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Land Use and Land Covers Change Detection of Mareka District (1995 up to 2015) of Dawuro Zone, Southern Ethiopia

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ABSTRACT

Land use and land cover (LULC) change is one of the challenges which strongly influence the process of agricultural development in the study area. Change in land use can negatively affect the potential use of an area and ultimately lead to soil and vegetation degradation that have an impact for loss of agricultural productivity. Land use land cover change analysis was conducted in Mareka district, Southwest Ethiopia between 1995 to 2015. In this study to detect the change image was taken from two different years as reference 1995 and 2015. The land cover change detection was done by using remote sensing and Arc GIS technology. As the result of analysis indicated, the vegetation or forest cover of the Mareka district was minimized from year to year about 33.85 Km2 and due to increment of cultivation practice. Therefore, it is good to strongly introduce modern farming system that allows farmers to get more agricultural products from small farming land plot in study district.

Keywords : Change Detection, GIS Technology, Land use Land Cover, Mareka District

I. INTRODUCTION

At a global scale, land-use changes are cumulatively transforming land cover at an accelerating pace (Turner *et al.*, 1994; Houghton, 1994). These changes in terrestrial ecosystems are closely linked with the issue of the sustainability of socio-economic development since they affect essential parts of our natural capital such as climate, soils, vegetation, water resources and biodiversity (Mather and Sdasyuk, 1991). Today, there is increased recognition that land-use change is a major driver of global change, through its interaction with climate, ecosystem processes, biogeochemical cycles, biodiversity and even more importantly human activities.

For centuries, humans have been altering the earth's surface to produce food through agricultural activities. Nearly a third of earth's land surface is composed of croplands and pastures and over half of the cultivated areas have been cleared in the last century (Houghton 1994). In the last few decades, conversion of grassland, woodland and forest into cropland and pasture has risen dramatically in the tropics (Houghton 1994; Williams 1994). This acceleration has spurred renewed concerns about the role of land-use change in driving losses in biological diversity, soils and their fertility, water quality and air quality. Also, land-use activities are calculated to contribute from 20–75% of all atmospheric emissions of important greenhouse gases (Penner, 1994).

In Ethiopia, population pressure is inducing, the clearing of forests for agriculture and other purposes, and the attendant accelerated soil erosion, is gradually destroying the soil resource (Hurni, 1990). This is because natural forests are the main sources of wood for fuel, construction and industry, even though plantation 3 forestry is also increasingly becoming important. According to KahsayBerhe (2004), in Ethiopia forests may have existed long

before history was recorded, but the present day forest cover does not correlate with human population in recorded history, even though environmental problems such as droughts may have also contributed to this phenomenon. Furthermore, the annual loss of natural forest cover has been estimated to be 150,000 - 200,000 ha/yr-1 and in 1989 forest cover estimated was only 2.7% of the Ethiopian land mass.

Remote sensing data and techniques and geographic information systems (GIS) provide efficient methods for analysis of land use issues and tools for land use planning and modeling. Understanding the driving forces of land use development in the past, managing the current situation with modern GIS tools, and modeling the future, we are able to develop plans for multiple uses of natural resources conservation. The knowledge about land use and land cover has become increasingly important as all nations plan to overcome the problems of haphazard, uncontrolled development, deteriorating environmental quality, loss of prime agricultural lands, destruction of important wetlands, and loss of fish and wildlife habitats (James R. Anderson *et al*, 2001). Therefore, the objective of this study was to assess land use and land cover change detection by using remote sensing and GIS software application in Mareka District of Dawuro Zone south Ethiopia.

II. MATERIALS AND METHODS

Mareka Woreda is one of 5 woreda's and 1 city administration of Dawuro zone. It is located in the southwestern part of the region and in the center of Dawuro zone. The woreda is astronomically situated between 60 09" and 7021" N Latitude and 370 01" E and 370 26" E Longitude.

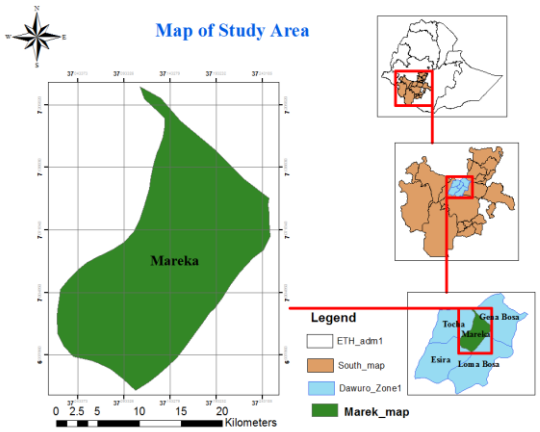

Figure 1. map of study area

III. RESULT AND DISCUSSION

3.1. Land use/cover change detection and analysis

For performing land use/cover change detection, a post-classification detection method was employed. A pixel-based comparison was used to produce change information on pixel basis and thus, interpret the changes more efficiently taking the advantage of "-from, -to" information. Classified image pairs of two different decade data were compared using cross-tabulation in order to determine qualitative and quantitative aspects of the changes for the periods from 1995 to 2015. A change matrix was produced with the help of ENVI5.1 Imagine software. Quantitative areal data of the overall land use/cover changes as well as gains and losses in each category between 1995 and 2015 were then compiled.

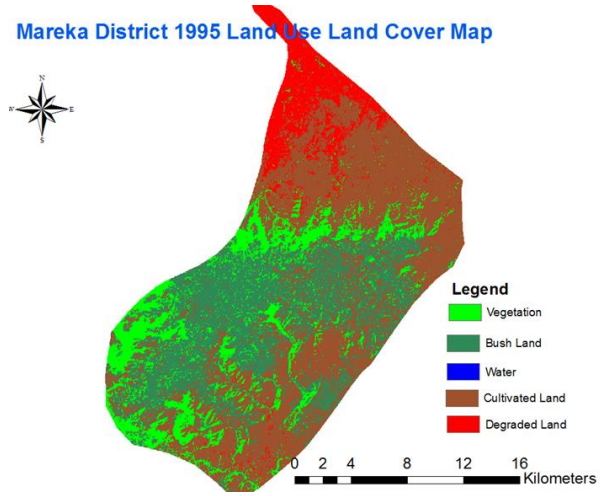

Figure 2. Mareka district of Dawuro zone land covers 1995

Overall Accuracy = (20106/22081) 91.0557%
Kappa Coefficient = 0.8794

Table 1. Shows accuracy of land covers 1995 mareka District

Class	Prod. Acc.%	User Acc.%	Prod. Acc.pixel	User Acc(pixel)
DL	95.18	94.97	2490/2616	2490/2622
V	94.59	85.41	6080/6428	6080/7119
BL	80.95	87.14	2716/3355	2716/3117
CL	96.13	94.87	7460/7760	7460/7863
mask1	100.00	100.00	1360/1360	1360/136

Class Distribution Summary 1995 mareka District
Degreded_land1(DL): 45,968 points (4.500%) (41.3712 Km²)

Vegetation(V): 73,643 points (7.209%) (66.2787 Km²)
Bush_land1(BL): 138,437 points (13.552%) (124.5933 Km²)

Cultivated_land1(CL): 216,426 points (21.186%) (194.7834 Km²)
Mask1: 547,074 points (53.553%) (492.3666 Km²)

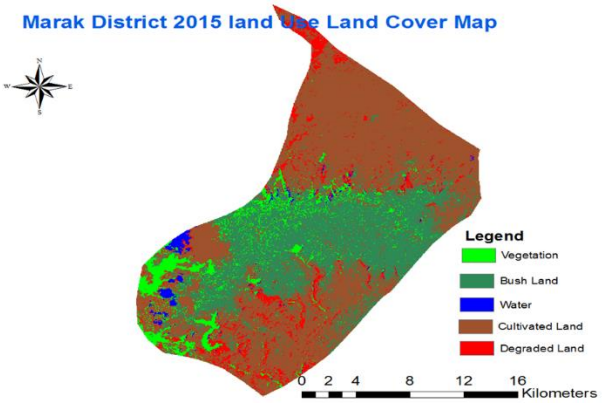

Figure 3. Mareka district of Dawuro zone land covers 2015

Overall Accuracy = (20293/21708) 93.4817%
Kappa Coefficient = 0.9122

Table 2. Shows Accuracy of land covers 2015 Mareka district

Class	Prod. Acc.%	User Acc.%	Prod. Acc.(pix)	User Acc.(pix)
DL	87.43	90.20	2357/2696	2357/2613
V	94.28	93.53	3414/3621	3414/3650
W	94.14	98.48	1557/1654	1557/1581
BL	89.59	90.51	3099/3459	3099/3424
CL	95.51	93.95	8766/9178	8766/9330
Mask	100.00	99.10	1100/1100	1100/1110

Land use/cover change in different categories during the last two decades in the Mareka District of Dawuro zone (1995–2015); degraded land, vegetation, bush land cultivated land and water (based on Landsat Thematic Mapper Satellite Imagery)

Table 3. Area in (km square) and amount of change in different land use/cover categories in the Mareka District of Dawuro zone during 1995 to 2015.

Land cover types	1995 Area		2015 Area		Land cover changes (1995-2015)	
	Square km	%	Square km	%	Square km	%
DL	41.37	9.69	25.35	5.94	-16.02	-38.72
V	66.2787	15.52	32.43	7.59	-33.85	-51.07
BL	124.5933	29.18	125.86	29.47	1.27	1.01

CL	194.7834	45.61	237.65	55.66	42.86	22
W	0	0%	5.73	1.34	5.73	5.73
Total	427.0266	100	427.026	100		

Table 4. Land use/cover change matrix showing land encroachment (in %) of Mareka District of Dawuro zone

		Initial image year of 1995							
	Land cover types	Vegetation	Water	Degreded_land	Bush_land	Cultivated_land	Mask	Row Total	Class Total
Final image year of 2015	Degreded_land	7.09	0	6.96	1.83	9.48	0	25.35	25.35
	Vegetation	23.71	0	0.06	7.84	0.83	0	32.43	32.43
	Water	3.61	0	0.01	1.46	0.64	0	5.73	5.73
	Bush land	9.54	0	0.11	79.32	36.89	0	125.86	125.86
	Cultivated_land	22.33	0	34.24	34.14	146.94	0	237.65	237.65
	Mask	0	0	0	0	0	492.37	492.37	492.37
	Class Total	66.28	0	41.37	124.59	194.78	492.37		
	Class Changes	42.57	0	34.42	45.27	47.84	0		
	Image Difference	-33.85	5.73	-16.02	1.27	42.86	0		

3.2. Land use/cover status

Accuracy assessment of the land use/cover classification results obtained showed an overall accuracy of 91.05% for 1995 and 93.48% for 2015. The Kappa coefficients for 1995 and 2015maps were 0.879 and 0.916 respectively.

Fig. 1 depicts spatial distributional pattern of land use/cover of the Mareka District of dawuro zone for the year 1995 while Fig. 2 for the year 2015.

These data reveal that in 1995, about 15.52% (66.28km^2) area of Mareka District of Dawuro zone was under vegetation, 9.69% (41.37km^2) under degreded land, 29.718% (124.59km^2) under bush land, 45.61% (194.78km^2) under cultivated land. During 2015 the area under these land categories was found about 5.94% (25.35km^2) under degreded land, 7.59% (32.43km^2) under vegetation land, 29.47% (125.86km^2) under bush land, 55.66% (237.65.59km^2) under cultivated land, 1.34% (5.73km^2)

3.3. Land use/cover change

Data registered in Table 3 and Figure.1 and Figure.2 reveals that both positive and negative changes occurred in the land use/cover pattern of the Mareka District of Dawuro zone. During the last two decades the degreded land and vegetation land in the study area has decrease from 41.37km^2 and 66.28 km^2 respectively in 1995 to 25.35km^2 and 32.43 km^2 resepectively in 2015 which accounts for -38.72%

and -51.07% of the total study area. The bush land, cultivated has increase from 124.59 km and 194.78km respectively in1995 to 125.86km and 237kmrespectively in 2015 which accounts for 1.01% and 22%. The water area has increased from 0 km in 1995 to 5.72 km in 2015 which accounts for 5.72%.

To understand land encroachment for different land categories during the last two decades, a change detection matrix (Table 4) was prepared which reveals that:

i. About 0.06% area of degraded land has been converted into vegetation, 0.01% area under water 0.11% area under bush and 34.24 area under cultivated land.
ii. About 7.02% area of vegetation has been converted into degraded land, 3.61% into the water, 9.54% area into the bush land and 22.33% area in to the cultivated land.
iii. about 1.83% of area of bush land has been converted into degraded land, 7.84% area under vegetation and 1.48% area under water land; and 34.25% area in to the cultivated land
iv. About 9.48% area of cultivated land has been converted into degraded land, 0.83% in to the vegetation, 0.64% into the water and 36.89 area in to the cultivated land.

About 00% of mask land has been converted into the degraded land, 00% in to the vegetation, 00% in to the bush land, 00% in to the water, and 00% in to the cultivated land.

IV. CONCLUSION

The study conducted in one of the development Mareka District of Dawuro zone advocates that multi temporal satellite imagery plays a vital role in quantifying spatial and temporal phenomena which is otherwise not possible to attempt through conventional mapping. The study reveals that the major land use in the study area is vegetation. The area under vegetation has decreased by -51.07% (-33.58km^2) due to deforestation and expansion arable land during 1995 to 2015. The second major category of land in the study area is degraded land which was decreased by -38.72% (-16.02km^2) due to conversion forest land to farm land, and other land. The third major category of land in the study area is bush land which has also increase. During the study period (i.e., 1995–2015), bush land has been increased by 1.01% (1.27km$^{2)}$ due to conversion in vegetation, and forth major category of land in the study area is cultivated land which has also increased by 22% (42.86km$^{2)}$ due to mainly expansion of the arable land in Mareka District of dawuro zone during the (1995–2015) and finally the fifth category of land in the study area is water land which has also increased by 5.72% (5.72 km^2) last two decades.

V. RECOMMENDATION

Based on the major findings of the study and conclusions drawn, the following possible recommendations have been forwarded

- Introduction of modern farming system that allows farmers to get more agricultural products from small farming land plot in study district is needed
- Conservation through the involvement of local community and participatory forest management activities are important aspect that is required for sustainable use of the resource in the study area
- It is necessary to increase awareness of the local communities and other stakeholders on the benefits sustainable use of the resource.

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