ASSESSMENT OF LAND USE LAND COVER CHANGE USING GIS AND REMOTE SENSING TECHNOLOGIES : THE CASE OF MISRAK BADEWACHO WOREDA, HADIYA ZONE, SNNPR, ETHIOPIA

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Abstract: This study assessed the causative factors of deforestation in the study area. It also assessed the land use land cover dynamics for last 20 years in the Woreda. This evaluated the areal extent, rate and patterns of forest cover change status in the study area for the last 20 years. In this study, a mixed research design of both qualitative and quantitative methods was employed. Both primary and secondary data sources were also used with simple random and purposive sampling techniques. The result revealed that cultivation land expansion, cutting trees for fire wood, charcoal production and expansion of grazing lands for livestock, cutting trees for constructions as well as using forest as source of income generation are the major causes of deforestation in the study area. The land use land cover dynamics assessment revealed that there is tangible land use land cover dynamics in the study area. Hence, Agricultural land, settlement and water body were increased by 75.5, 40.9 and 0.46 hectares respectively in the last 20 years. Whereas, bare land, grass land and forest were decreased by 23.7, 100.8 and 93.3 hectares respectively in the last 20 years. Therefore, it is recommended that protecting charcoal production, the implementation of the country's "Green Legacy" strategy and implementing land use planning in the Woreda awaking and creating awareness for the community about the forest conservation practices are the important remedies to minimize the deforestation rate in the Woreda.

Keywords: Deforestation, Land use Land cover, Change Detection, Green legacy

1. Introduction

1.1 Background of the Study

Land use land cover change in general and forest change in particular were assessed with a specified method. One of the most complete of these methods is supervised classification. It is computer-assisted classification, which depends on prior knowledge of researcher to classify satellite image in to various land use system or training areas. Change detection through remote sensing has now been applied widely because of its quick analysis processes, accurate results and visual spatial information. However, a rapid rate of deforestation and land degradation led to a loss of plant and animal species. For instance, studies conducted in the highland areas of Ethiopia indicated that there was a loss of over 1.5 billion tons of topsoil annually because of erosion, which implied for a soil loss of 35 to 40 tons per hectare in a year. In other words, it was equivalent to the loss of 1 to 1.6 million tons of grain per annum in the country (Abebe, 2005; Hussein, 2009). Gathering historical patterns of change and modeling, it helps for better understanding of processes of change that helps to improve a land management practice (Aithal et al., 2013; Behailu, 2010).

Forest is one of the most essential types of resources that human beings and other animals depend on. It regulates environmental and ecological system soil, water, climate and rainfall. The presence of forest in Ethiopia is relevant at several levels. Apart from its intrinsic value for many indigenous and other forest-dependent people, forests are their livelihoods. Forests provide them with edible and medicinal plants, bush meat, fruits, honey, shelter, firewood and many other goods, as well as with cultural and spiritual values. Whether it is private or public property, forest is

the nationally and globally mutual treasure. The value of forest resources to the world's human population is becoming increasingly evident (Tadesse, et. al., 2011).

Deforestation involves a decrease in the area covered by forest. However, it cannot be so defined without adding a reference to its use (or allocation). In point of fact, there exist certain forms of forest utilization and priority objectives of forest management - that clear temporarily the forest cover while guaranteeing its maintenance. This is the case of clear cutting of areas where forest will regenerate itself or be regenerated, or of the final cut in an even-aged forest silvicultural treatment once natural regeneration has been assured. In other words, there is no deforestation if there is a guarantee of continuity in maintaining the forest cover (Pontius, R.G et al., 2006).

This study was focused to assessing the main trends of LULC change and deforestation that took place in last 20 years in Misrak Badewacho Woreda by using GIS and RS technologies. Therefore, the aim of this study is to investigate the extent and rate of the land-use land-cover change for three periods (2000, 2010 and 2020).

1.2 Objectives of the Study

1.2.1 General Objective

The general objective of this study is to detect the LULC change between 2000 and 2020 in Misrak Badewacho Woreda by using Geographic Information System (GIS) and Remote Sensing (RS) technologies.

1.2.2 Specific Objectives

The specific objectives of the study were:

- To produce land use and land cover maps of the study area
- To examine the LULC changes of the study area from 2000-2020.

2. Material and Methods

2.1 Description of the Study Area

Misrak Badewacho Woreda is found in Southern Nations, Nationalities and People Regional State (SNNPRS) in Hadiya Zone. Geographically, Misrak Badewacho is located between 07° 03' 20" N to 07° 16' 08" N of latitudes and 037° 53' 02" E to 038° 06' 02" E of longitudes. It is bounded by Alaba zone in the North, Siraro Woreda of Oromiya region in the East, Kedida Gamela Woreda in Kambata Tembaro zone and Mirab Badewacho Woreda in the West, Damot Gale and Damot Pulasa Woreda's of Wolaita zone in the South. It is located at a distance of 354 km South West from Addis Ababa along the road from Addis Ababa through Shashemane to Wolaita Soddo (BOFeD, 2012).

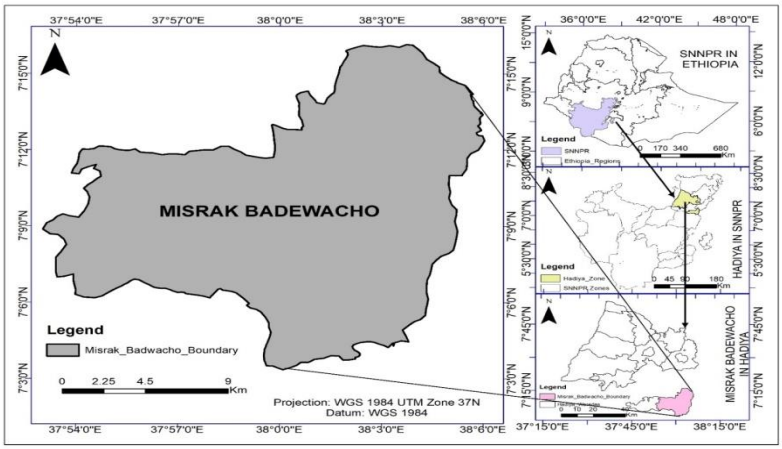

Figure 1: Location Map of the study area

It is also found at a distance of 123 km and 97 km from Hawassa, the regional capital town, and Hosanna the zonal capital town respectively. Shone town administration is the administrative center of Misrak Badewacho Woreda. The special feature in terms of location, Misrak Badewacho Woreda has no boundary share with the other Woredas of Hadiya zone, except Mirab Badewacho Woreda since it is separated by the presence of Kambata Tembaro zone between Misrak Badewacho and other Woredas of Hadiya zone (CSA, 2012).

2.2 Research Design and Methods of Data Collection

In this study explanatory sequential approach of the partial mixed research design has been used both qualitative and quantitative methods in this study. The purpose of mixed method design is to collect data from different sources and applied triangulation method to enhance and improve the quality of the data during the analysis and interpretation. Qualitative data are also carried out by the researchers in order to provide information on the causes and consequences of deforestation in the study area.

Maximum likelihood algorithm assumes that the statistics for each class in each band is normally distributed and calculate the probability that a given pixel belongs to a specific class where each pixel is categorized to class that has the highest probability (Arc GIS 10.5 Desktop Help). The technique was selected because it has greater probability to weight minority class that can be swamped by the large class during samples training from images. The assumption of this technique is that the minority classes in the image have the opportunity to be included in to their respective spectral classes thereby minimizing the problem of uncategorized pixel from entering in to another class during the classification process.

A study applied supervised classification technique for determining land use land cover changes in the study area suggested that in order to use supervised classification effectively then it's very crucial for the analyst to have a prior set of certain knowledge of the classes in mind and then develop the signatures accordingly.

In addition, personal field observations, collecting data using GPS, collecting Landsat satellite imageries such as TM (Landsat5 2000 & Landsat5 2010) and OLI (Landsat8 2020) were freely accessed via United States Geological Survey (USGS) earth explorer, in order to assess the land use land cover change dynamics of the study area for the year of 2000, 2010 and 2020 as well as to evaluate the areal extent, rate and patterns of forest cover change status in the study area for the last 20 years.

Table 1: Summary of sources of type, data and materials

Satellite Images							
Satellite Sensor	Year	Path	Raw	Resolution/ Cell size	Sources	Image Quality (Bit)	Acquisition date
Landsat5 TM	2000	169	55	30m	USGS	8 bit	Dec, 04,2000
Landsat5 TM	2010	169	55	30m	USGS	8 bit	Dec, 16, 2010
Landsat8 OLI	2020	169	55	30m	USGS	16bit	Feb, 27, 2020
Software's and Instruments				ArcGIS 10.5			
				Erdas Imagine 2014			
				GARMIN 72 Global Position Systems (GPS)			

2.3 Land-Use Land-Cover Classification of Misrak Badewacho Woreda

The study was carried by the frequent field visits to identify some of the LULC classes and discussions with farmers and also consulted secondary data, to have a clear understanding of the main categories of LULC as well to find out what types of changes are expected over time. Hence, six land use/cover types, settlement, grassland, agricultural

land, forest, water body and bare land (Table 2) were identified and mapped based on researcher experience in the study area.

Table 2 : Land use land cover classes after some modifications

SNo	LU/LC Classes	LU/LC Classification
1	Forest land (both natural and plantation)	Area covered with shrubs forming closed canopies and trees including Asst (Erica arborea) and others, which are relatively tall and dense trees, include scattered remnant Juniperus procera, Ficusvasta, and Ficus sur. Besides, plantations both indigenous and mainly exotic (Eucalyptus globulus and Cupressus lusitanica) trees that are planted in hillsides, mountains, and degraded areas.
2	Bare land	Land features with no vegetation cover; highly degraded areas with very little grass cover or bare rocks, and giving no or little services.
3	Grass land	Small grasses are the predominant natural vegetations. It also includes land with scattered or patches of trees and this land cover is used for grazing and browsing.
4	Agricultural Land	Areas allotted to extended rain fed crop production, mostly oil seed, cereals and pulses are managed.
5	Settlement	Land, which is mainly covered by bare soil and rock out crops and land covered by structures, which included towns and rural villages.
6	Water Body	Lakes, rivers and streams.

3. Results and Discussion

3.1 Land-Use Land-Cover Classification of Misrak Badewacho Woreda

This study has divided into six land use/land cover types, settlement; grassland, agricultural land, forest land, water body and bare land (Table 2) were identified and mapped.

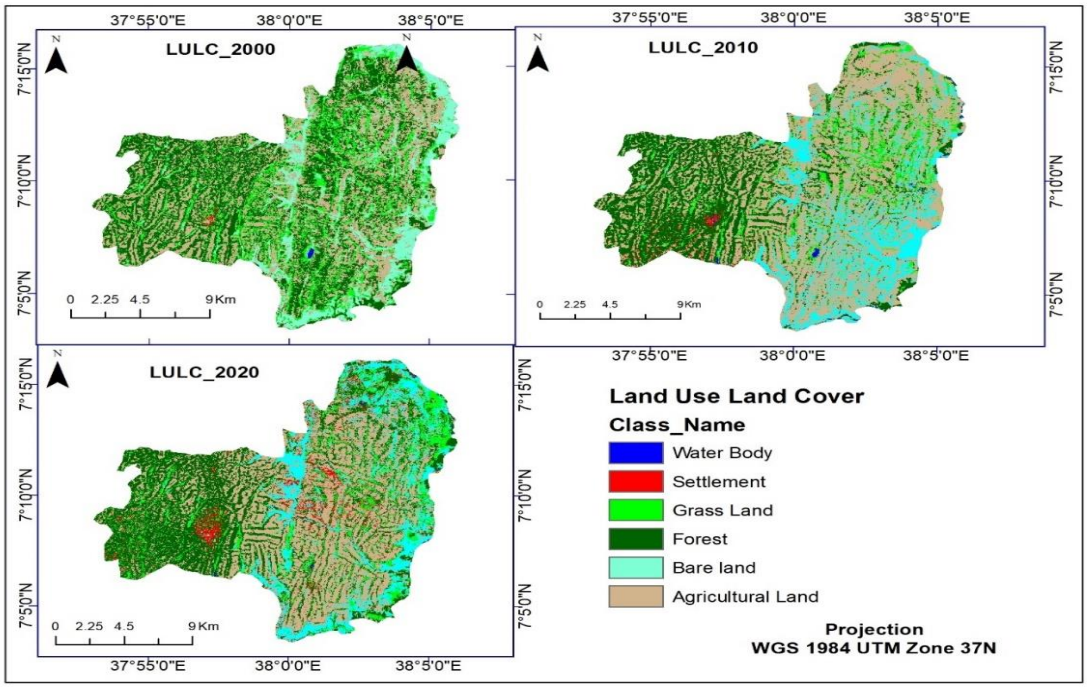

Figure 2: Land use land cover of 2000, 2010 and 2020

According to the figure 2, there were different water bodies in the Woreda but most of them were reduced and dried; however, there were some rivers and natural and man-made lakes. Basically, these lakes are highly increased from 2000-2010 due to heavy rain fall and people used wisely. From 2010-2020, the annual rainfall of the water body reducing from year to year because of the continuous deforestation around the area. As a result, the water density of the Woreda is highly decreasing due to high deforestation rate in the study area.

The results presented in Table 3 reveals that LULC of the study area has changed significantly since 2000. As indicated, there is a considerable reduction of bare land, forest and grassland between 2000 and 2020. Hence, the share of bare land declined by 11.1%, forest by 16.9% and grassland by 39.6% in the last 20 years. Whereas, there is also considerable increment of agricultural land, settlement and waterbody in the study area for these periods and the share of agricultural land is increased by 35.1%, settlement increased by 331.8% and waterbody by 33% between 2000 and 2020 (Table 3).

Table 3: Trends of LULC changes between 2000 and 2020 in the Study area

LULC type	Trends of LULC changes								
	2000-2010			2010-2020			2000-2020		
	Area Change(ha)	% Change	Rate of Change (ha /yr)	Area Change (ha)	% Change	Rate of Change (ha /yr)	Area Change(ha)	% Change	Rate of Change (ha /yr)
Agricultural Land	5304.9	52.8	530.5	-1774.6	-11.6	-177.5	3530.3	35.1	176.5
Bare land	59.6	1.4	6.0	-533.9	-12.3	-53.4	-474.3	-11.1	-23.7
Forest	-3353.4	-30.3	-335.3	1486.6	19.3	148.7	-1866.9	-16.9	-93.3
Grass Land	-2223.1	-43.7	-222.3	206.3	7.2	20.6	-2016.8	-39.6	-100.8
Settlement	115.3	46.7	11.5	703.2	194.3	70.3	818.4	331.8	40.9
Water Body	96.7	347.4	9.7	-87.6	-70.3	-8.8	9.2	33.0	0.5

Based on the land use land cover classification of the year 2000, 2010 and 2020 the following land use land cover with its respective areas in hectare generated.

Table 4: The area of each land use land cover classes with respective years

LULC Type	Area (ha)		
	2000	2010	2020
Agricultural Land	10049.67	15354.62	13580.01
Bare land	4292.07	4351.62	3817.74
Forest	11060.6	7707.17	9193.73
Grass Land	5088.87	2865.78	3072.1
Settlement	246.662	361.9393	1065.11
Water Body	27.8255	124.5724	37.02

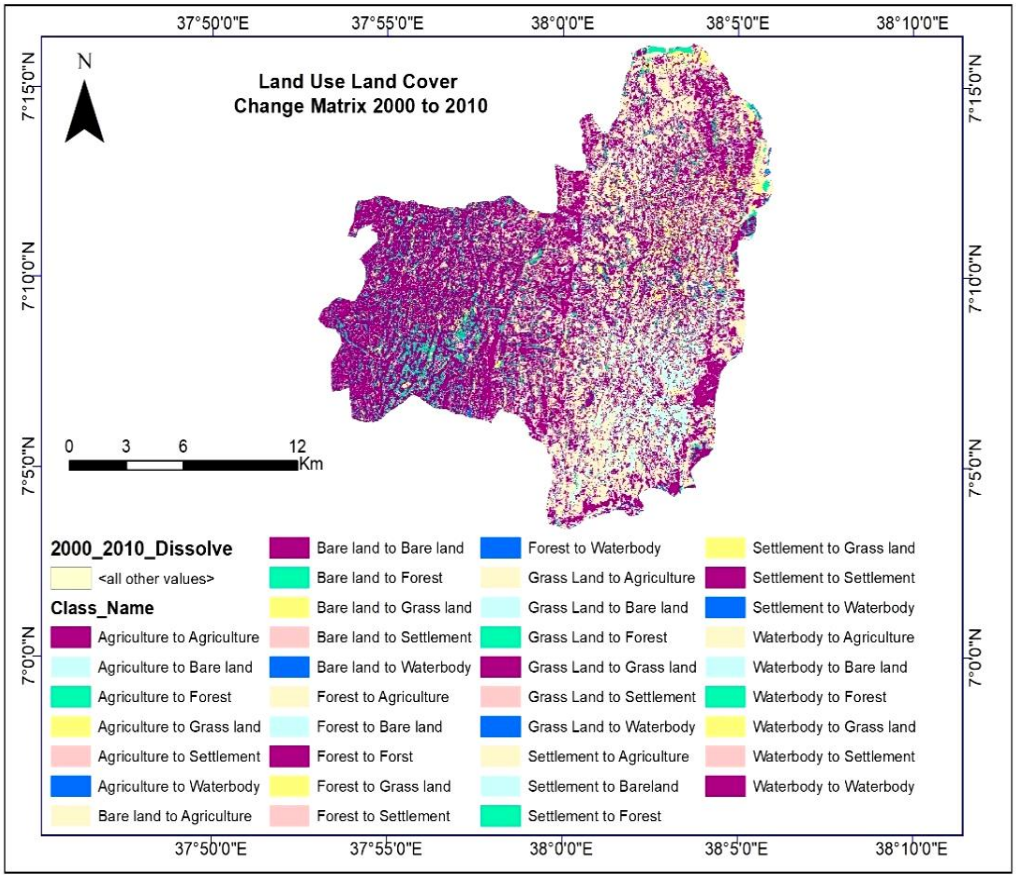

Figure 1: Land use land cover change matrix between 2000 and 2010

Table 5: Land use land cover change matrix between 2000 and 2010

LULC Classes		LULC 2010 (Area in ha)						
		Agriculture	Bare land	Forest	Grassland	Settlement	Waterbody	Total
LULC 2000 (Area in ha)	Agriculture	6576.6	1816.4	944.5	472.5	222.6	17.2	10,049.7
	Bare land	1971.6	1618.0	141.3	511.4	29.5	20.2	4292.1
	Forest	4595.5	661.9	5184.3	526.6	51.2	41.0	11,060.6
	Grassland	2140.8	198.9	1358.4	1328.6	47.0	15.2	5088.9
	Settlement	69.6	56.2	76.2	24.2	11.5	9.0	246.7
	Waterbody	0.5	0.3	2.5	2.5	0.2	21.9	27.8
	Total	15,354.6	4351.6	7707.2	2865.8	361.9	124.6	**30,765.7**

As indicated in the table 5, the agricultural land in the year 2000 is about 10,049.7ha, whereas, it is increased to 15,354.6ha in 2010. This gain of agricultural land is about 4,595.5ha from forest, 2140.8ha from grass land, 1971.6ha from bare land and the remaining areas from other land use classes. This result indicates that peoples are expanding agricultural land in the cost of forest, grass land and bare land. Therefore, 11,060.6ha of forest area in 2000 is declined to 7,707.2ha in 2010 and 5,088.9ha of grassland in 2000 is declined to 2,865.8ha in 2010.

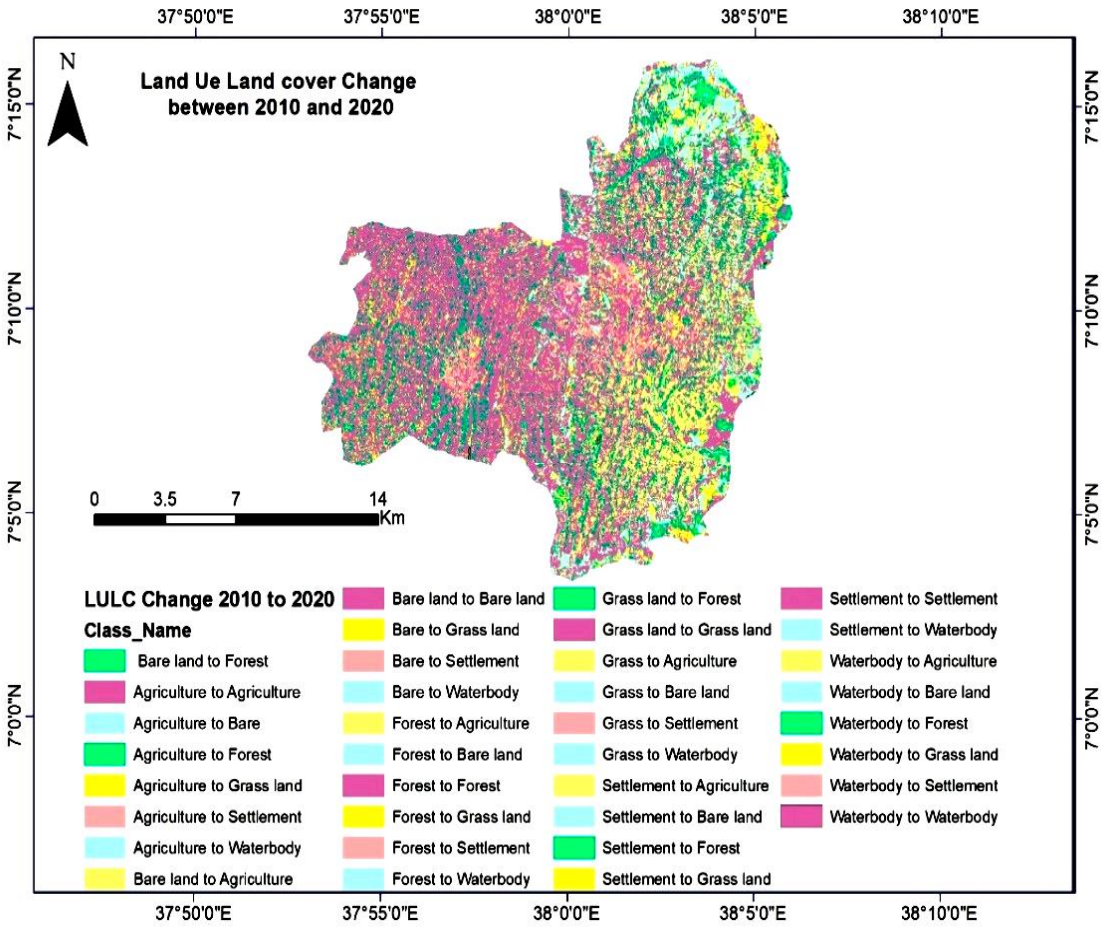

Figure 0: Land use land cover change matrix between 2010 and 2020

Table 6: Land use land cover change matrix between 2010 and 2020

LULC Classes		LULC 2020 (Area in ha)						
		Agriculture	Bare land	Forest	Grassland	Settlement	Waterbody	Total
LULC 2010 (Area in ha)	Agriculture	10,172	1832.99	1809.9	1058.72	467.99	13.00	15,354.62
	Bare land	2086.5	1683.6	234.4	192.71	150.59	3.85	4351.62
	Forest	625.8	45.8	6061.9	739.37	229.72	4.63	7707.17
	Grassland	541.0	230.4	894.6	1039.59	159.74	0.41	2865.78
	Settlement	132.9	15.9	139.4	26.99	46.46	0.27	361.9
	Waterbody	21.9	9.0	53.5	14.72	10.61	14.87	124.6
	Total	13,580.0	3817.7	9193.7	3072.1	1065.1	37.02	**30,765.7**

As indicated in the table 6 between 2010 and 2020, agricultural land, bare land and water body declined whereas, forest, grass land and settlement were increased. Except settlement all the other land use land cover classes dynamics was reverse when we compare it to the change between 2000 and 2010. This needs further investigation on the ground for detailed information and the researcher had field visits and asked some of the respondents about situation in recent years about land use land cover dynamics.

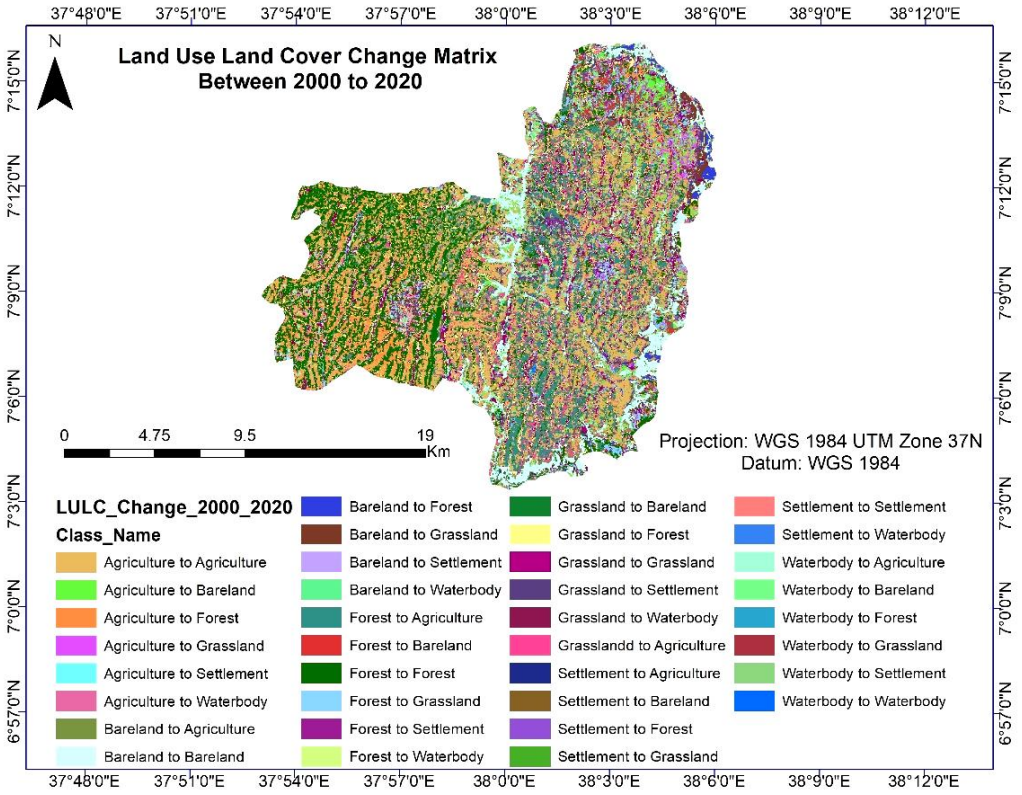

Figure 5: Land use land cover change matrix between 2000 and 2020

Table 7 : LULC Change Matrix between 2000 and 2020

LULC Classes		LULC 2020 (Area in ha)						
		Agriculture	Bare land	Forest	Grassland	Settlement	Waterbody	**Total**
LULC 2000 (Area in ha)	Agriculture	7374.3	839.4	1267.5	210.2	355.4	2.9	**10049.7**
	Bare land	635.7	2128.6	556.6	775.2	185.7	10.1	**4292.0**
	Forest	4091.9	496.4	5300.9	921.5	238.2	11.7	**11060.7**
	Grassland	1423.2	326.0	1953.5	1127.9	251.3	6.9	**5088.9**
	Settlement	52.0	26.3	106.0	28.1	33.8	0.5	**246.7**
	Waterbody	2.8	1.1	9.3	9.2	0.7	4.8	**27.8**
	Total	**13580.0**	**3817.7**	**9193.7**	**3072.1**	**1065.1**	**37.0**	**30765.7**

The overall land use land cover dynamics in the study area shows that land use land cover change is still in an uncontrolled condition. As indicated in the table 7 forest, grass land and bare lands are declined between 2000 and 2020. Whereas, agricultural land settlement and water body were showed an increment in these time periods. This result shows that there is an uncontrolled land use land cover dynamics in the study area for the last 20 years.

As indicated in table 7 the overall gain is goes to agricultural land in the year 2000 to 2020 which indicates that forest and other land use classes probability to be changed into agricultural land is high as the growth with its pressure is in place. Other studies also revealed the same result that agricultural land is overtaking other land use classes in many parts of Ethiopia for the last many decades. Over the past few decades, considerable LU/LC change has been happening in the highlands of Ethiopia. Previous studies indicated that the decrease of forest cover and expansion of agricultural land into steep slope areas not suitable for cultivation are significant forms of LU/LC change in most highlands of Ethiopia.

4. Conclusion

Land use/land cover is very dynamic in nature and has to be monitored at regular intervals for sustainable development thus it has become a central component in current strategies for managing natural resources. The advancement in the concept of vegetation mapping has also greatly increased research on land use/ land cover change.

The result revealed that cultivation land expansion, cutting trees for fire wood, charcoal production and expansion of grazing lands for livestock, cutting trees for constructions as well as using forest as source of income generation are the major causes of deforestation in the study area. The land use land cover dynamics assessment revealed that there is tangible land use land cover dynamics in the study area. Hence, Agricultural land, settlement and water body were increased by 75.5, 40.9 and 0.46 hectares respectively in the last 20 years. Whereas, bare land, grass land and forest were decreased by 23.7, 100.8 and 93.3 hectares respectively in the last 20 years.

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