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Analysis of Land Cover Change of Dedo District, Jimma Zone, Oromia Regional Government, South Western Ethiopia

Bekele Tona Amenu, Melaku Mathewos, Getinet Seid
Jimma University, P.O.Box, 307, Jimma, Ethiopia

ABSTRACT

In world level, land use has changed considerably in the last ten years – this was due to alarming rate of growth in human population and their requirement for basic human needs starting from food. The developing world accounts for about 95% of the population growth with Africa as the world's fastest growing region. Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. There are two primary methods for capturing information on land cover: field survey and analysis of remotely sensed imagery. Mapping land use/land cover (LULC) and change detection using remote sensing and GIS techniques is an area of interest that has been attracting increasing attention and this is the method that enabled us to analysis Dedo district land cover change. Land use or land cover-change is critically linked to the intersection of natural and human influences on environment change. The changes in state of biosphere and bio-chemical cycles are driven by heterogonous change in land use and continuation of those uses. The land cover assesssment of Dedo district was tried to analyized between different time reference. In this case we tried to analyzed the land cover change detection by taking four time reference 1987, 1995, 2000 and 2015. The land cover change detection was done by using Remote sensing and ArcGIS technology. As thr result of analysis indicated, the vegetation or forest cover of the Dedo district was minimized from year to year. Therefore, it is good to strongly apply integrated soil and watere conservation mechanism in study district.

Keywords : Land, Land Cover Change, GIS, RS, Dedo

I. INTRODUCTION

Land is delineable area of the earth's terrestrial surface, embracing all attributes of the biosphere immediately above or below this surface, including the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.) (IDWG-LUP at FAO in 1994).The term land cover originally referred to the kind and state of vegetation, such as forest or grass cover but it has broadened in subsequent usage to include other things such as manmade structures like building, soil type, biodiversity, surface and ground water(Meyer, 1995).

Land use refers to a series of operations on land, carried out by humans, with the intention to obtain products and benefit through using land resources including soil resources and vegetation resources which is part of land cover. Land cover is the physical material at the surface of the earth. Land covers include grass, asphalt, trees, bare ground, water, etc. (*Lex Comber; et al. (2005).* "Land cover" is distinct from "land use", despite the two terms often being used interchangeably. Land use is a description of how people utilize the land and of socio-economic activity. Urban and agricultural land uses are two of the most commonly known land use classes. At any one point or place, there may be multiple and alternate land uses, the specification of which may have a political dimension. The origins of the "land cover/land use" couplet and the implications of their confusion are discussed in Fisher et al. (2005).

Globally, land use has changed considerably in the past decades – mostly reflecting the enormous growth in human population and their need for food. The developing world accounts for about 95% of the population growth with Africa as the world's fastest growing region. The growing population has many implications but most of all it requires an increase in agricultural production to meet food demand. This demand can be met by expansion of agricultural land or by intensification of existing systems (Alfred, 2008). Because of rapid economic growth, population pressure and the degradation of natural resources, the resettlement of people to new locations has become a dominant development discourse in many parts of the world (Asrat Tadese, 2009).

As the result of population pressure, especially the absolute increase in human numbers each year. Human population can be in natural increase and/or mobility plays a crucial role in resource degradation. As population continues to expand in number, it exerts increased pressure on eco-system and natural resource stocks. One of the reasons for the shrinking size of land holdings as well as the degradation of forest, soil, and water resources in many areas of the developing world is the direct result of rapid population growth (Stellmacher, 2005). The most direct impact of humans on their natural surrounding is the use of land for agriculture, forestry, settlement, Changes in the land use directly influences the terrestrial environment (Ronneberger, 2007). That means when the number of population increases the carrying capacity of the land decreasing. Therefore it forced people to left the original place and to settle on another less populated area.

Land is the most important natural resource all over the world. It is a place from which human beings are exploiting a number of resources. Almost all food production for the world population is derived from land, and the need to produce more is increasing from time to time due to an increase in population. For increasing production, either area under cultivation must be expanded or its productivity needs to be increased (Taffa, 2002). Because of these land-use and land-cover change plays an important role in global environmental change. It is one of the major factors in affecting sustainable development and human responses to global change. The scientific community has now come to recognize diverse roles of land- use and land-cover change (Turner et al., 1995, Giest and Lambin, 2002). Consequently, the need for an understanding of land use/cover change has been increasingly recognized in global environmental research (Lambin and Giest, 2003).

In most developing countries, especially, Africa the socio-economic needs of rapidly increasing populations are the main driving force in the allocation of land resources to various kinds of uses, with food production as the primary land use. Heavy population pressure and the related increased competition from different types of land users have emphasized the need for more effective land-use planning and management. Rational and sustainable land use is an issue of great concern to governments and land users interested in preserving the land resources for the benefit of present and future populations (FAO, 1999).

We can use two primary methods for capturing information on land cover: These are: field survey and analysis of remotely sensed imagery.

Mapping land use/land cover (LULC) and change detection using remote sensing and GIS techniques is an area of interest that has been attracting increasing attention (https://www.researchgate.net/publication/228676035_Application_of_remote_sensing_and_GIS_inLand_useland_cover_mapping_and_change_detectio).

II. METHODS OF LAND USE SCIENCE

The methods of land-change science include remote sensing and geospatial analysis and modeling, together with the interdisciplinary assortment of natural and social scientific methods needed to investigate the causes and consequences of LULCC across a range of spatial and temporal scales.

Remote sensing:

Remote sensing is an essential tool of land-change science because it facilitates observations across larger extents of Earth's surface than is possible by ground-based observations. This is accomplished by use of cameras, multi-spectral scanners, RADAR and LiDAR sensors mounted on air- and space-borne platforms, yielding aerial photographs, satellite imagery, RADAR and LiDAR datasets (http://www.eoearth.org/view/article/154143/).

Geospatial Analysis

Maps and measurements of land cover can be derived directly from remotely sensed data by a variety of analytical procedures, including statistical methods and human interpretation. Maps of land use and land cover (LULC) are produced from remotely sensed data by inferring land use from land cover (e.g., urban = barren, agriculture = herbaceous vegetation). Conventional LULC maps are categorical, dividing land into categories of land use and land cover (thematic mapping; land classification), while recent techniques allow the mapping of LULC or other properties of land as continuous variables or as fractional cover of the land by different LULC categories, such as tree canopy, herbaceous vegetation, and barren (continuous fields mapping). LULC datasets may be compared between time periods using geographic information systems (GIS) to map and measure LULCC at local, regional, and global scales (http://www.eoearth.org/view/article/154143/).

Digital change detection techniques by using multi-temporal satellite imagery helps in understanding landscape dynamics (http://www.sciencedirect.com/science/article/).

The Land Use and Land Cover (LULC) data files describe the vegetation, water, natural surface, and cultural features on the land surface (http://www.webgis.com/lulcdata.html).

Land Use/Land Cover data refers to data that is a result of classifying raw satellite data into "land use and land cover" (LULC) categories based on the return value of the satellite image. There are not very many LULC datasets because a) satellite data acquisition is usually very expensive, and b) the classification process is very labor intensive. Most LULC data products are released several years after the satellite images were taken and thus out of date to a certain extent when they are released. Nonetheless, LULC provides a very valuable method for determining the extents of various land uses and cover types, such as urban, forested, shrub land, agriculture, etc (https://www.lib.ncsu.edu/gis/lulc.html).

Land use/land cover data are most commonly in a raster or grid data structure, with each cell having a value that corresponds to a certain classification. This structure allows for creating summary tables and performing suitability analyses. Sometimes LULC data is converted to a vector format, but file sizes become very large by doing so.(https://www.lib.ncsu.edu/gis/lulc.ht).

The term "land use/land cover" (lulc) is a general term, while an early USGS project, which is discussed below, uses the name "Land Use and Land Cover" (LULC) (https://www.lib.ncsu.edu/gis/lulc.html).

Driving Sorces

Land use or land cover-change is critically linked to the intersection of natural and human influences on environment change. The changes in state of biosphere and bio-chemical cycles are driven by heterogonous change in land use and continuation of those uses (Turner, 1995).

Analysis of detected change is the measure of the distinct data framework and thematic change information that can lead to more tangible discernment to underlying process involved in upbringing of land cover and land use changes (Ahmad, 2012). Change analysis of features of Earth's surface is essential for better understanding of interactions and relationships between human activities and natural phenomena. This understanding is necessary for improved resource management and improved decision making (Lu et al., 2004 and Seif and Mokarram, 2012). Change detection involves applying multi-temporal Remote Sensing information to analyze the historical effects of an occurrence quantitatively and thus helps in determining the changes associated with land cover and land use properties with reference to the multi-temporal datasets (Ahmad, 2012, Seif and Mokarram, 2012 and Zoran, 2006).

Objective of the project

The main aim of this project is to detect land cover change of Dedo district in Jimma Zone at different time reference using Remote sensing system and GIS technology.

III. Land Cover Assessmnet of Dedo District

The land cover assesssment of Dedo district was tried to analyized between different time reference. In this case we tried to analyzed the land cover change detection by taking four time reference 1987, 1995, 2000 and 2015. The land cover change detection was done by using Remote sensing and ArcGIS technology. The project was done by using ENVI classic software for analysing satelite images of the four years. Under ENVI classic we tried to classified the land cover by ROI tools using support vector machine. To export the disply the Dedo district different land cover on map use ArcMap10.1. based on this the land cover change is discused below.

3.1. Land cover assessment of dedo district in the year 1987

Dedo District 1987 land cover map

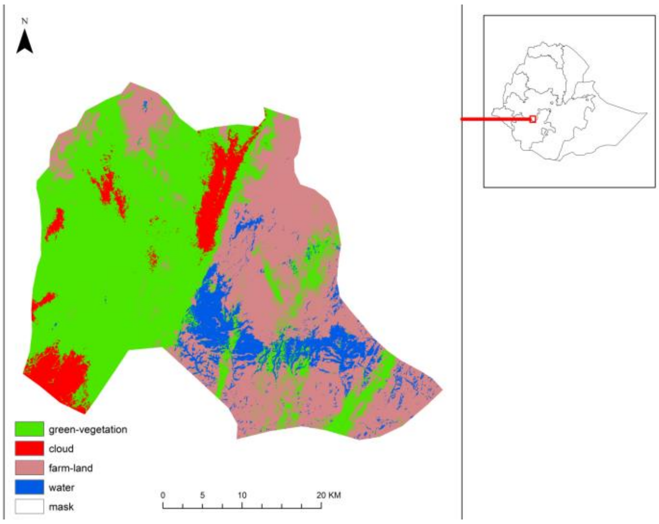


Table 1 Dedo district Land cover change between 1987 and 1995

		Initial state 1987						
		green-vegetation	cloud	farm-land	water	mask	Row Total	Class Total
Final state 1995	green-vegetation	90.003	92.779	92.498	98.914	0.000	100.000	100.000
	cloud	0.837	0.000	0.000	0.000	0.000	100.000	100.000
	farm-land	8.268	7.177	7.488	0.470	0.000	100.000	100.000
	water	0.892	0.045	0.014	0.616	0.000	100.000	100.000
	mask	0.000	0.000	0.000	0.000	100.000	100.000	100.000

	Class Total	100.000	100.000	100.000	100.000	100.000	0.000	0.000
	Class Changes	9.997	100.000	92.512	99.384	0.000	0.000	0.000
	Image Difference	90.974	-94.017	-80.402	-93.952	-0.000	0.000	0.000

Land covers change detection between the year 1987 and 1995 summarized in the above table, it indicates the land cover change between the two time references. As the result shows that, the land cover of vegetation in the year 1987, 90% of it was remains as green vegetation in 1995. The rest about 8.27% changed in to farm land and 0.89% changed to water, and also 0.84% was not identified due to cloud.

2.2. Land cover assessment of Dedo district in the year 1995

Dedo District 1995 land cover map

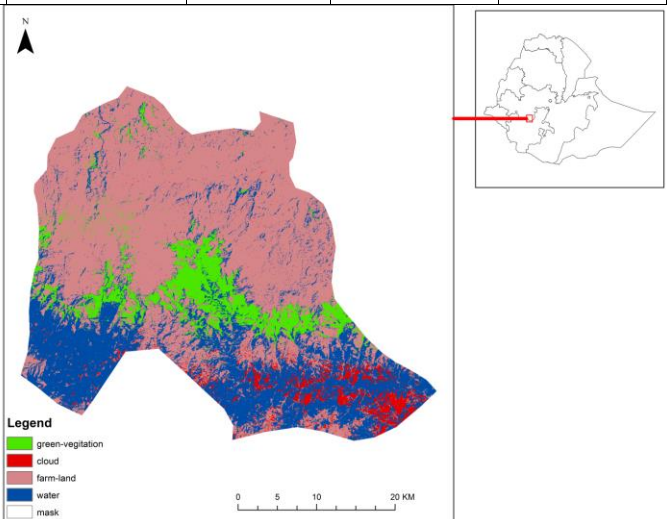


Table 2 Dedo district land cover change between the year 1995 and 2000

		Initial state 1995						
		green-vegetation	cloud	farm-land	water	mask	Row Total	Class Total
Final state 2000	green-vegetation	9.600	13.903	8.978	6.929	0.000	100.000	100.000
	cloud	4.077	0.016	0.207	0.592	0.000	100.000	100.000
	farm-land	57.486	73.844	83.428	82.357	0.000	100.000	100.000
	water	28.837	12.237	7.388	10.122	0.000	100.000	100.000
	mask	0.000	0.000	0.000	0.000	100.000	100.000	100.000
	Class Total	100.000	100.000	100.000	100.000	100.000	0.000	0.000
	Class Changes	90.400	99.984	16.572	89.878	0.000	0.000	0.000
	Image Difference	-89.590	834.314	718.469	5470.470	0.000	0.000	0.000

According to the table 2, we can see a change in different land cover type in Dedo district between the year 1995 and 2000. Vegetation cover falls from 100% in the year 1995 to 9.6% in the year 2000. The rest of the percentage, which once was a green vegetation cover dramatically changed to other land cover type during five year interval. Of this, 57.49% was changed to the farmland. But, here is unexpected result in the image processing system- 28.84% of originally green vegetation was changed to water body. In the area where there is a great deal of farmland extension we would not expect such change from green vegetation to water. Thus, this error may belong to our limitation in processing the satellite image. The change detected to a farm land during five year interval is somehow convincing. 83.43% of original farmland was survived to the year 2000. As it is clearly illustrated in the table, during these years, different land cover type originally found was mostly changed in to farm. For instance, 82.36% from water, 57.49% from green vegetation was detected change while 73.84% was cloud cover that blurs the change detection.

In general speaking, there was a significant change detected to land cover of the Dedo district to which more weight goes to the conversion of much of water bodies and vegetation cover in to farmland. This analysis has a strong interpretation associated to the capacity of a concerned body in land management. Accordingly the district is facing a great loss in vegetation cover and water body whose adverse consequence can be described more.

2.3. Land cover assessment of dedo district in the year 2000

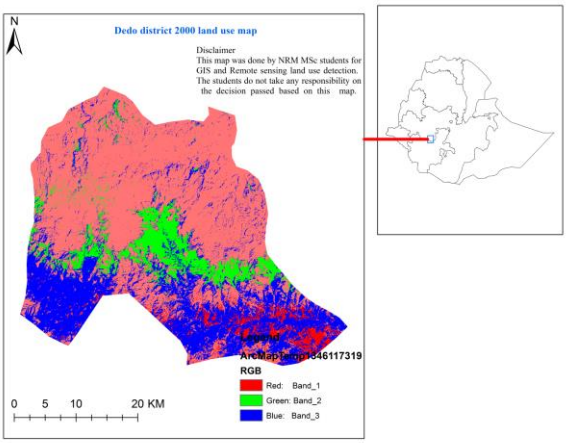
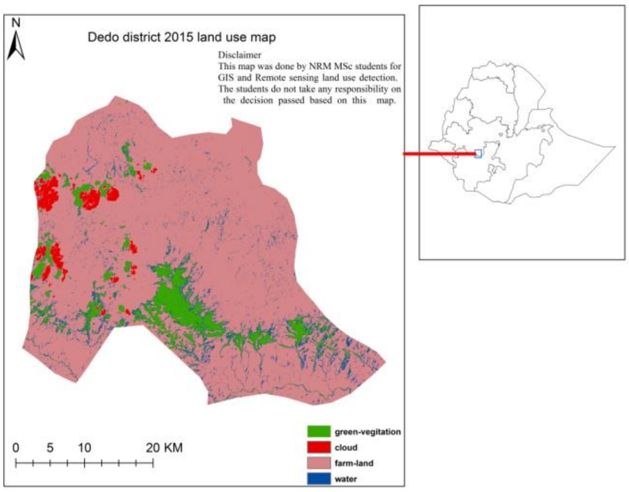


Table 3. Dedo district land cover change between the year 2000 and 2015

		Initial state 2000						
Final state 2015		green-vegetation	cloud	farm-land	water	mask	Row Total	Class Total
	green-vegetation	11.495	6.444	5.189	11.488	0.000	100.000	100.000
	cloud	1.466	0.102	3.419	0.819	0.000	100.000	100.000
	farm-land	81.154	83.218	87.536	78.680	0.000	100.000	100.000
	water	5.885	10.236	3.856	9.014	0.000	100.000	100.000
	mask	0.000	0.000	0.000	0.000	100.000	100.000	100.000
	Class Total	100.000	100.000	100.000	100.000	100.000	0.000	0.000
	Class Changes	88.505	99.898	12.464	90.986	0.000	0.000	0.000
	Image Difference	-21.051	-36.140	41.641	-79.022	0.000	0.000	0.000

2.3. Land cover assessment of dedo district in the year 2015



From the table 3, we can conclude that, there is a significant change in land coverage in Dedo woreda of Jimma Zone.

As the table shows, there was a 100% of a vegetation cover in 2000. From this, in the year 2015, 81.15% of the total coverage was converted to farm land and the vegetation cover dropped to 11.5%. At the time when the image was taken, there was 1.5% cloud that hijacks the system from determining the type of the land cover in the district.

During the time interval from the year 2000 to 2015, the farmland coverage of the district falls from 100% to 87.54%. The remaining percentage was changed to the green vegetation and water that was 5.2 and 3.86 percent respectively. The cloud content of the image was 3.4% so that the type of the land cover is undefined under this cloud. We wouldn't expect the farmland to show a declining trend as it is illustrated in the table above. The fact that much of the forest land in the area is entering in to a farm land: indeed this is most probably true. Nevertheless, we guess this error might come from our limitation amid image processing. 90% of the total water coverage was changed in to other land cover type from the year of 2000 to 2015. Finally, only about 9% of water body survived to the year of 2015. 11.48% of the original water body was changed to green vegetation and 78.68% was change to farmland according to the table. This result shows that there is alarming change in the water body in the area. This may be due to the sedimentation and eutrophication that collectively cause the plants to invade the water area. There is also the extension of the farmland in the area that consumes water bodies in the district. Erosion is the main cause of sedimentation that in turn causes the water body to be changed in to the farm land. The negative growth of vegetation cover is expected to contribute to the stated erosion too.

Generally, there is a substantial change in land cover in Dedo district. More land is being converted to agriculture. This shows that there is poor land use management practice in the district. Therefore, the concerned body the district needs to strengthen its weak side in land management if it has to bring a sustainable development to the area.

IV. CONCLUSION

Land cover change analysis is extraordinary activity that enables a management body to give a wise decision about the land use of the given area. GIs and remote sensing technology provides vital and accessible information about the land cover change that may occur through a given time frame. Dedo woreda is one of the woredas in Oromia Region with a rapid change in land cover.

According to the image we analyzed, we could able to detect a significant change that has been occurred since 1987. The green vegetation cover of the district is continuously degrading; the area that once was the forest land has been changed in the farm land. Water body of the district is highly endangered that it is being changed to the farmland with a high changing rate.

Unless a management body takes a decisive measurement to assure a sustainable use of the land in

Dedo woreda, the capacity of the land in the area to resist impeding degradation may get in to the question.

V. RECOMMENDATION

Having the information analyzed above we strongly recommend the following points to be implemented in Dedo woreda of Jimma Zone.

- Integrated soil and water management practices should be implemented soon.
- Awareness concerning wise use of natural resource should be created at the individual and community level.
- Further research has to be done in the area to come up with detail information about the trends of land cover.

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