverage are displayed in Table 2 The area under each land cover/use class was calculated and used for comparison and documentation of the temporal changes. Visual image interpretation was complemented with ground truth survey and socio-economic data collection from the field during the field survey. The results illustrated past and present processes impacting on the growth, development and the livelihoods of the communities in the Lake Victoria wetlands of Mbalika. The following results were drawn from the interpretations of Landsat satellite imagery of the Lake's wetland corridor of Mbalika.

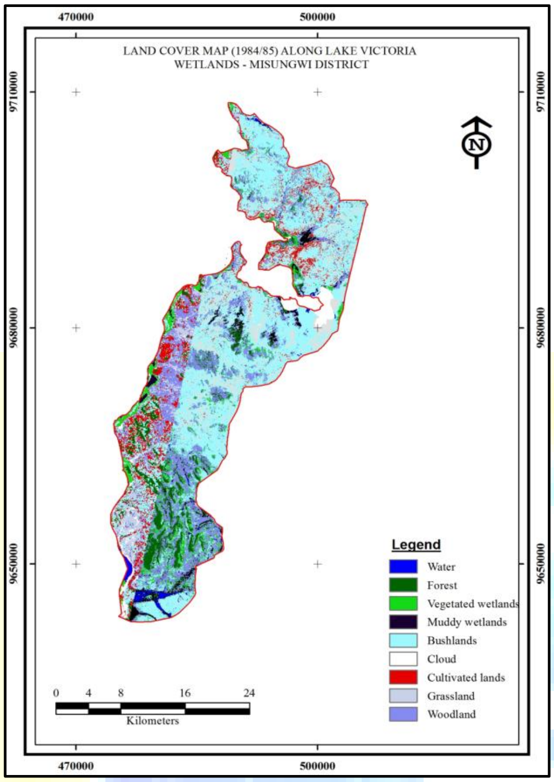

Fig. 1 Thematic map of Wards fringing Lake Victoria in Misungwi District 1984/85 from Satellite Imagery
Source: Mbalika Agro-pastoralists Migration Survey, 2012

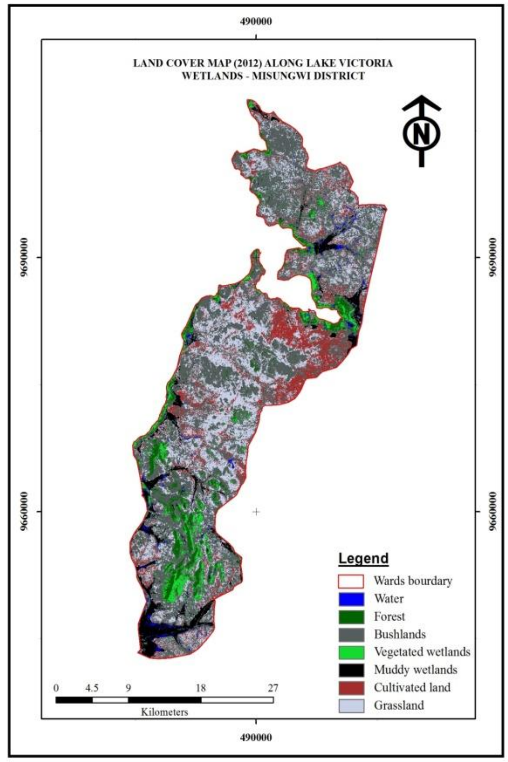

Fig. 2 Thematic map of Wards fringing Lake Victoria in Misungwi District 2012 from Satellite Imagery
Source: Mbalika Agro-pastoralists Migration Survey, 2012

Loss of Vegetation Cover

The land cover characteristics of the Lake Victoria wetland in Mbalika corridor were interpreted from Landsat standard false colour composite (bands 432 RGB) and the classification interpretation are shown in Table 2. The land cover classification results from the images analysis, showed the area of land cover/use and the percentage of those areas for each of the images by dates.

Table 2 Changes in Land Cover Classes in Lake Victoria's Wetland Corridor of Mbalika from Interpretation made from the 1984/85 and 2012 Landsat Images.

Land cover classes 1984/85		Land cover classes 2012		Rate of land cover change	
Class name	**Sum Area (Ha)**	**Class name**	**Sum Area (Ha)**	**Area (Ha)**	**%**
Bushlands	38456	Bushlands	39017	+561	0.01
Cultivated lands	6694	Cultivated land	7001	+307	4.4
Forest	6467	Forest	3651	-2816	(-0.77)
Grassland	8779	Grassland	17801	+9022	51
Muddy wetlands	1892	Muddy wetlands	4728	+2836	60
Vegetated Wetlands	3550	Vegetated wetlands	3080	-470	(-15.3)
Water	2131	Water	752	-1379	(-1.83)
Woodland	7271	Woodland	0	-7271	(0.10)
Cloud	790	Cloud	0	-790	(0.01)
TOTAL	**76,030**		**76,030**		

Source: Mbalika Agro-pastoralists Migration Survey, 2012

The broad classes of land use/cover established by interpretation included bushland, water, marshland vegetation, vegetated wetland, grassland, woodland, farmland, cloud cover and forest. Forest cover consisted of large and dense trees with definite tree trunks. Farmland referred to cultivated areas. Muddy vegetation is vegetation in marshland, which may be forest or wetland grasses such as sedge grass.

The satellite images analysis results for the area under study showed that the indigenous forest covered a total area of 3651 ha in 1984/85. By 2012 the forest cover had shrunk to -2816 with a rate of land cover change of -0.77%. Likewise, vegetated wetland area showed that the area has reduced so much from 3550 ha in 1984/85 to 3080 in 2012 equivalent to -470 ha (-15.3%). Cultivated land had increased from 6694 ha in 1984/85 to 7001 ha in 2012 indicating an increase of 307 ha (4.4%). The marshland cover area increased from 1892 ha in 1984/85 to 4728 ha in 2012 equivalent to 2836 ha (60%). This is a reflection of expansion of various land use activities in different periods.

Assessment of the Intensified Over-utilization of Wetland Resources of Mbalika Wetland

In this survey, it was observed that unsustainable agricultural activities in the Lake's wetland, water catchments, near river banks and around water sources accompanied with deforestation were common practices. Indeed, obvious extension of marshland which was observed in Lake Victoria's wetland in Mbalika corridor was partly caused by cultivation of rice using rain water harvesting techniques with structures known as *majaluba* (rectangular bounded fields, with heights from 25 to 100 cm) and extensive grazing of big herds of livestock. Many of the agro-pastoralist respondents (68%) reported to have their farms extended close to the Lake's wetland. The natural vegetation along the wetland was cleared to get more land for cultivation. Some of the farmers had their crops like banana grown close to the shore of the Lake, contrary to the established bylaws at Mbalika ward that prohibit cultivation. The rapid changes experienced in the wetlands between 1984/85 and 2012, are intricately difficult to point to a single factor to explain this land use/cover trend. However, residents in Ilujamate, Sumbugu, Mbalika and Igokelo during the focus group discussions attributed this to increase in population and the realization that there was a shortage of land. This made the communities to encroach the wetlands for cultivatable land to establish farms and gardens. Bucket irrigation was practiced by the people in the study area, during the dry season. In some places, cultivation had gone up to the water catchment areas.

A highly significant ($P<0.05$) number (97.5%) of small holder farmers reported that deforestation in Lake Victoria's wetland was a big problem and the main causes mentioned included timbering (66.3%), charcoal burning (65%), firewood (91.3%), construction (50%), logging (32.5%), 45% bush fire and clearing areas for farming (32.5%). Tree planting and other environmental conservation programs introduced by the government were present in all the study wards but were not implemented. About 84.5% of the both categories of respondents reported that excessive agricultural activities and increased livestock contributed to environmental degradation. Under conditions of heavy stocking rates, grass cover is destroyed, fires are normally eliminated, and erosion sets in and there after encroachment ensues. The development of grass cover is prevented by continuous grazing. An increase in erosion due to increased density of livestock as it was confirmed during the ground truth survey.

Discussions with small holder farmers on wetlands issues focused on the wetlands use, and how farmers gained the knowledge and skills necessary for actively managing their wetlands. Although it was expected that the community leaders and wetlands users would cite ancestral knowledge as a dominant source of wetlands information, most respondents stressed the importance of innovation in the draining and cultivation of wetlands.

According to the regression model, the log of households clearing land for agricultural activities was negatively related to education levels and awareness of degradation of wetlands ($P<0.05$) whereas positively related to the household size, awareness of relevant national policies (weak land use laws) and type of crops grown ($P<0.05$) (Table 3.3). In other words, household size, weak land use laws, and type of crops grown were statistically significant predictors of land use/cover change ($P<0.05$) compared to increasing livestock activities and education levels which were non-significant drivers of land use/cover change for small holder farmers but significant for agro-pastoralists in Mbalika Wetland Corridor ($P<0.05$) (Table 3).

Table 3 Main Drivers of Land Use/Cover Change

Predictor Variable	*B*	*S.E.*	*Wald*	*D*	*f*	*Odds Ratio*
Type of crops grown	5.43	.056	10.7	1	.001	1.21
Education levels	-.243	.212	1.23	1	.263n.s[a]	.722
Livestock activities	.644	.0359	.051	1	.648n.s[a]	1.01
Awareness of relevant national policies	2.03	1.03	29.21	1	.000*	214.02
Awareness of degradation of wetlands	-.546	1.002	21.72	1	.000*	224.87
Household Size	7.14	2.62	7.81	1	.003*	734.011

*Significant at P<.05, a = Not significant at P<.05

Source: Mbalika Agro-pastoralists Migration Survey, 2012

Forecasted Migration of Agropastoralists to Mbalika Wetland Corridor

A best fit logistic regression model identifying the relative importance of different factors influencing decisions for an individual adult male to migrate is applied here for agro-pastoralists. Empirical findings made it clear that the economic and ecological variables most commonly assumed to migration - poverty, and poor yields in the preceding season – were not major determinants of the decision to migrate. However, from the effect of environmental change, an agro-pastoralist household is far more likely to have an individual go if there are four or more adult males. Distance from the dry area where the environment is harsh due to persistent drought was more an influential variable and significant for short distances not exceeding 90 km. This indicates that migration of agro-pastoralists is much more pronounced when it involves a shorter distance. Majority of agro-pastoralist migrants in Mbalika area originated from surrounding districts and regions.

Table 4: Factors Influencing Agro-pastoralists to Migrate to Wetlands

Variable	Wald Statistic	Relative Probability of Exodus	Significance
Environment (km distance from the dry area)			
0-30	59.8		
31-60			
61-90		1.0	****
91-120		1.2	***
121-150		0.90	NS
		0.26	NS
		0.17	****
Age group	39.4		****
<24		1.0	****
24-30		2.96	**
31-39		1.93	**
40-52		1.86	NS
53+		0.66	
Household Production system	95.3		****
			****
Agropastoralist		5.15	*
Cultivator		0.06	
Household size	5.2		*
< 8			
8+		1.4	*

* = p< 0.05, **= p< 0.01, ***= p< 0.001, ****= p< 0.0001 NS = Not significant

Source: Mbalika Agro-pastoralists Migration Survey, 2012

Household production system is another strong determinant. Individuals from an agro-pastoralist household are over five times more likely to migrate than small holder farmers. Age and size of household from which the individual comes are both lesser significant influences.

Prediction of the Future Scenario of the Mbalika Wetland and its Catchments

The transition probability matrix was used to predict the future scenario of the Mbalika Wetland. It records the probability that each land cover category will change to the other category. This matrix is produced by the multiplication of each column in the transition probability matrix by the number of cells of corresponding land use in the later image.

For the 5 by 5 matrix table presented below, the rows represent the older land cover categories and the columns represent the newer categories. Although this matrix can be used as a direct input for specification of the prior probabilities in maximum likelihood classification of the remotely sensed imagery, it was however used in predicting land use land cover of 2027 fifteen years after the survey.

Table 5: Transitional Probability Table Derived from the Land Use Land Cover Map of1984/85 and 2012

Classes	Vegetated wetland	Cultivated land	Grassland	Forest land	Water	Woodland	Bushland
Vegetated wetland	0.1495	0.5553	0.0885	0.1969	0.0097	0.0122	0.3591
Cultivated land	0.1385	0.5132	0.1735	0.1692	0.0057	0.1342	0.0236
Grassland	0.0471	0.3902	0.5029	0.0507	0.0090	0.0043	0.1683
Forest land	0.2163	0.4050	0.0501	0.3203	0.0083	0.1276	0.0356
Water	0.1682	0.4378	0.0633	0.3174	0.0133	0.7612	0.9172
Woodland	0.1452	0.2451	0.0123	0.0013	0.1532	0.0271	0.7762
Bushland	0.2781	0.9563	0.1501	0.0035	0.3718	0.1721	0.5312

Source: Mbalika Agro-pastoralists Migration Survey, 2012

Row categories represent land use land cover classes in 2012 whilst column categories represent 2027 classes. As seen from the table, vegetated wetland has a 0. 1495 probability of remaining vegetated wetland in 2027 and a 0.5553 of changing to cultivated land in 2027. This therefore shows an undesirable change (reduction), with a probability of change which is much higher than stability. Cultivated land during this period will likely maintain its position as the highest class with a 0.5132 probability of remaining cultivated land in 2027. Grassland also has a probability as high as 0.5029 to remain as grassland in 2027 which signifies stability. On the other hand, the 0.4050 probability of change from forest land to cultivated land shows that there might likely be a high level of instability in forest land during this period. Water body which is the last class has a 0.0133 probability of remaining as water body and a 0.4378 probability of changing to cultivated land if the observed drought and retreat of the lake's water continues. Woodland with 0.0271 will remain as woodland but will change to bushland with 0.7762 as the continued trend of tree cutting prevails to cater for anthropogenic uses.

DISCUSSION

Findings from this study show that there are many unsustainable human activities which endanger the well-being of the Lake Victoria ecosystem. However, it is important to note that the lake also experiences some changes due to a combination of human activities and climate change, with potential serious implications for people's livelihoods and aquatic biodiversity (UNEP 2006). In tune with all these activities, environmental problems in Lake Victoria are diverse. This study recorded activities which range from overexploitation of the natural resources in the wetland to pollution discharges. Soil erosion in the basin was generally connected with cultivation, livestock and deforestations but specifically to farming methods and management. Deposition of soil in the lake and rivers leads to sedimentation. These uncontrolled human activities were rampant due to population increase, particularly incoming agro-pastoralists, poverty, poor policy governing agriculture and land use, low level of awareness of sustainable land use, agriculture and livestock keeping.

During the survey, it was observed that most of the land was either used for agriculture or grazing being escalated by an increase in human immigration both small holder farmers and agro-pastoralists to the areas. NBS (2002) and Niboye (2010) reported that the human population growth that could be supported by available agricultural land in Lake Victoria basin, by 2008 was in excess and the grasslands for pastoralists was overstocked. This observation concurs with (UNEP, 2006) which noted that population growth around Lake Victoria is significantly higher than the rest of Africa and it is the most densely populated rural area in the world. During each decade, population growth within a 100 km buffer zone around the lake outpaced the continental average. This reflects growing dependency and pressure on lake's resources. During the current study, it was observed that deforestation in Lake Victoria wetland was rampant and main causes mentioned included charcoal burning, firewood, timbering, logging, clearing areas for farming, construction, poor land practices, and extensive cattle grazing. Results of this study are similar to the studies by Copeland et al. (2010), Kangalawe and Liwenga (2005) and Ramsar (2009) who assert that poor farming practices and overgrazing have led to land degradation along with negative impacts on wetlands.

Tested data have further reinforced the notion that population is a key driver of land use/cover change over time. The fact that the higher the household size the more likely a household was to drive change falls into the land use/cover-population destabilization notion. This argument is reinforced by the assertion made by Ramankutty *et al.*, (2002) that the driving force for most land use change is population growth.

Another driver of land use/cover change in Mbalika Wetland Corridor is the weak environmental laws and policies. This is comparable to the findings made by Musamba, et al (2011) in his study about socio-economic activities around Lake Victoria in Musoma Municipality. The weak land use/cover conservation laws in Mbalika Wetland have been exploited by the local communities and are highly violated.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Consistent with the study objectives, it has been revealed that there is an alarming influx of agro-pastoralists and an increasing natural rate of population growth in the Mbalika wetland corridor. Overgrazing has adversely resulted into decreased plant species composition and loss of forage yield, leaving a lot of bare ground and bush encroachment. Household size and the weak environmental laws were the main drivers of land use/cover changes. Other drivers included; type of crops grown, unawareness of relevant national policies, all were statistically significant predictors of land use/cover change ($P<0.05$) for small scale farmers while for agro-pastoralists, household production system, and distance from the dry area were significant predictors. Time series satellite data have showed a general decline in the acreage of wetlands and vegetation cover implying increased anthropogenic pressure on the wetland resources. It is therefore concluded that environmental problems are deeply rooted in complex socio-economical issues, such as the concentration of population around the wetland corridor of the Lake, ambiguous and weak environmental jurisdiction and administration and underdeveloped regulatory framework. Unwise agricultural practices including uncontrolled use of dangerous agrochemicals, reclamation of wetlands for agriculture (mainly rice, banana and sugar cane) and other farming activities, are some of the major threats to which these wetlands are exposed. Given the scale of development and landscape modification occurring in the wetland areas of the Lake, it would be inequitable to rely on natural processes alone to protect the lake against present and future threats arising from surrounding poor land use.

Recommendations

Based on the findings of this study, the following recommendations are made. In order to protect the lake and its wetlands, agriculture, overgrazing and other human activities within the Lake's wetland must be managed in a way that ensures sustainability and minimizes adverse impacts. Appropriate policies and education about sustainable land management practices in the wetland, delivering wetland-scale benefits but which also create self-interest for local herders and farmers will help promote sustainability to the Mbalika wetland corridor. Measures that incorporate streamlining overstocking, agricultural malpractices, indiscriminate tree felling, extraction of fuelwood and charcoal production, boosting agro-forestry practices and monitoring the threatened wetland areas periodically including emphasis on awareness raising campaign are likely to restore the wetland corridor. Additionally, in order to maintain strong sustainability in wetlands usage, community households should invest in their young generation, who will be better equipped to utilise these resources. However, successful management of the lake and wetlands will depend more on the cooperation between government departments, local authorities and the general local community around.

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