EQA - International Journal of Environmental Quality
ISSN 2281-4485 - Vol. 57 (2023): 10-23
Journal homepage: https://eqa.unibo.it/

published by

Resettlement, spatiotemporal dynamics of land use/cover and livelihood aspects in Chewaka district, southwestern Ethiopia

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Article info
Received 8/11/2022; received in revised form 21/6/2023; accepted 15/7/2023
DOI: 10.6092/issn.2281-4485/15747

Abstract
Ethiopia has a long tradition of resettling people from drought-prone and degraded areas to sparsely populated parts of the country. This study aimed to investigate resettlement, spatiotemporal dynamics of land use/cover and livelihood aspects in Chewaka district of Ethiopia. A combination of geospatial and socioeconomic data were utilized to attain the intended objectives. Through multistage sampling procedure, 384 households were selected from sample kebeles for household survey. Descriptive and inferential statistics along with multinomial logit model have been employed to analyze the data. The study found that resettlement has resulted in the spatiotemporal dynamics of land use/cover in Chewaka district. Rapid population growth following resettlement program, encroachment of farmland and settlement to vegetated areas, deforestation, human-induced forest fire, illegal settlement expansion, lack of land use plan, and poor management practices are driving unprecedented land use/cover change. It was also found that agriculture is the main economic activity and basis of livelihoods in the study area. Besides, resettlers pursue non/off-farm activities to generate additional income and cope with the challenges of their livelihoods. The study suggests urgent attention on improving infrastructure and social services, environment conservation, controlling illegal settlement expansions and human-induced forest fire as well as supporting resettlers to diversify their income sources for betterment of livelihoods in the area.

Keywords
Resettlement, livelihood, multinomial logit model, Chewaka

Introduction

Ethiopia is a landlocked country located in the horn of Africa between 3-15°N latitudes and 33- 48°E longitudes with a total area of about 1,106,000 km^2 (Debele, 2013). The country is characterized by continued and high population growth rate, severe environmental degradation and persistent drought. Consequently, continuous occurrences of recurrent drought-famine crisis as well as the prevailing chronic and transitory food insecurity are affecting the life of considerable proportion of the population of the country (Mota et al., 2019). In addressing these critical problems, the successive governments of Ethiopia have designed and been exercising arrays of rural development policies, strategies and programs. Despite its often-questioned success stories, resettlement was/is among the often-practiced policy program in the history of the country (Abera et al., 2020). As pointed out by Woube (2005), resettlement is a phenomenon of population relocation from one geographical environment to the other either in a planned or spontaneous manner where adaptations to various systems occur. It has become a proliferating global issue that occurs in many countries of the world, especially in developing countries (Wang & Lo, 2015).

Likewise, Ethiopia has a long history of resettling people and there have been resettlement practices during Imperial, Derg and EPRDF led governments (Kassie et al., 2014). In the country, it has been conceived as a viable developmental program to the continual impoverishment and destitution of Ethiopian

DOI: 10.6092/issn.2281-4485/15747

rural communities with declared objectives of alleviating rural poverty, securing food self-sufficiency and restoring livelihood of vulnerable groups (Abera et al., 2021a; Alemu, 2014). Recently, Ethiopian government commenced intra-regional resettlement in four regions of the country (Amhara, Oromia, Tigray and SNNPR) to attain food security for 2.2 million people (Hammond, 2008; Wayessa & Nygren, 2016). Chewaka is one of the sites in Oromia region where large population are resettled (about 60,000 people were resettled). Prior to the resettlement, the area was covered by dense forest, savanna grassland, woodland and it has immense potential of natural resources. However, the program was undertaken in the area without due consideration of the natural resource issues. Particularly, it lacks environmental impact assessment and management plan for sustainable utilization of the resources. Consequently, ruthless destructions have occurred on the natural resources due to uncontrolled encroachment to vegetated area, human-induced forest fire and illegal settlement expansion. In addition, deforestation, swift land use/cover changes and unwise use as well as indiscriminate cutting of trees are major observable problems. This implies that the scheme brought considerable impacts on the local environment as well as on livelihood of the resettlers. The associated environmental and livelihood changes make resettlement an issue of remarkable scientific and societal relevance. Nonetheless, there are limited evidences showing the impacts of the program. In fact, several studies have been conducted in Ethiopia concerning resettlement issues (Adugna, 2011; Fratkin, 2014; Getahun et al., 2017; Hammond, 2008; Lemenih et al., 2012; Mengesha, 2009). Most of these empirical studies have focused on the socio-economic outcomes, planning and implementation related constraints, human safety (health & conflict) and food security in resettlement areas. Less attention has been given to assess how the current intra-regional resettlement has impacted on natural resources of the environment and livelihood of the resettlers. Thus, lack of rigorous investigation regarding resettlement, spatiotemporal dynamics of land use/cover and livelihood aspects has encouraged the researcher to conduct this study.

Materials and methods

Study site

The study site, Chewaka district, is located in Buno Bedelle Administrative *Zone* of Oromia region, southwest Ethiopia. It lies between $8^0$43’30” - $9^0$5’30” N latitude and $35^0$58’0”-$36^0$14’30” E longitude and covers a total area of 618.7 km^2. A diverse topographic condition which comprises of undulating terrain and gentle sloping lowlands characterizes the study site and the elevation ranges between 1130 to 2053 meters above mean sea level (Fig. 1). The district lies in moist *Woina Dega* (cool sub-humid) and *Kolla* (warm semi-arid) agro-ecological Zones. The mean minimum and maximum annual temperatures of the district range from 14.5 to 28.5°C and the average annual rainfall varies from 800-1200 mm (National Meteorological Service Agency (NMSA), 2018). Currently, the district is inhabited by 96,446 people distributed within twenty eight *Kebeles*, and agriculture is the main economic activity and basis of livelihood for people of the area (Abera et al., 2021b).

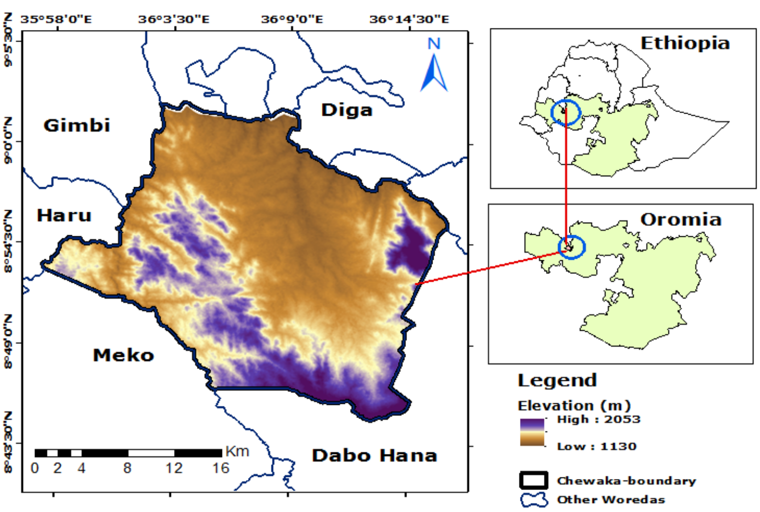

Figure 1 *Location map of the study area.*

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Research design and approach

The study utilized crossectional survey research design to attain the intended objectives. Mixed research approach, specifically concurrent triangulation inquiry strategy was employed in which both quantitative and qualitative data were collected simultaneously, and the results were triangulated during analysis. The reason to use mixed approach is that eclectic approach gives an opportunity to look at the problem from different angles. As stated by Creswell (2014), combination of methods enables to better and deeply understand the problem from different perspectives. When used in combination, quantitative and qualitative methods supplement each other and allow for more complete analyses. This helps to overcome a weakness of one method with the strengths of another and enables researchers to confirm and cross-validate the findings of the study.

Data types, sources and collection instruments

In this study, both geospatial and socio-economic data were employed, and the study was conducted by exploiting both primary and secondary sources of data. Even though remotely sensed data are crucial in land use/cover change studies, it cannot provide complete answers for the questions like why and how changes are occurring (Fisher, 2012). For this reason, to fully address the complex trends of land use/cover dynamics and describe the underlying drivers behind across spatial and temporal scales, it is necessary to incorporate other socio-economic data. This study employed a combination of techniques to evaluate resettlement, land use/cover dynamics and the livelihoods perspectives. First, the trend and level of land use/cover status of pre and post resettlement program was analyzed using satellite image and GIS techniques complemented with field observations. Second, socio-economic surveys were conducted to examine local experiences and perceptions related to land use/cover changes and the drivers behind. Third, the overall implications of such changes on natural resource conservation were referred and linked from the existing literatures. Therefore, different data collection tools such as questionnaire, in-depth interview, focus group discussion, GPS and field observations were used to attain the objective of the study.

Three sets of digital satellite imageries such as Landsat Thematic Mapper (TM) of 2000, and Enhanced Thematic Mapper Plus (ETM+) of the year 2009 and 2018 were used to analyse the spatio-temporal land use/cover changes of the area. The three Landsat imageries, each with 30m spatial resolution were downloaded free of charge from United States Geological Survey (USGS) websites *(https://earthexplorer.usgs.gov/)*.The acquisition dates of imageries were made during dry and clear sky months (December-February) to reduce the effect of cloud cover and seasonal variation on the classification result that blight the quality of image. The year 2000 was taken as a reference for this study to know the status of land use/cover prior to resettlement program because it was a year before resettlement for which cloud free satellite image is available. The 2009 image was used to have a clear picture on the rate of land use/cover changes during the study period. Besides, the researchers preferred to use the year 2018 to analyze the current land use/cover of the area. Toposheet of the study area with 1:50,000 scale was obtained from Ethiopian Geospatial Information Agency (EGIA) to support the classification and assure the rectification of imageries. Digital Elevation Model (DEM) was also obtained from EGIA to extract terrain attributes (Table 1). Ground control points have been taken during field observation by using Global Positioning System (GPS) to aid different steps of image processing and classification for change detection. Furthermore, GIS and remote sensing techniques were employed to map, quantify and analyze land use/cover changes of the area. Various Softwares such as ERDAS Imagine 9.1, ENVI 5.1, and ArcGIS 10.3 are used for image processing, classification, mapping and analysis purpose.

Table 1. Data types, sources and their description

Data type	**Sensor**	**Path and Row**	**Resolution (m)**	**Date of acquisition**	**Source**
Landsat 5	TM	170 & 054	30 x 30	27/12/ 2000	USGS
Landsat 7	ETM+	170 & 054	30 x 30	26/01/2009	USGS
Landsat 7	ETM+	170 & 054	30 x 30	05/02/ 2018	USGS
DEM	-	-	30 x 30	10/03/2018	EGIA
Toposheet	-	-	1:50,000	10/03/2018	EGIA

DOI: 10.6092/issn.2281-4485/15747

Sampling procedures, sample size and sampling technique

The study utilized multistage sampling procedure to select the study site and sample households. First, Chewaka was selected purposively as it is the largest resettlement scheme in southwestern Ethiopia where huge numbers of people are resettled. Second, sample *Kebeles* (Kebeles is the smallest administrative unit/ structure in Ethiopia (Chokorsa, Gudure, Waltasis, Jagan, Walda Jalala, Tokkuma Harar, and Urji Oromia), where the problem of natural resource degradation is more critical, are purposively selected from seven resettlement sub-sites of the district. Third, systematic random sampling technique was employed to obtain respondents from available lists of each sample kebeles. The sample size was determined using formula given by Kothari (2004):

$$n = \frac{P * (1 - P) * Z^2}{e^2} \qquad [1]$$

$$n = \frac{0.5*(1-0.5)*(1.96)^2}{(0.05)^2} = 384 \qquad [2]$$

where: Sample size; P Estimated proportion of respondents. As the proportion is not known, 0.5 was used as p value to obtain maximum number of the respondents; ZThe number of standard error corresponding to 95% confidence interval which is 1.96; eMargin of error that the researcher tolerates is 0.05. Accordingly, a total of 384 households were selected and the selection started randomly from the list of households which proceeds at every 9th interval until the required sample size reached. Therefore, households were selected proportionally from sample *Kebeles* for survey questionnaire. In-depth interview was conducted with development agents, kebele managers, district, and zonal level officials. Focus group discussion was conducted with six natural resource experts of the district from office of agricultural and rural development, natural resource management and environmental protection as well as rural land administration and management (i.e. two individuals from each office). Field observation was also carried out through transect walk with development agents by the aid of visual photographs to crosscheck data collected via other data-collection instruments. Besides, to substantiate the analysis, secondary or supplementary data that are relevant to the study were obtained from published and unpublished documents.

Methods of data Analysis

Digital image processing and analysis: In this study, image pre-processing, classification, accuracy assessment and change detection were carried out on the Landsat imageries of the study area. Image pre-processing such as radiometric corrections or haze reduction, image enhancement, de-striping and subsetting were executed. Supervised classification using maximum likelihood algorithm was carried out to categorize the images by taking training points which were defined based on the ground truth points and Google earths. As noted by Congalton and Green (2009), although there is no rule of thumb or universally accepted uniform sample size determination for land use cover classification, a minimum sample size of 50 (for each land use cover category) is recommended for classifications with less than 12 categories. Accordingly, a total of 800 training points for the signature file were collected for the reference years. The training points were collected using a stratified random sampling method. The land units of the study area were fixed for the purpose of mapping on the basis of information obtained from the field visits, discussions with farmers and land resource management experts of the district. The major land classes were: forest land, woodland, cultivated land, built-up area, grassland and bareland (Table 2). Thus, the land use/ cover maps of the three years were produced from the satellite imageries.

Accuracy assessment was done using confusion/ error matrix and reference data were collected during fieldwork using GPS which are independent of the ground truths that are used in the classification scheme. For accuracy assessment, 50 reference points for each land use cover category were collected. Accordingly, the overall accuracy, Kappa coefficient, producer's accuracy and user's accuracy were computed from the confusion matrix. In order to analyze the patterns of land use/ cover change, post-classification comparison approach was performed. Landsat imageries of the three reference years were first independently classified. After that, the classified imageries were compared and change statistics were computed by comparing image values of one data set with the corresponding values of the second data set.

DOI: 10.6092/issn.2281-4485/15747

Table 2. *Land use/cover types of the study area and their description*

LULC type	**Description**
Forest land	A vegetation type covered with dense growth of trees that formed nearly closed canopies.
Woodland	Land areas covered with woody plants mixed with shrubs, bushes, and grasses.
Grassland	Areas of land predominantly covered with grasses, forbs, grassy areas.
Built-up area	The land covered with settlement areas in rural or urban places.
Cultivated land	A land area ploughed/prepared for growing various crops/cultivated fields.
Bare land	Areas that have no vegetation cover consisting of eroded landscapes and exposed rocks.

The comparison values were summarized and presented in terms of area change in hectares, percentages and rate of change. To clearly understand which cover types goes to where during the study period, land cover conversion matrix was analyzed. In addition, Normalized Difference Vegetation Index (NDVI) was used to analyze the extent of vegetation greenness/density changes in the study area. The NDVI values were reclassified as non-vegetation, sparse vegetation and dense vegetation based on NDVI results. Non-vegetation (barren lands, sand, water) typically has NDVI value 0.1 or less; sparse vegetation (shrubs, grasslands) values are between 0.2 and 0.4 and dense vegetation values are over 0.4 (Arulbalaji and Gurugnanam, 2014). As to Gandhi et al. (2015), NDVI can be calculated as:

$$NDVI = (NIR - R)/ (NIR + R) \quad [3]$$

where: NDVI is Normalized Difference Vegetation Index; NIR is Near Infrared band reflectance at 0.76 – 0.9 μm and R is Red band reflectance at 0.63 – 0.69 μm.

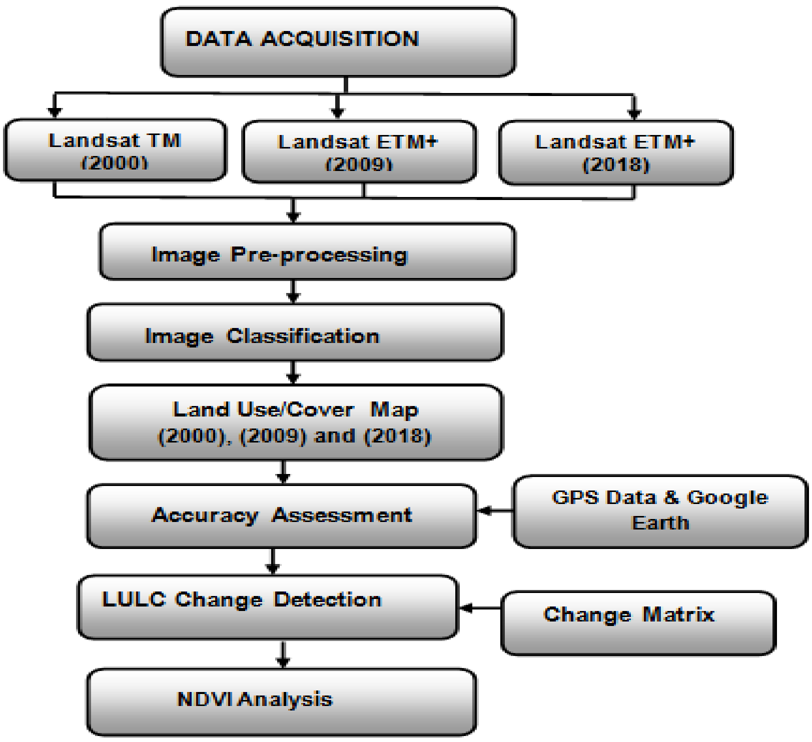

Figure 2
Flow chart for LULC change analysis process

Socio-economic analysis. Socio-economic data that are collected from various sources are analysed quantitatively and qualitatively using descriptive and inferential statistical tools. Descriptive statistics such as frequency distribution, percentages, means, standard deviation, cross-tabulations as well as Infrential statistics like chi-square test, One way ANOVA, and multinomial logistic regression were utilized to analyse the data.

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Results and Discussions

Resettlement and spatiotemporal land use/cover dynamics in the study area

In this study, the land use/cover of Chewaka district was mapped for the year 2000, 2009 and 2018 to analyze the patterns of change that occurred in the area (Figure 3 and Table 3). The result of satellite image analysis revealed that in the year 2000, the district was covered by forest, woodland, grassland and bareland. There was neither settlement nor cultivated land prior to the 2003 resettlement program in the area. The survey result also confirmed that land uses of various types like cultivated lands and built-up areas have been emerged as of 2003. Hence, six land use/cover types were identified on the 2009 and 2018 satellite imageries of Chewaka district.

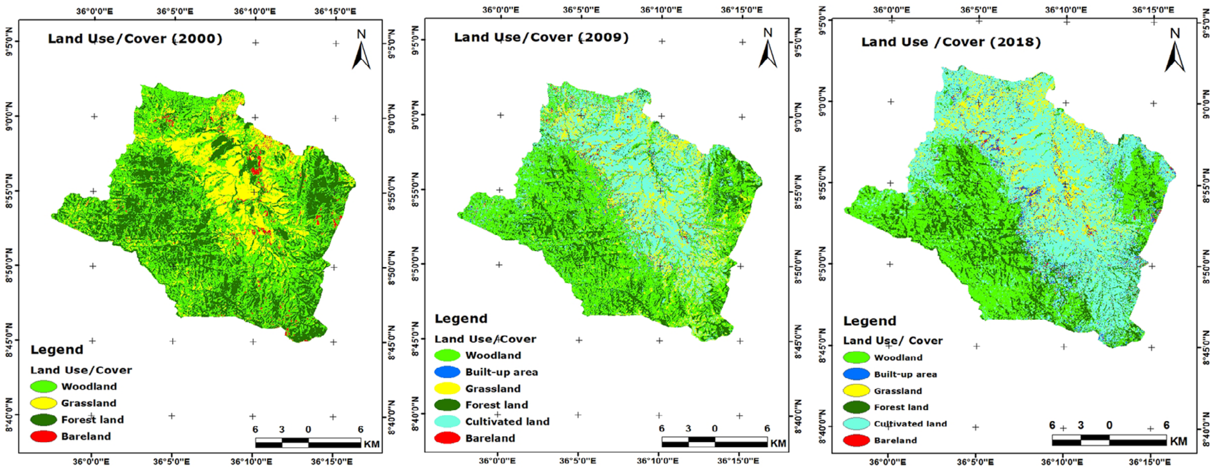

Figure 3. Land use/cover maps of Chewaka district in 2000, 2009 and 2018

The quantitative evidence obtained from the analysis of satellite imageries and socio-economic data indicated that Chewaka district has undergone substantial land use/cover changes during 2000-2018. There have been dramatic decreases in forests, woodlands, grasslands and barelands, while the extents of built-up areas and cultivated lands have increased profoundly during the study period. The district was dominantly covered by dense forests, woodlands and grasslands just before the onset of resettlement program. In agreement to this finding, previous studies conducted by Denboba (2005) in Shomba and Michity resettlement areas in Kafa *Zone*, Southwestern Ethiopia; Mulugeta and Woldesemait (2011) in Nonno resettlement sites, Central Ethiopia reported the occurrence of considerable cover dynamics due to resettlement programs.

Table 3. Comparison of land use/cover types during 2000-2018. Source: Computed from satellite imageries of 2000, 2009 and 2018

	2000		2009		2018		Change between (2000 - 2018)		
LULC types	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Area (ha)	(%)	Rate of change (ha/year)
Forest land	22368.95	36	9422.46	15.2	8954.7	14	-13414.25	-59.97	-745.2
Woodland	27647.97	45	25483.96	41.2	18088.5	29	-9559.5	-34.6	-531.0
Grassland	10808.23	17	7372.8	11.9	5353.3	9	-5454.9	-50.5	-303.0
Bareland	1042.73	2	721.62	1.2	555.2	1	-487.5	-46.8	-27.0
Built-up area	-	-	1566.09	2.5	1633.0	3	+1633	-	+90.7
Cultivated land	-	-	17300.97	28.0	27283.2	44	+27283.2	-	+1515.7
Total	61867.9	100	61867.9	100	61867.9	100			

DOI: 10.6092/issn.2281-4485/15747

However, significant conversions from vegetation cover to cultivated lands and built-up areas were observed after resettlement which devastated vegetation cover of the area. In agreement to this finding, previous studies conducted by Mulugeta and Woldesemait (2011) in Nonno resettlement sites, Central Ethiopia reported the occurrence of considerable cover dynamics due to resettlement programs.

Table 4. *Land use/cover conversion matrix for Chewaka district (2000 - 2018)*

LULC (2018) \ LULC (2000)					
LULC classes	Forest land	Woodland	Grassland	Bareland	Total area
Forest land	(6939.7)	1918.6	71.2	25.1	8954.7
Woodland	8472.8	(8881.7)	643.6	90.4	18088.5
Grassland	600.8	1992.4	(2560.3)	199.8	5353.3
Bareland	102.8	239.8	169.9	(42.6)	555.2
Built-up area	248	712.3	598.8	73.9	1633
Cultivated land	6004.8	13903.1	6764.5	610.8	27283.2
Total area	22368.95	27647.97	10808.23	1042.73	61867.9

* Numbers in the parenthesis indicates the unchanged values in land use/cover

The land use/cover conversion matrix was also analyzed to show which cover types goes to where between 2000 and 2018 (Table 4). The result of the study revealed that there was remarkable conversion of areas once covered with forests, woodlands and grasslands to cultivated lands and built-up areas. For instance, the total forest cover of the district was 22, 368.95 ha in 2000. However, the extent of forest cover has shrunk to 8954.7 ha in 2018 due to deforestation and conversion to other cover types. The expansion of cultivated lands and built-up areas largely contributed to the dwindling of forests, woodlands and grasslands of the area. In order to validate the accuracy of a classification, accuracy assessment was done for the imageries using error/confusion matrix (Table 5).

Table 5. *LULC types and accuracy assessment result of the classified imageries*

LULC types	2000		2009		2018	
	PA (%)	UA (%)	PA (%)	UA (%)	PA (%)	UA (%)
Forest land	88.46	92.0	87.65	90.0	93.88	92.0
Woodland	91.67	88.0	97.78	88.0	91.67	88.0
Grassland	84.0	84.0	95.83	92.0	86.54	90.0
Bareland	84.0	84.0	89.36	84.0	89.80	88.0
Built-up area	-	-	84.31	86.0	86.54	90.0
Cultivated land	-	-	86.54	90.0	88.0	88.0
Overall accuracy	87.00%		88.33%		89.33%	
Kappa coefficient	0.8267		0.8600		0.8720	

PA = Producer's Accuracy; UA = User's Accuracy

The overall classification accuracy assessment and kappa statistics result for the year 2000 , 2009 and 2018 were 87.00%, 0.82; 88.33%, 0.86 and 89.33%, 0.87 respectively. This implies that all maps meet the recommended minimum 85% accuracy and there is a strong agreement between the classified land use/cover classes and the reference data.

Resettlement and vegetation greenness/density changes in the area

In this study, Landsat imageries of 2000, 2009 and 2018 were used to extract NDVI values in order to analyze the extent of vegetation greenness/density changes in the study area (Table 6 and Figure 4).

DOI: 10.6092/issn.2281-4485/15747

Vegetation density classes	NDVI Value	Changes occurred during (2000-2018)
Non-vegetation	< 0.2	Increased
Sparse vegetation	0.2 – 0.4	Decreased
Dense vegetation	> 0.4	Decreased

Table 6. *Vegetation greenness/density changes in the area during 2000 – 2018. Source: Computed from satellite imageries of 2000, 2009 and 2018*

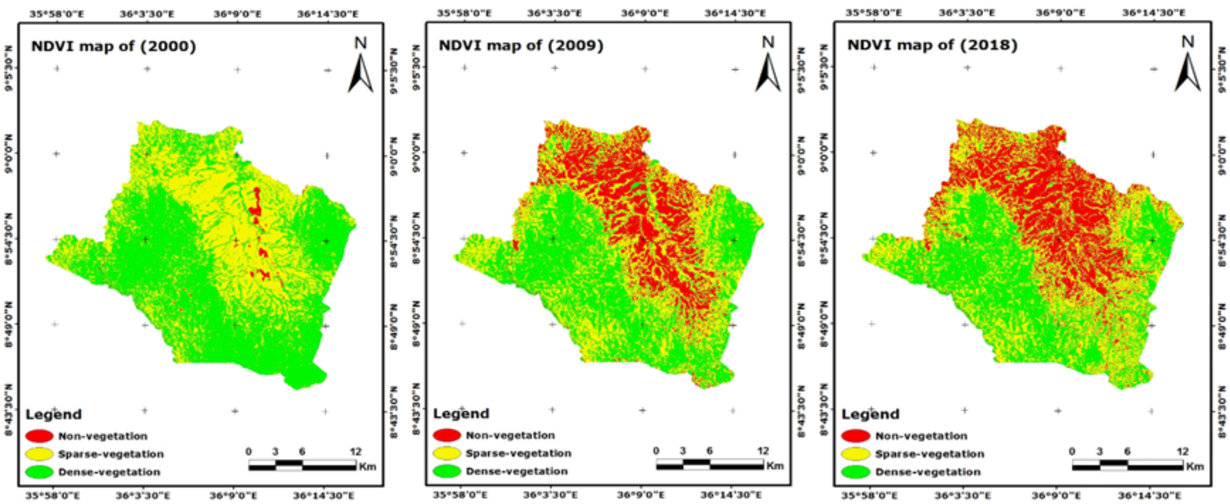

Figure 4. NDVI maps of Chewaka district for the year 2000, 2009 and 2018

The results showed that the extent of dense and sparse vegetation cover have decreased, while non-vegetation cover has increased during the study period mainly due to the increased rate of cultivated lands and built-up areas at the expense of vegetated lands. In agreement to this finding, study conducted by Aburas et al. (2015) in Malaysia using NDVI found that vegetation cover was decreased and non-vegetated areas increased between 1990 and 2010.

Drivers of land use/cover changes in the study area

This study explores the main driving forces of land use/cover change that are associated with the execution of resettlement scheme in Chewaka district of Ethiopia. The result of the study revealed that resettlement and population growth (91.4%), farmland and settlement expansion (87.5%), deforestation (68.5%), human-induced forest fire (59.6%), unwise utilization and poor management practices (72.9%) as well as wood extraction and charcoal production (54%) are the major factors attributed to the dynamics of land use/cover in the study site (Fig. 5).

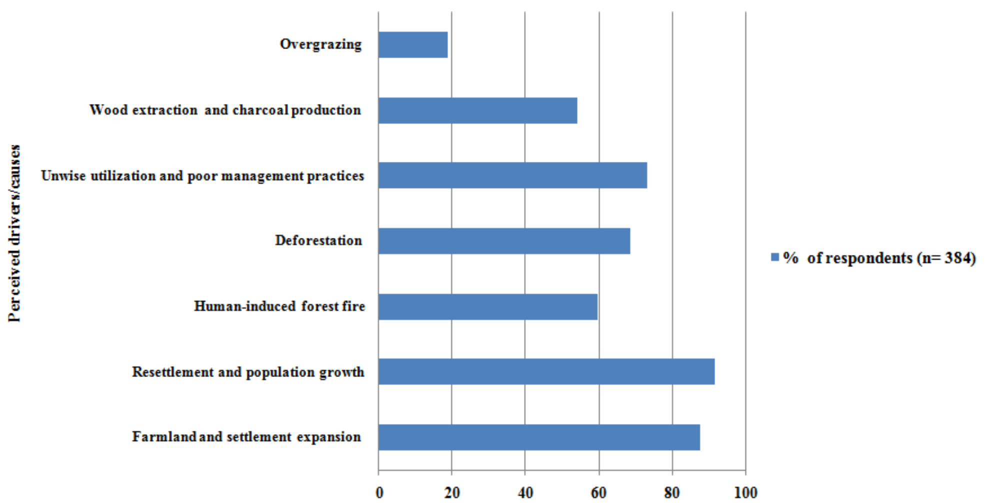

Figure 5. Drivers of land use/cover change in the district as perceived by respondents
Source: Survey data (2020); Note: The total is not 100 due to multiple response options

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Resettlement and implication for natural resource conservation in the area

Population resettlement coupled with socioeconomic activities of the resettlers' has exacerbated the dynamics of land use/cover and depletion of resources in Chewaka district. The changes in natural land covers are inevitable phenomenon mainly due to human-environment interactions that involve various implications. These implications could be positive (convey of desirable change to protect and regain the degraded resources) and negative (undesirable changes). The study revealed that minimizing the dependency of local people on the natural resources (93.0%), mobilizing local community participation through awareness raising program for sustainable vegetation resource management (88.5%), enhancing afforestation and reforestation activities (82.6%), promoting the use of alternative energy sources that are environment friendly (80.4%), diversifying livelihood activities of the resettlers (78.2%), and limiting population growth through family planning (73.9%) are the main implications as perceived by respondents in the area (Table 7). In addition, the key informants stated that strengthening coordination and collaborative works among different stakeholders, controlling illegal settlement expansion, developing proper land use plan as well as closely monitoring and regularly re-evaluating resettlement scheme by concerned stakeholders are found to be essential to conserve and protect the natural resources of the district. In other words, resettlement has threatened and posed great damage on natural resources of the area. This implies that unless appropriate and immediate conservation measures are undertaken, the natural resources of the district could greatly deplete within a few years. Thus, the findings of this study have implications for sustainable conservation and utilization of the resources. In view of this, minimizing dependency of local people on resources, mobilizing local community participation through awareness raising program for sustainable natural resource management, enhancing afforestation and reforestation activities, promoting the use of alternative energy sources that are environment friendly, diversifying livelihood activities of the resettlers, and limiting population growth through family planning are the main implications as perceived by respondents to conserve and protect the natural resources of the area.

Table 7. *Implications of resettlement on natural resource conservation as perceived by respondents.* Source: Survey data (2020), *Note: The total is not 100 due to multiple response options*

Perceived implications on conservation measures	% of respondents (n= 384)
Minimizing the dependency of local people on the natural resources	93.0
Promoting the use of alternative energy sources that are environment friendly	80.4
Limiting population growth through family planning	73.9
Mobilizing local community participation through awareness raising program for sustainable vegetation resource management	88.5
Diversifying livelihood activities of the resettlers in the area	78.2
Enhancing afforestation and reforestation activities	82.6

Livelihood aspects of the study households

As indicated in Table 8, agriculture, non-farm, off-farm and/or combination of activities are the most pertinent livelihood strategies in the study area. Agriculture is the dominant means of survival strategies for people of the area. The prevailing farming system is subsistence-oriented, predominantly rainfed, traditional and it is mixed crop-livestock production.

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Table 8. *Sample households' livelihood strategies and wealth category cross tabulation. Source: survey data (2020)*

Livelihood strategies	Households' wealth category							
	Poor (N=173)		Less poor N=141)		Better-off (N=70)		Total (N=384)	
	N	%	N	%	N	%	N	%
Agriculture only	41	23.7	78	55.3	47	67.1	166	43.2
Agriculture+non-farm	48	27.7	40	8.4	10	14.3	98	25.5
Agriculture+off-farm	59	34.1	9	6.4	6	8.6	74	19.3
Agriculture+non-farm+off-farm	25	14.5	14	9.9	7	10	46	12.0
$\chi2$			71.207					
P-value			000***					

Note: *** indicates significant at < 1% probability level; N: number

The chi-square test showed the existence of significant association among livelihood strategies and wealth groups at (**χ2-value=71, df=6, p< 0.01**). The result indicates that poor households are more engaged in non/off-farm activities than better-off households (Table 8). One-way analysis of variance was conducted to examine whether there are significant differences in the mean scores of continuous explanatory variables among the livelihood groups. The results showed the existence of a statistically significant mean difference among households falling in the four livelihood strategies in terms of landholding size, livestock ownership, market distance, total annual income, age and household size at less than 1% levels (Table 9).

Table 9. *Summary of continuous explanatory variables by livelihood strategies. Source: survey data (2020)*

Variables	Livelihood strategies of the households					F –value
	AG	AG+NF	AG+OFF	AG+NF+OFF	Total	
	Mean	Mean	Mean	Mean	Mean	
Age of household head	52.60	43.63	40.26	41.02	46.75	38.724***
Family size (AE)	4.71	5.71	4.78	5.23	5.04	12.517***
Land holding size(ha)	2.01	1.16	1.01	1.03	1.48	126.530***
Livestock size (TLU)	4.62	3.69	3.49	3.53	4.04	77.845***
Extension contact	9.07	8.66	8.61	8.17	8.77	2.512
Market distance	3.54	2.49	2.34	1.50	2.79	74.462***
Total annual income	7046.68	5930.10	4776.35	5308.69	6116.02	23.138***

Note: *** indicates significant at <1% probability level

Determinants of livelihood diversification strategies in the study area

This section presents the results obtained from multinomial logit model indicating significant factors that determine livelihood diversification strategies of the households in the area. Before running the model, multicollinearity tests among the hypothesized explanatory variables were checked using VIF for continuous variable and contingency coefficient for the discrete variables. The multicollinearity test results have shown no serious problems among explanatory variables. The model result is presented using agriculture alone strategy as a base case scenario and the result of the study indicated that among the hypothesized variables; age of the household head, landholding size, sex, education status, size of livestock holding size, distance to the market, access to credit, agricultural training, annual income and household sizes are the major determinants of livelihood diversification strategies in the study area (Table 10).

The model result revealed that sex had negatively and significantly affected the probability of diversifying livelihood into agriculture, non/off-farm combination strategy at less than 5% probability level. The negative coefficient implies that female headed households are less likely diversifies livelihood strategies compared

DOI: 10.6092/issn.2281-4485/15747

Table 10. Multinomial logit result on determinants of livelihood diversification strategies. Source: survey data (2018)

	Households' livelihood diversification strategies								
Variables	Agriculture + non-farm			Agriculture + off-farm			Agriculture + non-farm + off-farm		
	Coef.	Std. Err	Odds-ratio	Coef.	Std. Err	Odds-ratio	Coef.	Std. Err	Odds-ratio
Intercept	26.089	5.856		29.780	5.970		33.583	6.189	
SEX	-1.412	0.865	0.244	-1.457	0.889	0.233	-2.589**	1.181	0.075
AGE	-0.227***	0.057	0.797	-0.212***	0.057	0.809	-0.260***	0.063	0.771
FAMSZ	1.881***	0.400	6.562	1.560***	0.405	4.759	1.894***	0.431	6.644
EDULEV	-3.742**	1.176	0.024	-3.782*	1.205	0.023	-4.323**	1.244	0.013
AGECO	-0.512	0.782	0.599	-0.378	0.812	0.685	-1.049	0.889	0.350
FERTLZ	-0.449	0.795	0.638	-0.659	0.830	0.517	-0.272	0.894	0.764
LIVSTK	-2.284**	0.727	0.102	-2.704***	0.752	0.067	-2.518**	0.825	0.081
LANDSZ	-4.658***	1.084	0.009	-5.204***	1.140	0.005	-5.444***	1.227	0.004
IMSEED	0.699	0.736	2.013	0.724	0.758	2.062	0.529	0.824	01.697
CREDT	-1.957**	0.901	0.141	-1.917	0.929	0.147	-2.337*	0.989	0.097
EXTCON	0.244	0.172	1.277	0.342	0.177	1.408	0.196	0.194	1.216
MKTD	-1.554***	0.365	0.211	-1.549***	0.374	0.212	-3.069***	0.466	0.046
TRAIN	-2.199**	0.887	0.111	-1.873	0.917	0.154	-1.865	0.975	0.155
MCOOP	1.160	0.752	3.189	1.136	0.776	3.113	0.691	0.844	1.997
LEADER	-0.866	1.382	0.421	-0.811	1.427	0.444	-1.759	1.527	0.172
INCOME	1.000**	0.000	1.001	0.000	0.000	1.000	0.000	0.000	1.000
Reference category	Agriculture alone								
Dependent variable	Livelihood diversification strategies								
Number of observations	384								
– 2 Log likelihood model fitting	Intercept only: 985.023, Final: 446.243								
LR chi-square test	538.780								
Degrees of freedom	48								
Significance	0.000***								
Pseudo R^2	0.817								

***, **,* indicates significant at <1%, 5% and 10% probability levels respectively

to the male counterparts. Conversely, male headed households have more tendency of engaging in various livelihood options. The probable reason is that female households have difficulty of participation in non/off-farm activities due to cultural barriers and have more responsibilities in home management activities. If other factors remain constant, the likelihood of female headed households to diversify into agriculture, non-farm and off-farm combination strategy is less by a factor of 0.075 relative to the base case. The probable reason is that In other words, men and women have differentiated social roles in the community. The key informants also stated that culture based gender role discrepancy forces the female households to less engage in diverse livelihood activities and females were busy in domestic roles such as childcare, cooking, washing cloth and fetch ing water in the study area.

Landholding size had negatively and significantly influenced livelihood diversification at less than 1% level of significance. This implies that households with large landholding size are less likely diversifies livelihoods compared to those who have small land size. Thus, households having large farm sizes rely on agriculture than diversifying livelihood activities to meet their

DOI: 10.6092/issn.2281-4485/15747

livelihood requirements. The possible reason can be large landholding size enables the farm households to follow agricultural extensification in order to produce more and increase farm income. Household income has positive and significant influence on the choice of agriculture plus non-farm activities at less than 5% probability level. The positive coefficient indicates that households having large income were more likely to diversify livelihood into non-farm activities compared to those households with low income. The probable reason for this could be attributed to the fact that farm households with adequate annual income can overcome financial constraints and invest on a range of livelihood options. As prior expectation, households' having large size livestock are less likely diversify livelihoods compared to those who have small number of TLU. The possible explanation for this could be attributed to the fact that households with more TLU have better opportunity to earn more income from livestock production which enables them to fulfill their livelihood requirements. As expected, age of the household head negatively and significantly influence the diversification livelihood strategies at less than 1% probability level. This implies that the participation of households in diverse livelihood strategies decreases as age increases. In other words, younger households are relatively more engaged in non/off-farm and/or combination of activities than older households. The study also found that household size had positively and significantly affected the choice of agriculture+non-farm, agriculture+off-farm and agriculture+non-farm+off-farm activities equally at less than 1% significance level. Hence, households' with large family sizes are more likely participate in non/off-farm and/or combination of activities. The positive association between household size and diversification might be due to the relation between large family size and household labour as well as corresponding demand for food.

Conclusions and the way forward

The study analysed resettlement, spatiotemporal land use/cover dynamics and livelihood aspects in Chewaka district of Ethiopia. The results indicated that the district has undergone substantial land use/cover change since population resettlement in the area. There has been dramatic decrease in forests, woodlands, grasslands and barelands; while built-up areas and cultivated lands have increased profoundly during the study period. It was found that rapid population growth mainly following resettlement program, farmland and settlement expansion, deforestation, human-induced forest fire, illegal settlement expansion, lack of proper land use plan, unwise utilization and poor management practices are driving unprecedented land use/cover change in the area. It was found that agriculture is the main economic activity and basis of livelihoods in the study area. Besides, resettlers pursue non/off-farm activities to generate additional income and cope with the challenges of their livelihoods. The study suggests urgent attention on limiting population growth through family planning, promoting livelihood diversification strategies, mobilizing local community participation through awareness raising program, controlling human-induced forest fire, afforestation and reforestation activities for sustainable natural resource management and livelihood improvements in the area.

Acknowledgements
The author is grateful to the people of Chewaka district, enumerators, key informants, FGD participants and local administrators of the study area for their cooperation during the fieldwork. Finally, I am also thankful to the USGS for offering free access to satellite imageries of the area.

Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication
The author agreed and approved the manuscript for publication.

Competing interests
There is no competing interest.

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