The impacts of land use and land cover dynamics on natural resources and rural livelihoods in Dedza District, Malawi

Maggie G. Munthali[a,*], Nerhene Davis[b], Abiodun M. Adeola[b,c] and Joel O. Botai[b,c,d]

[a]Department of Forestry, Nkhalango House, Lilongwe, Malawi;
[b]Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa;
[c]Department of Research and Development, South African Weather Service (SAWS), Pretoria, South Africa;
[d]Department of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Durban, South Africa

*Correspondence to Maggie G. Munthali, email: nyaunthali2011@gmail.com

ABSTRACT

The sustainable management of natural resources requires critical understanding of land use and land cover changes and how these changes impact natural resources and rural livelihoods. This study examined the impacts of LULC changes on natural resources and rural livelihoods of Central Malawi. The study used an integrated approach combining remote sensing, household surveys consisting of structured and semi-structured questionnaires, focus group discussions and key informant interviews. Local communities perceived that LULC changes have resulted in the decline of agricultural land (57.3%), crop production (82.8%) and forest cover (87.4%) In response to observed LULC changes, respondents deployed short-term coping strategies such as seeking piecework opportunities and the use of savings and credits. The study has provided evidence that LULC changes have led to significant losses in natural resources, with serious consequences for rural livelihoods in Dedza. The study has contributed to better understanding of the complicated human-environment interaction in Malawi.

Keywords: word; LULC cover, livelihoods, local perceptions, coping strategies, shocks

1. INTRODUCTION

In many parts of the world, anthropogenic activities such as mining, deforestation, fires, human settlements and agricultural intensification have been reported as the major drivers to changing land use and land cover (LULC) locally, regionally and globally (Gamble et al. 2003; Halmy et al. 2015; Mei et al. 2016). These changes have directly or indirectly contributed to a decrease in the availability of natural resources, which have ultimately compromised the ability of the ecosystem to provide goods and services for human sustenance (Loveland et al. 2003; Leh et al. 2013; Butsic et al. 2015; Olanrewaju et al. 2018). For instance, LULC changes have led to deforestation, habitat fragmentation or destruction, biodiversity loss, ecological and natural resource deterioration, unplanned urbanization and undesired human settlements (Daye and Healey 2015; Munthali et al. 2019a; Enaruvbe and Atafo 2019). These drivers of LULC change synergistically interact with climate variations, demographic -, institutional - and socioeconomic factors to modify the landscape. The LULC dynamics of any landscape constitute a challenge for land management, ecological and natural resource management and sustainable development (Rawat et al. 2013; Beuchle et al. 2015; Chaudhary et al. 2016).

In Sub-Saharan Africa (SSA), changes in LULC have serious social, environmental and economic impacts on the livelihoods of rural inhabitants and the natural resource base they depend upon (Maitima et al. 2010; Kamwi et al. 2015). The natural resource base and local communities' livelihoods may be affected by LULC changes either positively or negatively and the consequences of these may be intended or unintended (Hansen and DeFries 2004). According to Enaruvbe et al., (2019) the sustainable management of protected areas, biodiversity conservation and the implementation of sustainable development strategies specifically targeting rural populations are some of the key challenges currently facing governments and authorities in SSA. These challenges are compounded in SSA where authorities and inhabitants also need to contend with the impacts of climate change, overdependence on natural resources, forest degradation, deforestation and rapid population growth rates (Enaruvbe et al. 2019). In this context, increasing competition for scarce natural resources may thus accelerate the incidence of land-related conflicts and unsustainable rural livelihood practices, which would ultimately shape observed LULC changes and the configuration of rural landscapes.

Overwhelming evidence around the world, different regions and countries show that there is a systematic relationship between changing LULC patterns and livelihoods (McCusker and Carr 2006). A study focussing on Chagga farming systems as practiced on the slopes of Mt. Kilimanjaro, Tanzania demonstrated how changes such as the expansion of settlements, and disappearance of bushland translated into changes in farmers' livelihoods (Soini, 2005). This study also concluded that growing population pressure combined with the increasing scarcity of land on the slopes of Mt. Kilimanjaro caused communities to switch their main occupation from farming to non-agricultural activities and paid employment for income (Soini, 2005). Similarly, in Senegal, people were aware of the conditions between the state of their environment and their well-being (Herrmann et al. 2014). The communities in this studied landscape shared the perception that the continuously changing LULC resulted in deteriorating climatic conditions (unfavourable rainfall distribution), loss of trees and degrading pasture quality. As a result, the communities in Senegal opted to diversify their income opportunities, adjusted their livelihood strategies and also pursued adaptation strategies to respond to their perceived environmental crisis (Hermann et al, 2014).

Dedza District like any other District in Malawi has experienced gradual LULC changes (Munthali et al. 2019a). The district has experienced a reduction in forest cover, agricultural and wetlands; and an increase in the incidence of barren and built-up areas. A recent study concluded that these changes are driven by population growth, poverty, firewood collection and charcoal production (Munthali et.al 2019b). Findings from the study by Munthali et al. (2019a and 2019b) thus clearly indicates that the livelihoods of rural people in the Dedza District are highly dependent on natural resources. However, the increasing dependence of these rural inhabitants on the natural resource base has contributed to significant changes in the landscape with serious environmental consequences as reflected in the reduction of forest cover, wetlands, water bodies and agricultural land (Munthali et al. 2019b). Given the dependence of rural inhabitants on natural resources and the fact that LULC changes are impacting on the capacity of the natural resource base to meet the needs of local residents there is,therefore, an urgent need to understand the nature of the impacts of LULC changes on rural livelihoods in the area. Linked to this fact, there is also a need to understand how rural residents cope or adapt to given changes in LULC. A sound understanding of the nature of LULC changes taking place in the study area and its impacts on the rural livelihoods of inhabitants coupled with the coping strategies being deployed in response to these changes is thus seen as a crucial requirement for sustainable land management, use, planning and decision-making.

To date, the impacts, and implications of changing LULC in Dedza District on natural resources and the rural livelihoods dependent on these resources, are not known. More importantly, little is known about the impacts of these changes as a function of rural livelihoods and the coping strategies deployed in response to the changing landscape. An in-depth understanding of the impacts/implications of the changes taking place in the study area on rural livelihoods; and the strategies used to cope with these changes; is important for decision-makers. For instance, knowledge of these impacts will assist policy-makers to develop strategies and interventions that will assist rural communities to cope with the changing LULC in the study area. Further, understanding the linkages between the impacts of LULC changes and related shocks such as drought, floods, fires and epidemics, and the coping mechanism used to counter these shocks are beneficial to resource managers. Moreover, these linkages will also help resource managers to design welfare-improving policies and strategies for local communities in the study area aimed at restoring the landscape over the long term. Thus, it will assist in the development of land-use planning, management strategies and policies that promote restoration and sustainable management of natural resources and eventually sustainable development of Dedza landscape as a whole. According to Adger et al. (2005), understanding LULC dynamics and how it impacts and interact with communities is crucial for designing interventions that will positively impact the natural resource base and communities at large. The research for this paper therefore aimed to explore the impacts of the LULC changes in Dedza District (from 1991 to 2015) on the livelihood strategies of local community members and is also tried to capture the range of adaptive strategies used by communities to cope with these observed changes. Moreover, the research was also concerned with exploring linkages between the socio-economic positioning of the respondents and the types of coping strategies they choose to deploy.

2. MATERIALS AND METHODS

2.1 Study area

The study area, Dedza District, is located in Central Malawi about 88 km from the capital city of Malawi, Lilongwe District (Figure 1). The altitude based on the topographic zones ranges from 1100–1300m, 1000–1500m and 1200–2200m for Lilongwe plains, Dedza escarpments the Dedza highlands respectively (GoM 2013). The rainfall pattern is bimodal spread over one long growing season from November to

March. The average annual rainfall spatially varies from 800 mm to 1200 mm while temperature ranges between 14 ^{o}C and 21 ^{o}C, with an average temperature of 15.5 ^{o}C. Recently, the District has experienced dry spells and droughts. According to the recent national population census, Dedza has an estimated population of 830,512 with an annual growth of 2.8% (NSO 2018). The population density has increased from 172 persons per km^2 in 2008 to 221 persons per km^2 in 2018. The rural livelihood structure is predominantly characterised by subsistence farming. Agriculture remains the primary source of livelihoods with more than 80% of the population depending on subsistence farming as their main economic activity (Munthali et al. 2019b). The major crops grown in the area include maize (*Zea mays*), Irish potatoes (*Solanum tuberosum*), sweet potatoes (*Ipomoea batatas*), groundnuts (*Arachis hypogaea L*.), beans (*Phaseolus vulgaris L*), and soybeans (*Glycine max*). Rice and cotton are also grown along the lakeshore and valleys and fishing farming is also common along the lakeshore. People in the district also keep livestock comprising of cattle, goats, pigs, sheep, and poultry. Additionally, the majority of the population's economy and livelihoods is primarily based on natural resources (GoM 2010; 2013). As a means of diversifying income, the communities are also involved in non-farm activities such as Village Loan Savings (VLS), businesses, piece work (occasional jobs) and handcraft (Munthali et al. 2019b).

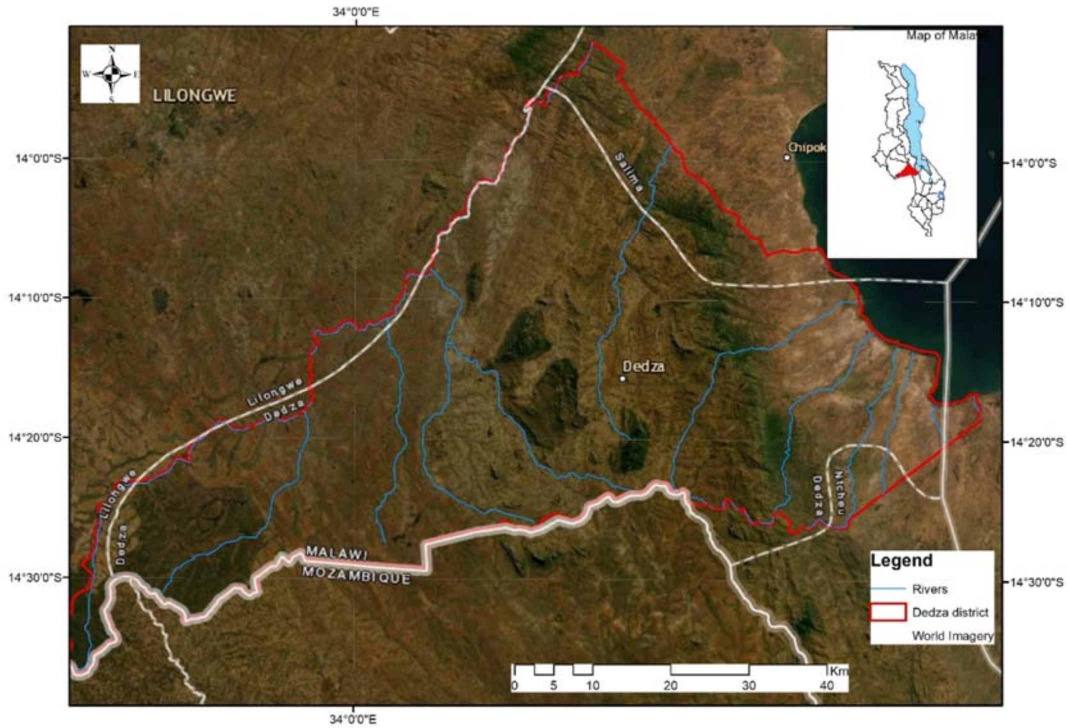

Figure 1. Map of Dedza District.

2.2 Land use and land cover dynamics

The research presented in this paper builds on the findings already reported by the authors in Munthali et al. (2019a) and Munthali et al. (2019b). As detailed in these papers, change detection was conducted using multi- spatiotemporal Landsat images of 1991, 2010 and 2015. Hybrid procedure using both supervised and unsupervised classification was employed to generate LULC maps using the maximum likelihood classification algorithm in ArcGIS 10.5 software. The study area was classified into six (6) LULC classes (Table 1).

Table 1. Land-use land-cover (LULC) categories used in Dedza District.

LULC class	Description
Water bodies	Rivers, permanent open water, lakes, ponds, reservoirs.
Wetland	Permanent and seasonal grasslands along lake, river, and streams, marshy land and swamps.
Agricultural land	All cultivated and uncultivated agricultural areas, such as farmlands, crop fields including fallow lands/plots, and horticultural lands.
Forest	Protected forests, plantations, deciduous forests, mixed forest lands, and forests on customary land.
Built-up areas	Residential, commercial and service, industrial, socioeconomic infrastructure, and mixed urban and other urban, transportation, roads, and airports.
Barren land	Areas around and within forest-protected areas with no or very little vegetation cover, including exposed soils, stock quarry, rocks, landfill sites, and areas of active excavation.

In this study, LULC classifications results were subjected to a minimum of 85% overall accuracy as recommended by Anderson (1976) and Kamusoko and Aniya (2007). A total of 221 points for accuracy assessment were collected based on the stratified random sampling method. Accuracy assessment was achieved through a combination of Google earth professional images, ancillary data, field surveys conducted in October 2017 and the researcher's knowledge of the study area. The accuracy assessment was only performed on the 2015 classified map due to difficulties and unavailability of ground validation data in the forms of aerial photographs and archived Google earth images. The overall accuracy for the 2015 classification map was 91.86%. According to Munthali et al. (2019a & b), the change detection was done using post-classification comparison (PCC) and the results showed that agriculture land, forest, wetlands, and water bodies drastically decreased during the study period, 1991 – 2015 (Table 2 and Figure 2). Conversely, built-up areas and barren land substantially increased during the same period.

Table 2. LULC change trends and the annual rate of change of the study area.

LULC Class	1991 Area (Ha)	%	2015 Area (Ha)	%	LULC Changes (1991–2015) (%)	Annual Change Rate (1991–2015) (%)
Water	1380.60	0.37	899.55	0.24	−0.13	−1.78
Wetland	3626.73	0.96	2680.29	0.71	−0.25	−1.26
Forest	9939.15	2.64	6237.63	1.66	−0.98	−1.94
Agriculture	267,977.43	71.3	260,879.31	69.41	−1.89	−0.11
Barren	92,185.38	24.53	97,174.62	25.85	1.32	0.22
Built-up	761.67	0.2	7999.56	2.13	1.93	9.8
Total area	375,870.96	100	375,870.96	100		

Source: Munthali et al. 2019a, 2019b.

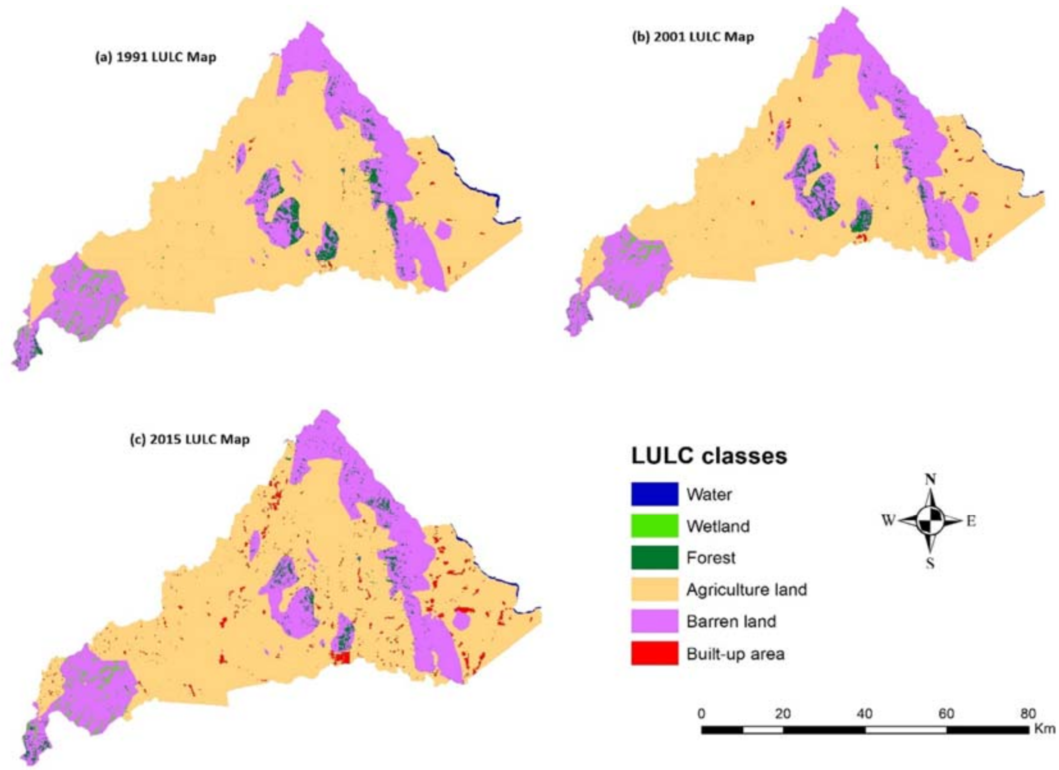

Figure 2. LULC Maps for 1991, 2001 and 2015.

2.3 Primary data collection and analysis

Primary data was collected using household surveys, focus group discussions (FGDs) and key informant interviews. A combination of structured and semi-structured interviews was conducted with representatives from 586 households (HHs) in Dedza District which were randomly selected from villages under the rule of four (4) traditional authorities (TAs) namely TA Kasumbu, Inkosi Kaphuka, Senior Chiefs Kachindamoto and Kachere. The study employed a questionnaire which comprised of both open and closed-ended questions. The questionnaire was translated to the local language (Chichewa) and each HH interview lasted for about 30 to 60 minutes. A pilot survey prior to the formal HH surveys was conducted and the questionnaire was pretested on 20 HHs to ensure that all questions were clear and reliable and to collect valid data for the study. The HH surveys covered topics related to socioeconomic and demographic characteristics of HHs, land tenure and access to resources. The questionnaire also captured information about the respondents' perception with regard to LULC changes, drivers of LULC changes, the impacts of these changes on rural communities and natural resources and finally, the coping mechanisms/strategies employed HH members in response to LULC changes.

In addition to HH interviews, FFGDs and key informant interviews were conducted to triangulate, contextualize and gather detailed and in-depth information about respondents' perceptions about LULC dynamics, the drivers behind the changes, impacts of these changes and coping strategies used by the local communities. A specific checklist with open-ended questions was developed by the researcher to collect this information. A total of four (4) FGDs were held in the four (4) TAs of the study area where HH surveys were conducted. These FGDs targeted the Area Development Committees (ADCs) which in Malawi is an administrative or representative body of all Village Development Committees (VDCs) under a traditional authority with the vested responsibility to mobilize community resources and implement development interventions within the area. VDC members include group village head persons, members of parliament whose constituencies are in the area, the district councillors of the area, representatives of business communities, religious leaders, youth and women groups and representatives of a network of CSOs. Each FDG comprised of 10 – 15 discussants and lasted between 2 to 3 hours. These FDGs were facilitated by the researcher and were guided by a checklist of questions on various aspects of LULC changes, the drivers and impacts and the coping strategies employed by communities in their respective areas. For the key informant interviews, respondents were purposively targeted to include professionals or natural resource experts from Dedza District council. These included the technical members such as the District Commissioner, researchers and officers from agriculture, natural resource and environmental institutions and organizations. More than 10 key informants were interviewed.

2.4 Data and statistical analysis

For the analysis, a combination of different data analytical methods was employed. This process included descriptive statistics and GIS-based processing analysis. Change detection was done using ERDAS Imagine 2015 and ArcGIS 10.5 software. The socioeconomic data derived from the questionnaire were analysed using SPSS 25. Data collected through FGDs and key informant interviews were qualitatively analysed in alignment with the qualitative techniques used by Hsieh and Shannon (2005). A thematic analysis was conducted on the data collected during FGDs and key informant interviews. Responses by the respondents regarding the impacts of LULC dynamics and coping strategies used were ranked. The ranking exercise was computed using the principle of a weighted average ranking index as adopted in Musa et al. (2006) and Solomon et al. (2018). For this approach the following equation was applied:

$$Index = \frac{R_n C_1 + R_{n-1} C_2 \cdots + R_1 C_n}{\sum R_n C_1 + R_{n-1} C_2 \cdots + R_1 C_n} \qquad (1)$$

where R_n = value given for the least-ranked level (for example, if the least rank is the 5th, then R_n = 5, R_{n-1} = 4, R_1 = 1; C_n = counts of the least ranked level (in the above example, the count of the 5th rank = C_n, and the count of the 1st rank = C_1).

3. RESULTS

3.1 Socioeconomic characteristics of the respondents

The majority (93.3%) of the sampled members of the HHs interviewed had lived in the study area throughout the study period (1991 – 2015). The results have shown that the respondents' age ranged from 20 to 97 years with a mean age of 39.2 years (Table 3). The minimum, mean and maximum household size was 1, 5 and 13 persons respectively. The farm size owned by HHs interviewed ranged from 0.25 to 13 acres. Almost 80.2% of the HHs owned ≤3 acres of land. The larger proportion (63.3%) of the respondents were female and only 77.8% of the HH respondents were literate. Approximately, 78.7% of the interviewees were married and over 70% of the HH were male-headed. The mean annual income per HH was MK283,843.26 (US$397.68) whose majority (81.6%) primarily depend on farming as their main occupation. Most of the HHs (88.2%) use a 3-stone open fire as a common domestic stove for cooking.

Table 3. Household characteristics of the sampled respondents (N = 586).

Household attribute		**Value**
Mean household age (years)		39.20
Gender (%)	Male	36.70
	Female	63.30
Head of the family (%)	Male	71.70
	Female	28.30
Education (%)	No formal education	22.18
	Primary	64.33
	Secondary	13.48
Occupation (%)	Farmer	81.57
	Business	8.36
	Housewife	0.17
	Professional	0.51
	Construction	0.34
	Craft work	6.66
	Domestic work	2.39
Marital status (%)	Single	2.56
	Married	78.67
	Separated	1.37
	Divorced	9.22
	Widowed	8.19
Ethnic group	Chewa	50.68
	Ngoni	39.59
	Yao	8.53
	Lomwe	0.51
	Tumbuka	0.51
	Mang'anja	0.17
Mean household size (No.)		5.58
Mean land holding size (acres)		2.32
Mean income (MK/year)		286,843.26
Sources of income (%)	Farming	64.20
	Full time private/government employment	1.28
	Selling of forest produce	1.25
	Piece-work/occasional jobs	9.84
	Self-employed	19.99
	Renting out land	1.08
	Village saving loan	2.31

Note: * Malawi currency at the time of the study, 1 USD = MK721.30.

3.2 Impacts of LULC changes on agricultural land

In the context of this study, the household members interviewed held the perception that the size of agricultural land and crop production between 1991 and 2015 has drastically declined (Figure 3). Approximately, 57.3% and 82.8% of the interviewees shared the perception that agricultural land and crop production has declined respectively. With respect to the contributing factors leading to a decline in crop production, the HHs interviewed were asked to rank the major five (5) causes. The results revealed that soil infertility, unreliable rainfall, high cost of agricultural inputs, lack of money for inputs and lack of agricultural inputs were the five (5) major causes of low crop production in the study area (Table 4).

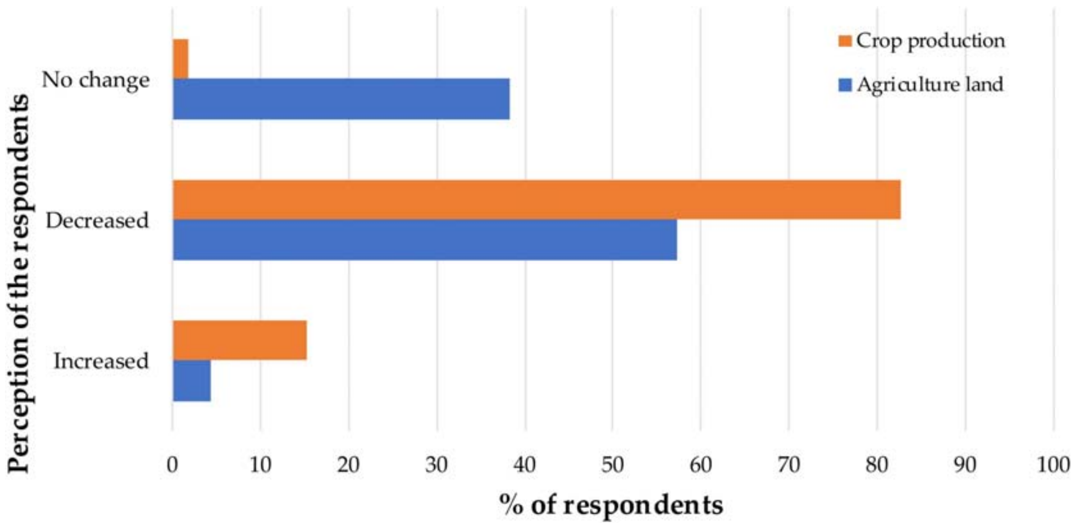

Figure 3. Perceptions of respondents on agricultural land and crop production.

Table 4. Causes of declined crop production in the study area.

Causes	**No. of Respondent Per Rank**					**Weight**	**Index**	**Rank**
	1	**2**	**3**	**4**	**5**			
Soil infertility	141	85	66	33	29	1338	0.216	1
Unreliable rainfall	98	116	54	44	13	1217	0.196	2
Pests and diseases	55	37	50	24	15	636	0.103	6
Limited/inadequate land	9	20	24	25	19	266	0.043	8
Lack of agricultural inputs	46	44	56	29	12	644	0.104	5
Inadequate labour	12	13	8	12	12	172	0.028	10
Low marketing prices	12	19	14	11	9	209	0.034	9
Lack of money for inputs	38	54	57	29	23	658	0.106	4
High cost of agricultural inputs	46	59	51	25	16	685	0.110	3
Poor access to subsidy programme	22	20	17	12	17	282	0.045	7
Soil erosion and waterlogging	5	6	7	8	4	90	0.015	11
Lack of access to information on improved agricultural technologies	0	0	1	1	0	5	0.001	12

3.3 Impacts of LULC dynamics on forest resources

From Figure 4, the results reveal that forest cover of the study area has declined which resulted in increased distances that had to be covered for the collection of forest produce and products (Figure 4). Almost 87.4% of the HHs interviewed perceived that forest cover had declined while 7.8% and 4.8% felt that forest cover had increased and remained unchanged during the study period respectively. On the other hand, approximately half (50.7%) of these HHs perceived that distance to the collection of forest produce and products have substantially increased, with only 31.4% perceiving a decrease and 17.9% perceiving no change in distances to cover. Evidence from the household data clearly reveals that a decrease in forest cover as a result of deforestation has impacted the local communities in different ways (Table 5). The households identified lack of firewood as the most important impact of increased deforestation in the study area followed by loss of soil fertility, floods and droughts, lack of wood for construction and finally depletion of water resources.

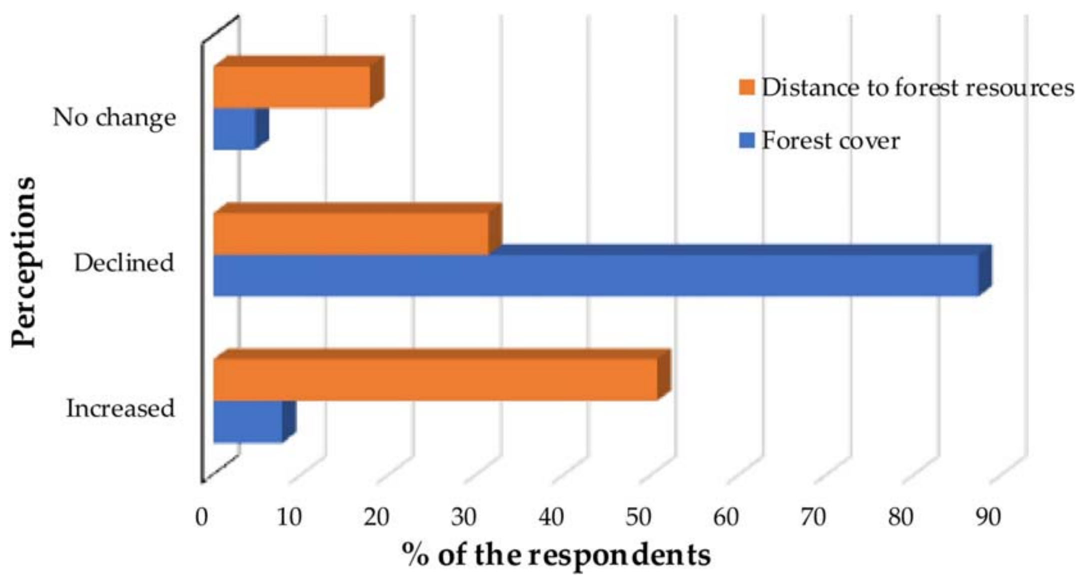

Figure 4. Perceptions of respondents' forest cover and distance to forest resources.

Table 5. Impacts of declined forest cover or deforestation to communities.

Impacts of deforestation	No. of Respondent Per Rank					Weight	Index	Rank
	1	2	3	4	5			
Lack of firewood	206	135	89	34	14	1919	0.269	1
Lack of wood for construction	36	112	67	73	30	1005	0.141	4
Floods and droughts	127	72	77	37	19	1247	0.174	3
Depletion of water resources	42	50	53	49	26	693	0.097	5
Decline in scenic value	6	18	31	23	42	283	0.040	7
Loss of soil fertility	74	116	101	56	30	1279	0.179	2
Unreliable rainfall	73	35	27	14	5	619	0.087	6
Heavy winds	2	12	13	2	1	102	0.014	8

3.4 Shocks experienced by rural communities over the past five years

The study revealed that HHs interviewed in the study area experienced remarkable shocks over the past five (5) years as a result of LULC change impacts (Table 6). Drought was the highest-ranked shock reported by HHs followed by floods, food shortage, loss/damage of crops and death of household members. These shocks have affected rural community members in the area to such an extent that the majority (>50%) of the community members lost their assets and income with a reported decline in crop yield (Figure 5). Additionally, results from FGDs and key informant interviews revealed that the District also experienced heavy winds/hailstorms and crop pest outbreaks during this period

Table 6. Major shocks experienced by in Dedza in the past 5 years.

Major Shock	No. of Respondent Per Rank					Weight	Index	Rank
	1	2	3	4	5			
Fire	27	10	4	2	3	194	0.081	6
Drought	43	25	12	10	4	375	0.156	1
Irregular rainfall patterns	17	18	6	7	5	194	0.081	6
Increase in price of inputs	5	7	9	9	6	104	0.043	10
Great loss of crops/crop damages	23	16	11	9	2	232	0.096	4
Great loss/death of livestocks	15	5	4	2		111	0.046	9
Theft/robbery and other violence	16	10	5	3	1	142	0.059	8
Floods	39	25	13	2	1	339	0.141	2
Food shortage	19	27	16	8	11	278	0.115	3
Price rise of food items	3	7	3			52	0.022	11
Illness of household member	20	14	8	2	3	187	0.078	7
Death of household member	27	10	3	6	5	201	0.083	5

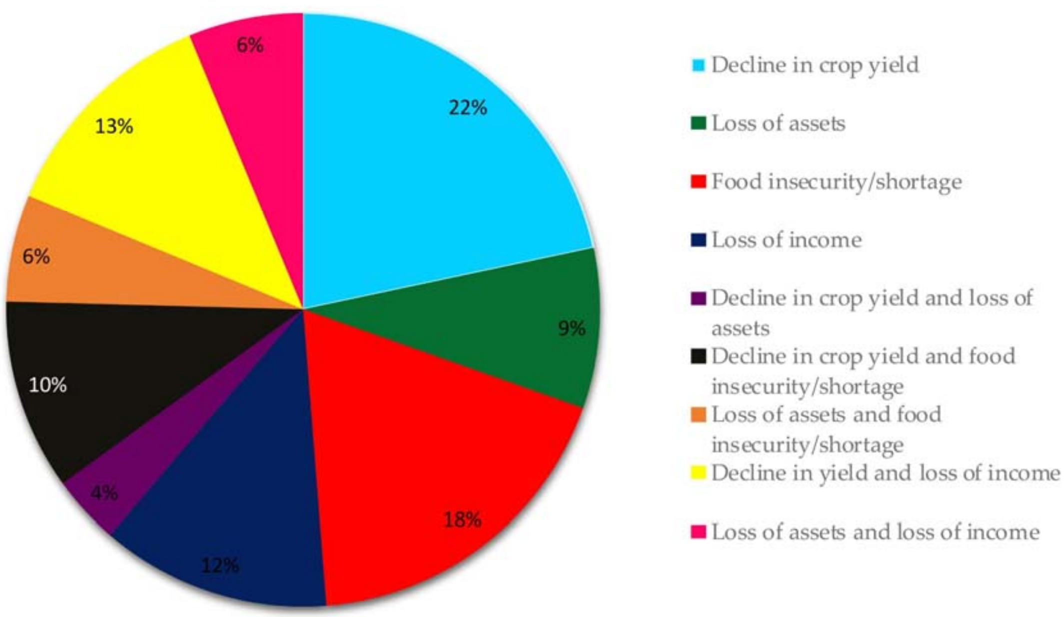

Figure 5. Effects of shocks on the livelihoods of the sampled HHs.

3.5 Coping strategies used to counter shocks experienced by rural communities

The rural communities from Dedza District are engaged in different livelihood coping strategies to counter the shocks they faced due to LULC changes that have taken place in the study area during the study period. The results have revealed that the most prominent coping strategies used in response to LULC change-related shocks included participation in piecework, receiving aid from government and NGOs, procuring financial support from relatives and the reliance on savings and credits (Table 7). Other livelihood coping strategies included the selling of agricultural assets, crops, livestock and forest produce. In addition, the focus group discussants and key informants said that people in the District coped with the shocks by planting drought-tolerant crops, collecting wild fruits and tubers, constructing dikes and practicing irrigation farming.

Table 7. Household/livelihood coping strategies.

Livelihood coping strategy	**No. of Respondent Per Rank**					**Weight**	**Index**	**Rank**
	1	**2**	**3**	**4**	**5**			
Participated in piece works	126	23	6	7	1	755	0.360	1
Received food aid from government and NGOs	8	37	10	7	5	237	0.113	2
Relied on own savings	19	11	12	4	1	184	0.088	4
Obtained credit	17	13	9	3	13	183	0.087	5
Reduced food consumption	7	8	3	3	0	82	0.039	8
Household members migrated	6	2	0	0	0	38	0.018	12
Reduced expenditures	1	3	0	0	0	17	0.008	13
Sold Agricultural assets	15	9	2	0	1	118	0.056	6
Received unconditional aid from relatives	20	14	8	10	1	201	0.096	3
Sold livestock	9	6	6	1	1	90	0.043	7
Sold crop stock	6	4	6	2	0	68	0.032	10
Sold land/buildings	1	6	9	9	5	79	0.038	9
Sold forest produce	0	7	5	1	0	45	0.021	11

4. DISCUSSION

4.1 LULC changes and their impacts on natural resources and livelihoods

Changes in LULC of any landscape at the spatiotemporal scale have increasingly been recognized by many researchers around the world as an important driver of environmental change. Accordingly, this has become a major issue for the management and monitoring of the natural resource base (Gamble et al. 2003; Halmy et al. 2015; Mei et al. 2016). The capacity of an ecosystem to provide goods and services are impacted by LULC changes of any landscape (Burkhard et al. 2012). Thus, they have significant impacts on the functioning of socioeconomic and environmental systems. The results from this study clearly indicated that LULC modifications in Dedza District between 1991 and 2015 has resulted in a decline of agricultural and forest resources coupled with a depletion of water resources and wetlands. The decrease in agricultural land has resulted in declined crop production in the study area. These results are similar to findings from elsewhere in which rural communities perceived that LULC changes resulted in declined agricultural land, forest resources, depletion of water resources and wetlands (Gessesse and Bewket 2014; Kirma et al. 2016; Benti et al. 2017; Karki et al. 2018).

The households in the study area believed that the observed decline in crop production was being exacerbated by factors such as soil infertility, unreliable rainfall, high cost of agricultural inputs and a lack of money for farming-related resources. Responses from the key informants and FG discussants also suggested that reduced crop production was due to persistent dry spells (drought), climate change effects, poor land husbandry practices and inadequate market opportunities. Accordingly, reduced crop production implies declining agricultural productivity which has been linked to the incidence of food insecurity in the study area. Scherr and Yadav (1996) projected that by 2020, land degradation in the form of soil nutrient depletion and soil erosion will negatively affect food production and livelihoods of rural people especially in poor and densely populated areas in the developing countries (which would include a country such as Malawi). It is also predicted that these conditions would cause a decline in the ecological, physiological and productive capacity of the land resulting in reduced potential agriculture yields. Some of the causes of reduced crop production were reported in a study by Desalegn et al. (2014) that revealed that farmers' crop production in Central Highlands of Ethiopia was constrained by lack of access to credit, deterioration of soil fertility and shortage of land. Furthermore, a recent study by Agidew and Singh (2017) reported on the implications of LULC changes that occurred between 1973 and 2015 on the food and livelihoods of communities located in the Teleyayen sub-watershed region of Ethiopia. The communities in Ethiopia perceived that LULC changes in the region resulted in climate change, land degradation, shortage of farmland, crop yield reduction, farmland fragmentation, soil erosion rural-urban migration.

The depletion of water sources and declined wetlands as observed by the communities in Dedza District compromises the capacity of the landscape or ecosystem to perform its hydrological functions efficiently. The results agree with findings from remotely sensed analysis that the areas occupied by water bodies and wetlands in Dedza District decreased by 34.8% and 26.1% respectively (Munthali et al. 2019a). Pervez and Henebry (2015) and Memarian et al. (2013) reported that LUCC changes have a great influence on the hydrological response or water resources of any watershed. In recent years, frequent human activities, for example, deforestation, afforestation, and farmland reclamation, have led to significant agricultural-land-pattern changes. Additionally, LULC changes affect water resources mainly through vegetation interception, evapotranspiration, runoff, surface infiltration, soil moisture status, and so forth, thereby affecting the process of watershed hydrology and water resource cycles. According to Bronstertet et al. (2002), IPCC (2007) and Gibbard et al. (2005), changes in LULC substantially affect the climate of any landscape which adversely affects water resources such as wetlands and water. This observation was confirmed by the findings of studies conducted by ICIMOD and MoFSC (2014) who reported that water bodies (streams/rivers) and wetlands (swamps/marshes) decreased by 14% and 3% respectively in Nepal since 1976 which reportedly also contributed to the loss of threatened species and other biodiversity/habitat indicators in the country. Chaudhary et al. (2017) made similar observations in the Phobjikha valley of Bhutan. The reduction in wetlands and water bodies in Phobjikha valley aggravated flooding in the open and mountainous areas of Bhutan. According to Temesgen et al. (2018), shrinkage and disturbance on wetlands and water bodies reduce their capacity to regulate flooding in any landscape.

The decline in forest cover or increased deforestation reported in Dedza district has consequently also resulted in a shortage of firewood and wood for construction, persistent floods and droughts, depletion of water resources and loss of soil fertility in the study area. In Dedza, forest cover loss and increased deforestation are highly linked to population growth and poverty (Munthali et al. 2019a). These results clearly show that rural communities from Dedza District depend almost entirely on forest resources for their daily energy needs and construction. Consequently, these two factors exert pressure on the forest resource base leading to increased demand for fuelwood and wood for construction. These findings align with Sandhu and Sandhu (2014) and Wangchuk et al. (2014) whose studies concluded that a decline in forest produce and products such as fodder, fuelwood, timber and litter where livelihood options are mainly limited to agriculture and livestock in the Himalayas increased the vulnerability of forest dependent rural dwellers. The types of conditions described in this study could thus force local communities to overexploit the remaining resources, thus reducing its availability and quality which could end up leaving them in a poverty trap (Gerlitz et al. 2012; Gerlitz et al. 2014).

Concerning the impacts of LULC changes on natural resources, the findings of this study are in line with Gessesse and Bewket (2014) and Gessesse (2018) who reported that changing LULC that took place in the Central Highlands of Ethiopia had impacts on food security of the communities, water resource availability and agricultural land productivity. Further, Agidew and Singh (2017) found that LULC changes had implications on rural households in the North-eastern highlands of Ethiopia. These impacts included land degradation, shortage of farmland, crop yield reduction, farmland fragmentation, increased rate of soil erosion and climate change. The authors argued that the expansion of agricultural land and degraded land in their study area was at the expense of forest land, grasslands and shrublands (Agidew and Singh, 2017). In fact, several authors have reported that mismanaging terrestrial ecosystems and other natural resources such as forests, water and agriculture land leads to severe environmental problems such as forest degradation and deforestation, soil erosion and degradation, siltation of rivers, water shortage and deterioration and loss of biodiversity (Girma et al. 2002; Seto et al. 2002; Muluneh 2003; Verburg 2006). Shiferaw (2011) and Rientjes et al. (2011) confirmed that the negative effects of changing LULC on the environment are strongly influenced by the conversion of resources such as land and forests. Reduction in forest cover also implies a shortage of timber for construction and fuelwood supply to the communities. Thus, forest-dependent communities are affected by changing LULC. Forest degradation and deforestation hamper the rural livelihoods (especially the indigenous communities) whose basic life strongly depend on the natural resource base in proximity (Banerjee and Madhurima 2013).

4.2 Shocks and rural livelihood strategies

Rural households in developing countries are frequently affected by multiple shocks, either, idiosyncratic or covariate shocks, resulting from changes in LULC. These greatly threaten rural communities' livelihoods and adversely impact their welfare. As postulated by Fafchamps (2009) and Haq (2015), these shocks could be social, natural/agricultural, economic or related to health. In Dedza district, rural communities devised various coping strategies to overcome the shocks induced by changing LULC. The specific shocks that occurred in the studied landscape as perceived by the communities included; drought, floods, food shortage, loss/damage of crops, the death of a household member, crop pest outbreak, strong winds/hailstorms. Most of the crops were attacked by pests such as armyworms. Similar results have also been reported by Bryan et al. (2010) where local communities experienced shocks such as drought, erratic rainfall, floods, loss of income and assets, crop yield reduction, food shortages, death of livestock and increase in food prices. Other findings from Dercon et al. (2005) and Kamwi et al. (2015) indicated that rural households reported droughts and food shortages as the most important shocks affected by in Zambezi region of Namibia and Ethiopia respectively.

Berkes and Jolly (2001) define coping mechanisms/strategies as a short-term response to the crisis on livelihood systems in the face of unwelcome/undesired situations. These possible strategies help in reducing people's vulnerability to LULC change and climate change impacts. Rural households of Dedza District are engaged in different coping mechanisms. Rural communities in the study area adopted piecework, receiving aid from government and NGOs, receiving unconditional aid from relatives, relying on their savings and credits as coping strategies to counter the shocks faced during the reporting period. Similar results were revealed in the West-Arsi zone of Ethiopia where local communities coped with the LULC and climate impacts through savings, aid from relatives and government and other institutions, credits, diversification and selling of wood and livestock (Senbeta 2009). In another study by Kamwi et al. (2015), rural households from the Zambezi region indicated borrowing from relatives, piecework, wild food collection and food aid as the prominent coping strategies. In other countries, rural communities adopted different coping strategies from Dedza rural households in responding to the shocks. For instance, in Kenya, rural communities were able to cope with the shocks by reducing food consumption, purchasing additional food and consuming different food (Bryan et al. 2010). For the local communities in Nepal to cope with the shocks resulting from LULC changes, they used the following short-term strategies; borrowing money, cutting down the living expenditure, labour migration, use of kerosene and buying food on credit (ICIMOD and MoFSC 2014).

6. CONCLUSION

This study assessed the perceived impacts of land use and land cover changes on natural resources and rural livelihoods of communities in the Dedza district, Malawi for the period 1991 to 2015. The study further examined on one hand, the shocks experienced by communities resulting from LULC and climate change impacts and on the other hand, the short-term strategies used to cope with these changes. Our findings show that the changing LULC in the study area has substantially impacted natural resources and rural livelihoods in Dedza district which included a general decline in agricultural land (57.3%), crop production (82.8%) and forest cover (87.4%) and an increase in distance to forest resources (50.7%). All these changes pose a big threat and risks to the livelihood of especially vulnerable communities owing to their dependence on the diminishing ecosystem services linked to natural resources in the study area. Results from the study also revealed the distinct vulnerability of forest-dependent community members in the Dedza district who are increasingly affected by changing LULC with forest degradation and deforestation seriously hampering their livelihood strategies.

The analysis of the community's vulnerability to shocks revealed that the majority of rural households were exposed to shocks such as drought, floods, food shortage, loss/damage of crops, death of household members, crop pest outbreak, strong winds/hailstorms. In response to these shocks, , communities were engaged in short-term adaptation strategies which include undertaking piecework, receiving aid from government and NGOs, receiving unconditional aid from relatives and relying on their savings and credits. In gaining access to these listed coping strategies, the socio-economic positioning of community members in Dedza clearly informed not only the frequency with which members were able to access these strategies, but also their ability to combine them.

The findings of this study contribute to a better understanding of a complicated interaction between people and the environment. The consequences and undesirable impacts of the changes on natural resources and rural livelihoods observed in this study need urgent attention by the natural resource managers, planners and decision-makers. Overall, the following summary recommendations arise from the present study;

(a) The government and other stakeholders involved in the management of natural resources and welfare of communities need to work on redesigning appropriate natural resource management strategies that are better suited towards ensuring people's welfare and their ability to respond to shocks resulting from undesirable LULC changes taking place in the study area. This implies the need for managers to have a far more comprehensive understanding of the nature of LULC changes that are taking in place in the area.

(b) The findings of this research should also be used as baseline information to develop rational and integrated approaches towards implementing policies and strategies that would promote sustainable resource management, conservation and the restoration of natural resources in the Dedza landscape.

Finally, to achieve any meaningful form of sustainable resource management in the Dedza district, the paper concludes with the recommendation for innovative participatory approaches to be piloted in the district. These participatory approaches should be extensive and robust enough to ensure sensible natural resource management aimed at reversing the undesirable trends in terms of LULC changes experienced in the district to date. Most importantly, these participatory approaches should include co-creation and co-development of sustainable livelihood options/strategies for rural communities in Dedza to cope with current and predicted livelihood-related shocks .

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