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Land Use and Land Cover Change Analysis in Choke Mountain, Ethiopia (2013-2023)

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Abstract. *In this study, spatial and temporal trends of Land Use and Land Cover Change (LULCC) in Choke Mountain, Ethiopia, between 2013 and 2023 were explored employing a mixed-methods approach. Satellite imagery (Landsat 8 OLI/TIRS) was analyzed through supervised classification and post-classification change detection techniques, supported by field observations, key informant interviews, and focus group discussions. The results reveal extreme changes: agricultural land raised by 4.5% (1,207.95 ha), predominantly at the expense of grasslands (−11.9%) and shrublands (−34.8%). Forest cover unexpectedly raised by 28.6% (1,156.26 ha) due to Eucalyptus plantations, while natural forest decline persists. Settlement areas raised by 133%, which reflects heavy urbanization. Slope analysis revealed that 67.4% of the area is composed of gentle slopes (<30%), and 32.6% is composed of steep slopes that are susceptible to erosion. The main drivers of these changes are population growth, agricultural expansion, fuelwood requirements, and unsustainable land-use policies. These changes have deep implications for ecosystem services, soil conservation, and climate resilience in this critical Upper Blue Nile Basin region. The study recommends that integrated land-use planning, forest conservation programs, and sustainable agriculture practices are required to balance ecological integrity with livelihood needs. These findings constitute the scientific basis on which policymakers can base policies to facilitate sustainable land management in the highland ecosystems of Ethiopia.*

Keywords: *Land conversion, remote sensing, choke mountain, agricultural encroachment, sustainable land management*

1. Introduction

In developing nations where most of the human population relies mainly on natural resources to sustain themselves, there are other demands for utilization, development, and sustainable exploitation of the land resources (e.g., natural vegetation), creating land-use and cover changes (1). Land Use and Land Cover Changes (LULCC) are either a transformation into new land use or a rise in current land (2). These days, in the world, there is a growing demand for space for settlement, investment in agriculture, and industrial purposes being felt (3).

Land use change is one of the issues which intensify environmental problems. Understanding the magnitude of land use change, drivers, and implications is very crucial in a successful management of land resources. We analyzed land use/land cover changes using remote sensing data (for 2013, 2018, and 2023), and field observation, key informant interview, and focus group discussion were used to determine drivers and implications of land use/land cover changes in Choke Mountain, Ethiopia. The Upper Blue Nile is the most diversified and most significant river basin of Ethiopia (4). The basin experiences severe environmental

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degradation such as soil erosion leading to soil loss, land degradation, soil fertility loss, and deforestation.

Ethiopian land use/cover change rate is based on three significant drivers of agricultural land demand: resettlement programs, population increase, and rising demand for agricultural investments (5). Hence, the extent and trend of land use/land cover changes and the assessment of drivers of changes over the last three decades (2013–2023) in Choke Mountain were the research goals. Google Earth images in 2013, 2018, and 2023, secondary data gathering, focus group discussion, key informant interviews, and field observation were used to identify changes and drivers of changes.

Land use and land cover (LULC) change impact the environment, biodiversity, and livelihoods of communities. Choke Mountain in the Amhara National Regional State of Ethiopia is an ecologically sensitive location with varied landforms, high biodiversity levels, and high socioeconomic importance. Development, agricultural encroachment, forest loss, and climate change have, however, led to LULC pattern modification, undermining the sustainability of the mountain.

Satellite Remote Sensing and GIS are the most common quantification, mapping, and pattern identification techniques of LULCC, due to their accurate geo-referencing, digital processing ability, and capability for the acquisition of multi-temporal data (6, 7). Land degradation because of LULCC is arguably the most significant environmental issue in Ethiopia and other countries in the Sub-Saharan region, impacting ecosystem productivity as well as service provision (8). Agricultural expansion as well as wood removal are identified through studies to be central drivers of deforestation in highland Ethiopia (9), frequently linked with shifting cultivation as well as overgrazing (10).

Climate change is the other driving mechanism for speeding LULC dynamics as societies have been reacting to the unpredictable precipitation and drought occurrence by expanding area under cropland and diminishing lengths of fallow periods (11, 12). Besides that, policy transitions and institutional relations at the country and local authorities' levels govern land use and land management (13).

Urbanization and infrastructure development are new drivers of land conversion in Ethiopia, even in highland rural landscapes (14). Habitat fragmentation and edge effects diminish species richness and increase invasives susceptibility (15). Remote sensing-based assessment provides objective and repeatable data for long-term monitoring of the dynamics of LULC (16). The combination of multi-temporal satellite imagery with participatory methods ensures integrated understanding of changes, especially when indigenous knowledge is included (17).

Several researchers have demonstrated that the Choke Mountain region is a hotspot of land cover dynamics with a reduction in forest cover and wetlands but an increasing cropland and settlement area (18). Besides population pressure, the disintegration of customary land management systems has created unsustainable practices such as cultivation on riverbanks and slopes (19). Soil erosion and falling farm productivity have been documented as the consequences of un-sustainable land use practices, which in turn compel farmers to marginal lands (20, 21). Also, land use change through the conversion of grassland to agricultural land affects livestock grazing capacity and increases land use conflict (22).

Current land use planning regulations, i.e., land certification and the Sustainable Land Management Program (SLMP), have tried to restore some of the degradation, but to a lesser extent (23). It is usually hard to enforce land use plans and environmental regulations due to institutional weaknesses (24). Satellite image analysis of Normalized Difference Vegetation Index (NDVI) reflects significant reduction in greenness of vegetation over Choke Mountain, showing signs of land degradation and biodiversity loss (25). Land suitability analysis using GIS will guide future land management interventions and restoration efforts (26).

Ecosystem services valuation integration in land use planning decision-making is increasingly a need route to sustainability (27). Payment for ecosystem services (PES) could offer incentives to maintain valuable forest cover (28). Agroforestry and reforestation activities have been encouraging in reversing land degradation tendencies and re-establishing ecological balance (29). Success, however, depends on community participation, secure tenure, and long-term funding agreements (30).

The spatio-temporal dynamics of LULC change identification enables policymakers and planners to establish zones of conservation as well as priorities for intervention (31). The ecological susceptibility and socioeconomic relevance of Choke Mountain represent a perfect test bed for integrated land resource planning (32). To build resilience, climate-resilient land use practices that combine conservation agriculture, afforestation, and water-saving management must be adopted (33). Landscape-scale planning that includes watershed management and biodiversity corridors can also minimize adverse impacts (34).

Local participation in decision-making and benefit-sharing is crucial in making land management interventions sustainable (35). Institutionalization of long-term monitoring of land through coordination among universities, research institutions, and environmental agencies (36) is essential. In short, a multi-disciplinary solution involving satellite remote sensing, socio-economic assessment, and participatory rural appraisal is needed to plan sustainable land use in Choke Mountain and other ecological hotspots (37, 38).

2. Methods

The study employs the mixed-methodology by integrating the quantitative remote sensing approaches with the qualitative field-based observations to conduct a balanced analysis of land cover and land use changes from 2013 to 2023. The approach takes advantage of the comprehensive understanding of both the spatially explicit dynamics in land cover change as well as the drivers of these conversions.

2.1 Quantitative Analysis

The emphasis of the study is a temporal analysis of LULC patterns using satellite imagery of Landsat 8 OLI/TIRS in 2013 and 2023. Having high resolution, these images allow accurate classification of land cover types like forests, grasslands, agricultural land, human settlements, and water bodies. Post-classification comparison technique is utilized by the study to identify and quantify land cover changes over time and give accurate information regarding the spatial pattern of transitions.

2.2 Qualitative Analysis

To understand the drivers of such land use changes more deeply, local stakeholders including farmers, government officials, and community leaders are interviewed. These interviews are content-analyzed to identify recurring themes, human-induced drivers like agriculture expansion and settlement expansion, and natural drivers like climatic fluctuation. Such qualitative information is required to comprehend the satellite-derived outcomes in light of local practice and socio-economic considerations. By combining these two methodologies, the study produces both empirical, evidence-based information and contextual understanding, presenting a more comprehensive understanding of land use patterns and their climate change, natural resource management, and sustainable development implications.

DataSources

The 2013-2023 land use and land cover (LULC) change mapping were made possible via a combination of satellite imagery, field observations, and reliable secondary sources in order to make the spatial and context appropriateness possible.

Satellite Data:

The primary geospatial inputs were Landsat 8 OLI/TIRS images for the years 2013 and 2018, which were of medium resolution, multi-spectral data suitable for classifying various land cover types. Digital Elevation Models (DEMs) were also utilized to improve the accuracy of classification by taking into account the variability of topography-especially in hilly or sloping areas where elevation can influence the pattern of vegetation as well as land use patterns.

Field Data:

Additional improvement in classification and validation robustness was achieved through field data referenced using GPS data obtained during scheduled field visits. They were precise geo-located ground control points (GCPs) defining the major land use classes and field-recorded observations of land use practice as practiced. Field data like this also served as the training samples in supervised classification and as reference points for measuring accuracy.

Secondary Data:

Further datasets were obtained from authentic government and institutional sources. These included: Population and land use census reports, which provided socio-economic context and facilitated identification of drivers of land use, Land management policy documents and spatial development plans obtained from national and regional government offices and Climatic data (e.g., rainfall, temperature trends) obtained from national meteorological agencies, which were used to interpret natural drivers of LULC changes, e.g., vegetation change and agriculture trends.

Stakeholder Input:

Stakeholder participation implies the active consultation, involvement, and cooperation of all concerned entities-government institutions, local communities, private sector agents, academic entities, NGOs, and development partners-whose lands and interests or activities are or may be influenced directly or indirectly by or contribute to land use and climate change activities. They possess essential experience, interest, and knowledge critical for providing data correctness, productive policy-making, and successful policy implementation of the land use management system and Interview with local farmers, government administration, and conservations.

3. Results and Discussion

3.1 Study Area

Choke Mountain is covering about 50947.3 ha and located at 38 km north-east of the capital city of Gojam, Debre Markos town which is the main tributaries of Upper Blue Nile River basin. The area is located between 37˚39'41" - 38˚2'54"E longitude and 10˚33'27" - 10˚47'56"N latitude and it is 4100 meters above sea level and it is the first place in East Gojam zone and the fourth place in the country. Choke Mountain is part of the Blue Nile Basin and spans diverse agro-ecological zones, ranging from high-altitude grasslands to mid-altitude farmlands. The area is home to critical water sources, agricultural activities, and biodiversity hotspots, making it a key region for environmental research.

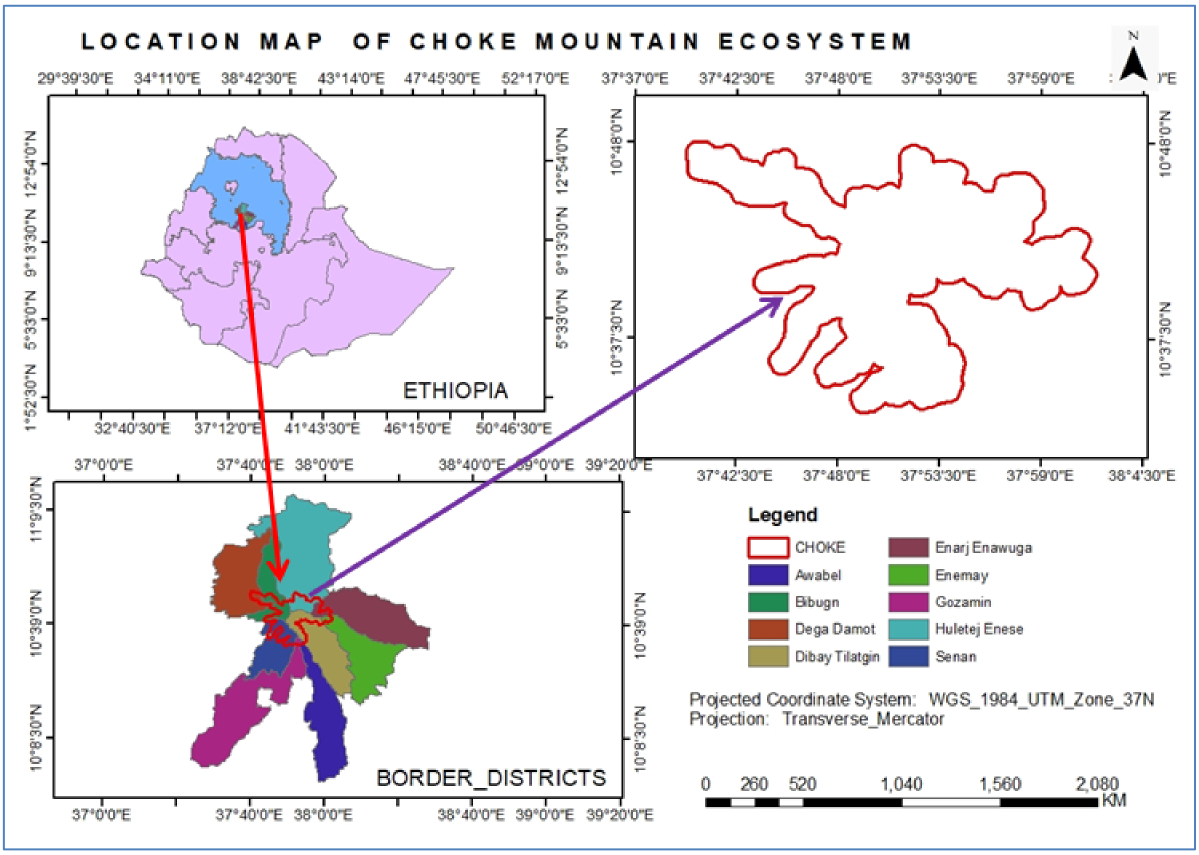

Figure 1. Location map of the study area

3.2 Extent of Change

Significant deforestation and conversion of forested areas to agricultural lands. Urban expansion at the expense of grasslands and farmlands

The status of land use/cover (LULC) change and key drivers of change over the past 10 years through a combination of satellite remote sensing and surveying of the local understanding of LULC patterns and drivers. Five major LULC types (forest land, grass land, farm/agriculture land, bush and shrub land and settlement) from Landsat images of 2013, 2018, and 2023 were mapped.

Land use and land cover changes that occurred from 2013 to 2023 in the Choke Mountain, Gojam, in the North-western highlands of Ethiopia, and were monitored using geographic information system (GIS) and a remote sensing approach with field verification.

The study area covers 50947.32 ha. However, given the age-old tradition of clearing increasingly steeper land for cultivation and the lack of appropriate land use policies, productivity is currently heavily threatened by soil degradation.

Different land use types had been converted to agricultural lands in various places of the world since time immemorial (39). Forestlands/woodlands had been continuously converted to agricultural lands at the highest rate than the other land use types (40) Similarly, grasslands had also been converted largely to croplands to fulfil the food demand for the increasing population (41).

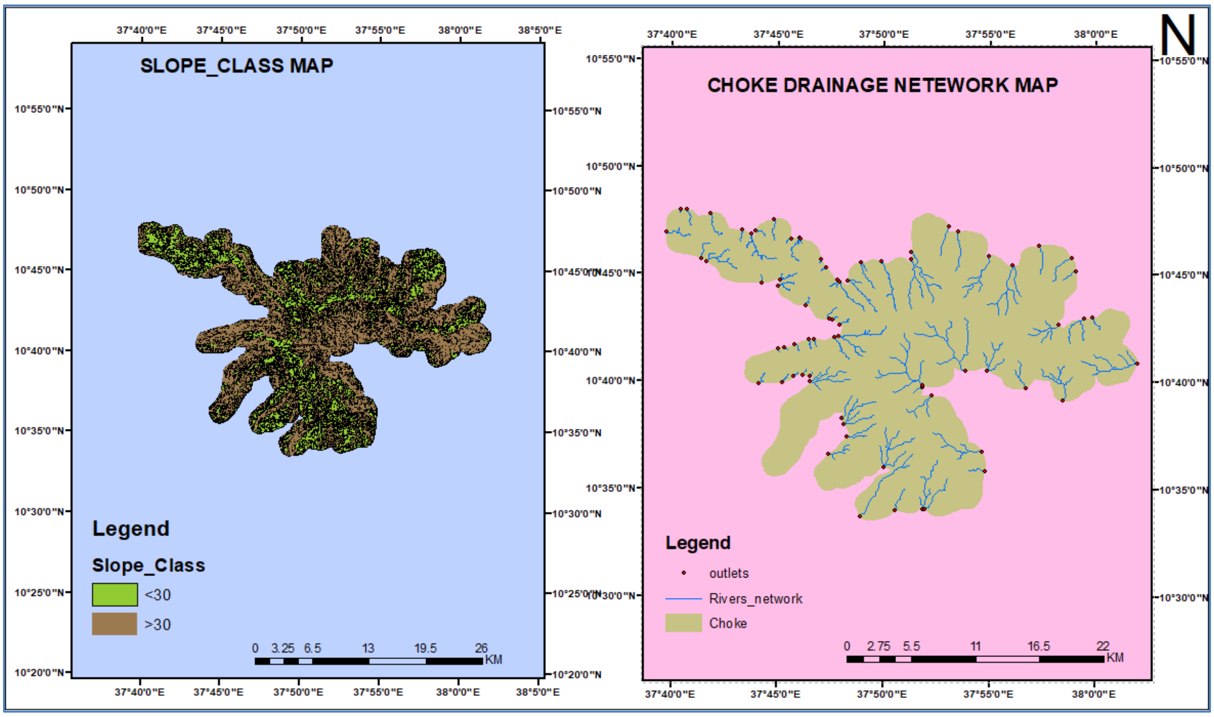

Figure 2. Choke mountain slope class &drainage system map

As shown in the map, approximately 34,334.11 hectares (67.4%) of the land have slopes below 30%, and approximately 16,600.25 hectares (32.6%) have slopes above 30%.

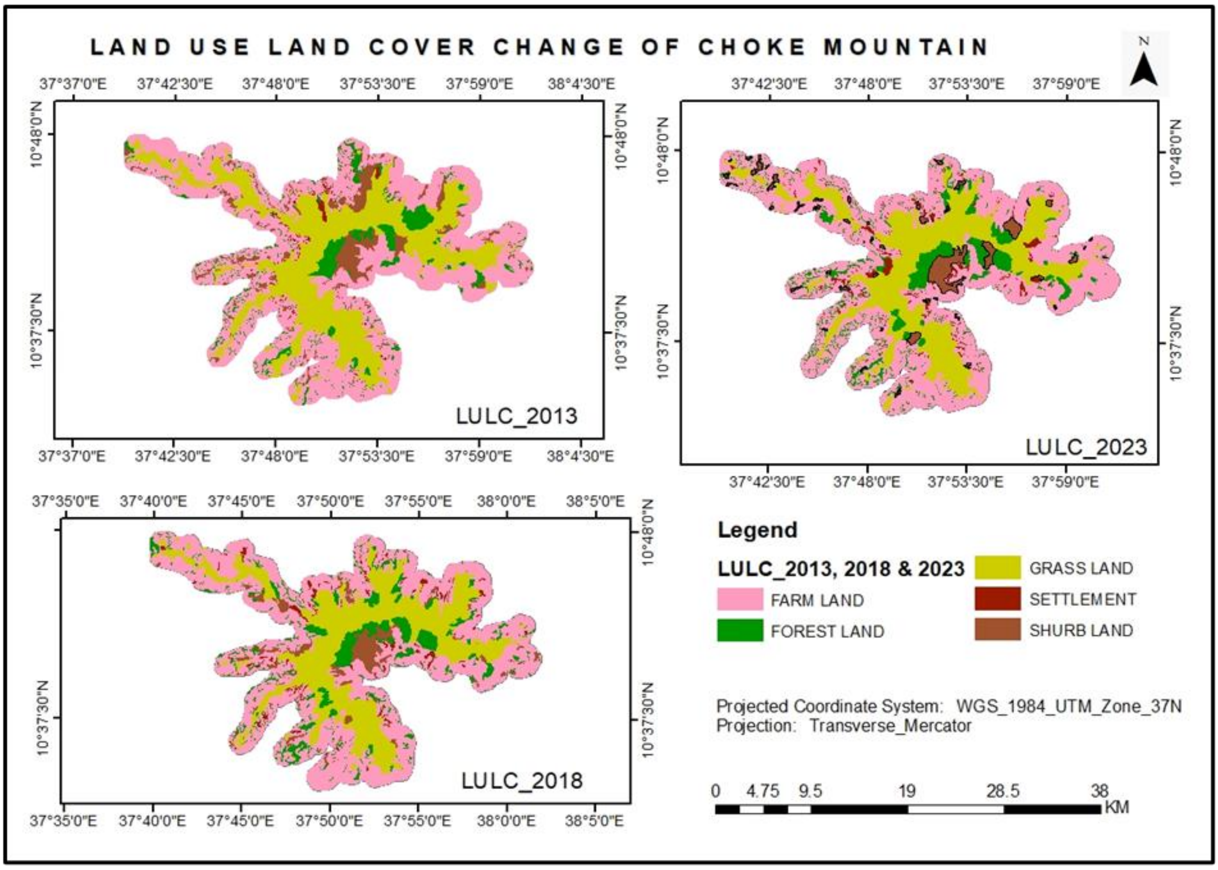

Figure 3. LULCC of Choke Mountain ecosystem for 2013, 2018 &2023

As shown above, the land use/land cover (LULC) changes of Choke Mountain Forest ecosystem over the past fifteen years were studied. Research findings show that a considerable extent of the land went through the process of transformation from one land cover to another land cover during the study period.

Table 1. Major land use/cover classes and their description

LULC Classes	Description
Farm Land	The area covered with crop cultivation. This land use type includes rural settlements fenced with trees that are commonly found around homesteads and towns. This class also includes homesteads and the scattered trees on farmlands
Grass lands	The area covered by permanent grass that is used for communal and Private grazing lands. This class also includes rangelands.
Forest land	Areas covered by dense natural trees forming closed or nearly closed canopies, mainly growing naturally in the reserved land and along the Riverbanks and the hillsides.
Bush & Shrubs	Land covered by bush and shrub land vegetation. This class also Includes sparse trees on shrub and bush land.

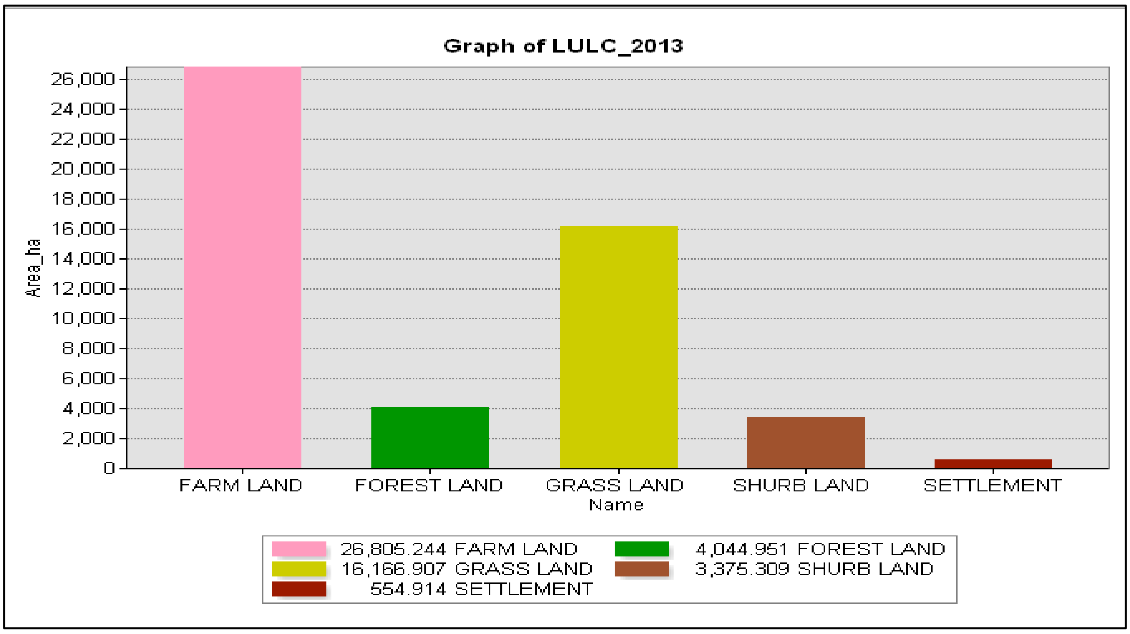

Figure 4. LULCC for 2013

As is shown in the above graph, five prevailing land use classes were mapped within the Choke Mountain Forest ecosystem during 2013: forest land, agricultural land, settlement, grassland, and shrubland. Natural forest cover has been reducing each year, while plantation forest cover, particularly eucalyptus, has been increasing. According to (42), this transformation could be due to political change in 1991 that led to extensive Ericaceous deforestation by local communities for several purposes such as agricultural intensification, fuelwood collection, and construction material.

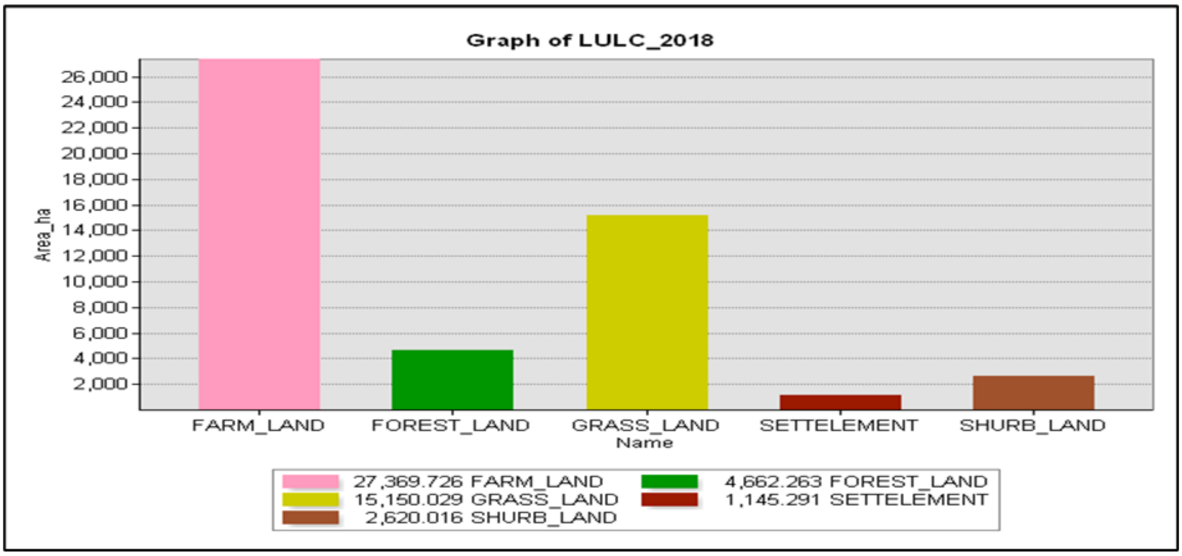

Figure 5. LULCC for 2018

As shown in Figure, the land use pattern in the current year remains similar to that of 2013, with five major land use types identified: farmland, grassland, forest, shrubland, and settlement. However, the difference lies in their respective areas. Farmland accounts for 27,369.72 hectares, grassland covers 15,150.02 hectares, forest occupies 4,662.26 hectares, shrubland spans 2,620.01 hectares, and settlement covers 1,145.29 hectares.

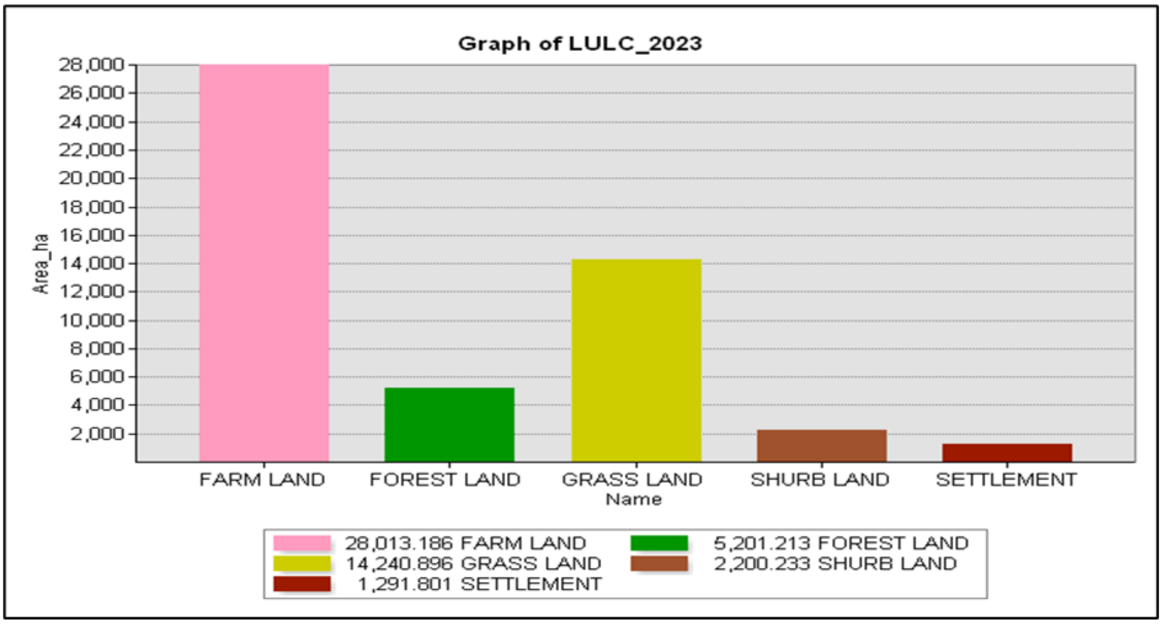

Figure 6. LULCC for 2018

This year, there are also five types of land use were identified, but as mentioned in the 2018 report, agricultural/farm/land occupies the first level of coverage, while grass land has the second level of coverage. However, among the five land uses classes, the Settlement has the lowest coverage. Similar study reported that, the result showed that crop land has continuously increased in area extent as compared to other land use/land cover types between 1986 and 2011 (42). This is attributed to expansion of cultivated land in the Choke Mountain ranges at the expense of alpine vegetation in the region.

Settlement: increased by 106.39%, due to population growth, Economic growth (i.e., new housing/commercial developments) and Lax land-use zoning regulations, which signifies economic growth and improved infrastructure in the area.

Table 1. Net Change Per Class (2013-2018)

Land Use Type	**2013 (ha)**	**2018 (ha)**	**Net Change (ha)**	**% Change**	**Trend**
Farm Land	26,805.24	27,369.73	+564.49	+2.11%	↑ Increase
Forest Land	4,044.95	4,662.26	+617.31	+15.26%	↑ Increase
Grass Land	16,166.91	15,150.03	−1,016.88	−6.29%	↓ Decrease
Shrub Land	3,375.31	2,620.01	−755.30	−22.38%	↓ Decrease
Settlement	554.91	1,145.29	+590.38	+106.39%	↑ Increase
Grand Total	**50,947.33**	**50,947.33**			

Farm land: increased by 2.11% via Agricultural intensification (e.g., higher yields, expanded fields) and conversion of marginal lands (e.g., Grass/Shrub Land) to agriculture.

Forest land: increased by 15.26% increase by 11.56% Significant increase in forest cover suggests success to Eucalyptus tree planation being practiced by the community coupled with high demand of construction poles and fuel wood consumption.

Grass Land: decreased by 6.29%, Conversion to Farm Land (biggest contributor), Urban sprawl (Settlement expansion) and Degradation due to overgrazing or climate stressors (e.g., drought). As a result of this grass land loss over time it leads to Loss of grazing pastures, less habitat for grassland-dependent species.

Shrub Land: decreased by 22.38%, Clearing for agriculture (i.e., livestock or crops), Wildfires or invasive species destabilizing ecosystems and Urban/industrial development (least likely but possible) since it is well understood that shrublands generally act as wildlife corridors; however, their loss fragments habitats, due to its size diminished.

Table 2. Net Change Per Class (2018-2023)

Land Use Type	2018 Area (ha)	2023 Area (ha)	Net Change (ha)
Farm Land	27,369.73	28,013.19	+643.46
Forest Land	4,662.26	5,201.21	+538.95
Grass Land	15,150.03	14,240.90	−909.13
Shrub Land	2,620.01	2,200.23	−419.78
Settlement	1,145.29	1,291.80	+146.51
Total	50,947.32	50,947.33	

Farm land: During the period (2018-2023) revealed that, farm land increased by 2.35% due to the fact that Farmland increased, potentially via agricultural intensification, conversion from other land uses (e.g., Grass Land or Shrub Land), or policy incentives for farming. This increase can be concerning if it comes at the cost of ecologically vulnerable areas, e.g., deforestation or loss of natural habitat.

Forest Land (FL): Raised by 11.56% Significant increase in forest cover reflects successful to Eucalyptus tree planation introduced by the community due to high demand of construction poles and fuel wood consumption.

Grass Land (GL): decreased by 6%, the largest decrease among all classes, most likely transformed into Farm Land, Forest Land, or Settlement and the possible drivers: agricultural expansion, urbanization, or environmental degradation (e.g., overgrazing).

Shrub Land (SL): decreased by 16.02%, Sudden drop can indicate land clearing for settlement, agriculture, or fire/erosion-induced degradation and Shrublands are often transitional ecosystems; their removal can disrupt regional fauna.

Settlement: increased by 12.79%, Impelled by Urbanization and population growth, such expansion might be at the cost of Grass Land or Shrub Land and Poses challenges to infrastructure planning and environmental sustainability.

Table 3. Net Change Per Land Use Class (2013-2023)

Land Use Type	Area in 2013 (ha)	Area in 2023 (ha)	Net Change (ha)
Farm Land	26,805.24	28,013.19	+1,207.95
Forest Land	4,044.95	5,201.21	+1,156.26
Grass Land	16,166.91	14,240.90	−1,926.01
Shrub Land	3,375.31	2,200.23	−1,175.08
Settlement	554.91	1,291.80	+736.89
Total	50,947.33	50,947.33	

Fam land: Increased by 4.5%, Presumably due to conversion of shrubland, grassland, and possibly forest. Expansion can be attributed to: Population pressure and food and land requirements and Land redistribution policy or agriculture intensification.

Forest land: Prominent increased by (28.6%) in forest cover, Successful Eucalyptus tree plantation and expansion due to high demand of trees for construction, for charcoal and fuelwooduse.

Grass land: Great reduced by 11.9% in grassland, Agricultural or forest conversion (either crops or tree plantation), overgrazing and deterioration,

Shrub Land: Notable loss (34.8%, attributed to Agriculture and Urban expansion (settlement), and this could lead to soil erosion, GHG emissions, and fragmentation of habitats unless offset by forest gain.

Settlement: 133% expansion of settlement/built-up land through rapid urbanization or rural growth and town expansion, road network, institutions, etc. This result revealed that, human population increased from time to time in the study area, this may open up widely for natural resource scrabbling for housing and other multi use. The rates and intensities of LULC processes are changing fundamentally in Africa, where population growth is high with the overexploitation of natural resources and low productivity of land (43).

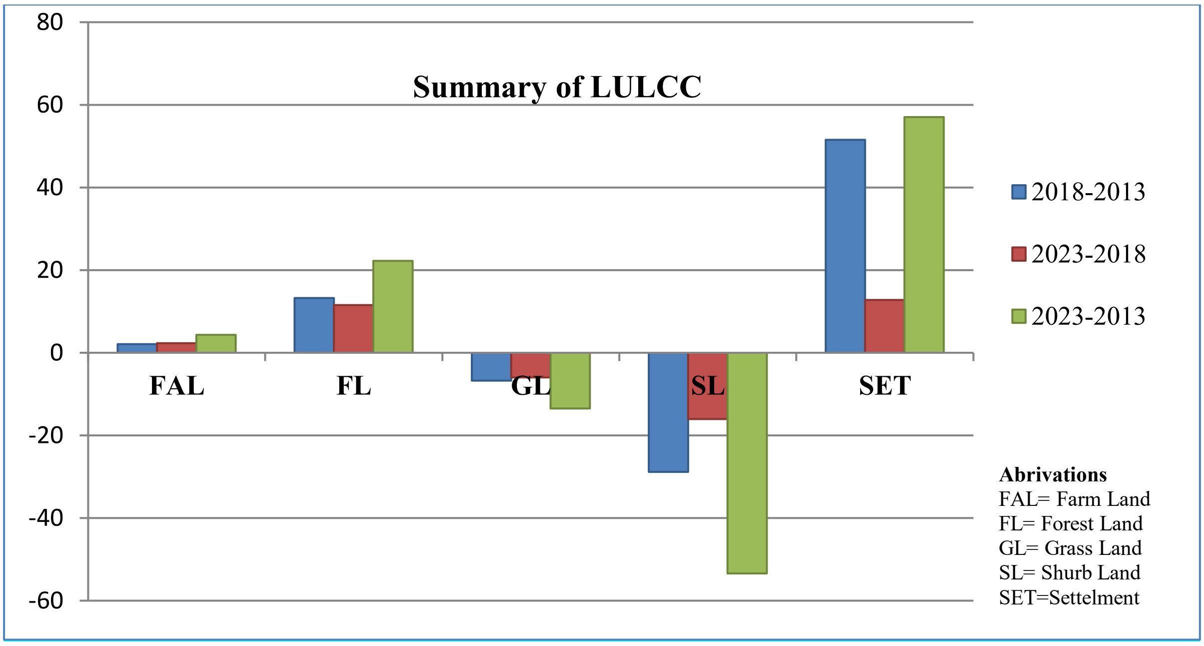

Figure 7. Summary description of LULCC Choke Mountain 2013, 2018 &2023

Generally, the results imply that farm land or agricultural expansion increased crop production by increasing farm size, but it is also a result of deforestation and high soil erosion. Similarly, firewood collection and charcoal production are among the sources of livelihood for the rural poor, particularly youths, but they are also a cause of shrubs & forest clearances. Eucalyptus planation is one of the key sources of income for rural smallholders in the study area, but it has negative ecological impacts on water and indigenous trees. The decrease in some percentage change of natural forest land stopped due to the absence of suitable natural forest land for further conversion to agriculture land and settlement land and the implementation of local rules and regulations with respect to forest management.

Table 4. Land use land cover transition matrix for the period 2013-2023 (ha)

2013 \ 2023	**Crop Land**	**Forest Land**	**Grass Land**	**Shrub Land**	**Settlement**	**Total (2013)**
Crop Land	24,490.97	1,083.04	1,769.62	199.87	468.92	28,013.2
Forest Land	876.07	3,438.21	248.43	28.06	65.83	4,656.60
Grass Land	3,501.49	607.69	12,104.77	112.16	263.11	16,589.22
Shrub Land	731.04	126.87	207.30	1,870.20	54.93	2,990.34
Settlement	120.18	20.86	34.08	3.85	471.67	650.65
Total (2023)	28,013.2	5,201.21	14,240.9	2,200.23	1,291.8	50,947.34

The land use transition matrix from 2013 to 2023 reveals a dynamic landscape shaped by agricultural expansion, reforestation, and urbanization. The total land area remained constant at 50,947.33 hectares, but significant internal shifts occurred among land use categories.

Cropland was not much different, with 87.4% of its area being constant. However, it grew significantly by expanding over grassland, forest, and shrubland. The highest inflow into cropland was from grassland, which accounted for over 3,500 hectares, followed by shrubland and forestland. This reflects increasing pressure on land for agriculture production, possibly due to food needs, population growth, or changes in land tenure or land use policy. On the other hand, a substantial portion of cultivated land was also being converted into forest and grassland, indicative of possible reforestation measures or land abandonment.

Forest land also lost and gained. While some 74% of forest land remained unchanged, about 26% was converted, mostly into agricultural land, showing deforestation. However, more than 1,000 hectares of converted cropland previously was converted to forest land, which shows successful afforestation or reforestation efforts. This net gain in forest cover could reflect policy efforts towards restoration of ecosystems or natural regeneration impacts, especially in degradedforests.

Grassland suffered extensive loss, with almost 21% having been converted to cropland and smaller areas changing to forest, shrubland, and settlement. This could be a reaction to land degradation, overgrazing, or conversion to more intensive uses. Even though some of the grassland has been reallocated from cropland or shrubland, the net loss is enormous and can impact pastoral livelihood and ecosystem processes.

Shrubland has been highly converted, with over one-third of its original coverage changing to cropland, grassland, or forest. Only about 63% of the shrubland remained unchanged and is thus susceptible to land use pressures. Shrubland conversion to cropland means marginal land being cultivated, which may lead to soil degradation if not practiced sustainably.

Settlement areas increased significantly, increasing over twice in the decade. Most growth occurred at the cost of grass and tillable land. This is the level of rural development and urbanization, which can be economically rewarding but leads to permanent land conversion and potentially higher greenhouse gas emissions from the installation of infrastructure.

Overall, approximately 83% of the land remained in the same category and 17% changed. Land use conversions from forest, grassland, and shrubland to cropland and settlement would have most likely led to emissions, while changes into forest land can be regarded as carbon sinks. This matrix is crucial input in estimating net emissions and removals that are required by national reports and climate change mitigation strategies

3.3 Drivers

The major drivers of land use change, population growth and food demand, leading to expansion of agricultural land, urbanization and rural development, increasing demand for settlement space, reforestation and restoration activities, promoting conversion to forest land, land degradation and climate stress, inducing changes from grassland and shrubland to other uses and economic and policy incentives, including land tenure reforms, community land management, and government agricultural packages.

3.4 Implications

The net gain in cropland signifies increased biomass loss and soil disturbance, resulting in net GHG emissions. However, conversions from cropland to forest signify some carbon sequestration. This two-way trend highlights both emission sources and removal opportunities. The huge net expansion of forest land promotes carbon removals, benefitting national climate objectives. However, ongoing conversion to cropland signifies ongoing deforestation pressures, reduces the carbon sequestration potential of the landscape in vegetation and soil. Additionally, this can affect pastoral systems and biodiversity, and also stress the remaining natural lands, Conversion of shrubland can lead to GHG emissions, especially where woody biomass is lost. These areas of type usually function as transition ecosystems and refuges for habitat, so their loss can compromise ecosystem integrity and Irreversible land use change from the expansion of settlements contributes to irreversible construction and infrastructure-related emissions.

3.5 Recomendations

1. Encourage Forest Conservation and Expansion: Enact and reinforce forest conservation policies to prevent forest from being constantly converted to agricultural land, expand afforestation and reforestation activities, especially on previously cultivated land and grassland that has potential to be forest regrowth and apply high-resolution satellite tracking to track forest gain and loss and validate carbon removal estimates.
2. Control Agricultural Expansion through Land Use Zoning: Implement and enforce land use plans that promote agricultural intensification instead of expansion, particularly in high-carbon-stock areas like forests and grasslands, promote climate-smart agriculture and agroforestry to increase productivity without further encroachment and Map and restore degraded lands for agriculture to relieve pressure on natural ecosystems.
3. Grassland and Shrubland Conservation: Identify grasslands and shrublands as a carbon store, especially in soil, and as land-based mitigation, encourage pastoral systems and rotational grazing to avoid overgrazing and conversion of land to

cropland and incorporate shrubland management into national restoration and conservation of biodiversity.

4. Regulate Settlement Expansion: Develop compact and climate-resilient urban development strategies to reduce land take and emissions from new settlements, Mandate environmental impact analyses (EIAs) before cropland and natural habitat are converted to urban land and encourage green infrastructure and preserving ecological corridors in expanding towns and peri-urban areas.
5. Enhance Data Collection and Monitoring, build capacity for regular land use mapping using remote sensing, GIS, and ground truthing, establish a centralized data base for land use change, biomass, soil carbon, and activity data to support reporting needs under the Enhanced Transparency Framework (ETF) and facilitate inter-bureau, research institute, and international partnership collaboration for methodological enhancement and data exchange.
6. Raise Awareness and Engage Stakeholders: Enhance the awareness of decision-makers and local communities about the impact of land use change on livelihoods, climate, and ecosystems, Encourage community-based natural resource management (CBNRM) and incentive schemes like payment for ecosystem services (PES) to utilize and conserve land resources in a sustainable manner and Integrate land use considerations into school education and extension services to bring about long-term behavioural change.

Conclusions

From 2013 to 2023, Choke Mountain, Ethiopia, has significant land use and land cover (LULC) dynamics due to agricultural expansion, population increase, urbanization, and afforestation activity. Key findings are: Agricultural Expansion: Cropland increased by 4.5%, primarily from grassland and shrubland loss, due to high food demand and land-use intensification, Forest Cover Growth: Forest cover grew by 28.6%, mainly as a result of Eucalyptus plantation for building and fuelwood purposes, though natural forests remain vulnerable, Decline in Grasslands & Shrublands: Grasslands lost 11.9% and shrublands 34.8%, which reflects ecosystem decline and loss of biodiversity corridors and Urbanization: Settlements expanded by 133%, driven by population and infrastructure growth, leading to permanent land-use alterations.

Overall, Choke Mountain's LULC changes are mirror images with competing requirements for resources, where coordinated policies must be developed to maintain ecological integrity and livelihoods. Policymakers, scholars, and people must collaborate in addressing environmental degradation to enable climate adaptation within this important watershed landscape.

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