Anthropogenical Drivers on Land Use/Cover Change and their Implications to Rural Livelihood in Kilombero Wetlands, Tanzania

1 Msofe, N.K., 2Lyimo J., 3Josephat Saria
1 Department of Environmental Studies
The Open University of Tanzania

[2]Institute of Resource Assessment
University of Dar es Salaam
Correspondence E-mail: nangware.msofe@out.ac.tz

Abstract: *Anthropogenic activities and their influences are well-known around the globe; their intensity and severity are higher in ecosystems rich in biodiversity and natural resources such as tropical forests and wetlands. This paper examined the influence of anthropogenic drivers on land use/cover change and their implications to rural livelihoods and wetland resources in Kilombero wetlands. Different methods including household questionnaire survey, key informants interview, focus group discussion, wealth ranking and participatory field observation were used in data collection. Remote sensing techniques were used to analyze satellite images – namely, Land sat MSS of 1975 and Land sat TM of 2010 scenes to trace spatial and temporal land use/cover changes. The study observed spatial and temporal changes in land use/cover mainly agricultural land use expansion and intensification, expansion of human settlementsand decreased forests and woodlands cover. Further, the study established that, the anthropogenic drivers to these changes were high population growth, removal of subsidies on agricultural input and the growing market demands for different agricultural and forest products, coupled with improved road and railway infrastructures. Moreover, other factors include rainfall variability and increased temperatures have also fuelled land use/cover changes. As a result of such changes, households have opted for diverse livelihood strategies to adapt the impacts of land use/cover changes depending on their ownership of livelihood assets, which varied from one socio economic group to another. In this context, the well-off group were found to have more livelihood assets that influence them to cope with situation as compared to medium and low wealth groups which possess relatively less assets. The study recommended to the government to facilitate participatory land use planning at village level, agro-forestry, provision of extensions services, and modern family planning services to check overpopulation for sustainable land use and improvement of rural livelihoods in and beyond the study area.*

Key words: Land use/cover changes, population growth, rural livelihoods, Land Use Plan

INTRODUCTION

Globally, land use/cover change has been occurring since 1950s due to rapidly growing human population that increased demand for food, fresh water, timber,

fibre and fuel (Lambin et al., 2003; Millennium Ecosystems Assessment, 2005; Kangalawe and Lyimo, 2010). The most significant land use/cover changes have been reflected through decreased forest cover, urbanization, agriculture expansion and intensification and conversion of natural habitat to pasture land (FAO, 1997; Lambin et al., 2003). These changes have currently become a global concern due to the negative impacts associated with them such as soil degradation, loss of biodiversity, and wetland degradation (Majule, 2003; Olson, et al., 2004; Maitima et al., 2009). According to Geist and Lambin (2002), human activities at the local level directly affect land use/cover types in specific area. They involve a physical action on land cover such as agricultural expansion, wood extraction and infrastructure development. Underlying drivers of land use/cover changes are formed by a complex of socio-economic, demographic, political, technological, and biophysical variables (Geist and Lambin, 2002).

Wetlands are considered to be among the world's most biological productive ecosystems and rich in species diversity (Mwakaje, 2009). They occupy about 6% of the world land surface (WWF, 2004). The potentials of wetlands are quite significant in Tanzania whereby it is estimated that 10% of the land surface is wetlands ranging from coastal marine to freshwater wetlands that provide essential ecosystem and livelihood support functions (URT, 2007). Wetland ecosystem functions include provision of habitats for biodiversity, regulation of local and global climate and nutrients retention and export (ibid). Moreover, wetlands provide fertile and moist soil for crop production, fishing areas, as well as green pasture and water for livestock especially during the dry season ensuring food security and income to rural communities (Kadigi et al., 2004; Yanda et al., 2004; Kangalawe and Liwenga, 2005).

Kilombero wetland is one of the wetlands which have been characterized by increased population pressure, high livestock population and increased demand for land resources (Kangalawe and Liwenga, 2005). All these factors may have contributed in shaping the land use/cover changes over time in Kilombero wetland. Thus, there is a need to assess and establish the extent to which human activities and other factors have influenced land use/cover changes; the direction of change and their implications on community livelihoods and wetland resources. Thus this paper assessed the land use/cover dynamics by tracing the spatial and temporal patterns of cultivated land, forest cover, woodlands, bushland and grasslands between 1975 and 2010, examined anthropogenic drivers and their implications to the rural communities' livelihood in the Kilombero wetlands.

RESEARCH METHODOLOGY

The study was conducted in Idete and Kiberege villages in Kilombero wetlands. Kilombero wetlands are located in Kilombero District lying between Latitude 7°30' to 8°15' South and Longitude 35°30' to 37°45' East (Figure 1). The main vegetations in the Kilombero wetlands are natural forests, wooded grass, deciduous Miombo woodland characterised by species of Brachystegia and Julbernardia(Kangalawe and Liwenga, 2005).

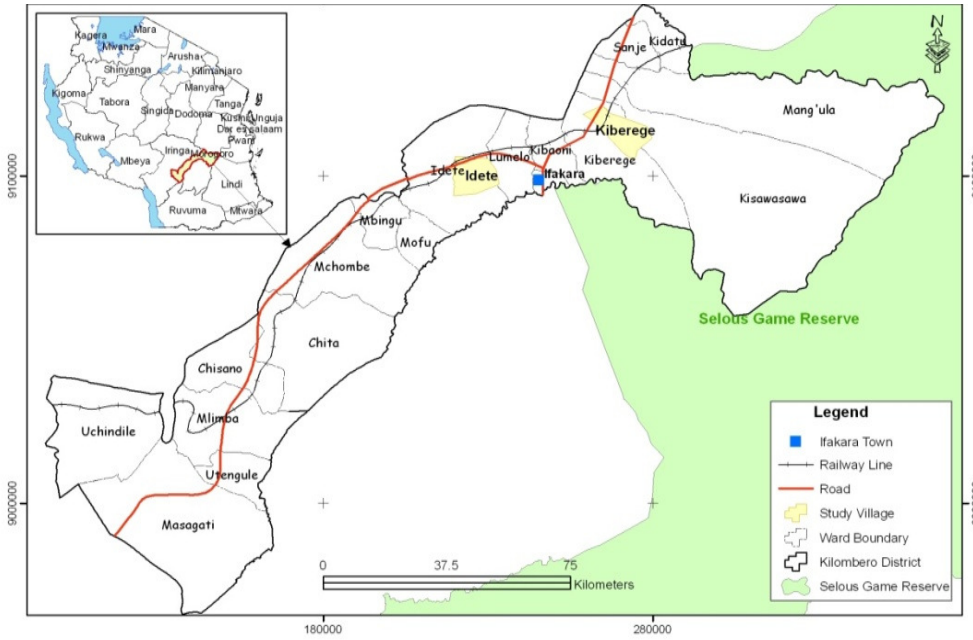

Figure 1: Geographical location of the study villages in Kilombero District
Source: Modified from Kilombero District topographical map of 2002

Different methods were used to gather quantitative and qualitative information such as livelihood diversity, type of wetland resources and their uses, socio-economic and physical aspects relevant tothe study. Secondary data on socio-economic and physical aspects were collected from various sources, both published and unpublished records, papers and other relevant sources.Primary data collection techniques involved include questionnaire survey, focus group discussion (FGD), key informants interviews, wealth ranking and participatory field observations. In questionnaire survey, the study used household as a sample unit whereby random sampling technique was employed in the selection of households for interviews. A sample size of 10% of households constituting a total sample size of 150 householdswas randomly selected from each village for interview. A group of twelve people including community leaders, the elderly, youth, women and influential people were randomly chosen to participate in each FGD. Two focus group discussions were conducted one from each village. Similarly, people involved in FGD were also participated in categorization of household into different socio-economic groups, wealth ranking depending on their perception of wealth and poverty in their respective villages.

The qualitative data collected were analyzed basically by content analysis. The quantitative data were edited, coded and entered in the computer programme known as Statistical Package for Social Science (SPSS) software version 16 for analysis. The results from this analysis were presented in form of pie charts, tables of frequency, percentages and cross tabulation distribution to compare different variables within and across the villages.

Moreover, land use/land cover maps that provided an insight on the extent of land use/cover changes over spatial and temporal dimensions were generated from the analysis and interpretation of Land sat MSS and Land sat TM satellite images captured on 13th July 1975 and 20th December/2010 respectively. The analysis was done through Geographical Information System (GIS) computer software, Arc View Version 3.2.

RESULTS AND DISCUSSION

Land Use/Cover Change between 1975 and 2010

The GIS Analysis showed that there was an overall increase in area under cultivation and settlement while area under forests and woodland cover has significantly decreasedin the Idete and Kiberege villages entailing high deforestation rate (Figures 2a & b and Figures 3a &b).

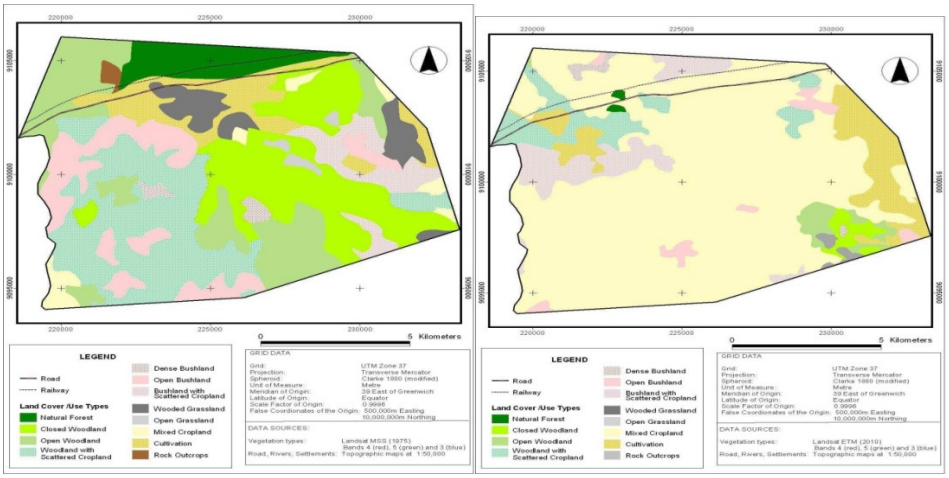

Figure. 2a: Land Use/Cover Map of 1975 in Idete village
2b: Land Use/Cover Map of 2010 in Idete village
Figure. Source: IRA, GIS lab

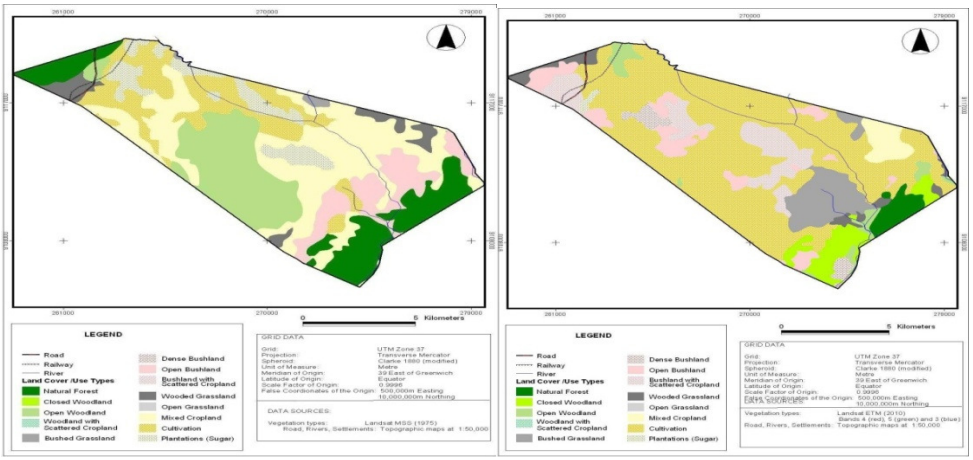

Figure. 3a: Land Use/Cover Map for 1975 in Kiberege village
Source: IRA, GIS lab

Figure. 3a: Land Use/Cover Map for 2010 in Kiberege village
Source: IRA, GIS lab

Cultivated land

The area under cultivation in Idete village has substantially increased from 10.9% (1,464 ha)in 1975 to 80.2% (10,765 ha) in 2010 implying an increased change of 635% (Table 1). In Kiberege village, land under cultivation has increased by 10.8% from 53.3% in 1975 to 59.3% in 2010 (Table 2).

Table 1: Land-use/cover types for Idete village (1975–2010) expressed as percentages of total village land

Land Use/Cover Types	1975	2010	Cover Change between 1975-2010
Bushland	16.7	9.4	-43.4
Cultivated land	10.9	80.2	+635
Forests	6.3	0.3	-95.9
Grasslands	6	0.5	-90.9
Woodlands	59.7	9.6	-84
Rock Outcrop	0.5	NA	-100

- = Decrease, + = Increase, NA = Not applicable
Source: Analysis of Satellite Images from 1975 and 2010.

Table 2: Land-use/cover types for kiberege village (1975–2010) expressed as percentages of total village land

LandUse/Cover Types	1975	2010	Cover Change between 1975-2010
Bushland	10	19	+90.4
Cultivated land	53.5	59.3	+10.8
Forests	14.2	2.7	-80.7
Grasslands	4.4	10.4	+139.3
Woodlands	18	8.5	-52.4

- = Decrease, + = Increase, NA = Not applicable
Source: Analysis of Satellite Images from 1975 to 2010.

Forests cover and Woodlands

The analysis shows that at Idete village there was a significant decrease in forests cover by 95.5% from 839 ha (6.3%) in 1975 to 34 ha (0.3%) in 2010 (Table 1); while at the same time forests coverage at Kiberege village decreased by 80.7% from 14.2% in 1975 to 402 2.7%) in 2010 (Table 2). Woodlands which represented the largest proportion of land cover at Idete village (8016 ha) in 1975 has decreased by 84.0% in 2010; whereas woodland cover at Kiberege village decreased by 52.4% from 18% ha in 1975 to 8.5% in 2010 (Tables 1 & 2).

Bushland and Grasslands

The area under bushland in Idete village has considerably decreased from 16.7% in 1975 to 9.4% in 2010 implying decreased change of 43.3%, while grassland has decreased by 90.9% (Table 1). These changes imply that much of natural vegetation in Idete village has been cleared to provide land for cultivation at the expense of the natural vegetation cover. As opposed to Idete village bushland in Kiberege village bushland has increased by 90.4% from 1464 ha in 1975 to 2788 ha in 2010 while area under grassland has substantially increased by 139.3% (Table 2). This was

observed to be the impact of Kiberege village conservation measures for natural vegetation.

Anthropogenic Driving of Land Use/Cover Change

The study has shown that changes in land use/cover types over time has been influenced by demographic dynamics, economic factors such as market prices and access, technological advancement, biophysical factors and government policies.

Demographic Dynamics

Demographic variables which were assessed in this study include population size, household size and age profile in the study area. According to population census reports and village profile of 2010, the studied villages have experienced increasing population size within time period of 32 years (Figure 4).

Table 3: Place of origin for respondents

Place of origin	Idete village (%)	Kiberege village (%)	Total (%)
Born in the village	33.9	50	44.2
Outside the region	50.0	13	26.3
Outside the village but within the district	8.9	21	16.7
Outside the district	7.1	16	12.8
Outside the district	7.1	16	12.8
Total	**100**	**100**	**100**

Source: Field Survey, 2011

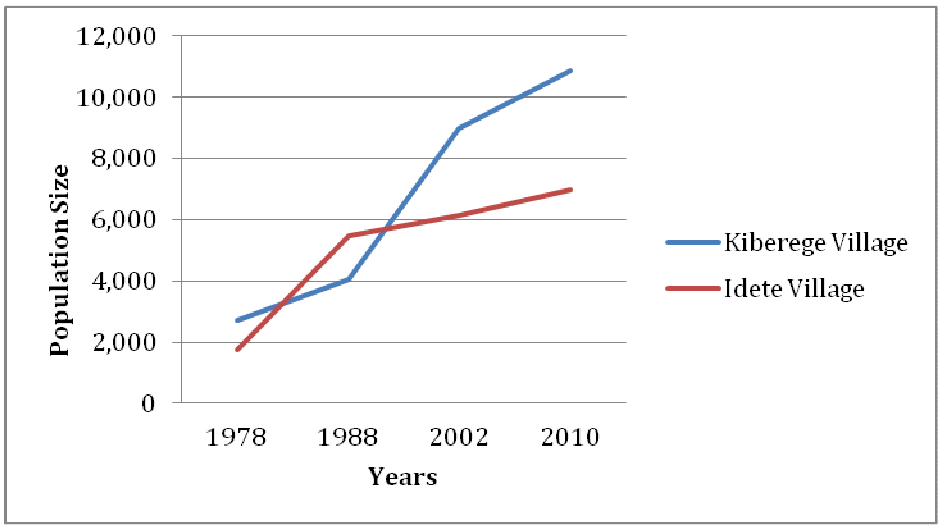

Figure 4:Population size of the study area

Source: URT (1978, 1988 and 2003 and the Idete and Kiberege villages Profiles of 2010)

The observed population increase is contributed by 44.2% of natural increase and 55.8% of internal migration of people from different parts of the country (Table 3).

Through questionnaire survey it was revealed that 65% of the household size range from 4-10 family members. This implies that most of the household need to produce more food to sustain their families, consequently results into agriculture expansion into marginal areas, agriculture intensification and deforestation. And that 50.6% of the total respondents were people with age ranging between 35-60 years. This implies that there is large active labour force involved in the exploitation of the wetland resources, especially farming as 99.9% and 98.9% of the total respondents in Idete and Kiberege villages, respectively depend on farming as a major livelihood activity. In addition, household questionnaire survey revealed that population change in the area has contributed into expansion of cultivated land and human settlement (49%), forest destruction (40%) and reduction of the pasture land (11%).

The linkage between population and land use/cover changes can also be traced back to the Malthus and Boserup theories. Malthusian theory postulates that the power of population growth if unchecked is indefinitely greater than the power to produce subsistence for mankind (Malthus, 1960). According to Malthus growing rural population increases more demand on agriculture to feed the ever-increasing population, leading to expansion of agricultural land to the marginal land, land fragmentation, decreased productivity and famine, a pathway to poverty and environmental degradation. Similarly, the neo-Malthusian consistently argues that natural resources (land) are absolutely limited and finite, and that the increasing population leads to agricultural expansion, deforestation, and desertification. This is because more people consume more trees (deforestation) and more food (agriculture). Thus, the solution is to limit the number of people/consumers/polluters through the use of contraceptives. Boserup (1965 and 1985), focusing on the same issue of population deviates from Malthus (1960) assumption of constant technology by emphasising the role of high population growth in stimulating land use change (agricultural intensification) through development and adoption of new technologies.

Impact of Market Price and Access on Land Use /Cover Change

The role of market in fuelling land use/cover changes has been facilitated by policy changes and transport infrastructures improvement. The implementation of market liberalization policy has resulted into removal of state monopoly on agricultural marketing that opened agricultural markets to private sector (Kato, 2007). These enabled private vendors to go to the villages and purchase agricultural produce consequently leading to high demand for agricultural products that facilitates agricultural expansion and intensification. In the study area, it was observed that high market prices and urban demand for cash crop such as rice and horticultural crops have motivated farmers to increase production through land expansion and intensification in the Kilombero wetlands.

This is similar to what Gleave and White (1969) suggested that the production of cash crop could lead to land use intensification and that changes in market in terms of price incentives create changes in land use. The role of market prices in agricultural intensification has also been demonstrated in von Thunen's model of the "isolated state" (Hall 1966; Brush and Turner 1987; Dicken and Lloyd, 1990).

Moreover, improved road and railway infrastructures have enhanced accessibility to and from the studied area. This eased access to the markets for agricultural and forest products leading to increased deforestation rate and wetland resource utilization through agricultural intensification and expansion into the marginal areas.

Impact of High Agricultural input Prices on Land Use/Cover Change

About 46.8% of the respondents, reported that agriculture inputs - particularly fertilizers - were expensive and therefore unaffordable by the majority, hence making farming less profitable. FGD revealed that due to increased prices of agricultural inputs, respondents with less purchasing power adopted different measures to substitute for fertilizers. Some of these measures include reduction in the use of agriculture inputs, crop diversification with leguminous crops and farm expansion through clearance of new farm land to compensate for declining yield due to limited access to inputs. Key informant interviews also indicated that the reduction in the use of agricultural inputs decreased crop yields, compelling household to engage in nonfarm economic activities such as selling charcoal as an alternative source of livelihood, hence deforestation and destruction of the environment.

Impact of Biophysical Factors on Land Use/Cover Change

Biophysical factors such as climate change and variability (rainfall and temperature) terrain, soils, and accessibility to irrigation water have an impact on land use/cover change. Through FGD and household survey, the study revealed that there has been climate change/variability interms of rainfall variability and increased temperature. About 63% of total households interviewed observed variability in rainfall amount.

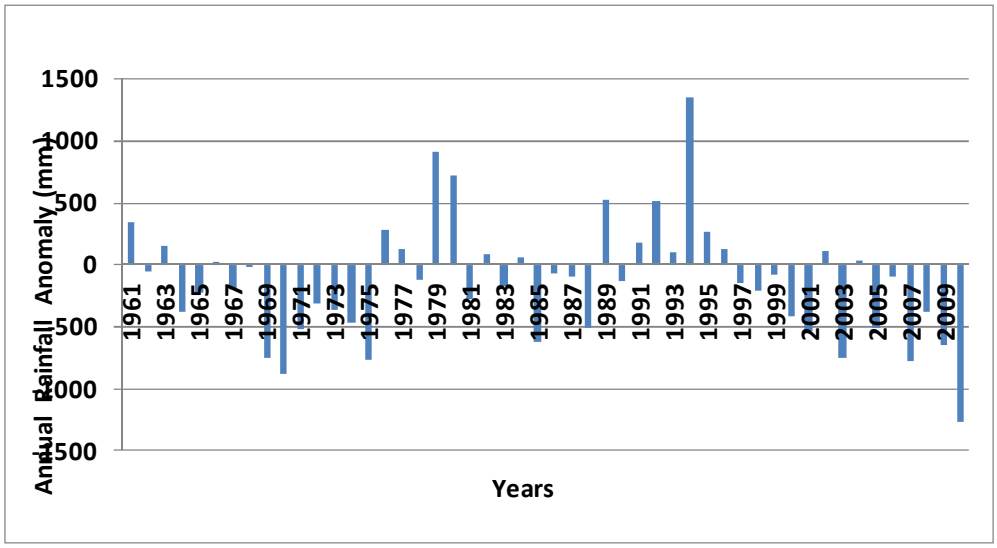

Figure 5: Annual Rainfall Anomaly (1961-2010) from KATRIN and Mahenge Hospital Stations, Kilombero District

Source: TMA, 2011

This was supported by rainfall data analysis from Tanzania Metrological Agency (TMA) (Figure 5). As the result of rainfall variability and change, villagers had changed their farming practices including 40.4% of the total respondents cultivating in the wetland, (35.9%) change types of crop planted and (8.4%) changed crop planting time.

Focus group discussions and questionnaire survey indicated that farmers were switching from cultivating rice to upland crops such as maize, peas and cassava which can tolerate drought, pests and diseases. Moreover, it was reported that other farmers, due to rainfall variability coupled with frequent drought seasons and prolonged dry spell were compelled to expand cultivation into the wetland as the adaptation strategy.

On the other hand, analysis of temperature data from Tanzania Metrological Agency showed that temperature has gradually increased over the last 16 years. Both minimum and maximum temperature showed an increasing trend. Minimum temperature has increased faster (R^2=0.52) while maximum temperature increased steadily (R^2=0.32) (Figure 6). Both maximum and minimum mean annual temperature increased by 2^0C in last 16 years.

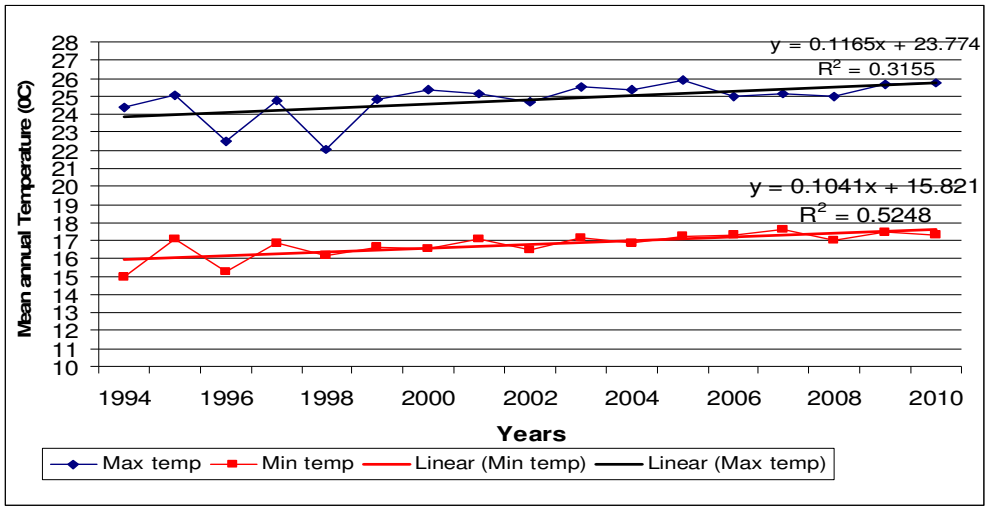

Figure 6: Kilombero Annual Mean Minimum and Maximum Temperature (^{0}C) 1994 to 2010, from KATRIN station
Source:TMA, 2011

The findings shows that 74% of total respondents claimed that the increased temperature has contributed to increased incidence of weeds, diseases and pests such as stock borers and rice yellowing viruses that affects crop production. Therefore, the observed variability in rainfall patterns and increasing temperature trends have influenced agricultural expansion in the wetland and in changing farming practices in the study area.

Impact of Terrain Characteristics on Land Use/over Change
Focus group discussions revealed that the terrain characteristics of Kilombero wetland compel people to engage themselves in agricultural production. The flat terrain and heavy black alluvial soils coupled with high water holding capacity

support agricultural production in the wetland especially for in-water thriving crops such as rice. These soils are also preferably used for intercropping crops such as tree crops, bananas and sugarcane. Moreover, these soils support natural vegetation and pasture for grazing during dry season influencing large scale livestock keeping in the Kilombero wetland. Both crop production and livestock keeping accelerate changes in land use/cover types in the study area. Therefore, terrain characteristics have partly contributed to land use/cover changes in the study villages.

Influence of Government Policies on Land Use/Cover Change

The government policies and weak institutional framework that govern the natural resources use and management have - to the large extent, influenced land use/cover changes in the Kilombero wetlands. During FGD and key informant interviews it was revealed that Villagization Policy of 1974, National Forest Policy of 1998 and Agricultural Strategies are among policies that influenced land use/cover changes in the study area. Villagization policy which was implemented in Tanzania - including the study area, was associated with reallocation of settlements from scattered settlements into dense and nucleated villages (Kikula, 1997). Through FGD villagers reported that implementation of this policy had contributed to migration of the farmers and poor urban dwellers from Iringa, Mbeya and Kilimanjaro regions into their villages, thus increasing population pressure on wetland resources.

Also, private investment in the forestry sector encouraged by the National Forest Policy of 1998 influenced the conversion of Miombo woodland into teaks plantations in Idete village. About 1,000 ha of Miombo woodlands in Idete village have already been cleared for teaks plantations to date. The current agricultural strategy under the theme "Kilimo Kwanza" and its interventions has to some extent encouraged farmers to expand land under cultivation into the wetlands as well as clearing woodlands for crop cultivation. In Kilombero wetlands, there are various ongoing interventions including River Basin Management-Smallholder Irrigation Improvement (RBMSIIP) that aimed at providing improved irrigation and drainage facilities to increase rice yields and total crop production and Programme Participatory Agricultural Development Programmes (PADEP) that aimed at raising the production of food, incomes, and assets of participating households and groups through the implementation of small agricultural development sub-projects planned and managed by groups of farmers.

Impact of Land Use/Cover Change on Rural Livelihoods

Impact of land use/cover changes on livelihoods focused on major activities mainly crop production, livestock keeping, fishing and non-farm economic activities. Crop production is a major livelihood activity in the study area as reported by 99.9% and 98.9% of the respondents in Idete and Kiberege villages, respectively. Besides crop production (farming); livestock keeping, fishing, petty business and causal labour are imperative economic activities used to complement income from farming.

Household Socio-Economic Group and Livelihood

The extent of household involvement in livelihood activity depends on the household socio-economic status. The study found that there are three major socio-

economic groups that reflect differences in household ownership of livelihood assets such as land, cattle, financial capital, ability to hire labour and access to agricultural inputs and small scale irrigation schemes. Those socio-economic groups are the welloff 'Mbupa kibupa/Lindu', medium wealth group 'Hali ya kawaida' and low wealth group (LWG) 'Muloofa/Mgalauke pasi. Social characteristics of the welloff include the ability to own a plot of land >10 acres, own 3-10 cattle, have burnt bricks houses roofed with iron and cemented floor, have household income more than 1,000,000/=, own milling machine, have food surplus and enough cash to buy crops for selling, own shop, can hire labour, use agricultural inputs and can hire a tractor. Those in the medium wealth group owns 3-5 acres, 2 cattle and chicken, have a house made of burnt bricks house roofed with grass, have enough food, sometime hire labour. Those in the low wealth group own 1-2 acres of land, one cattle and few chicken, have mud house roofed with grasses, household income less than 200,000/=, not food secure, they sell labour, have big household size and cannot afford agricultural inputs - thus encroach the forest for farming. This shows that welloffs are able to exploit the existing opportunities associated to land use/cover changes such as expansion and intensification of land use to optimise their livelihood compared to other socio-economic groups.

Impact of Land Use/Cover Change on Crop Production

Key informant interviews revealed that land use/cover changes associated with increased frequency of cultivation without replenishing soil nutrients, deforestation and soil erosion in the study area have resulted into decreased crop production. Moreover, questionnaire survey revealed that 58.5% of the total respondents observed general decrease in crop production while 35.1% observed crop production remained the same and only 6.4% observed an increase in crop production. Decreased crop production affected the livelihood of the people in the study area. However, through FGD and key informant interviews it was reported that the welloffs were not impacted by decrease in crop production since their relatively endowed with more livelihood assets which enable them to cultivate large farms, especially in the wetland. Also, due to their financial strength they have access to agricultural inputs, can employ labour mostly from LWG and few from the medium group, can hire and some own tractors which enable them to cultivate and manage large farms, consequently high crop productivity and increased income as compared to other socio-economic groups.

Impact of Land Use/Cover Change on Livestock Keeping

Eighty five percent of the livestock kept are indigenous cattle and goats while 15% were improved dairy cattle for milk and meat production. Livestock are grazed in the wetland under free-range system except for improved dairy cattle. FGD revealed that the increased demand for agricultural land and land for settlement and establishment of teaks plantations has considerably decreased the grazing lands. Such circumstances have compelled some of the livestock keepers to take their animals far away in search of pasture. While some livestock keeper remain behind competing on little available resources, consequently causing conflict among the resource users.

Moreover, key informant interview reported that the well-off households who owns more livestock especially cattle were less impacted by decrease in grazing land compared to other socio-economic groups, as they have more livelihood strategies, owning better income and other livelihood assets that make them able to utilize wetland resources to support their livelihood. Such socio-economic groups hired people to take care of their animals far away where there is enough pasture and water.

Impact of Land Use/Cover Change on Non Farming Economic Activities

Fishing, casual labour and petty business are the commonly non-farm economic activities carried out in the study area. Key informant interview revealed that the expansion of crop land into the wetland, high livestock grazing pressure and deforestation negatively affect fish breeding sites thus, reducing availability of fish and fish catch. And this has more impact on LWG because this group depend much on this activity compared to the welloff and medium wealth groups. Diversifications to non-farm economic activities were reported by focus group discussion to increase an important source of income as well as adaptation to the impact of land use/cover changes. The activities involved are food vendor, casual labour, kiosk and selling of crops, burnt bricks and charcoal. The extent of involvement of household depends on the nature of the activities. Many households in welloff and very few from medium wealth groups are involved in activities which demands more capital such as buying crops, running shops/kiosks and selling burnt bricks and wood products such as timber. Moreover, it was reported that non-farm livelihood activities have increased opportunities to compensate for the declined crop production in the study area.

Land use/cover change through agricultural expansion and intensification has enhanced the opportunities for casual labouring, giving rise to high market demand for hired labour. The study found that about 70% of the households in LWG and 18% in the medium wealth group were engaged in casual labouring to obtain income. This implies that land use/cover changes have positively impacted by increasing income of the LWG who mostly engage themselves in casual labour compared to the medium wealth group and well-off group.

CONCLUSION AND RECOMMENDATION

It was established from this study that Kilombero wetland area has experienced spatial and temporal changes in land use/cover types towards expansion and intensification of cultivated land, decreased forests and woodland cover. The anthropogenic drivers to land use/cover changes are rapid population increase creating more demand of land for agricultural production, settlement and pasture. Also, market development as conditioned by road infrastructure improvement and market liberalization policy has influenced changes in land use/cover patterns in Kilombero wetlands. Biophysical factors mainly rainfall variability and increased temperature patterns have to some extent influenced land use/cover change and increased cultivation of wetlands. Land use/cover changes have negative implication to community livelihood sources including decreasing crop and livestock production and destruction of fish habitats which negatively affected the income of the people that depends on such livelihoods. However, households have

responded differently to these changes depending on their livelihood strategies and ownership of assets which are reflected by different socio-economic groups. The study recommended that Kilombero district council should initiate participatory land use planning, provision of modern family planning services to check overpopulation, facilitate afforestation programmes at village level and provision of inputs and financial credits to enhance crop productivity and to ensure a sustainable land use management.

ACKNOWLEDGMENTS
This paper is based on a research undertaken with financial support from University of Dar es Salaam Sida/SAREC for which the authors are grateful.Authors are also thankful to the Institute of Resource Assessment (IRA) for providing guidance and logistical support during this study. Finally, authors would like to thank the Idete and Kiberege villagers for their enthusiastic participation in this study particularly in the participatory rural appraisal (PRA) sessions and household interviews. Authors would also like to thanks officers in the department of Natural Resources and Food Security in Kilombero District for their cooperation during the fieldwork in Kilombero District.

References

Brush, S. P. and Turner II, B. L. (1987). The Nature of Farming System and Views of their Changes. In Turner II, B.L. and S.B. (Eds). *Comparative Farming Systems*. The Guilford Press: London.

Boserup, E. (1965). *The Condition of Agricultural Growth*. Aldine: London.

Boserup, E. (1985). Demographic Interrelationships in Sub Saharan Africa, *Population and Development Review* **11**:3

Dicken, P. and Lloyd, P. E. (1990). *Location in Space*. Harper Collins Publishers.

Food and Agriculture Organization (FAO) (1997). "Agriculture and climate change: FAO role". Information Division, Viale delle Terme di Caracall, Italy. FAO.

Geist, H. J. and Lambin, E. F. (2002). "Proximate Causes and Underlying Driving Forces of Tropical Deforestation", *BioScience*, **52**(2):143-150

Gleave, M. B. and White, H. P. (1969). Population Density and Agricultural System in West Africa. In M. F. Thomas and G. W. Whittington (eds.), *Environment and Land use in Africa.* London, Pp 273-300.

Hall, P. G. (1966). Von Thunen's Isolated State. Oxford: Pergamon Press.

Kadigi, R. M. J., Kashaigili, J. J. and Mdoe, N.S. (2004). "The Economics of Irrigated Paddy in Usangu Basin in Tanzania: Water Utilization, Productivity, Income and Livelihood Implications", *Physics and Chemistry of the Earth,29*: 1091-1100

Kangalawe, R. Y. M. and Liwenga, E. T. (2004). "Sustainable Development and Management of Wetlands in Tanzania: A Case Study of Kilombero Valley". Final Consultancy Report Submitted to FNPP.

Kangalawe, R. Y. M. and Liwenga, E.T. (2005) "Livelihoods in the Wetlands of Kilombero Valley in Tanzania: Opportunities and Challenges to Integrated Water Resource Management", *Physics and Chemistry of the Earth,***30**: 968–975

Kangalawe, R. Y. M. (2009). "Land Use /Cover Changes and their Implications on Rural Livelihoods in the Degraded Environments of Central Tanzania", *African Journal of Ecology,* **47**: 135-141

Kangalawe, R.Y.M and Lyimo J. G. (2010). "Population Dynamics, Rural Livelihoods and Environmental Degradation: Some Experiences from Tanzania", *Journal of Environ Dev Sustain,* **12**: 985–997

Kato, F. (2007). "Development of a Major Rice Cultivation Area in the Kilombero Valley Tanzania", *Africa Study Monographs,* **36**: 3-18

Kikula, I.S. (1997). *Policy Implications on Environment. The Case of Villagization in Tanzania.* Dar es Salaam University Press

Lambin, E. F., Geist, H.J. and Lepers, E. (2003). "Dynamics of Land Use and Land Cover Change in Tropical Regions", *Annual Review of Environment and Resources,* **28**: 205-241

Lyimo, J. G. (2005). Changes in Agricultural Land Use and Household production in Tanzania. A case of small farm holders in the Usangu Plain, Mbarali District. PhD Thesis, Faculty of Science University of Copenhagen.

Maitima J. M., Mugatha, S. M., Reid R.S., Gachimbi L.N., Majule A., Lyaruu H., Pomery D., Mathai, S. and Mugisha, S. (2009). "The Linkage between Land Use Change, Land Degradation and Biodiversity across East Africa" *Africa Journal of Environmental Science and Technology*, **3**: 310-325.

Majule, A. E. (2003). "Impacts of land Use/ Land Cover Change on Soil Degradation and Biodiversity on the Slopes of the Mount Kilimanjaro, Tanzania", LUCID Project Working Paper: 26, University of Dar es salaam.

Malthus, T. (1789 and 1803, republished 1960). First Essay On population (First Essay on Population, 1978 and second essay on population, 1803). Modern Library and Random House, New York.

Millennium Ecosystem Assessment (MA) (2005), "Ecosystems and Human Well–being: General Synthesis". Island Press: Washington DC.

Mwakaje, A.G. (2009). "Wetlands, Livelihoods and Sustainability in Tanzania", *African Journal of Ecology*, *47*: 179-184

Olson, J., Misana, S., Campbell, D., Mbonile, M. and Mugisha, S. (2004). "The Spatial Pattern and Root Causes of Land Use Changes in East Africa". LUCID Project Working Paper 47.

United Republic of Tanzania (URT), (2003). *2002 Population and Housing CensusGeneral Report.* Government Press: Dar es Salaam, Tanzania.

United Republic of Tanzania (URT), (2007). *National Wetland Strategies Draft*. Ministry of Natural Resources and Tourism: Dar es Salaam.

United Republic of Tanzania (URT), (2007). *National Adaptation Programme of Action (NAPA)*. Vice President's Office, Division of Environment: Dar es Salaam.

WWF (2004), The Economic Values of World's Wetlands. Luke Brander Institute for environmental studies: The Netherlands.

Yanda, P. Z., Majule, A. E. and Mwakaje, A. G. (2004). "Wetland Utilisation, Poverty Alleviation and Environmental Conservation in Semi rid Areas of Tanzania. The Case of Singida Regions". A Report presented in REPOA 9th annual workshop.