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Land Use Cover Changes and Household Livelihoods Adaptation Strategies in Mbulu and Karatu Districts, Tanzania

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Abstract

The interactions between the human and the biophysical factors at different spatial scales have triggered Land Use Cover Changes (LUCC). The study uses both qualitative (in-depth interviews and focus group discussions) and quantitative techniques (household survey and spatial data analysis through the use of Geographical Information Systems (GIS) to acquire information and data for the study. The results have shown that overall LUCC is decelerating in both districts, Mbulu and Karatu across the two-time intervals. In the period between 1987and 2001, cultivation, settlements, wetland, grasslands and bare soils gained at the expense of forest, woodland, bush-land, and water. However, in the period between 2001 and 2015, again cultivation, settlements, wetland and bare soils gained except grassland which joined the categories of losers. The results have also revealed that communities have engaged in long term adaptation strategies to cope with the impacts of land use and land cover changes in the study area. These included agricultural intensification, afforestation programs and engaging in non-farming activities such as bee keeping and tourism. Despite the existing adaptation strategies to LUCC impacts in the study area, still community empowerment for enhancing the strategies is needed. This is due to the fact that, the community has limited options for livelihoods diversification that can absorb shocks and trends attributed to land use/cover change impacts over time and space.

Keywords: *Land use cover; impacts; households' livelihoods; adaptation; Tanzania*

Introduction

Land Use Cover Change (LUCC) is a global challenge in agro-pastoral communities (Armah et.al. 2016). The impacts of LUCC on the livelihoods and living conditions of poor people in East African countries will continue to be more pronounced due to less adaptive capacity such as low technology, low capital, and poor environmental conservation skills compared to their counterparts (Paavola, 2001). Long-term changes in LUCC will disproportionately affect the semi-arid and arid parts of the globe and the more humid tropics. Within these areas, the effects vary across regions, farming type and food systems, households and individuals. The United Nation's Inter-Governmental Panel on Climate Change (IPCC) stated that Africa in general, and

sub-Saharan Africa in particular, is highly vulnerable to impacts such as widespread poverty, inequitable land distribution, over-dependence on rain-fed agriculture, and recurrent droughts (IPCC 2001). Considering that the African continent is warmer now than 100 years ago (Hulmes et al., 2001), these impacts are likely to become more prevalent.

Armah et al., 2015 revealed that historical data shows that, temperature in Africa has increased by 0.7^0 C during the 20th century. Contrary, to the increased temperature, rainfall has decreased in the Sahel, the Eastern and Central Regions. In East Africa the temperature is expected to increase by 0.5^0 C per decade with the hope of increased frequency and magnitude of rainfall. Hulmes et al. (2001) noted that more climate risk is expected in East- Africa, particularly in Tanzania. This is partly explained by the solely dependence of local people on land resources in attaining their daily livelihoods (Carney, 1998; John et al., 2014). The increased change in land use cover is also related the current extreme meteorological events such as droughts and floods that have profound impacts on the agricultural systems resulting to changes in community livelihoods from purely farming and pastoralism to mixed farming.

The studies by John et al. (2014), Armah et al. (2016), and URT (2011) have documented the effects and adaptation strategies to climate change on agricultural practices and biodiversity in Tanzania. However, little is known on the impacts of LUCC on household livelihoods and their adaptation strategies in rural communities in Tanzania. The current situation in the country reveals that agro-pastoral community is vulnerable to the impacts of LUCC. Therefore, the study examined the household adaptation strategies for LUCC impacts on rural communities in Mbulu and Karatu highlands.

This paper is divided into seven major sections. The next section describes theoretical perspectives on land use/cover changes and adaptation strategies; and is followed by a section on a synthesis of nature-society and livelihoods adaptation nexus. Section four deals with the materials and methods used in data collection and analysis. Section five presents the results of the study while section six is a discussion of the findings. The last section is a conclusion of the study, and provides some policy recommendations.

Theoretical Perspective on Land Use Cover Changes and Adaptation strategies

The principal question to this theoretical view is "how man relates to nature", which translates into the more common and popular question of "man's role in the human causes of the global environmental change" (Briassoulis, 2000). In this context, the study considers the totality of the interactions between the intra and inter human (socioeconomic factors) and the nature (ecological factors) under the prevailing political factors (including policies and institutions), that resulted into LUCC and their respective adaptation strategies (Figure 1).

Community is considered as the distal driver, and socio-economic, ecological, and political factors as proximal drivers of LUCC. Figure 1 shows feedback arrows linking these drivers to LUCC and adaptation strategies at individual and community levels. In Figure 1, three feedback loops are discernible. One hoop exists between community land through socio-economic, ecological and political factors, which linked to LUCC. Another loop exists between socio-economic, ecological and political factors, which are linked to LUCC over time and space. Third direction existed between LUCC and adaptation strategies actuation system. This stable environment is expected to triggered balance in socio-economic, ecological and political factors towards effective and efficient community land use to attain sustainable livelihoods. The loops between each sub-system can either be reinforcing or balancing. For instance, out-migration reinforces (increases) the establishment of human settlement in destination communities whereas it balances (reduces) the establishment of such settlements in the original community. The arrows represent unidirectional, bidirectional, linear and non-linear causal relationships. The study attempted to treat the community, environment and land use concretely and comprehensively – as material entities relating to one another and to that impinge on them.

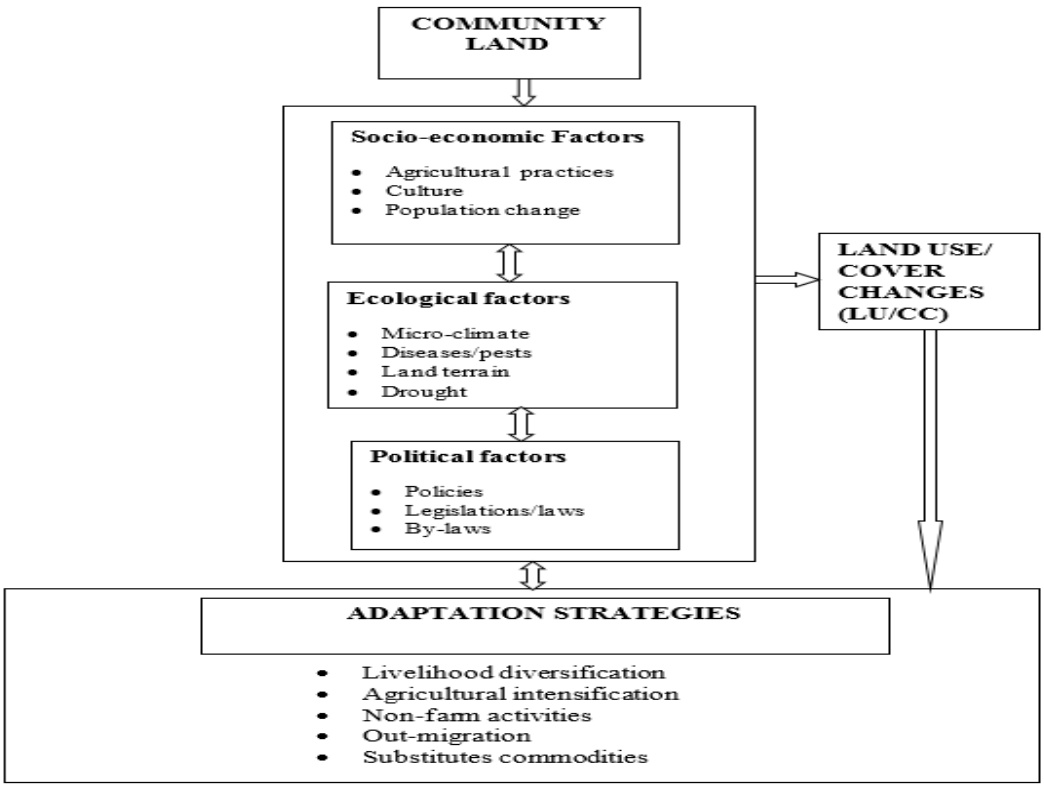


Figure 1: Household Livelihoods Adaptation strategies for land use cover changes
Source: Modified from Rounsevell et al. (2010)

Synthesis on the Nature-society and Livelihoods adaptation Nexus

Nature-society and livelihoods adaptation focuses specifically on "cultural-human ecology" (Briassoulis, 2000). This provides comprehensive descriptions of the complex interactions between people and their bio-physical environment as stated by Sack (1990) and Butzer (1990). Interactions sustain the adaptive processes by which human societies adjust through patterns to the specific parameters of their local habitat (Johnston et al., 1994) in long term or short term. Together with adaptive processes, internal and external impulses also (Neumann, 1998; Schakowsky 2006) creates a balance between population, resources, and LUCC.

The theoretical approach in explaining land use cover change has its limitations. For instance, Briassoulis, (2000) argues that cultural-human ecology inadequately specifies the processes of social change that leads to environmental impacts. In agro-pastoral communities, power relations maintain class structures and lead to social struggles. Likewise, the relations ineffectively encourage the inequalities created by classes that do not give communities similar choices, including environmental changes (Briassoulis, 2000). Moreover, a cultural-human ecology perspective is "a historic and does not account for the fact that environmental transformations are the product of decisions made in specific social systems and locational settings" (Sack, 1990). This theoretical conceptualization is used to explain the drivers of LUCC and household adaptation strategies in improving rural livelihoods.

Carney (1998) explained livelihood as material assets which are put into productive activities such as land resources, financial capital, tools and inputs. John et al. (2014) note that in any household livelihoods, human capabilities (the knowledge and skills) determine and reflect terms of social, economic and environmental interactions. The interactions are in terms of mutual relations, networks and the societal functioning at local, national and international scales. Therefore, this study describes livelihoods as means of attaining daily needs through utilization of land resources (arable land, pasture land, vegetation and water resources) under the existing social, economic, political and technical know-how. While the IPCC (2001) report defines adaptations as adjustment in natural or human systems in response to actual or expected stimuli or their effects, which moderate harm or exploit beneficial opportunities. For the purpose of this study, adaptation refers to 'individual household adjustments to attain daily livelihoods in response to actual land use/cover changes impacts in the study area'.

Methodology

The study area is situated between Latitudes 3º05'S and 4º15'S and Longitudes 34º45'E and 36º00'E. Karatu and Mbulu Districts were one district before they were separated into two in 1995, and one fall into Arusha and the other into Manyara Regions respectively (Map 1). Thus, to study their LUCC as one ecosystem jointly is important due to their shared socio-economic backgrounds since time immemorial. The area was selected because it is located just at the eastern arm of the East African rift valley in Tanzania with some distinct volcanic features such as lakes, valleys, craters and conical hills. Being a volcanic fertile land, the area is endowed with

natural vegetation which attracted agro-pastoral communities from different parts of the country for farming and livestock keeping. The landscape structure which has different vegetation covers vary from valley bottoms, gentle slopes, interfluves and steep slopes. These highly dissected landscapes are home to wild life and pastoral communities. The communities have been utilizing land resources for their daily livelihoods over time. However, the dynamics on LUCC might have implications on agro-pastoral communities' livelihoods when the proportion of land use/cover deteriorates per household. Therefore, the study area's ecosystem renders itself an appropriate case study in view of the LUCC in Tanzania.

Both qualitative and quantitative data were used to collect data for this study. Qualitative data comprised In-Depth Interviews (IDIs), Focus Group Discussions (FGDs) and field observation (FO) that elicited information on household perceptions and adaptation strategies in response to LUCC in the study areas. Quantitative data comprised household surveys and interpretation of remotely sensed data through GIS data analysis techniques. The blending of two data collection methods in this study were important to allow triangulation and ground truthing of the information. For instance, the data acquired from remote sensing through GIS techniques were verified during fieldwork through household surveys, IDIs, FGDs and field observations.

Map 1: Location of Sampled Wards in Karatu and Mbulu Districts, Tanzania
Source: Cartographic Unit – UDSM (2022)

IDIs and FGDs were carried out in the study areas in 2022. In-depth interviews (n=50) were held with households in Mbulu (n=25) and Karatu (n=25) communities, respectively. Six FGDs were conducted in six (6) villages, three (3) villages from each district. One FGD was formed in each village under the study. Each FGD comprised seven members, two village leaders (Village Executive Officer and Village Chairperson), two farmers (male and female), one extension officer, and two experienced and influential people (male and female) in each village. An analysis was done according to the principles of grounded theory described by Hay (2005), using open and axial coding. The process involved breaking down, examining, comparing, labelling and categorizing data. Then, data were further categorized according to themes and sub-themes to enable content analysis. Analysis and interpretation of interview data were facilitated with the NVIVO 9 software. The technique was useful in interpreting perceptions and lived community experiences regarding changing livelihoods triggered by LUCC that unarticulated in the survey. The household survey was administered to 384 households (25 percent of the total households) in the area. The survey elicited household demographic and socio-economic information data set. Then, the coded data from the household survey were entered into the SPSS software version 23 to enable further analysis through derived tables of frequencies and cross-tabulation of dependent and independent variables. Field observation involved taking photographs of activities such as cultivation patterns, crops grown, types of grazing, and human impacts on land. The method was useful in providing and verifying previous information proofs of LUCC in Mbulu and Karatu Districts.

Landsat images of the study area for the years 1987, 2001 and 2015 were obtained from the data repository of the United States Geological Survey's (USGS) Center for Earth Resources Observation and Science (EROS) website (www.glovis.usgs.gov). These are multi-spectral data acquired by Landsat satellite. Landsat images have been extensively used for LUCC studies and natural resources assessment by many researchers (Pontius et al. 2013; Lambin, et al. 2003). This study uses Landsat scenes from Landsat 5 and Landsat 7 sensors. The images used were those acquired in 1987 and 2015 (Landsat 5) and 2001 (Landsat 7) to detect land use cover change. The Land use cover change detection was done using ArcGIS10 software. The two classified Land use cover layers i.e. Land use cover 1987 and 2001 and Land use cover 2001 and 2015 were used. The Landsat images of those years seem to be clearer in the past forty year (1980 - 2020) to enable spatial data analysis. The spatial analysis tool using the zonal tabulated area function was used to generate a land use cover change matrix. The function calculates cross-tabulated areas between two datasets and outputs a table. The table displays a record for each unique value of the zone dataset and a field for each unique value of the class dataset. Calculated geometry was used to calculate the areas (in hectares) of each land use cover in the matrix.

Results

The main Land Use Cover Changes (LUCC) in the study area

The wood land and bush land which occupied the largest part (more than 53 percent) of the total land in the study area (see table 1; Map 2) gradually declined from 53 per cent (431,133ha) in 1987 to 44 per cent (355,556ha) in 2001 and dropped by -35.46 per cent (-75,577ha) throughout the period in between 1987 – 2001 (table 2). The forest land and water bodies occupied 8 per cent (67582 ha) and 16 per cent (126,564 ha) of the total land respectively in 1987 declined to 6 per cent (46,424 ha) and 15 per cent (120,817 ha) in 2001 respectively. Gradual decline by -31.31per cent (-21,158 ha) and -4.54 per cent (-5747 ha) respectively (Tables 1 and 2) was observed. Three possible reasons were given during the FGDs in study areas about the decline on land use cover aforementioned.

> *First, in the study area there was occupation declaration of most suitable farming areas for crop cultivation under the so called villagelization programme in early 1970s until 1980s. Secondly, the tsetse fly challenge to the livestock keepers leads to the massive clearance of vegetation cover in early 1950s. Finally, highlands cultivation resulted into the siltation of water bodies such as Lake Eyasi in the West of the study area* (refer Map 2).

From1987 to 2001, the cultivated land gained for about 18.49 per cent (40,327ha) bush land, 28.75 per cent (24,795 ha) grassland, 6.77 per cent (14,426 ha) woodland, 0.89 per cent (197 ha) bare land (due to slight regeneration and shortage of farmland), 9.24 percent (11 ha) settlement (abandon settlements due to villagelization programme), and 0.65 per cent (439 ha) of the forest land (Table 3).

Table 1: The extent of Land use covers Categories in the study area in 1987, 2001 and 2015

Vegetation Land Use Cover Types	Land Cover Type / Vegetation Land Use in Ha and percent					
	1987		2001		2015	
	Ha	Percent	Ha	Percent	Ha	Percent
Forest	67,582	8	46,424	6	41,800	5
Woodland	213,030	26	138,503	17	63,659	8
Bush land	218,103	27	217,053	27	209,715	26
Grassland	86,243	11	105,796	13	21,445	3
Cultivated Land	73,492	9	123,592	15	322,301	40
Wetland	2,594	0	7,236	1	33,209	4
Water	126,564	16	120,817	15	54,206	7
Settlement	114	0	437	0	614	0
Bare Soil	22,728	3	50,592	6	63,501	8
	810450	100	**810,450**	100	**810,450**	100

Source: Landsat imagery: 1987, 2001 and 2015.

Bush land was mainly located on steeper slopes of the mountains unsuitable for crop cultivation and formed the largest spatial extent. It is commonly composed of the following trees species with their botanical names in brackets: red stink-wood (Prunus Africana), Elgon olive (Olea capensis) and Julbernardia (Julbernardia globira) and varieties of grass species. The extent of the bush land, however, continuously shrunk from 27 per cent (218,103 ha) in 1987 to slightly less than 27 per cent (217,053 ha) in 2001 and declined at an average rate of -0.04 per cent (75 ha)/year (Tables 1 and 2). As shown in Table 3, the bush land cover was transformed to cultivated land (18.49 percent), grassland (17.52 percent), woodland (11.55 percent), bare land (6.3 person), water bodies (0.45 percent), forest (0.41 percent) and settlement land (0.1 percent). As noted during the household interviews, 67 per cent noted that the conversion of bush land to bare land, cultivated land, settlements and grassland can aggravate the loss of soil, biodiversity and expansion of land degradation.

Woodland, the second largest LUCC from 1987-2001, occupied 26 per cent (213,030 ha) in 1987, but decreased to 17 per cent (138,503 ha) in 2001. The woodland land use cover (WLUC) declined by 34.98 per cent (74,527 ha) between 1987 and 2001 at a rate of 2.5 per cent (5323 ha)/year (Tables 1 and 2). The woodland LUCC category was largely transformed to bush land (36.46 percent), grassland (13.95 percent), cultivated land (6.77 percent), bare soil (3.57 percent) and forest (2.4 percent) in the first period (Table 3; Map 2).

The cultivated land in the study area expanded from 15 per cent (123,592 ha) in 2001 to 40 per cent (322,301 ha) in 2015 at a rate of 11.48 per cent (14,194 ha/year) (Tables 1 and 2). In both periods (1987-2001 and 2001-2015), cultivated land gained more than other land uses categories (tables 1 and 2; map 2). For instance, over the 28 years periods from 1987-2015, cultivated and land grew by 338.55 per cent (248,809 ha) at the expense of grassland (53.20 percent), bush land (45.55 percent), bare soil (27.15 percent), settlements (26.88 percent), woodland (25.46 percent), wetland (8.82 percent), water (2.01 percent) and forest land (0.84 percent) (Table2). In between 2001 and 2015; 207,732 ha of grass, bush, bare, settlement, wood, wetland, water and forest lands were totally converted to cultivated land (Table 4). As confirmed during an in-depth interview and group discussion, the farmers' inability to pay for modern agricultural inputs largely contributed to cultivated land expansion.

Since the 2000s, the forest cover in the study area decreases at decreasing rate of 0.71 per cent (330 ha/year) in the second period between 2001 and 2015 compared to 2.24 per cent (1511 ha/year) in the between 1987 and 2001(Table 2; Map 2). As observed during field surveys, Eucalyptus globulous, Cyprus and gravellier were the dominant forest species planted by the community in their areas. These new species of trees explain clearly the decline in forest land deterioration during second period (2001-2015). During in-depth interview with one of the village leaders in the study area, affirms that the forest has been the source of household income and he started by saying that:

> "*The high demand for timber, construction material and firewood triggered by the urban population increase stimulated tree planting activities resulting to forest land expansion. Large areas of wood, bushes, grass and cultivated lands became forestland. Furthermore, many rural residents in the study area sell Eucalyptus globulous as a source of firewood at the town centers in Mbulu and Karatu towns*".

This implies that the incentives gained through vegetation cover and planted forest is the source to household livelihoods improvement and conservation measures in the study area. Therefore, the gain and loose of each land use/cover is determined by the socio-economic, ecological and political factors in the studied ecosystems over time and space.

Table 2: Trends of land use cover change in the study area in different periods of time

	1987 - 2001			**2001 - 2015**			**1987 - 20015**		
Vegetation LUCC Types	Change in ha	Percent Change	Ann.Ave.rate of Change in percent/Yr	Change in ha	Percent Change	Ann.Ave.rate of Change in percent/Yr	Change in ha	Percent Change	Ann.Ave.rate of Change in percent/Yr
Forest	-21158	-31.31	-2.24	-4624	-9.96	-0.71	-25782	-38.15	-1.36
Woodland	-74527	-34.98	-2.5	-74844	-54.04	-3.86	-149371	-70.12	-2.5
Bush land	-1050	-0.48	-0.04	-7338	-3.38	-0.24	-8388	-3.85	-0.12
Grassland	+19553	+22.67	+1.62	-84351	-79.73	-5.69	-64798	-75.13	-2.68
Cultivated land	+50100	+68.17	+4.87	+198718	+160.79	+11.48	+248809	+338.55	+12.09
Wetland	+4642	+178.95	+12.78	+25973	+358.94	+25.64	+30615	+1180.22	+42.15
Water	-5747	-4.54	+0.32	-66611	-55.13	-3.94	-72358	-57.17	-2.04
Settlement	+323	+283.33	+20.24	+177	+40.5	+2.89	+500	+438.6	+15.66
Bare Soil	+27864	+122.6	+8.76	+12909	+25.52	+1.82	+40773	+179.4	+6.41

Source: Landsat imagery in 1987, 2001 and 2015
Note: (+) refers to land gains from other land use cover while (-) indicates land loss to other land use cover.

Table 3: Land use cover (LUC) classes' matrix between 1987 and 2001 in Mbulu and Karatu Districts

Source: Landsat imagery in 1987, 2001 and 2015

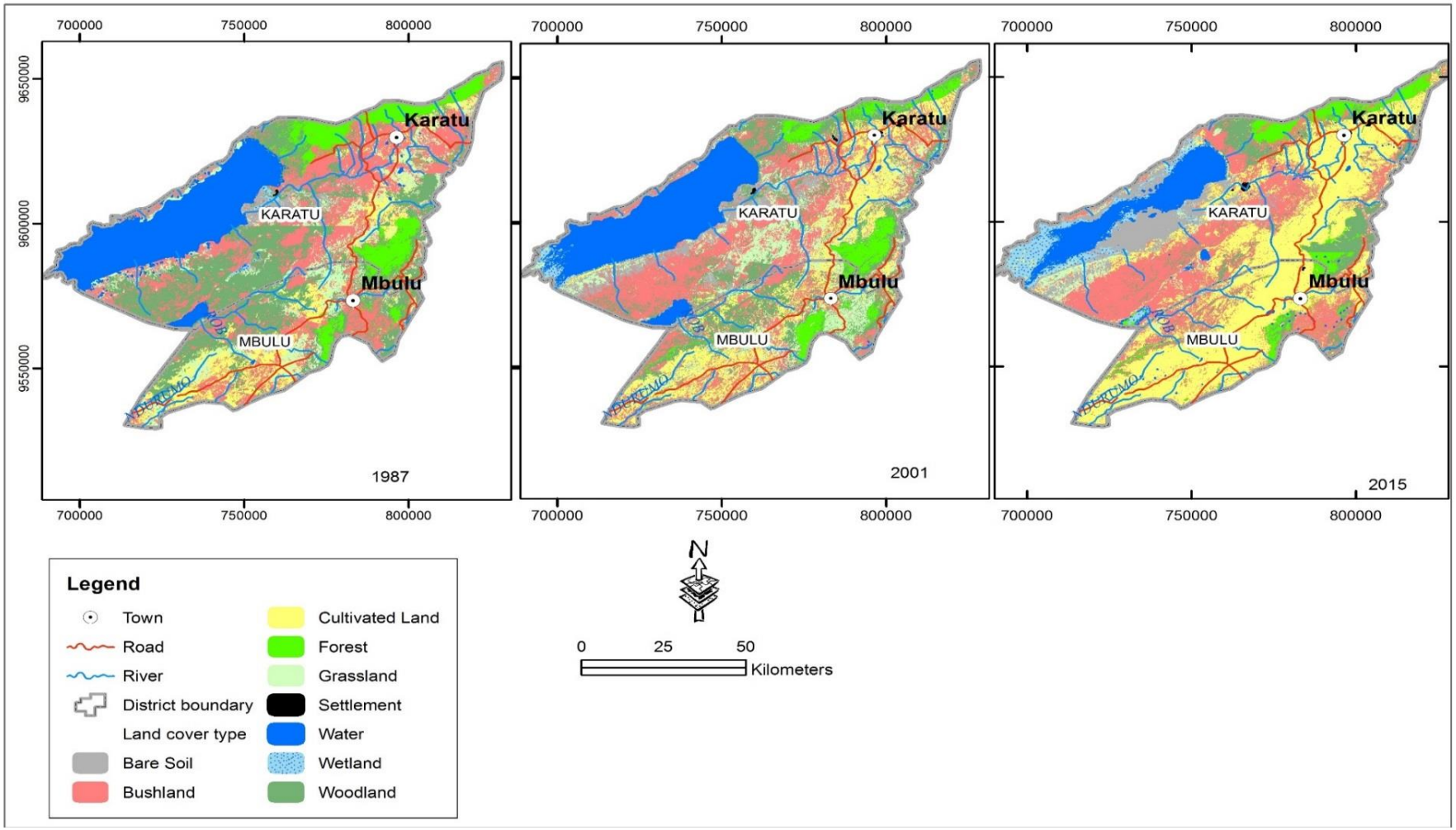
Table 4: Land use cover (LUC) classes matrix between 2001 and 2015 in Mbulu and Karatu Districts

	From LUC class in 1987																	
VLU/LC classes	**Bare Soil**		**Bush land**		**Cultivated Land**		**Forest**		**Grassland**		**Settlement**		**Water**		**Wetland**		**Woodland**	
To LUC class in 2001	Ha	Percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent
Bare Soil	16752	73.71	13,745	6.30	1,655	2.25	56	0.08	8,329	9.66	0	0.00	1,937	1.53	520	20.04	7,598	3.57
Bush land	2,355	10.36	98369	45.10	15,724	21.40	2,895	4.28	18,447	21.39	7	6.39	791	0.63	780	30.06	77,674	36.46
Cultivated Land	197	0.87	40,327	18.49	43581	59.30	439	0.65	24,795	28.75	11	9.24	89	0.07	0	0.00	14,426	6.77
Forest	0	0.00	885	0.41	32	0.04	40091	59.32	85	0.10	0	0.00	5	0.00	0	0.00	5,291	2.48
Grassland	2,423	10.66	38,202	17.52	7,352	10.00	1,708	2.53	23983.2	27.81	2	1.34	1,982	1.57	247	9.52	29,719	13.95
Settlement	0	0.00	211	0.10	100	0.14	0	0.00	18	0.02	93.6	82.11	0	0.00	0	0.00	15	0.01
Water	670	2.95	978	0.45	32	0.04	203	0.30	3,491	4.05	0	0.00	114895	90.78	0	0.00	509	0.24
Wetland	43	0.19	185	0.08	112	0.15	2	0.00	230	0.27	0	0.00	6,513	5.15	17.1	0.66	147	0.07
Woodland	289	1.27	25,200	11.55	4,905	6.67	22,187	32.83	6,865	7.96	0	0.08	351	0.28	1,030	39.72	77652	36.45
Total in year 1987	22728	100	218102	100	73492	100	67582	100	86243	100	114	100	126564	100	2594	100	213030	100

	From LU/LC class in 2001							
VLUC classes	**Bare Soil**	**Bush land**	**Cultivated Land**	**Forest**	**Grassland**	**Settlement**	**Water**	**Wetland**	**Woodland**

To LUC class in 2015	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent	Ha	percent
Bare Soil	19404	38.35	2,552	1.18	422	0.34	195	0.42	4,753	4.49	90	20.52	35,102	29.05	764	10.56	220	0.16
Bush land	9,587	18.95	94426	43.50	6,144	4.97	2,532	5.45	34,952	33.04	24	5.42	3,432	2.84	124	1.72	58,495	42.23
Cultivated Land	13,736	27.15	98,875	45.55	114568	92.70	389	0.84	56,282	53.20	117	26.88	2,434	2.01	638	8.82	35,261	25.46
Forest	11	0.02	516	0.24	59	0.05	28879	62.21	745	0.70	0	0.00	1,141	0.94	4	0.06	10,444	7.54
Grassland	6,946	13.73	5,712	2.63	1,838	1.49	6	0.01	3578	3.38	0	0.00	1,191	0.99	268	3.71	1,906	1.38
Settlement	67	0.13	50	0.02	50	0.04	0	0.00	267	0.25	173	39.59	3	0.00	0	0.00	3	0.00
Water	7	0.01	437	0.20	10	0.01	45	0.10	333	0.31	0	0.00	53011	43.88	102	1.41	262	0.19
Wetland	718	1.42	744	0.34	26	0.02	44	0.09	1,676	1.58	1	0.33	24,368	20.17	5324	73.58	309	0.22
Woodland	117	0.23	13,741	6.33	475	0.38	14,336	30.88	3,211	3.03	32	7.27	135	0.11	10	0.14	31602	22.82
Total in year 2000	50592	100.00	217053	100.00	123591	100.00	46424	100.00	105796	100.00	437	100.00	120817	100.00	7236	100.00	138503	100.00

Source: Land sat imagery in 1987, 2001 and 2015



Map 2: Land use cover changes in Mbulu and Karatu Districts in 1987, 2001 and 2015 respectively

Source: Landsat imagery in 1987, 2001 and 2015

The Impacts of land Use Cover Change on Household livelihoods

The households in the study area affirmed that, in the course of attaining their daily livelihoods they were exposed to diverse impacts of land use/cover changes (LUCC). During the household survey, nearly one third respondents (28 percent) agreed that, they have experienced drought and food shortage whereas 27.6 per cent experienced soil erosion. Slightly, more than a quarter, 23 per cent confirmed deforestation and decline in pastures in their areas. About 12 per cent experienced water shortage; 5 per cent experienced decline in wildlife and their habitat while 2 percent experienced conflicts over resources and family member's migration to others areas within and outside the districts (Table 5). During the in-depth-interviews, most of the respondent link LUCC with rainfall variability patterns, decline in pastures, deforestation and the long drought seasons. However, they were not able to tell exactly the duration of changes that could justify the observed variations as indicators of land use/cover change. Therefore, knowledge on the relation-ship between land use/cover changes and its impacts on their livelihoods is needed in developing common understanding as an important element for developing adaptation strategies within the household.

It was also observed that, the LUCC impacts vary over space and time. For example, soil erosion is more frequently mentioned by respondents in Slahhamo (39 percent), Tloma (35 percent), Mahheri (31 percent), Khaday (28 peercent), Mongo wa Mono (20 percent) and Buger (13 percent). During the interview with the households in Slahhamo, Tloma, Mahheri and Khaday villages; it was noted that most of their land uses have been changed to cultivated land (refer to Tables 2; Map 2). This is an indication that, the village land is subjected to soil erosion if proper farming methods will not be applied. This might be the main reason for the increased in bare land in the districts between 1987 and 2015 (refer to Tables 1, 3, 4; Map 2).

Deforestation and pastures decline were mainly observed and reported by respondents from Mahheri (47 percent), Buger (42 percent), Tloma (18 percent), Khaday (13 percent), Slahhamo (12 percent) and Mongo wa Mono (8 percent). Most of the land uses in the study villages were transformed to cultivation and settlements during villagilization policy of 1960s – 1970s while at the same time destroying the habitats of tsetse flies that affected their livestock. During the in-depth interview, one male respondent aged 65 years asserted that:

> "*My dear friend, due to deforestation we have lost the pastures for our cattle, sources of firewood, and rivers have dried up. We have no place to get building materials, wild products such as honey, fruits and meat have disappeared drastically during 2000s. We are now suffering from the secondary impacts of deforestation and soil erosion such as frequent drought, irregular rainfall patterns, and decline in farm productivity".*

This argument was in line with ideas raised during the Focus Group Discussion (FGD) and in-depth interview, that the secondary impacts of deforestation were drought, food shortage, and decline in surface water discharge, migration and disappearance of wild animals.

Table 5: The impacts of land use cover changes in the study area

Village/Impacts		Land use cover change impacts							Total
		Soil erosion	Deforestation and decline in pastures	Drought and food shortage	Water shortage	Decline of wildlife habitat	Conflicts over resource	Migration	
Tloma (Ganako)	N.	22	11	16	8	0	2	4	63
	%	34.9	17.5	25.4	12.7	0.0	3.2	6.3	100.0
Slahhamo (Mbulumbulu)	N.	25	8	17	12	0	1	2	65
	%	38.5	12.3	26.2	18.5	0.0	1.5	3.1	100.0
Buger (Buger)	N.	8	27	7	15	1	6	0	64
	%	12.5	42.2	10.9	23.4	1.6	9.4	0.0	100.0
Khaday (Endagikot)	N.	18	8	31	7	0	0	0	64
	%	28.1	12.5	48.4	10.9	0.0	0.0	0.0	100.0
Mahheri (Muray)	N.	20	30	12	2	0	0	0	64
	%	31.3	46.9	18.8	3.1	0.0	0.0	0.0	100.0
Mongo wa Mono (Yaeda Chini)	N.	13	5	24	2	20	0	0	64
	%	20.3	7.8	37.5	3.1	31.3	0.0	0.0	100.0
Total	N.	106	89	107	46	21	9	6	384
	%	27.6	23.2	27.9	12.0	5.4	2.3	1.6	100.0

Source: Field Survey, 2022

As indicated in Table 5, wildlife animal's disappearance in the study area threatened seriously the livelihoods of hadzabe people who are hunters and gatherers largely residing in Mongo wa Mono village, around Lake Eyasi. Moreover, conflicts over land resources were mentioned by the community living near Manyara National Park (MANAPA) and Ngorongoro Conservation Area (NCA) in Buger (9 percent) and Slahhamo (2 percent) villages respectively. During the FGDs, conflicts on land resources use in those villages were triggered by introduction of new policies which banned the use of forest products from Marang and Ngorongoro forests in Buger and Slahhamo villages respectively. In high population density areas of the study area such as North-eastern Tloma (6 percent), Slahhamo (3 percent)] and South-eastern highlands (Buger, Khaday and Mahheri); LUCC has triggered migration of the household members to other area such as Mbulumbulu (Karatu district) and Kilindi (Handeni in Tanga) areas.

During the in-depth interview with one woman aged 70 years old in Khaday village which mostly experienced drought and food shortage as mentioned during the household interview (Table 5), asserted that:

> *"Nowadays in our village the patterns of rainfall are inconsistence and unpredictable. This shortage of rainfall and seasonal changes has affected our agricultural productivity thus leading to food insecurity to most of the households in the area. I predict the condition of food security to be poorer in the future if the observed impacts of LUCC will persist".*

This statement denotes that local communities 'livelihoods will continue experiencing the impacts of LUCC. Therefore, efforts of reducing poverty and inequality between the rural and urban community in the country will be threatened. This calls for integrating LUCC issues in to the policy dialogue for developing suitable mechanisms that could help to reduce the extent of being exposed to shocks and threats attributed to LUCC impacts.

The Household livelihoods adaptation Strategies to land use/cover changes

In ensuring living, households in rural areas develop both short- and long-term adaptations mechanisms so as to respond to LUCC impacts. This is due to the fact that, human survival is imperative. During the household interview, the respondents mentioned both short- and long-term adjustments to LUCC impacts. The long-term adjustment mechanisms mentioned by the households interviewed included: Selling of livestock (37 percent), casual labor (17 percent), planting of drought resistant crops (17 percent), migration (14 percent) and use of alternative sources of energy/substitute commodities is mentioned by 2 per cent (Table 6). While on other hand 13 per cent mentioned short term adaptation strategies; out of those respondents; five (5) per cent mentioned remittances from family friends, relatives and children who are living in urban areas while eight (8) per cent have mentioned government assistance and reducing the number of meals per day from tree to two meals (Table 6). During the field observation it was noted that, the majority of household in Buger, Khaday and Slahhamo vilages were agro-pastoral people who their main livelihood activities are farming and livestock keeping. This implies that, selling of livestock means decline in manures which is the main source of traditional fertilizer in most of the rural households in Tanzania, thus, decline in household farm productivity and increasing the rate of food insecurity.

Table 6: Households' adaptation strategies for land use cover changes in the study area

Village/adaptation		Household Adaptation strategies							Total
		Migration	Selling of cattle	Casual labor	Family/ friends remittances	Drought resistant crops	Rely on government Meals/day	Alternative/ Substitutes	
Tloma (Ganako)	N.	8	15	5	9	21	0	5	63
	%	12.7	23.8	7.9	14.3	33.3	0.0	7.9	100.0
Slahhamo(Mbulumbulu)	N.	5	17	37	1	3	0	2	65
	%	7.7	26.2	56.9	1.5	4.6	0.0	3.1	100
Buger (Buger)	N.	17	43	2	0	2	0	0	64
	%	26.6	67.2	3.1	0.0	3.1	0.0	0.0	100

Village/adaptation		Household Adaptation strategies							Total
		Migration	Selling of cattle	Casual labor	Family/ friends remittances	Drought resistant crops	Rely on government Meals/day	Alternative/ Substitutes	
Khaday (Endagikot)	N.	7	33	6	4	11	2	1	64
	%	10.9	51.6	9.4	6.3	17.2	3.1	1.6	100
Mahheri (Murray)	N.	13	16	14	1	20	0	0	64
	%	20.3	25.0	21.9	1.6	31.3	0.0	0.0	100
Mongo wa Mono (Yaeda Chini)	N.	3	19	0	6	7	29	0	64
	%	4.7	29.7	0.0	9.4	10.9	45.3	0.0	100
Total	N.	53	143	64	21	64	31	8	384
	%	13.8	37.2	16.7	5.5	16.7	8.1	2.1	100

Source: Field Survey, 2022

During the in-depth interview, most of the respondents affirmed that they have switched from traditional livestock keeping and cropping (their normal livelihoods activities) to casual laborers in coffee plantation and planting drought resistant crops in their farms. This implies that, land use cover change has indirectly affected climate in the study area. Thus, the climate change is a reality for this community, however some of the coping strategies developed such as option to drought resistance crops are still climate sensitive that can continue experiencing climate change impacts and therefore, the community could be left to the higher degree of risks attributed to land use cover change and climate change impacts.

During the household interview, some of the households who have mentioned to rely on remittances and government assistance have also reduced the number of meals they take from three meals to one per day. The majority of the respondents were from Mongo wa Mono (45 percent), Tloma (14 percent and Khaday (3 percent) (Table 6). This implies that, indirectly there is an issue of food insecurity in the study area which is not mentioned clearly but it is among of the secondary impact of land use cover change in agro-pastoral community.

During the household interviews in Slahhamo, Khaday and Mongo wa Mono villages, it was noted that, some members of the households (2 percent) have engaged in alternative livelihoods activities (non-agricultural activities) to earn living to address the issue of food insecurity. Those activities included; petty business, tourism, weaving, pot making and bee-keeping. These non-agricultural activities were mentioned to be environmentally friendly during the FGDs in Tloma, Buger and Mahheri as it conserves the vegetation resources compared to farming and grazing activities.

Despite the non-agricultural adaptation strategies developed by the community, there is a possibility that community will continue to experience more impacts of LUCC on their daily livelihoods due to the fact that some of the adaptation strategies are not environmentally friendly. For instance, petty businesses on charcoal or fire wood, cultivation on wetland areas and near water sources were adapted for survival. These activities have altered the hydrological cycle of the area and make a large part of the area to experience drought due to lack or

inadequate water to support farming and livestock keeping activities. This is indicated by disappearance of several natural streams and rivers in the study area caused by cultivation and over-grazing. One of the respondents in Slahhamo Village affirmed that;

> "*Agricultural activities near water sources in the study area have triggered the drying up of six natural streams e.g. overgrazing (removal of the vegetation cover) and over cultivation (which resulted to soil erosion, thus siltation of streams and rivers) and if there will be no feasible interventions on safeguarding natural water bodies; there is a possibility of the remaining eight natural streams and four springs to dry up in the near future*".

The statement implies that vegetation land cover is the source of surface water and drainage systems in the study area. Thus, the removal of the vegetation cover has directly affected the livelihoods of people especially the farmers and the livestock keepers. During the field survey, it was observed that over cultivation and grazing activities in the study area have resulted into the siltation and disappearance of permanent natural streams and rivers.

During the household interview, the majority (87 percent) of the respondents have mentioned that, the increase in vegetation cover change in the study area was accelerated by the increase in the needs of fuel wood (charcoal and firewood) in the town of Mbulu, Karatu and Arusha city. This was affirmed by one of the respondents during the in-depth interview in Slahhamo village who say that:

> "*…we have lost our vegetation cover to feed the people who are living in urban areas in Karatu, Mbulu and Arusha towns. The people living in those towns depend on charcoal and firewood to cook their food. As long as we don't have any source of income as our farm outputs have decline, the only way to survive is to sell our forest products i.e. charcoal and firewood. However, recently there is total ban of forest products business such as charcoal and firewood. The middle-income earners have started using alternative source of energy such as biogas and solar energy to reduce the dependence on vegetation as source of energy".*

This implies that, the high demand of fuel wood both to the rural and urban dwellers, has triggered the rapid decline in vegetation cover in the study area as indicated in previous sections (Tables 1-4; Map 2). In order to address the adverse impacts of firewood/charcoal energy to the environment, the households were sensitized to use alternative energy (biogas and solar) which are cost effective and environmentally friendly renewable energy sources.

The adaptation strategies to the impacts of land use cover changes found to be associated with some potential opportunities in the study community. One of the respondents in Tloma village argued that to some extent they are sure of food availability in lean rain seasons through harvests from drought resistant crops (sunflower and improved maize seeds) grown in the study area. Furthermore, the shift from maize and beans production (highland areas) to onions and vegetables in wetland areas (lowland areas) has assured them of getting money and buy food to support their living despite the fact that wetlands are degraded. There is a high possibility

of altering the hydrological cycle in the areas which will have more impacts on the agro-pastoral community livelihoods in the future.

Discussion

John et al. (2014) clarified those suitable climatic conditions in tropical savanna particularly in northern highlands of Tanzania, favour crop cultivation. Therefore, maximizing crop production through farmland expansion cannot be a feasible strategy in the future as it will result into degradation of marginal areas. This condition exacerbates soil erosion, soil moisture constraints and hinders improvement of crop productivity. Hambati (2013) observed the similar situation in the northern highland of Tanzania where agricultural suitability decreases with the increase in slope gradient. As noted by Pontius et al. (2013) and FAO (2010), the expansion of cultivated land is a necessity to cope with food insecurity and to increase income for rural people who are poor and lacks alternative sources of livelihoods.

FAO report in 2010 (FAO, 2010) noted that there is an inextricable link between the impacts land use cover change and livelihoods adaptation practices in the rural communities. In addition, rural livelihoods depend on rains and it is labor intensive. Rainfall availability depends on the climate of an area and poor household has no capacity on it. Lack of rainfall also affects vegetation growth resulting to community risks of exposure to drought, diseases and hunger. As explained in Forkuo and Frimpong (2013) community relaying on rainfall for their production, should be aware with the environmental changes, good timing of farming and accept changes in their livelihoods for their survival and subsistence.

As indicated by Kabonesa and Kindi (2013), the adaptation measures whether long term or short term in rural households are often in terms of: livelihood diversification, agricultural intensification, selling of animals and engagement in non-farming activities such as beekeeping and eco-tourism. As noted in the study by Armah et al. (2016), adaptation to land use cover changes in coastal areas in Tanzania was influence by household accessibility to resources. This implies that households within an area respond to impacts of land use cover changes differently as they have different scale in resources accessibility either as an individual or as a community. This is also similar to what has been observed in the study area whereby poor households and rich households have different adaptation strategies. Poor households have developed mechanisms and strategies that are short term in nature whereas rich households have developed the strategies that are for long term to respond towards land use cover changes in the study area.

As noted in the study by John et al. (2014), the influx of migrants into the town areas or headquarters of the districts since 1975 in Tanzania was attributed to the changes in agricultural policies and the reform programs that have been introduced in Tanzania since then and intensified after the 1990s. The study further added that, in the mid-1980s Tanzania adopted the structural adjustment program (SAP), as a way of improving the country's economy. However, the agricultural sector, among other things, has been negatively affected by this program. This is simply because; one of the conditions of SAP was to remove subsidies on agricultural inputs, hence leaving a great burden on the farmers. Before SAP, farmers received

subsidies in the form of seeds, fertilizers and farm implements. With removal of subsidies, agriculture has become more of a burden to farmers. The returns have decreased due to the low productivity since most of the farmers cannot afford the high cost of farm inputs and implements. Therefore, the only solution is to migrate into the virgin fertile land which has ultimately increases the rate of vegetation land cover changes in the area of destination while healing their area of origin.

As noted in the study by Armah et al. (2015) costal area in Tanzania, remittances have been used as a tool to conserve the costal forest reserves land not to be invaded by neighborhood communities. These remittances were in terms of money, goods and free services in health and education at the expense of conserving vegetation land cover.

Timothy (2013) noted that overcoming the impacts of land use cover changes (LUCC) needs to have suitable adaptation strategies. However, as noted in the study area the adaptation strategies differ from one location to the other depending on the socio-economic characteristics of the communities trying to address the on-going and expected future impacts of land use cover changes. As noted during the field, the community is implementing some adaptation strategies to overcome the impacts of LUCC whereby, of the 384 respondents, 85 per cent of the respondents argued that, they have started afforestation programs in their fields and abandoning the burning of plant residues respectively. They consider afforestation as a long-term mitigation strategy due to the fact that, trees act as a carbon sink, and therefore it could reduce the concentration of carbon dioxide gas from the atmosphere which is considered to be the main cause of global warming that alters the global climate.

As observed by Bruno et al. (2015), burning of plant residues add carbon monoxide gas to the atmosphere when undergo some processes result to formation of carbon dioxide gas and hence the concentration of chlorofluorocarbons (CFCs) in the atmosphere that gears the atmospheric circulations to alter the global climate. It is true that a larger part of the vegetation cover in Mbulu and Karatu districts has been depleted irrespective of the restoration programs. This implies that, the government efforts and other environmental stakeholders should continue to sensitize the community on the benefits of the environmental land resources so that the remaining vegetation cover to be safe from degradation and hence steady vegetation cover ecosystem in the study area. Furthermore, empowerment to the afforestation programs could be achieved in the presence of tree seed subsidies from environmental stakeholders that could motivate people to engage themselves in the campaign of restoring the degraded environment.

Conclusions and Recommendations

Impacts of land use cover change have been observed and confirmed to affect different livelihood activities (farming and livestock keeping) of agro-pastoral community. LUCC is not a new phenomenon to most of the respondents in the study area due to the fact that they were able to link issues that justify the thriving of land use cover changes including changing in rainfall patterns, prolonged drought periods and decrease in river flows. However, despite the observed impacts, community has developed some short-term coping and adaptation mechanisms such as growing resistant crops, destocking, urban-rural remittances and reducing

the number of meals per day. The community have also engaged in long term adaptation strategies to the impacts of land use cover changes noted in the study area. These included afforestation programs and engaging in non-agricultural activities. Nonetheless, there are some opportunities associated with coping and adaptation strategies in the study area. These included agricultural intensification strategies which have resulted into high yields in crop and animal products. These improvements in household productivity have contributed positively to the livelihoods of the community in the study area. For example, the availability of food in unfortunate seasons through growing drought resistant crops and income earned from non-agricultural activities have improved the food security in the area.

Despite the existing adaptation strategies to LUCC impacts in the study area, community empowerment for enhancing the strategies is needed. This is due to the fact that, the community has limited options for livelihood diversification that can absorb shocks and trends attributed to land use/cover change impacts. Empowerment can be done through education on: sustainable agriculture, environmental conservation, field farmer schools, access to credits and improved farming implements as well as the access to markets for agricultural produce. This will enhance their efforts towards reducing the vulnerability and risks attributed to LUCC impacts and therefore, more benefits will be accrued from the livelihoods that will contribute significantly to poverty reduction strategy in the country.

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