

# Assessing land use and land cover changes and Effects of Large-scale Agricultural Farm Expansion in Southwester Ethiopia by using remote sensing/GIS tools.

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## Research Article

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# Abstract

Development initiatives like the recent increase in large-scale investment agriculture have made a significant impact on the forest. In the name of development, the land is often given to investors often in long-term leases and at bargain prices. Research on deforestation has been mostly restricted to poverty and population growth as the driving forces for tropical deforestation; however, explanations emphasizing market factors such as increases in large-scale investment agriculture as a cause of deforestation have only been carried out in a small number of areas. The aim of this study is to explore the effects of agricultural land expansion in changing land use and land use cover changes using remote sensing/GIS tools in Sheka zone southwester Ethiopia from 1995 to 2015. The results showed that expansion of investment agriculture has a clear impact on both the local people and the forest ecosystem. The conversion of forestland to investment agriculture has caused varied and extensive environmental degradation to the Sheka forest. The Land Use and Land Cover changes in the Sheka zone are discussed based on underlying socioeconomic factors.

## Introduction

In the name of development, the land is often given to investors often in long-term leases and at bargain prices. This trend is often referred to as "land-grabbing". A variety of terminologies has been in use to describe the meaning of "land-grabbing", such as large-scale land acquisitions, enclosures, and global land rush. Even if a variety of definitions of the term "land-grabbing" has been suggested, this study will make use of the "large-scale agricultural investment" throughout this research article for the purpose of explaining land transfer.

Development initiatives like the recent increases in large-scale investment agriculture have made a significant impact on the forest and change indigenous forest resource management practices (Nepstad et al., 2006). Such kind of scenarios benefit primarily outside economic interests, but could possibly weaken traditional knowledge and degrade local culture. Research on deforestation has been mostly restricted to poverty and population growth as the driving forces for tropical deforestation; however, explanations emphasizing market factors such as increases in large-scale investment agriculture as a cause of deforestation have only been carried out in a small number of areas. There appear to be relatively few studies in the literature that explicitly examine the impact of global economic and political processes on forest ecology.

Most large-scale agricultural investment processes happened in the tropical region of the world, particularly in forested areas, for their high investment returns (GRAIN, 2008). To put it differently, tropical forests are the target of the process of the 'global land grab'. The global process of large-scale agricultural investments not only affects the forest ecosystem, but also engenders a growing impact on food and agro-fuel, climate change, migration, and economic relations (ABN, 2007; Campbell, 2009; Andrianirina-Ratsialonana et al., 2011; Cotula, Vermeulen, Mathieu, & Toulmin, 2011).

Large-scale agricultural investments have been identified as major contributing factors for the current high rate of deforestation in the tropics (FAO FRA 2010). According to FAO (2010) estimates that the global rate of gross loss of standing forest was 16 million hectares per year during the 1990s, and there was a loss of 13 million hectares per year between 2000 and 2010. Therefore, analysis of its impact in the study area is very urgent and vital because the trend of land grabbing undermines local people's culture and generates massive displacements of people.

Ethiopia is a country characterized by high rate of deforestation and rapid rate of forest cover change this is mainly because of various adverse human actions, like the expansion of cases of large-scale investment agriculture and the declining of traditional forest conservation culture. Subsequently, a precise investigation land-use/land-cover (LU/LC) change is so pivotal to precisely fathom the degree of the change and bring important measures to downsize the rate of changes and secure the land cover assets reasonably. This study assessed changes in forest cover in Sheka zone southwestern Ethiopia between 1985 and 2015 by looking at classified satellite images coupled by GIS investigations and analyzed the relationship of forests cover change with the social, political, economy and natural ramifications the past and current forests cover change in Sheka forest.

This LU/LC study has made use of sequential satellite images (1985, 1995, 2005 and 2015) and GIS technologies in combination with ground verification. The study detected both types of changes (conversion and modification) and four major land use types namely Dense forest, open forest, agricultural land and settlement in the Sheka zone Masha and Anderacha woreda.

## **Materials And Methods**

### **Study area**

The Sheka Zone is located at about 670km from Addis Ababa. It is found in the South Nations Nationalities and Peoples Regional State. The Sheka zone shares boundaries with the Oromia Regional State in the North, Bench Maji Zone in the South, Gambella Regional State in the West, and Kefa Zone in the east. The total area of Sheka was 2175327 ha. Geographically, the Sheka Zone lies between 7°24'-7°52' N latitude and 35°31'-35°35'E longitude. The Zone has three woredas namely: Masha, Andracha, and Yeki. In the Zone, there are 56 rural and seven urban peasant associations (Pas) in three woredas.

### **Methods for GIS**

Various soft wares and equipment were used during the study. The soft wares like ENVI 5.0 and Arc GIS 10.4.1 were used to analyze the satellite image and to classify the images. The ArcGIS 10.4.1 was used to analyze the classified data and to delineate the study area. Other materials like topo sheet (1:50,000 scale). Multi-temporal Landsat imageries of TM (1985, 1995) and ETM+ (2005, 2015) data were used to classify the land use and land cover map of the study area.

Freely available time series Landsat satellite images were downloaded from USGS website and proper Imageries of bands combinations are important for image enhancement to identify changes in land-use/land-cover features (table 3). The four-time period Landsat satellite images were obtained from Multi-temporal Landsat imageries of Landsat 5 TM (1985, 1995) and ETM+ for 2005 and 2015 Landsat 7 and 8 respectively.

The preprocessing and processing of these land use/ cover data were done by using ENVI 5.0 and Arc GIS 10.4.1 software. The images were georeferenced into the same map projection of World Geodetic System UTM 1984 Zone 37 N. All satellite images were sub- mapped (subset) for covering only the study area.

Table 1: Sensor, Acquisition dates, Path/Row, and Resolution of the study area image

Sensor	Date of acquisition	Path and Row	Special resolution(M)	Source
Landsat 5	19/01/1985	170/55	30*30	USGS
Landsat 5	12/01/1995	170/55	30*30	USGS
Landsat 7	04/03/2005	170/55	30*30	USGS
Landsat 8	10/03/2015	170/55	30*30	USGS

## Research Procedures for GIS

Images freely downloaded from USGS were analyzed using the following procedure for land use land cover change analysis. It is trusted that the time hole of around thirteen years between the four-satellite imagery is sufficiently wide to indicate changes and patterns in Land Use and Land Cover in the Sheka forest and encompassing region. These wellsprings of data were utilized to break down land cover and land use changes throughout the years for the investigation zone.

Topographic maps and map of the Sheka forest, both at 1: 50,000 scales and associated population information were obtained from Ethiopian Mapping Authority (EMA) and Central Statistics Authority (CSA), respectively.

## Land use land cover classification

Table 2: Land Use and Land Cover Classes and Definitions

Land Use/Cover type	Land Use/Cover Description
Dense forest land	Deciduous and semi-deciduous forest tree cover with canopies typical of the tropical rainforest biome. Mostly restricted to the upper elevations of mountains ranges of the area including along the rims of Lake Bosomtwe.
Open forest land	Actively cultivated and fallow lands and prepared lands for cultivation. Vegetative communities dominated by perennial and annual grasses with occasional herbaceous species presence.
agriculture	Areas of land plowed/prepared for growing various crops.
Settlement	Land covered by buildings and other ma made structures. Residential, commercial services, industrial area, mixed urban or built uplands

## Image Processing

Classification process and analysis of the different LULC classes were done using four Landsat satellite images covering the Multi-temporal Landsat imageries of TM (1985, 1995) and ETM+ (2005, 2015) acquired in 2017. These images include; Landsat 5 for the year 1985 and 1995 (path 170, rows 55) and Landsat 7 for the year 2005 (path 170, rows 55) and Landsat 8 for the period 2015 see (table 3).

The Landsat images were downloaded from United States Geological (USGS) Earth Explorer (<https://earthexplorer.usgs.gov/>). The selection of the Landsat satellite images dates was influenced by the quality of the image especially for those with limited or low cloud cover in the dry month of the year. Each Landsat was georeferenced to the WGS\_84 datum and Universal Transverse Mercator Zone 35 North coordinate system.

## Results

### Status of Land Use Land Cover of Sheka zone during Study Years

Using Satellite Remote Sensing and Geographic Information System, this research work analyzes the land use and land cover change dynamics in the Sheka zone southwestern Ethiopia. The four images were taken from the Multi-temporal Landsat imageries of TM (1985, 1995) and ETM+ (2005, 2015). All images were geo-referenced and images classification was prepared by using the maximum likelihood classifier algorithm. In Sheka zone, Masha and Anderacha woreda four major land cover classes were identified in each date of the satellite image. The land cover classes and coverage in each date of the image are given below (table 4).

Conversion of dense forests to other forms of land use has been the general trend in Sheka zone Masha and Anderacha woreda. Such changes have been broad in the previous quite a few years in the Sheka forest.(MELCA Mahiber, 2007). The fast extension of investment agriculture and the declining of traditional forest conservation culture in the study area have required this sort of change. The same trend has been observed in the Masha and Anderacha woreda in the Sheka zone.

The present examination was expected to dissect the nature and degree of land use/ land-cover changes in Masha and Anderacha woreda since most recent three decades and recognize the fundamental powers behind them. The land use/ land-cover changes statistics of 1985 and 2015 and the change and growth in areal degree in various land use/ land-cover changes between the three times periods in Sheka zone Masha and Anderacha woreda are given in (Table 5 and Figure 5).

The study area has been divided into the four major land use/ land-cover classes as shown in (Table 5). The forest of Sheka in Masha and Anderacha woreda in Sheka zone is the main natural resource. Most of the forestlands are reserved by traditional forest conservation cultures like DEDO, GUDO, and KOBO. Nevertheless, gradually, the dense forest is being lost to open forest, agricultural land, and settlements.

Table 3 :Summary of LULC Class Statistics of 1985, 1995, 2005 & 2015

Land use	Land cover in each year of image							
	1985		1995		2005		2015	
	(sq.-km)	(%)	(sq.-km)	(%)	(sq.-km)	(%)	(sq.-km)	(%)
Dense forest	912	57.35%	824	51.82%	790	49.68%	514	32.32%
Open forest	437	27.48%	469	29.49.2%	470	29.55%	480	30.18%
Agriculture	233	14.65%	284	17.86%	316	19.87%	572	35.97%
Settlement	7	0.44%	13	0.81%	14	0.88%	23	1.44%

Each land use land cover map has been classified into four classifications which are the dense forest, open forest, agricultural land, and settlement see table (Table 5). The land use land cover map of 1985 is considered as the baseline or zero change of the study. The land use land cover classification of 1985 is shown on the map (Figure 6). This research work tried to show the current land use land cover situation in Sheka zone Masha and Anderacha woreda from the period 1985 to 2015. The result of the study showed that significant conversion of one land uses land cover to the other land cover class. Farming area and the open forest has been extending and exceedingly ruling different classes. It is a result of the addition of the populace and the presentation of estate farming in the examination territory.

Only about 14.65% of the land was used for agriculture in Sheka zone Masha and Anderacha woreda by the year 1985, while the other land cover classes that are a dense forest, open forest and settlement

covered the remaining 84%. In the year, 2015 agricultural land dominates the other land cover classes. For example, agricultural land in the year 1995 has increased by about 3.21% in 10 years gap. While open forest has shown 2% increment and settlement are increasing only by 0.37%. In reverse to this, dense forest decreased by 5.53% in the same year. In the successive period i.e. 1995–2005, agricultural land has shown an increase of about 2.01% while, open forest and settlement have shown very little increment it is only by 0.06 % and 0.07% respectively.

In 1985 as it is illustrated in land use land cover map (Fig. 6), it was on the northern, southern and western part of the study area where the dense forest was concentrated while open forest and agricultural land were most abundant at the central part of the study area. But as time goes on agricultural land and open forest expand toward the northern, southern and western part of the study area and then after 2015 the majority of the land come under agricultural land followed by open forest. Very small part of the study area now under dense forest.

ENVI 5.0 and ERDAS 2015 change detection statistics show that 57.35% dense forest of the 1985 land use land cover was reduced to 32.32% thus there was a 25.03% loss of dense forest cover from the 1985s to 2015 which was mainly associated with the conversion of dense forest to other land cover class in the study area see table 5. In 1995, it was observed that 912 sq. Km dense forest was cleared and reduced to 824 sq. Km that resulted in 5.53% decrement of dense forest.

The study area has four land use land cover categories, which were dense forest, open forest, agricultural land, and settlement. The description of these land cover categories was presented previously (Table 5).

Table 4 : the spatial extent of various land-use and land cover categories during 1985

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	912	57.35
Open forest	437	27.48
Agricultural land	233	14.65
Settlement	7	0.44
Total	1590	100

The satellite image of 1986 was classified based on reflectance signature of solar radiation that differs according to various Earth surface objects. The land use land cover classification for 1985 from TM satellite image (Figure 6) showed that dense forest and open forest accounted for 912 sq. km (57.35%) and 437 sq. km (27.48 %) respectively, while agricultural land and settlement amounted to about 233 sq. km (14.65%) and 7 sq. km (0.44%) respectively (Table 6). Most segment of the land use land cover class was thick forest amid this period.

The land use land cover classification for 1995 from TM+ satellite image (fig 7) showed that dense forest and open forest accounting for 824 sq. km (51.82%) and 469 sq. km (29.49%) respectively, while agricultural land and settlement amounted to about 284 sq. km (17.86%), 13 sq. km (0.81%) respectively.

Table 5: the spatial extent of various land-use and land cover categories during 1995

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	824	51.82
Open forest	469	29.49
Agricultural land	284	17.86
Settlement	13	0.81
Total	1590	100

The land use land cover classification for 2005 from ETM+ satellite image (figure xxx) showed that dense forest and open forest accounting for 790 sq. km (49.68%) and 470 sq. km (29.55%) respectively, while agricultural land and settlement amounted to about 316 sq. km (19.87%), 14 sq. km (0.88%) respectively.

Table 6: the spatial extent of various land-use and land cover categories during 2005

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	790	49.68
Open forest	470	29.55
Agricultural land	316	19.87
Settlement	14	0.88
Total	1590	100

The land use land cover classification for 2015 from ETM+ satellite image (figure xxx) showed that dense forest and open forest accounting for 514 sq. km (32.32%) and 480 sq. km (30.18%) respectively, while agricultural land and settlement amounted to about 572 sq. km (35.97%), 23 sq. km (1.44%) respectively.

Table 7: the spatial extent of various land-use and land cover categories during 2015

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	514	32.32
Open forest	480	30.18
Agricultural land	572	35.97
Settlement	23	1.44
Total	1590	100

### Classification Accuracy Assessment

This appraisal is completed to assess the classification efficiency of the ERDAS IMAGINE 2015 software programming in order to speak to the present land use /cover map of the investigation territory. The procedure had decided how adequately pixels were assembled into the right component classes under scrutiny. It is expert the characterized image with the ground by the assistance of field survey or reference map. To evaluate the productivity of classification precision, a confusion matrix was developed.

To conduct this assessment 100 random points were decided to be collected using thump rule; states that 30 points for each land use land cover class and the image were containing four classes. The overall accuracy for the four-time period of classification results 86% and accuracy of each Land Use Land Cover classes are present in the table below.

Table 8: LULC confusion matrix.

Land use land cover class	Dense forest	Open forest	Agricultural land	Settlement
Dense forest	<b>89</b>	8	3	0
Open forest	8	<b>87</b>	9	3
Agricultural land	2	5	<b>88</b>	8
Settlement	1	0	0	<b>89</b>
Total	100	100	100	100

### Land Use Land Cover Change Detection Scenarios

A change analysis for the study period was performed in the ERDAS IMAGINE 2015 software to prepare a change detection map. The use/land cover categories delineated from the Multi-temporal Landsat imageries of TM (1985, 1995), ETM+ (2005, 2015) data were an overlay, and the transformation of land-use and land-cover classes from one to another was observed. The spatial extent of various land /land

cover statistics of the changes in land use/ land cover categories over the period from 1985 to 2015 was generated.

During the period 1985 to 2015 spanning over four decades, there have been remarkable changes in dense forest, open forest, and agricultural land. The agricultural land has expanded from 14.65% in 1985 to 35.97% in the year 2015. Conversely, the dense forest has shrunken from (57.35% in 1985 to 32.32% in 2015). A similar trend has been observed in open land and settlement which has increased from 27.48% in 1985 to 30.18% in 2015 and in 1985 0.44% to 1.44% 2015 (Tables 11 & 12).

Table 9: the spatial extent of various land-use and land cover categories during 1985

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	912	57.35
Open forest	437	27.48
agriculture	233	14.65
Settlement	7	0.44
Total	1590	100

Table 10: the spatial extent of various land-use and land cover categories during 2015

Land-use	Area (sq.-km)	Percent Area (%)
Dense forest	514	32.32
Open forest	480	30.18
agriculture	572	35.97
Settlement	23	1.44
Total	1590	100

### **Land Use Land Cover Change Transition Matrix between the Years**

#### **Land Use Land Cover Change Transition Matrix from 1985 – 1995**

Total percentage growth in different LULC categories in the study area is very high. Some LULC classes have registered a growth while others have witnessed a negative growth as shown in (Table 13 and Figure 12). The dense forest has reduced from 57.35% in 1985 to 51.82% in 1995 thus registering a decrement in growth by 5.53%. Deforestation, expansion of agricultural land and increasing settlement are putting massive weight on the woodland assets of the investigation zone.

Since the area is very rich in cash crops like coffee and timber, it has attracted many migrants from distance and neighboring this coupled with the rapid rate of urbanization in the study area has brought about the speeding up in the deforestation procedure. Open forest cover is one of the major land-cover categories in the Masha and Anderacha woreda in the Sheka zone and has registered a further growth of 27.48% from 1985 to 29.49.2percentage 1995. The degradation of forests because of different reasons over a significant lot of time changes them into other land use land cover class. In the study area agricultural land has registered a significant increase from 14.65% (233 Sq. Km) in 1985 to 17.86% (284 Sq. Km) in 1995, therefore, showing an absolute change of -3.21% that is, -51 Sq. Km at an annual rate of -0.32%.

Most of the settlement area has shown a significant increase as compared to other class in the Masha and Anderacha woreda of the Sheka zone. From 0.44% (7 Sq. Km) in 1985 to 0.81% (13 Sq. Km) in 1995, therefore, showing an absolute change of 0.37% that is, 6 Sq. Km. Population increase and rapid rate of urbanization are responsible for the expansion of settlement in the study area.

Table 11: Land Use Land Cover Change Transition Matrix from 1985 – 1995

Land Cover Type	The area in 1985 (Sq. Km)	(% ) Land Cover in 1985	The area in 1995 (Sq. Km)	(% ) Land Cover in 1995	Change between 1985 and 1995	
					The area in Sq. Km	%
Dense forest	912	57.35	824	51.82	-88	-5.53
Open forest	437	27.48	469	29.49	+32	+2.01
Agricultural land	233	14.65	284	17.86	+51	+3.21
Settlement	7	0.44	13	0.81	+6	+0.37
Total	1590	100	1590	100		

### LU/LC Change Detection for 1995 to 2005

When the land uses land cover change detection for the year 1985 to 1995 compared with land use land cover change detection 1995 to 2005, there were similar trends that showed decrease or increase in particular land use land cover. The land uses land cover categories, which showed an increase are an open forest, agricultural land, and settlement for 470 Sq. Km (29.55%), 316 Sq. Km (19.87) and 14 Sq.

Km (0.88%); respectively in the year 2005. On the other hand, the land use land cover categories like dense forest showed decreasing pattern amounted to 790 Sq. Km (49.68%) for the same period.

In the year between 1995 and 2005, dense forest and agricultural land show a remarkable change to other land cover classes. About 34 Sq. Km of dense forest was converted to agricultural land and open forest followed by settlement. In general, based on the matrix result, it was concluded that open forest, agricultural land, and settlement showed incremental changes with the total percentage of +0.06, +2.01, and +0.07 respectively. This improvement could be attributed to the implementation of plantation agriculture in the study area. The percentage of open forest and settlement has shown a slight increase from 469 Sq. Km (29.49) in 1995 to 29.55Sq. Km (0.88) in 2005 and 13 Sq. Km (0.81%) in 1995 to 14 Skim (0.88) respectively.

Figure 13 illustrates the matrix map result of land use/land cover change in the year between 1995 and 2005. The result depicts 34 Sq. Km (2.14%) of dense forest area were changed to other land cover type in the 10-year duration. Thus, this very large amount of land cover type was changed to agricultural land this is mainly because of population growth, declining of traditional forest-related knowledge and conservation culture and the introduction of plantation agriculture in the study area.

The change has an adverse impact on the physical environment as degradation of natural resources, deforestation, soil erosion, soil fertility reduction, biodiversity losses are the main results of the land cover change in the study area. The following map (Figure 12) showed the coverage of LU/LC in the years between 1995 and 2005.

Table 12: Land Use Land Cover Change Transition Matrix from 1995 – 2005

Land Cover Type	The area in 1995 (Sq. Km)	(% Land Cover in 1995	The area in 2005 (Sq. Km)	(% Land Cover in 2005	Change between 1995 and 2005	
					The area in Sq. Km	%
Dense forest	824	51.82	790	49.68	-34	-2.14
Open forest	469	29.49	470	29.55	+1	+0.06
Agricultural land	284	17.86	316	19.87	+32	+2.01
Settlement	13	0.81	14	0.88	+1	0.07
Total	1590	100	1590	100		

## LU/LC Change Detection for 2005 to 2015

In the time period between 2005 and 2015, a dramatic decrease in the dense forest was observed which is about 790 Sq. Km (49.68%) of dense forest in the year 2005 to 514 Sq. Km (32.32%) in the year 2015 was noticed; the dense forest was converted into open forest, agricultural land and settlement respectively. About 276 Sq. Km (17.36 %) of dense forest was directly converted to open forest, agricultural land, and settlement in between 2005 and 2015. open forest, agricultural land, and settlement were shown to have incremental changes from 2005 to 2015.

As can be seen from Figure 13 matrix map the coverage of agricultural land shows the greatest change compared to open forest and settlement. Open forest and settlement increased by 13 Sq. Km (0.63%) and 9 Sq. Km (0.56%) respectively whereas agricultural land 276 Sq. Km (17.36%). The following matrix map (Figure 14) showed coverage of LU/LC in the years between 2005 and 2015.

Table 13: Land Use Land Cover Change Transition Matrix from 2005 – 2015

Land Cover Type	The area in 2005 (Sq. Km)	(% Land Cover in 2005	The area in 2015 (Sq. Km)	(% Land Cover in 2015	Change between 2005 and 2015	
					The area in Sq. Km	%
Dense forest	790	49.68	514	32.32	-276	-17.36
Open forest	467	29.55	480	30.18	+13	+0.63
Agricultural land	316	19.87	572	35.97	+256	+16.1
Settlement	14	0.88	23	1.44	+9	+0.56
Total	1590	100	1590	100		

## Discussion

Africa has been a specific focus of land-and eager for water financial specialists, involving in excess of 70 percent of the speculators' request (Deininger and Byerlee, 2011). The recent expansion of large-scale investment agriculture in developing countries, particularly in Africa has been attributed largely to the global food and energy crises. There have been a number of studies that has tended to focus on the drivers for the expansion of large-scale investment agriculture in Africa particularly focusing on food and energy crises as a driving force (GRAIN 2008, Cotula et al. 2009, McMichael and Scoones 2010; Arezki et

al., 2011; Brüntrup, 2011; Zoomers 2010, De Schutter 2011; Anseeuw et al., 2012a). Similarly, growing interest in agricultural land investment in Ethiopia has been linked in addressing the food crisis (Collier 2008); creating employment (Deininger & Byerlee 2010) and earning foreign exchange.

The expansion of large-scale agricultural investment has been widely recognized by national inventories and media reports. Data on the scale and patterns of expansive scale arrive exchange, for the most part, has originated from National inventories like Cotula et al (2009), Görden et al. (2009), World Bank (2010) and media reports included on the blog of the International Land Coalition. In any case, solid figures on scale and patterns are yet hard to get, therefore, figures obtained from national inventories and media reports must be treated with extreme caution.

Quantitative data for the total land areas acquired for investment not yet clear, however, the lion share of global land transfer is from Africa. As indicated by the World Bank, more than 56.6 million hectares of land had been all around exchanged, over 70% of the land is in Sub-Saharan Africa (The World Bank, 2011). In July 2013 alone there were 1,044 deals, and representing 51.6 million hectares out of this around 54% of these deals are located in Africa (Kerstin Nolte 2016).

A number of studies have reported that large-scale agricultural investments in Sub-Saharan Africa are commonly observable, and an impressive number of such vast scale arrive moves are packed in Ethiopia. Information obtained from a different source on the current trend in land transfer in Ethiopia asserts this fact. During the past 10 years, much more information has become available on the current trends and patterns of large-scale agricultural investments in Ethiopia.

Notwithstanding, there is no exact figure on how much land is exchanged. According to the recent reports by the Oakland Institute (2011a), around 3.6 million hectares of land has been transferred to 1,349 investors by January 2011. Data from the World Bank have identified that around 1.2 million hectares of land transferred to 406 investors since 2004–2009. Another estimate made by the Land Matrix indicated that there is around 2,401,021 ha of land transfer for 73 deals (Mulleta et al., 2014).

Information obtained from national inventories in different regional office in Ethiopia like Amhara BoEPLAU, MoARD, Oromia Investment Commission, SNNPR Investment Agency, Tigray EPLAUA, CSA, and EIA have indicated that there has been a large-scale foreign investment in active projects (ha) in different regions of the country. Surprisingly, no differences were found in all regions of the country in terms of foreign investments in active projects (ha). According to Amhara BoEPLAU (MoARD, 2011), there has been 20,702 (ha) of land for foreign investments in active projects.

Surprisingly, in Oromia 214,003 (ha) of land was given for foreign investments in active projects and 438,212 (ha) of land identified for future investment (Oromia Investment Commission). Similarly, in SNNPR 79,770(ha) of land was given for foreign investments in active projects and 529,181(ha) of land identified for future investment (SNNPR Investment Agency, 2008). In Tigray, 300(ha) of land are given for foreign investments in active projects (Tigray EPLAUA).

One study by EIA (2011) examined the trend in large-scale agricultural investments (LSAIs) in Ethiopia found that there is a significant rise in the number of large-scale land acquisitions (LSLAs) and this has earmarked an area of over three million hectares. A subset of these LSLAs will lead to "large-scale agricultural investments" (LSAIs) (PhilippBaumgartne et al., 2015). A recent study by CSA (2009) indicates that the contribution of commercial farms in Ethiopia is less than 5% of the country's total agricultural production. However, there has seen a critical ascent in expansive scale agrarian interests as of late.

When looking into the regional distribution of agricultural investments in Ethiopia, the majority of these large-scale land acquisitions are occurring in the southern and western parts of Ethiopia, namely the states of Benishangul-Gumuz; Gambella; Southern Nations, Nationalities, and Peoples' Region (SNNPR) and Oromia. According to the Oakland Institute (2011a), the regional distribution of land transfers for investment in four regions of the country has amounted to 1,319,214 hectares in Oromia, 635,831 in Benishangul Gumuz, 470,287 in SNNP and 256,000 in Gambella respectively. These are the most affected regions in the processes of land transfer to investors.

Previously, the Ethiopian federal government's rural development strategy has focused on smallholders' agricultural production by encouraging labor-intensive agriculture to increase productivity. The federal government has shifted the rural development policy and strategy in early 2000 and began to implement large-scale commercial agriculture and foreign investment in farmland. In 2009, Ethiopia established the Agricultural Investment Support Directorate (AISD), operating under the federal Ministry of Agriculture and Rural Development (MORAD), to oversee all external or foreign large-scale land acquisitions over 5,000 hectares.

Up to this point, the administration has elevated land leases to outside and residential financial specialists prompting the likelihood of huge scale agriculturist is viewing to arrive with smallholders (Lavers, T. 2012). Hardly any ongoing examinations have depicted the patterns in farming interest in Ethiopia by evaluating the effect of specific agrarian undertakings in the nation (Fisseha 2011, Guillozet and Bliss 2011, and Shete, 2011).

According to the Oakland Institute (2011a), large-scale agricultural investments (LSAIs) have occurred across Ethiopia except for the state of Harari, as well as the city administrations of Addis Ababa and Dire Dawa. Both MOARD and the Regions (Rahmato, 2011) allocated the land to investors at the different time. In the period near 2009 and 2010, MOARD and the Regions apportioned around 500,000 hectares of land to financial specialists. As indicated by the World Bank (2010), the aggregate land moved to financial specialists in Ethiopia near 2004 and 2008 was 1.2 million hectares. On the off chance that the pattern proceeds along these lines, before the finish of 2015 an aggregate land exchanged to financial specialists will gauge almost 7 million hectares, which is equivalent to around 38 percent of the land as of now used by smallholders (Rahmato, 2011).

Most of the large-scale land acquisition projects are focused either on food crops or on non-food agricultural commodities, such as flowers, silk, or honey for export. Other projects also included biofuels,

timber, and conservation. MELCA Mahiber's (2008) report looks at the extent of land allocated for biofuel investments in Ethiopia. The report shows that critical levels of farmland are being procured for fuel crops. For example, National Biodiesel Corporation Company, 80% of which owned by UK Sun Biofuels, has acquired 80,000 (ha) of land to cultivate *Jatropha* crop, and another UK company called Sun Biofuels has acquired 5,000(ha), of which only 1,000 planted to cultivate *Jatropha*.

Global Energy Company of Israel has acquired 2,700-7,500(ha) of land to cultivate Castor bean. Flora Eco Power Company has acquired 56,000 ha of land through concessions to cultivate Castor and *Jatropha* and applying for another 200,000. The Brazil Company called BDFC has acquired 18,000(ha) of land and securing an additional 30,000(ha) throughout growers to cultivate Sugarcane/sugar beet (Welz, 2009).

When examining the external actors by country and the number of large-scale land acquisition projects, India and Saudi Arabia were the two countries involved in the most large-scale land acquisition projects in Ethiopia, with 13 and 8 projects respectively (Land Matrix,2014). For example, the Saudi government and king to make "investments" abroad to aid Saudi Arabia's food security (Pearce, 2012) have tasked the Saudi company, Saudi Star. The Saudi Star Agriculture Development Plc, owned by Saudi-Ethiopian billionaire Mohammed Al-Amoudi, acquired 10,000 hectares of land along the Alwero River in the Gambella region of Ethiopia. This Plc has acquired 10,000 hectares (ha) lease of land rent. The company has a plan to acquire additional 500,000 ha of land in Gambella and other states to grow a projected one million tons of rice, as well as maize, teff, sugarcane and oilseed (Land Deal Brief, 2011).

Other studies by World Bank (2012) has reported that the Indian floricultural and agro-business conglomerate Karuturi global ltd has leased 10,000 hectares of land in Bako, Oromia provinces and 100,000 ha in Gambella, and this agro-business company has an option for 200,000ha of land in Gambella. Taken together, these results suggest that there is a large-scale land acquisition in Ethiopia.

## Conclusion

In the Sheka zone southwestern Ethiopia, demographic growth and large-scale land investment has caused social and environmental impacts, as forests are cleared and communities are displaced, or lose access to farmland and forest resources. Particularly, large-scale land investment without proper environmental impact assessments were the cause of enormous LULCC in the Sheka zone southwestern Ethiopia.

The results of this research revealed the existence of significant LULCC over the last 30 years. The observed changes varied from one LULCC category to another. This study showed that the expansion of large-scale commercial farmland increased in 2015 compared to 1985. The expansion of small-scale farmland between 1985 and 2015, on the other hand did not show any significant change, and it is less than 2% area change unless one would expect a higher increase to a massive population growth. This shows the dominant influence of commercialization on agriculture in the region. In addition, barren land has increased considerably during the last two decades. On the other hand, tropical grassland and forest areas are declining at a rapid pace.

The Sheka forest, which is the nation's largest forest reserves, has been affected by LULCC. The conversion of tropical grasslands and forestland to large-scale farmland has caused varied and extensive environmental degradation in the Sheka forest, and major negative outcomes for local people's livelihood. For instance, the establishment of the new large-scale farmland resulted in a loss of large parts of the wetland vegetated area and water bodies. Identifying the complex interaction between changes and its drivers over time is significant in determining future change, setting up decision-making mechanisms and constructing alternative scenarios. Therefore, in future, sustainable development LU/LC has to be monitored at regular intervals and an integrated LU policy is required.

In general, this study advocates the use of Multi-temporal Landsat images of TM (1985, 1995) and ETM+ (2005, 2015) data were used to classify the land use and land cover map of the study area comprehensively. Only local fieldwork and the compilation of additional sources can enable the observed changes to be put into a larger perspective, and to be able, finally, to understand the LU/ LC dynamics in the Sheka forest. This is a prerequisite to formulating successful LU strategies required for the appropriate and sustainable development of the study area.

To sum up, this paper has documented LULCC in the Sheka forest of Ethiopia. It quantifies the changes and illuminates reasons and effects. The Sheka zone is among the least developed and the most fertile regions of Ethiopia. It has large natural reserves in terms of pristine forests, wetlands, tropical grasslands and biodiversity.

## Declarations

Competing interest: The authors declare that they have no competing interests.

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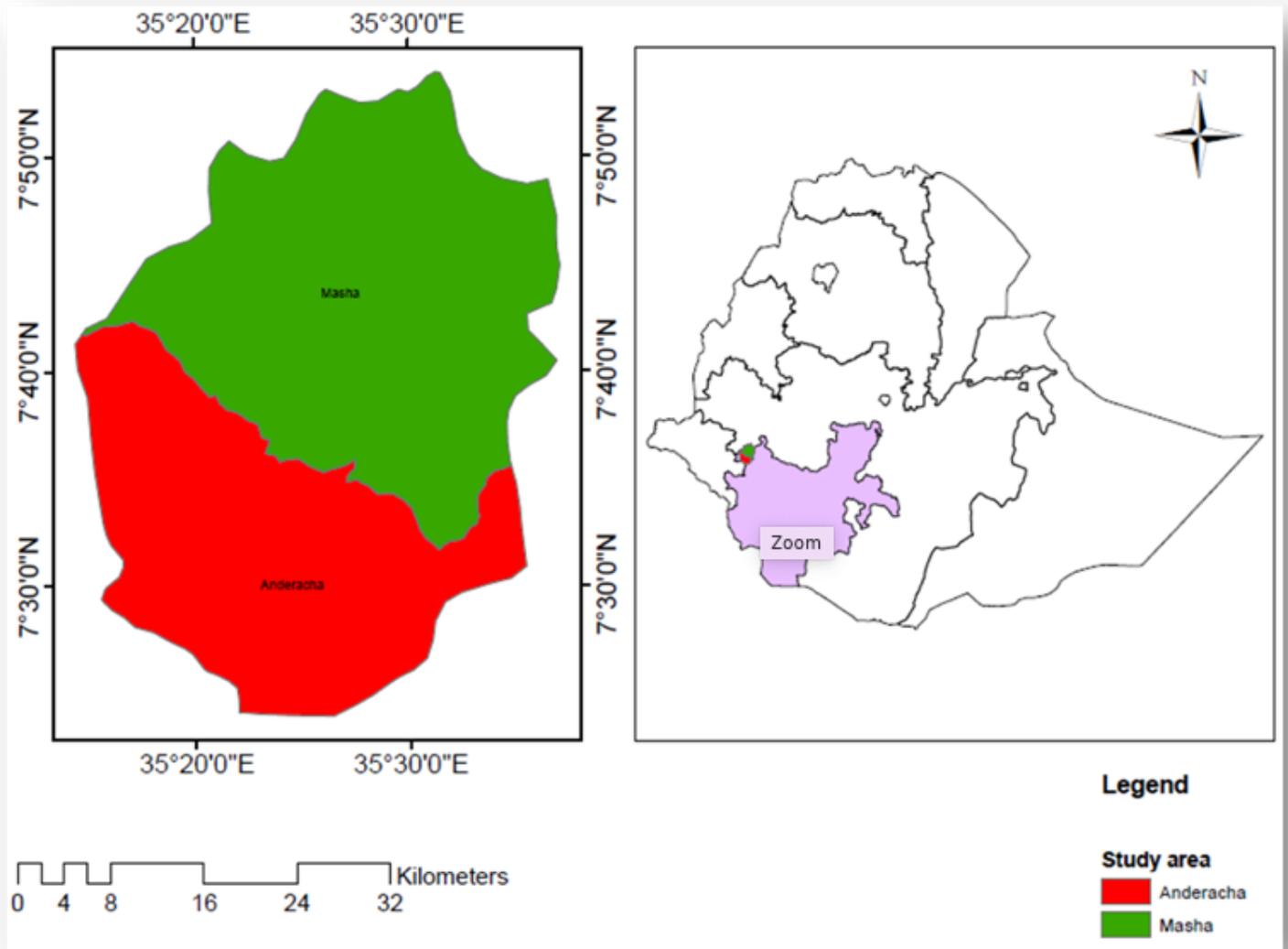
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## Figures



**Figure 1**

Methods Figure 1: Map of the study area. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

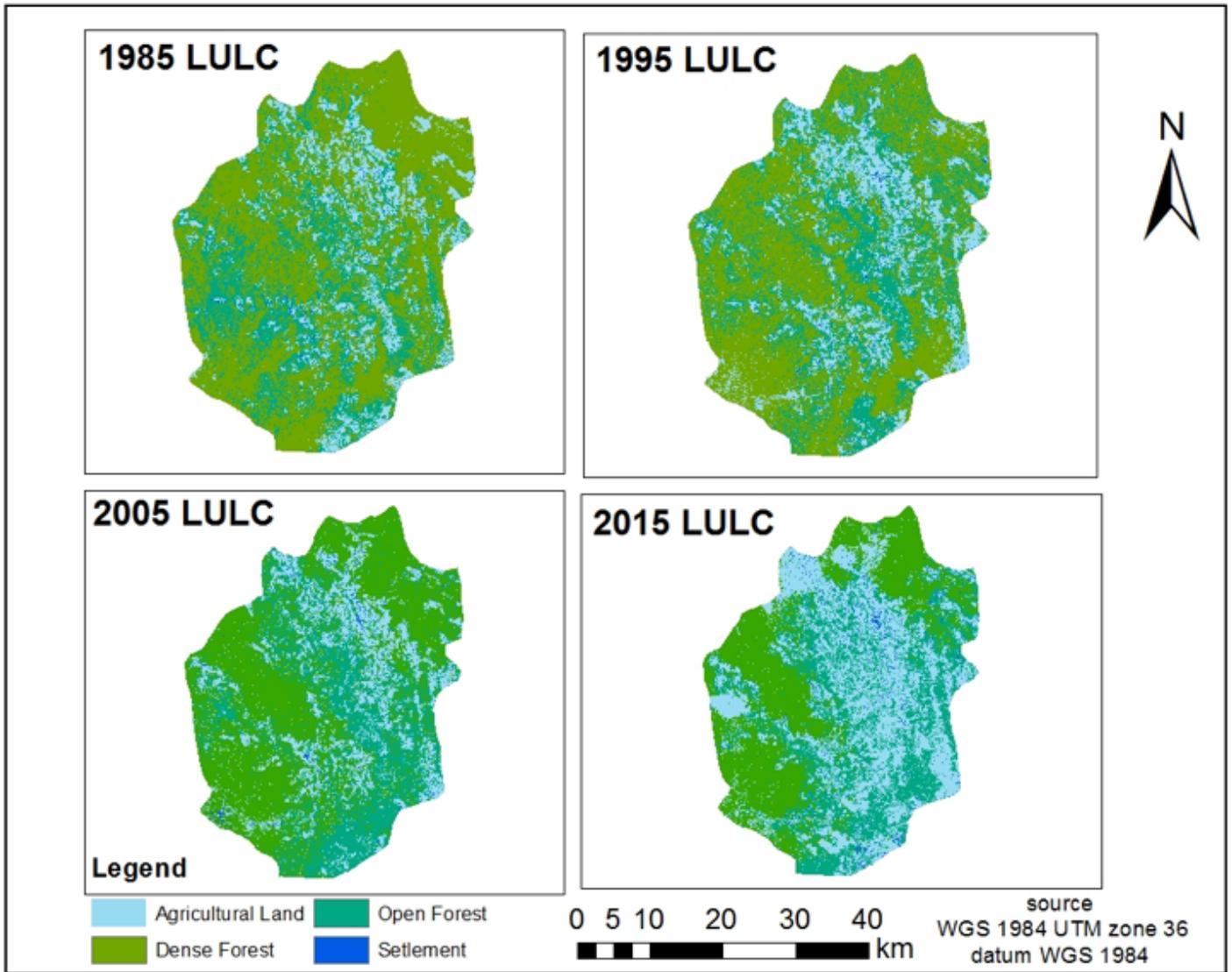


Figure 2

Results Figure 1: LULC change from 1985, 1995, 2005 and 2015.

# Nature of Land Use Land Cover During 1985

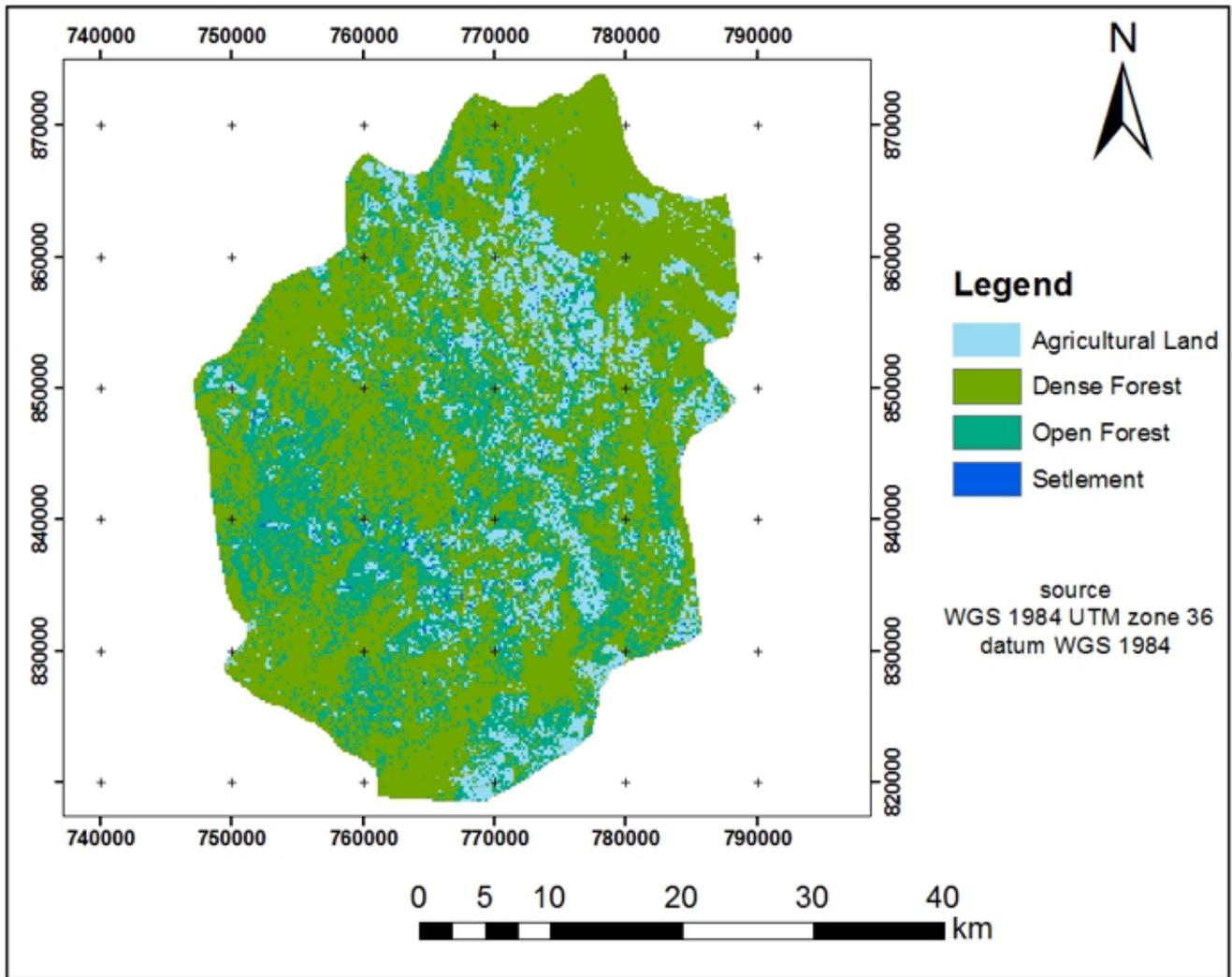


Figure 3

Results Figure 2: Nature of Land Use Land Cover During 1985

## Nature of Land Use Land Cover During 1995

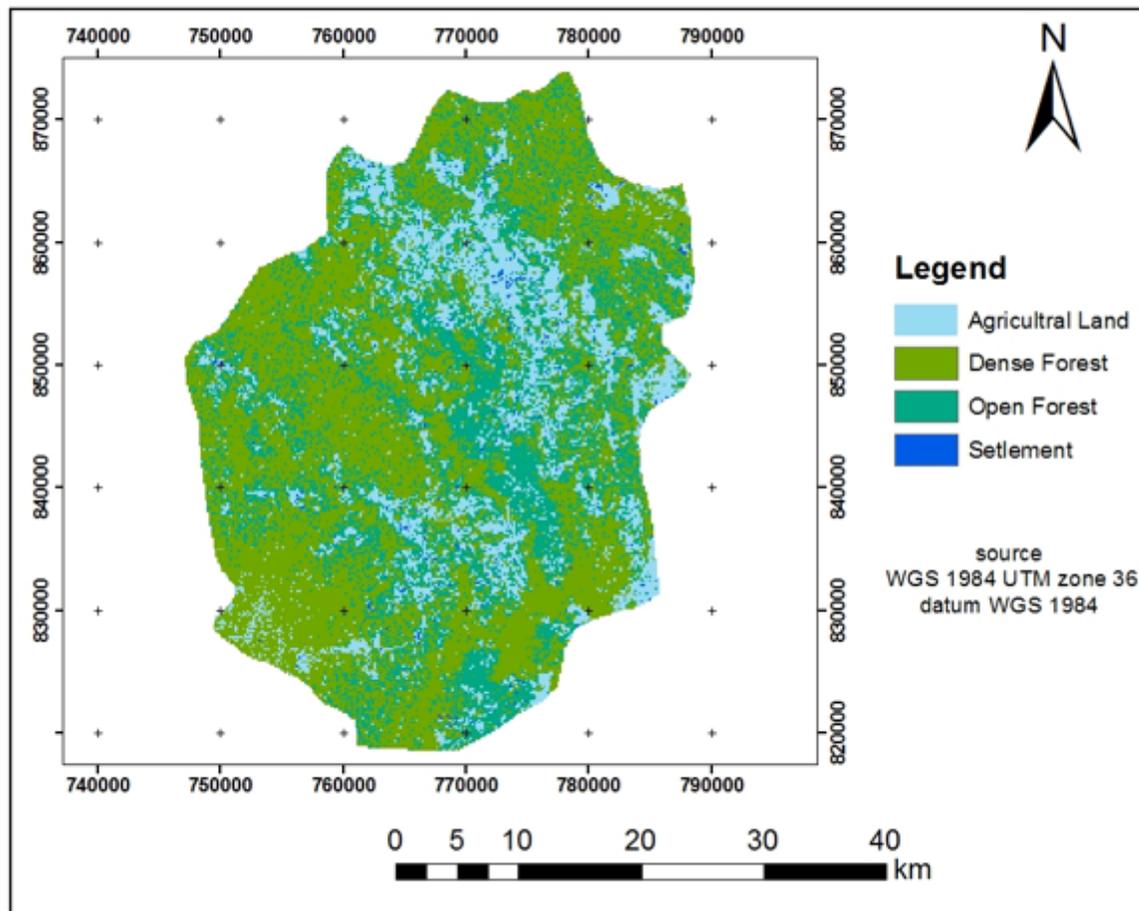


Figure 4

Results Figure 3: Nature of Land Use Land Cover During 1995

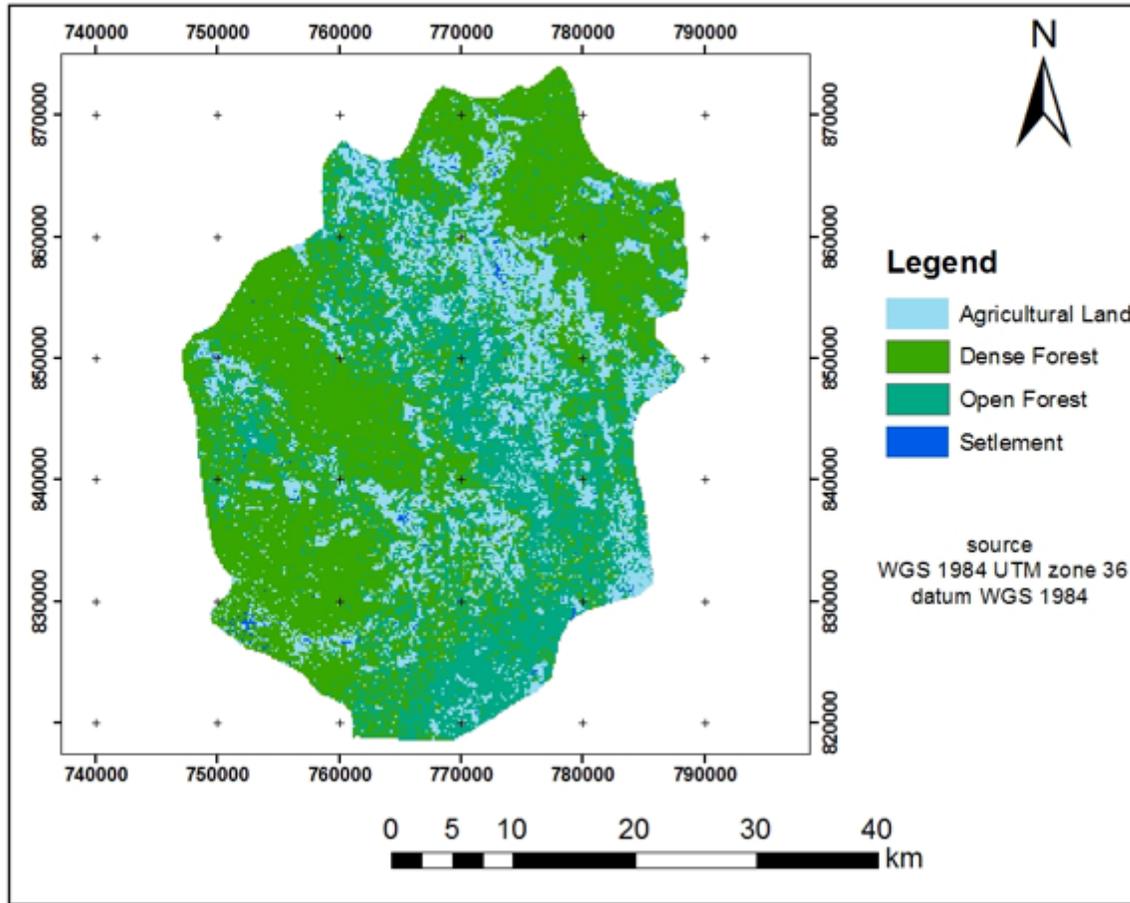


Figure 5

Results Figure 4: Nature of Land Use Land Cover During 2005

## Nature of Land Use Land Cover During 2015

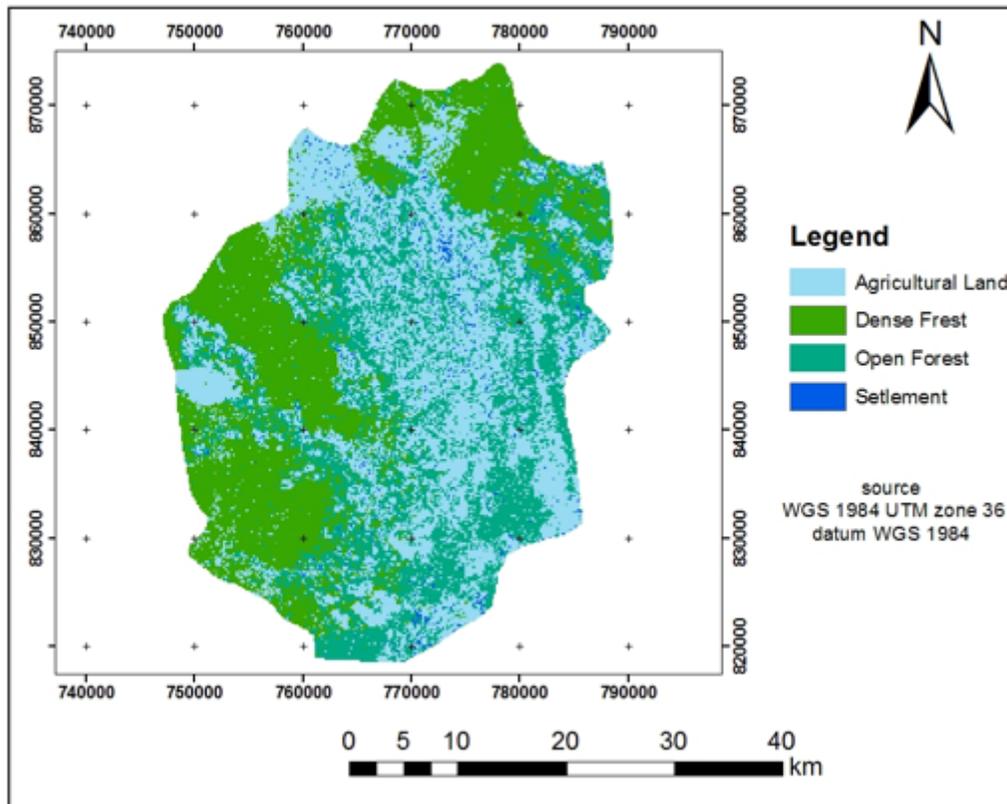


Figure 6

Results Figure 5: Nature of Land Use Land Cover During 2015

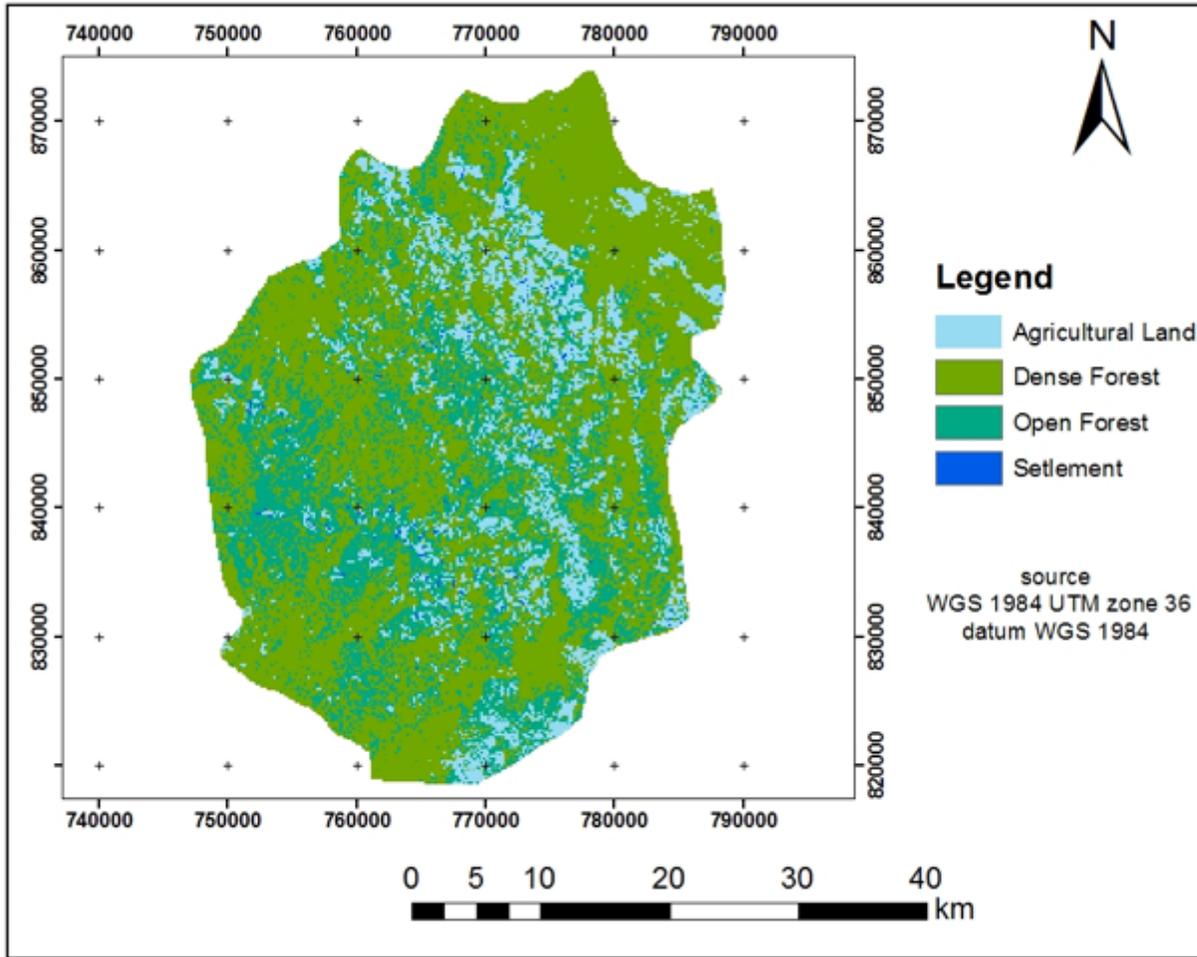
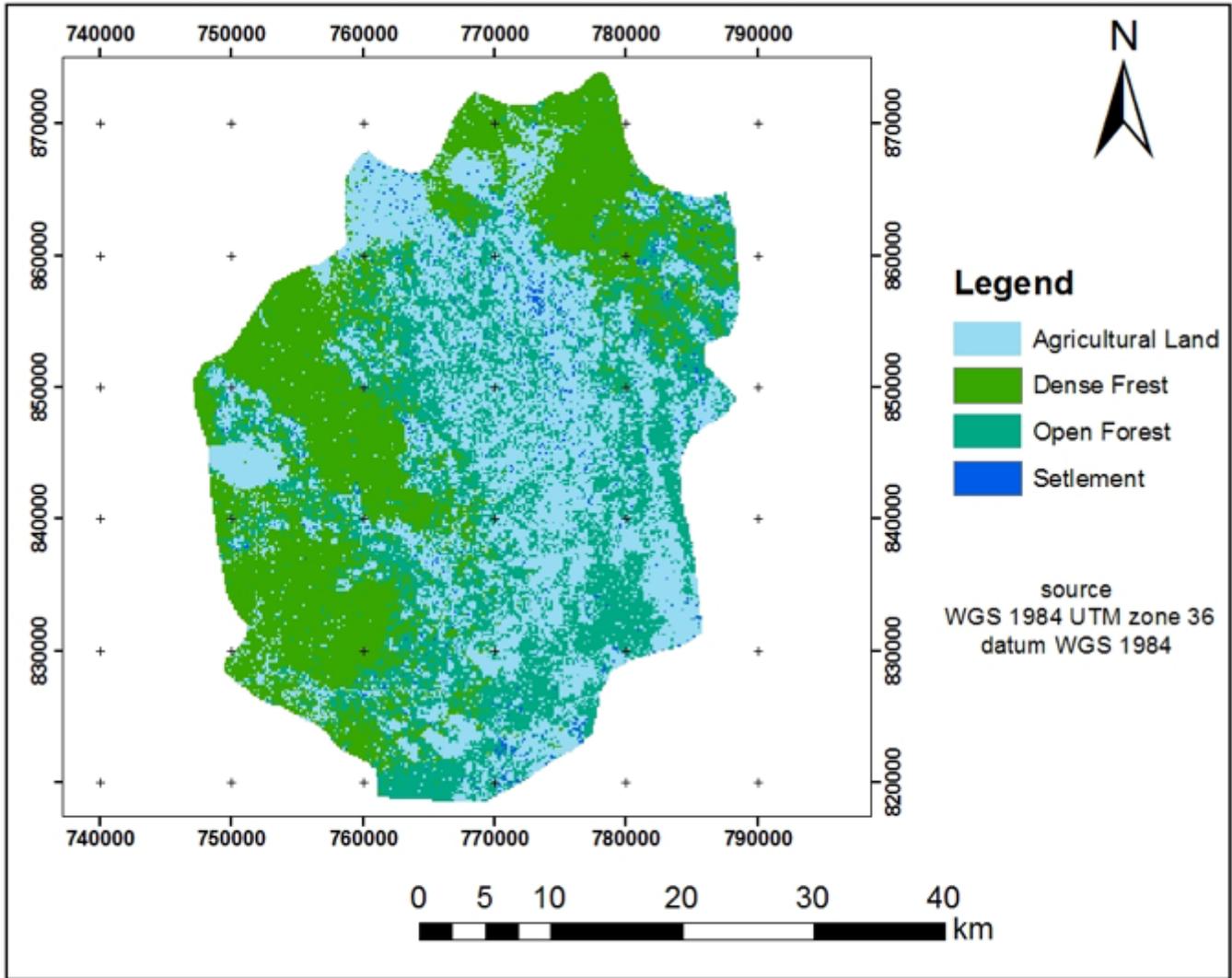


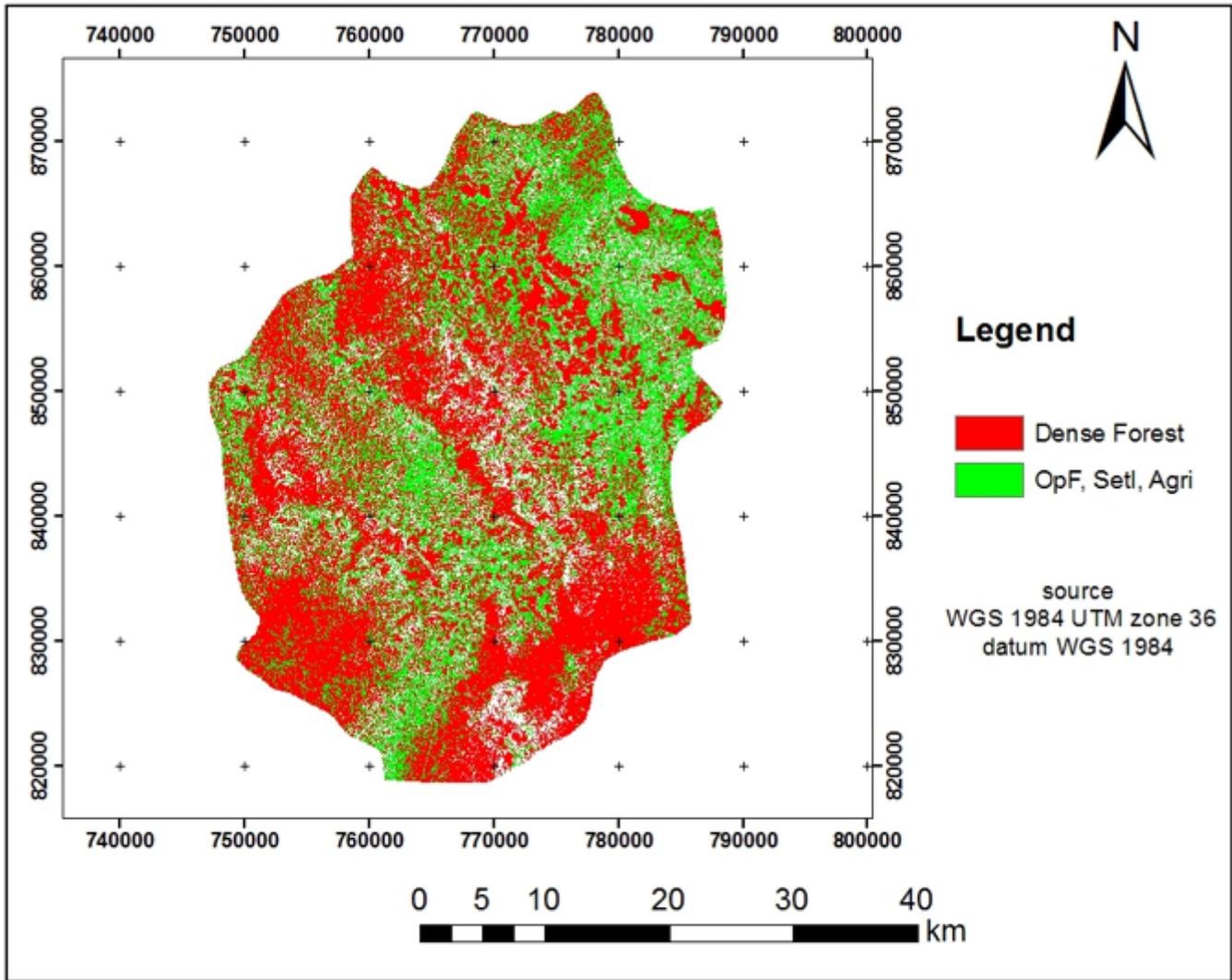
Figure 7

Results Figure 6: Nature of Land Use Land Cover During 1985



**Figure 8**

Results Figure 7: Nature of Land Use Land Cover During 2015



**Figure 9**

Results Figure 8: Land Use Land Cover Change Transition Matrix from 1985 – 1995

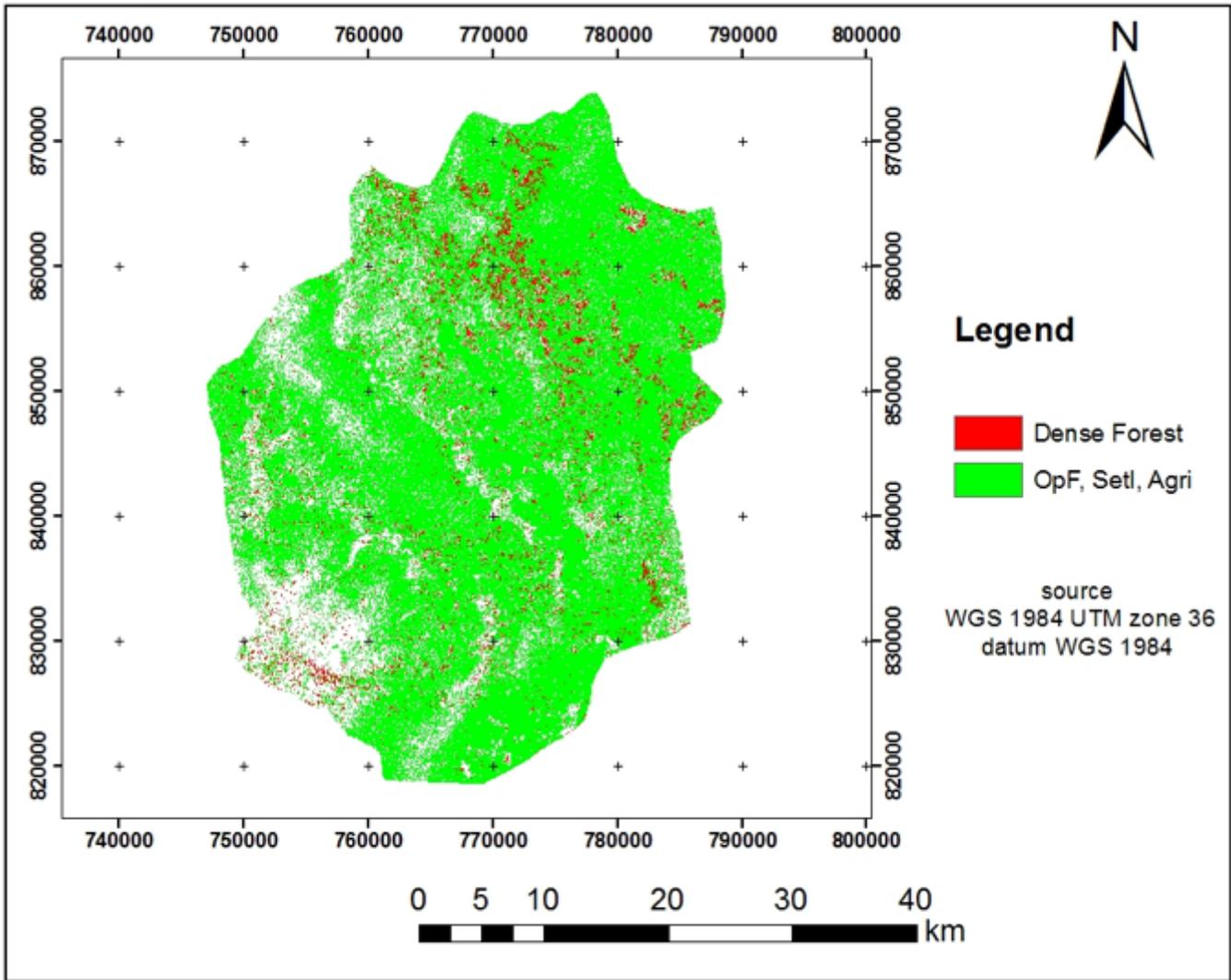


Figure 10

Results Figure 9: Land Use Land Cover Change Transition Matrix from 1995 – 2005

# Land Use Land Cover Change Transition Matrix from 2005 – 2015

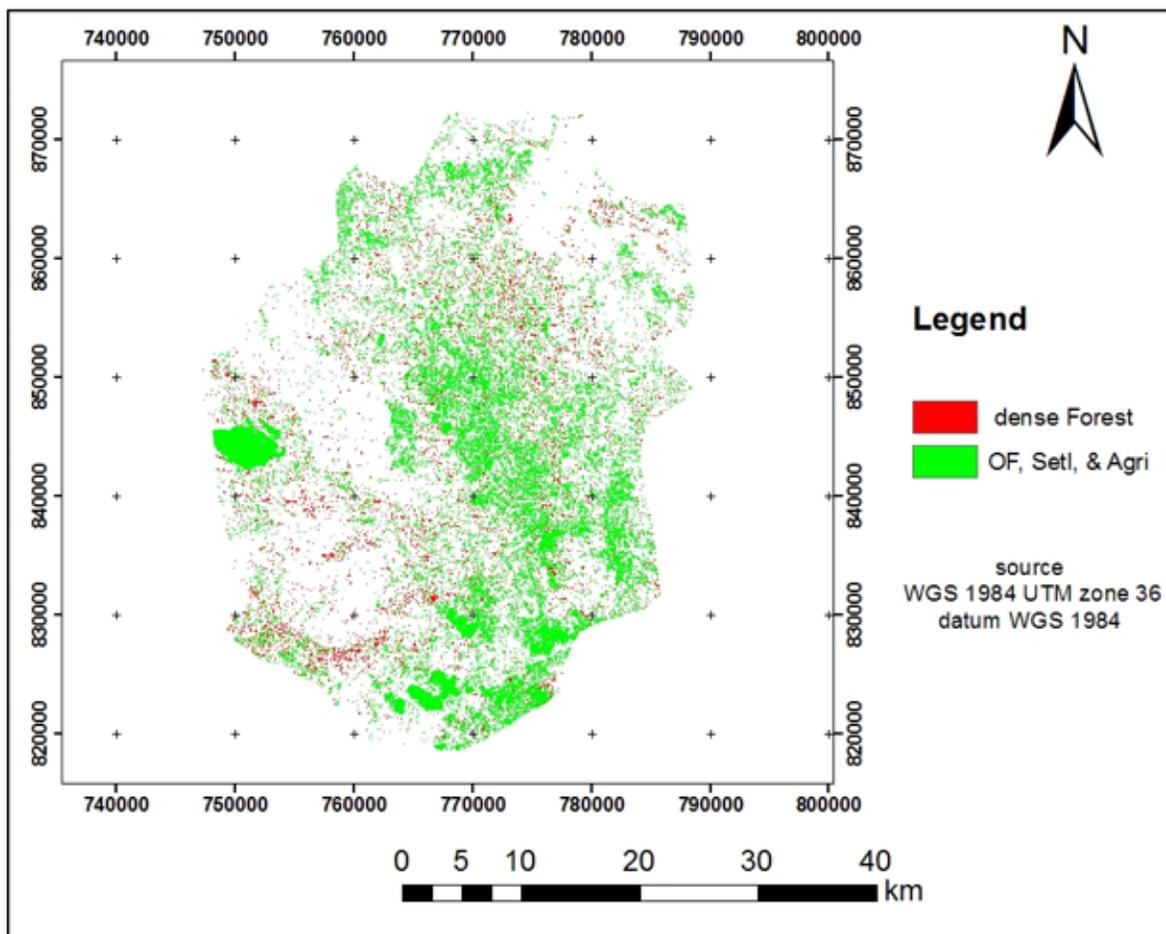


Figure 11

Results Figure 10: Land Use Land Cover Change Transition Matrix from 2005 – 2015