Land Use/Cover Dynamics in Ribb Watershed, North Western Ethiopia

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ABSTRACT
Land use/cover change dynamics influences many aspects of the natural environment. Its shifting patterns as a component of many existing climate change problems has been gaining recognition as key cause and consequences of environmental problems and livelihood changes. The Ribb River watershed has been subjected to prolonged use for agriculture without conserving natural resource. Forest degradation, biodiversity and habitat loss and soil degradation are the common problems in the area. Therefore, determining the land use and cover dynamics in the Ribb River Watershed was important to make decisions on resource conservation, executing sustainable development activities in the watershed areas. The main objectives of the study was to determine the land cover/use status of Ribb River watershed in the years 1973, 1987, 1995, and 2011 by using landsat images. The overall results of the analysis have shown that between the last 38 years in the Ribb Watershed, about 57.4 % of forest, 52.3 % of bush lands 63.5 % of areas of water bodies were converted to cultivated and settlement lands, grazing lands and wetlands,whereas the cultivated and settlement lands, grazing lands and wetlands were increased in area by 36.2%, 50.9% and 66.3% respectively. Population pressure and, land tenure policy were identified as causes for changes in land use/cover. The results of this study were significant indicators for planners and other stakeholders in the watershed to take measures that can help to bring long term solutions for resource conservation and bringing sustainable development and livelihood attaining mechanisms in the watershed.
Keywords*:* Ribb, Watershed, Land Use/Cover, dynamics, GIS and Remote Sensing

1. INTRODUCTION

Land cover refers to the bio-physical sate of the earth's land surface and immediate sub-surface (Turner *et al.,* 1995). Land cover conversion involves a change from one cover type to another. Land use/cover plays an important role in affecting spatial patterns and shaped under the influence of forces of human needs and environmental features and processes (Briassoulis, 2000). It could involve changes in productivity, biomass, or phonology (Skole and Cochrane, 1994). Most of the land cover changes of the present and the recent past are due to human actions. Man kind’s presence on the Earth and his modification of the landscape has had sound effect upon it. (Aspinall and Hill, 2008.Land use/cover change involves either direct or indirect modification of the natural habitat and impact on the ecology of the area (Prakasam, 2010). The total environmental effects such as change in vegetation cover, soil characteristics, flora and fauna population and hydrological cycle have been strongly influenced by the conversion of land and forest resources (Abebe, 2005). Different studies in the world revealed that Land use/cover dynamics and subsequent conversion lead to loss of biodiversity, deterioration in the physical and chemical properties of soil which causes degradation of the land (Emadodin *et al*., 2009). According to Rientjes *et al.* (2011) changes in stream flow records were a result of changes in land cover observed in the area.Land use/cover (LUC) dynamics have attracted interest among a wide variety of researchers, ranging from those who favor modeling spatial and temporal patterns of land conversion to those who try to understand causes and consequences of land use change (IBID).

Population pressure has been found to have negative effect on LUC of the area (Sewnet and Rao, 2011; Shiferaw, 2011), riverine trees in Chemoga watershed (Bewket, 2002. Spatial and demographic changes in Ethiopia have sharp impact on agricultural land and the supply and amount of fuel wood in the surrounding areas. Human activities including agriculture change, the land use /cover and ecosystem use that are together alter the amount of available photosynthetic production (Sewnet and Rao, 2011). There was mismanagement of land, including overgrazing and clearing of forests for different purposes. The rural poor people have been also degrading the natural resources to sustain their livelihoods (Amare and Kameswara, 2012). Because of small land holding size and shortage of land in highlands of Ethiopia, plowing steep slopes with marginal output is common practice which has led to land and other natural resources degradation (Grepperud, 1996; Amare, 2013). Thus, land tenure insecurity, poverty, lack of land and inaccessibility to market and road facilities assumed to be the main drivers of natural resource degradation and the cause for extinction of fauna and flora from Rib **River** watershed. Different LUC change studies are made using GIS and remotely sensed data of different years, in some parts of Ethiopia. An important factor contributing to the decline in natural resources is the ever increasing human population, which resulted in an increase in cropland at the expense of traditional grazing areas such as bush lands, natural pasture and forests (Amare, 2013). Particularly, ever-increasing unsustainable utilization of resources coupled with land use changes; agricultural intensification, rapid population growth, and poverty intensification are the major causes of natural resource degradation. Lack of integrated watershed/landscape management and lack of proper land use planning and clarity in the procedures for, and jurisdictions over, resource utilization of the watershed and its associated biodiversity have also been contributory causes. Hence, Collective effort is needed to balance between utilization and conservation of the natural resources in areas where there is lack of awareness about the wise use of natural resources and the possibilities of utilizing alternatives. The study was aimed to determine the land/cover changes between 1973 and 2011 and identifying the main causes of land cover/use on the Rib **River** watershed.

2. Study Area and Methodology

2.1. Study Area Description

Ribb Watershed, , is located in northwestern Ethiopia and stretches between 10°43' - 11° 53' N latitude and 35^0 - 37° 47' E. Ribb **River** watershed is part of Lake Tana Sub-basin. It has a total area of about 199,160 hectares. Within the watershed, elevation ranges from 1785 - 4000 masl. The most elevated areas are found in the eastern part of the watershed and declines westwards. According to CSA (Central Statistical Authority 2007) the number of population that shares the watershed was 878,261 and about 89.7% of the population live in rural areas and the mainly depend on agriculture. The relative location of Ribb **River** watershed in respect to the four districts included in the watershed, Amhara Region and Ethiopia is shown (Fig.1).

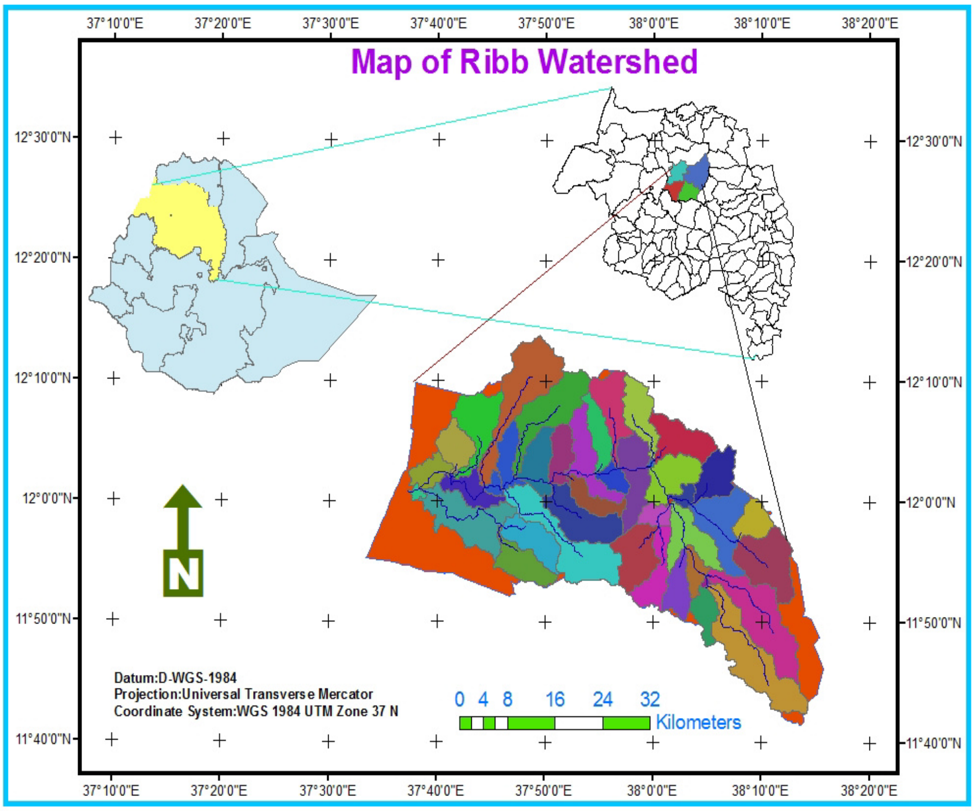

Fig.1 Location of the study area, Ethiopia, Amhara Region and Ribb River watershed

2.2 Data Sources and Methods of Analysis

The principal data that was used in this research was landsat images, climate data and population from different sources. The major data source for land cover/use analysis was **http://glovis.usgs.gov** where free landsat image was available (Table1). Four multitemporal remotely sensed images were acquired for change detection for this study, including Landsat 1973, Landsat TM 1987, Landsat TM 1995 and Landsat TM 2011.. The process of detecting LUC from the satellite images were prepared through image processing, and classification of images LUC classes were determined based on the information acquired from unsupervised classification, field observation of the sample LUC areas. Images chosen from the same season can also reduce the misclassification error related to spectral analysis of different land use/cover types. In addition, contour map of study area, the topographic maps with scale of 1:150 000 and vector data to assist in field investigations and accuracy assessment of the image classification. Each image was enhanced by using linear contrast stretching and histogram equalization to improve the image to help identify ground control points for rectification. These data were resampled by using the nearest neighbor algorithm, so that the original brightness values of pixels kept unchanged. The MSS and Landsat images were georeferenced by using ground control points. To make the classified land cover images comparable in terms of landscape metrics, the images must have the same spatial resolution. Our approach is to resample the classified images to 30 m, which is close to the lowest spatial resolution of all images using the majority rule aggregation, the method that Petit and Lambin (2001) proposed. After resampling, a majority filter (3×3) was applied to the classified images for the removal of isolated pixels to minimize potential analytical errors.

The supervised classification is the most common method in obtaining land use/cover information. In this research, after data preprocessing, a training sample was selected according to spectrum features. Unlike the conventional classifications of land use/cover, the maximum likelihood classification was used to map the land use/cover of watershed. When finishing supervision classification, manual-work interpretation was done in the image classified, and the precision of classification result was assessed. *Using classification result of two-time remote sensing images and conversion matrix model, formula land use conversion matrix can be obtained through cover analysis. Movement direction of certain type of land and resources of newly increased area of certain type can be seen clearly by matrix like below.*

$$\begin{bmatrix} (A_{11} & A_{12} & - & - & - & A_{1n}) \\ (A_{21} & A_{22} & - & - & - & A_{2n}) \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ (A_{n1} & A_{n2} & - & - & - & A_{nm}) \\ & & & & & \end{bmatrix} \quad (1)$$

Where: Aij is the area of conversion from i type of land use in k time to j type of land use in k+1 time.

Table 1 Description of Image Data and Sources

Image	Path	Row	Spatial Resolution	Acquisition Date	Source
Landsat MSS	181	52	57x 57	01 - 02 - 1973	USGS
Landsat TM	169	52	28.5 x 28.5	31- 01 - 1987	USGS
Landsat TM	169	52	28.5 x 28.5	21 - 01 - 1995	USGS
Landsat TM	169	52	28.5 x 28.5	01 -01 - 2011	USGS

3. Results and Discussion

The LUC maps of the Ribb River watershed for four reference years, and statistical summaries of the different LUC types were presented (Fig 2 and Table 2). Land cover/use change results were obtained by using combined methods of remote sensing and GIS techniques from Landsat MSS images of 1973, Landsat TM images of 1987, 1995 and 2011.

Table 2 Land use/cover classes and their description

Code	Land class	Description
1	Water Bodies	Areas with surface water in the form of ponds, lakes, streams, rivers, and reservoirs.
2	Wetlands	Areas covered by marsh, playas, ox-bow lakes, cut-off meanders which are seasonal as well as permanent in nature
3	Cultivated and Settlement Lands	Areas with standing crop, tree crops, and crop lands where the crops were harvested and rural and urban settlement areas.
4	Forest Cover	Areas with tree cover of more than 10% and more than 0.5ha, with minimum tree height of 5m.
5	Bush Lands	Scrub vegetation at the fringes of forest cover and areas dominated by scattered tree less than 5m height
6	Grazing Lands	Areas of natural/semi-natural grass land with other grazing-like plants and non-grazing-like plants.

Source: FAO, Africover (1997)

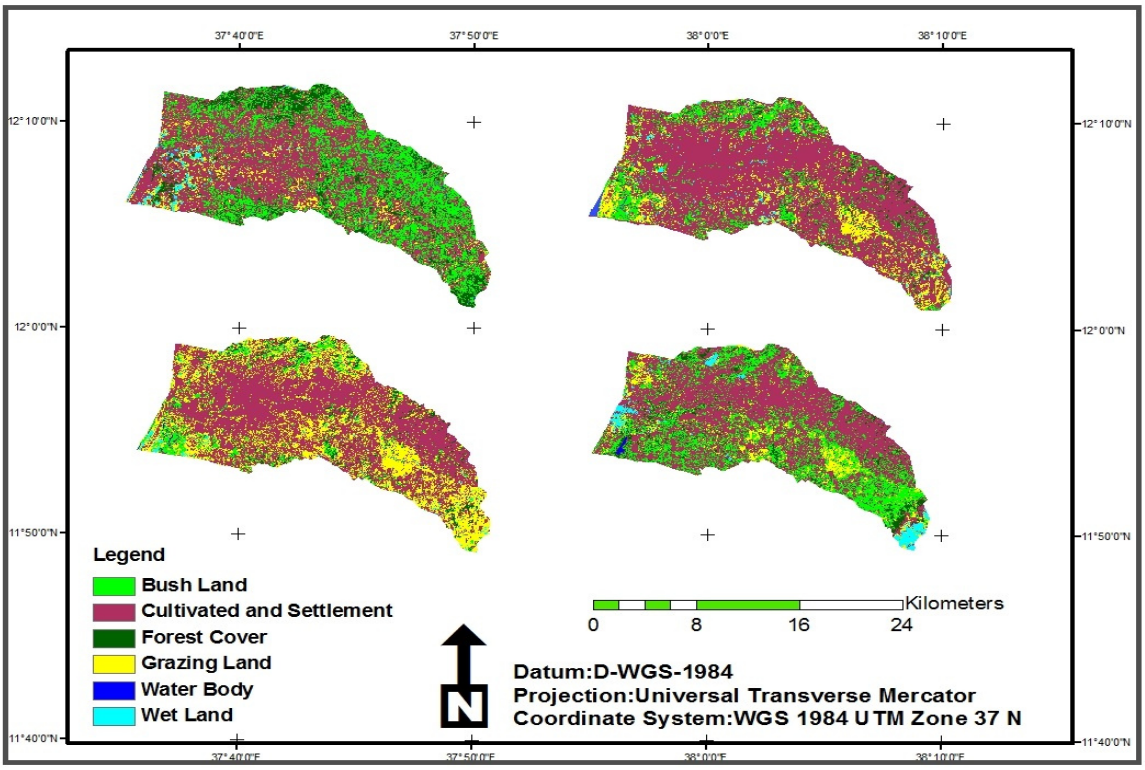

Fig. 2 Land Fig2 land Use/Cover dynamics Map from 1973-2011 ***Water bodies (WB)***, which include areas with surface water in the form of ponds, lakes, rivers, and reservoirs (FAO, 1997). The water bodies were covered about 0.5% of the total area of the watershed in 1973. The land cover share of WB has been continuously declining to 0.3%, in 1987 and1995 and 0.2 %, in 2011 respectively (Table3). This scarce natural resource in the watershed has lost its 63.5 % cover between 1973 and 2011. This result also agrees with Ellis (2010) and Amare, 2013). These studies confirmed that there was land cover change in Gilgel Abbay watershed on the same time. These studies have indicated the declining of water on this watershed.

Wetlands (WL) for this study include lands marsh, playas, ox-bow lakes, cut-off meanders which are seasonal as well as permanent in nature with marsh vegetation and other hydrophytic vegetation and manmade and wetlands like seasonal and perennial waterlogged areas (FAO 1997) .The wetlands in the Ribb River watershed have shown dynamic changes. In 1973, it was about1.69% and little bite increased to 1.87% in 1987, but declined to 1.85% in 1995, and increased to 2.81 in 2011(Table3 and Fig.2). Studies on flood hazard (Legesse and Gashaw, 2008) in the area revealed that downstream part of the Ribb **River** Watershed and the different land uses in these areas were within high to very high flood hazard and risk level. Specially, flood hazard was severe in the years 1996, 1998, 1999, 2000, 2001, 2003 and 2006 may be one reason for the wetlands increase in the Ribb watershed.

Cultivated and Settlement Lands (CSL) include both lands with standing seasonal and perennial tree crops adopting agricultural management techniques in rain fed and/or irrigated lands, educational, health, and other socio-economic facilities found associated with rural and urban settlement areas (FAO,1997)). Cultivated and settlement areas have shown increasing trends between 1973and 2011.In 1973 it was about 51.7% and increased to 67.97 in 1987, 70.67 in 1995, but decreased to 70.43% in 2011, respectively (Table3 and Fig.2). It was the largest expansion and larger share than other land use types. This implies agriculture and settlement has expanded by converting other covers such as grass, forest, bush lands and water bodies. It also implies presence of degradation of land and water resources in the watershed. Similar studies in other parts of areas have shown that population growth was a major driving force for LUC dynamics (Turner, 2009). This implies that the existence of little or no possibility of earning livelihood from off-farm employment has made no alternatives and made people to participate on cutting trees and expanding agricultural areas (Shiferaw, 2011; Amare,12913).

Forest cover(FC) category in this study includes areas with tree canopy cover of more than 10 percent and which constitute more than 0.5 hectare where trees were with height of greater than five meter (FAO, 1997). Forest cover constituted 11.74% of the total area of Ribb River watershed in 1973 and , has shown rapid decrease during the next period of the study. The land cover share of forest has declined to 2.40% in 1987 (Table3 and Fig.2). However it slightly increased in the remaining study years because of conservation practice in the area. But this scarce resource in the watershed has lost its 57.42 % of cover from 1973 to 2011. This has shown that deforestation rate in the watershed was rapid and the majority of available forests have changed into other land use units. This implies that because of deforestation, there may be rapid run off and less infiltration and other related effect on the watershed (UNEP, 1983; Kassa, 2003).

Bush land (BL) *LUC class* encompasses covers that include scrub vegetation which found at the fringes of relatively dense forest cover and areas dominated by scattered tree (FAO, 1997). Bush land has shown a decreasing trend during the stated years. Bush land cover has increased from 29.34 % in 1973 to 16.29 8.15 % and 14% respectively from 1973-2011 (Table3 and Fig.2). The result had shown two fold decrease of bush lands in the watershed. However, in 2011 bush lands increased to 14.00% because of recent conservation activities in the area. Generally, in the years between 1973 and 2011 bush land decreased by 52.3%. This indicates that there was extensive clearing of bush lands for human settlement, farming and other household uses (Kassa, 2003; Muluneh, 2010).

Grazing lands (GL) in this study encompasses the land covers that include areas of natural grazing along with other vegetation, predominantly grazing like plants (monocots) and browsing like plants (FAO,1997). Within the stated years grazing lands have shown continuous increment that is from 5.02% in 1973 to 11.12, 15.45 in 1987 and 1995 respectively (Table3 and Fig.2).. However, in 2011 the cover declined to 7.58 %. For the last 38 years, about 50.77 % of grassland was converted from other land covers. This was related to the land ownership of librated of tenants from the then landlords by the proclamation of 1975 and which may led to clearing of forest and bush lands for wood consumption and increasing of grazing lands.

Table 3 Land Use/Cover Classes in the Study Area from 1973-2011

	1973		1987		1995		2011		1973-2011
Class	**Area(ha)**	**%**	**Area(ha)**	**%**	**Area(ha)**	**%**	**Area(ha)**	**%**	**Total loss or gain**
WB	972	0.48	685	0.34	684	0.34	355	0.18	-617
WL	3367	1.69	3729	1.87	3704	1.85	5599	2.81	+2232
C&S	102986	51.71	135365	67.97	140737	70.67	140275	70.43	+37289
FC	23394	11.74	4782	2.40	7035	3.53	9962	5.00	-13432
BL	58440	29.34	32449	16.29	16232	8.15	27882	14.00	-30558
GL	10001	5.02	22150	11.12	30768	15.45	15087	7.58	+5086
Total	**199160**	**100**	**199160**	**100**	**199160**	**100**	**199160**	**100**	

WB=Water Bodies; WL=Wetland; C & S=cultivated &settlement; FC=forest cover; BL=bush land GL=grazing land

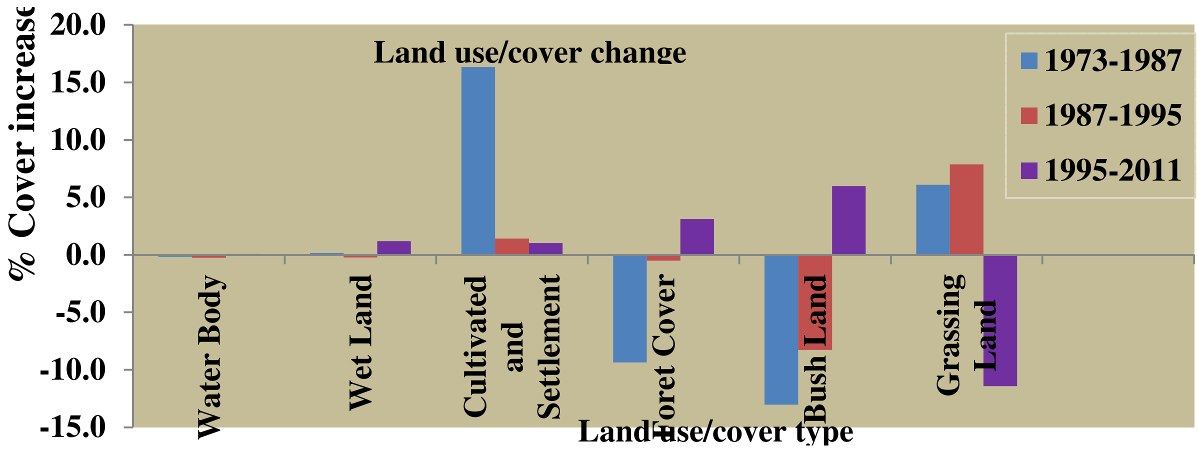

Fig. 3 Land Use/Cover in Ribb Watershed between1973 and 2011

3.1Accuracy Assessment

The accuracy assessment was made, and it was 100% for water bodies and 80% for bush lands (Table 4). The users' accuracy that was the percentage of correctly classified from total classified shown 100 % for water bodies LUC and 85% for the grazing LUC. The overall classification accuracy was 89.75% and the overall kappa statistics was 0.85. According to Amare (2012) the scientifically accepted result for kappa statistics was defined as poor when kappa coefficient is less than 0.4; good when it was between 0.4 and 0.7 and it will be taken as excellent when kappa coefficient is greater than 0.75. Thus, based on this expression the LUC classification for 2011image in this study was excellent.

Table 4 Confusion Matrixes of the Classification of 2011 Landsat TM Image

Classified Classes	WB	WL	C&S	FC	BL	GL	Total	Producers Accuracy (%)	Users Accuracy	Kappa for Each Category
WB	**10**	0	0	0	0	0	**10**	100.00	100.0	1.00
WL	0	**18**	0	0	1	0	**19**	94.74	94.7	0.95
C and S	0	0	**179**	1	21	1	**202**	95.21	88.6	0.79
FC	0	0	1	**26**	0	0	**27**	83.87	96.3	0.96
BL	0	0	6	4	**96**	1	**107**	80.00	89.7	0.85
GL	0	1	2	0	2	**30**	**35**	93.75	85.7	0.85
Total	**10**	**19**	**188**	**31**	**120**	**32**	**400**	**-**	**-**	**-**

3.2 Causes of Land Cover Change in Ribb Watershed

Demographic Factors: The population of watershed districts has shown a rapid increase and in less than 20 years population of the watershed has doubled. The driving force for most land use changes was population growth (Amare, 2013). Other studies at the local level in Ethiopia have found that in the Ethiopian highlands population pressure has led to land cover change (Grepperud, 1996). In Rib River watershed, selected land cover units and population increase were tried to correlate. The correlation result has shown strong relationship between population and the given land covers. There was strong positive correlation between population and farm and settlement lands, which means there was increase in both cases that is with increase of population there was parallel expansion of agriculture and settlement areas. But the correlation between population and forest has shown strong negative relationship that is, population size increased; there was decline of forest and buss land covers (Table5). This implies that population growth in Rib River watershed was one of the causes of conversion of forest, water and bush lands into farm and settlement lands.

Table 5 Trends of Populaton of Rural Districts and Changes in Land Use/Cover

	1973-1987	1987-1995	1995-2011	1973-2011
Population ('000')	+107	+62	+151	+320
Cultivated and Settlement (ha)	+32379	+5372	-462	+37289
Forest Cover (ha)	-18612	2253	2927	-13432
Bush Land (ha)	-25991	-16217	11650	-30558

Land Tenure Factors: Prior to 1975 in Ethiopia land was in hands of lords. Since 1976, after a dramatic land reform in the wake of the overthrow of the emperor, the state owes all land, and rights to cultivation are handed over to rural households. The respondents in the selected sample area have been interviewed about management efficiency of the land holding systems. About 74.5% of the respondents were aware of tenure security and land management relationship. They believed that if the land was individually owned, it would be well managed. In addition, from respondents about 95.8% of them believed that private land holding was more manageable and protected than other land holding systems. Thus, for the land to be secured and use for long and sustainable manner the land holding system should be private. Hence, one of the reasons for the land cover and use change in Rib River Watershed was the land security problem.

Shiferaw and Holden (2011) have shown that in Ethiopian highlands with the absence of appropriate policies and technological assistance, and increasing population, rural poor households can be caught in poverty – population – environment trap that may be triggered and lead to increased poverty and land degradation. They believed that land cover change can be resulted from the existing poverty. As a result of this, many people in the watershed have to get income for living from other sources such as selling fire wood, cow dung and others that are obtained from exploitation of environmental resources. These activities in turn degrade the land and expand the land cover and use change in the watershed. This implies poverty was one of the causes of land conversion in the GAC, especially at the upper part of it (Fig.4).

Fig 4 Cow dung sellers and Head loaders of from Rib watershed

Because of small land holding size and shortage of land in highlands of Ethiopia, plowing steep slopes and lack of knowledge how to manage the land were also contributing to land conversion. People in highlands also practiced mixed farming, producing crops and rearing animals because animals are both the sources of food as well as labor activities. From my personal experience and observation and discussion with community in the area farmers did not have enough land and they have not practiced use of chemical fertilizers because of high cost. Instead they try to expand their plot by clearing forests and communal grazing near their plot of farm lands. They also use the communal grazing land to graze their livestocks. The farmers, because of lack of land, they plow steep slopes with no more products. Their farming was the most ancient type and has no any attached technique of managing soil loss.

4. Conclusion

The results of the study indicate that the LUC was changing n the watershed. This was related to the continued expansion of cultivated and settlement over years in Ribb River watershed. This has brought significant decrease in water bodies, forest and bush LUC classes. On the whole in the Rib River watershed, increased population caused bringing in more natural landscapes into use for the needs of the population resulting in change in the land use pattern. In the absence of taking urgent measures, the lands of the Ribb River watershed may lose the remaining soil and the productivity shall be much lower, and causes more degradation of natural resources and intensify poverty. Thus, the study recommends that the Ribb River watershed should adopt an ecological management plan combined with good population control policy linked to land distribution and poverty alleviation.

REFERENCES

Abebe, S. (2005) *Land Use and Land Cover Change in Headstream of Abbay Watershed, Blue Nile Basin, Ethiopia* (Unpublished Master's Thesis). Addis Ababa University, Addis Ababa, Ethiopia.

Amare, S. (2013) Retrospective Analysis of Land Cover and Use Dynamics in Gilgel Abbay Watershed by Using GIS and Remote Sensing Techniques, Northwestern Ethiopia, *International Journal of Geosciences*, 4 (7): 1003-1008.

Amare, S. (2013) Population and Environment Interaction: The Case of Gilgel Abbay Catchment, Northwestern Ethiopia. *E3 Journal of Environmental Research and Management*, 4(1):153-162.

Amare,S., K. K. Rao (2012) Impacts of Land Cover/Use Dynamics of Gilgel Abbay Catchment of LakeTana on Climate Variability, Applied *Geomatics*, 4(3):155-163.

Amare Sewnet and K. Kameswara Rao (2011) Hydrological Dynamics and Human Impact on Ecosystems of Lake Tana, Northwestern Ethiopia. Ethiopian Journal of Environmental Studies and Management 4:56-63

Aspinall, R. J., & Hill, M. J. (2008) *Land Use Change: Science Policy and Management,* New York; CRC Press, Taylor and Fransis Group,

Bewket, W. (2002) Land Cover Dynamics since the 1950s in Chemoga Watershed, Blue Nile Basin, Ethiopia. *Mountain Research and Development, 22* (3), 263 - 269.

Brassoulis, H. (2000) *Analysis of Land Use Change*: *Theoretical and Modeling Approaches*. URL: http://www.rri.wvu.edu/Briassoulis/.htm, Retrieved, on January 26, 2012.

CSA (Central Statistical Authority) (1995) The *1994 population and housing census of Ethiopia. A statistical report on the population size and characteristics. Results for Amhara Region.* Addis Ababa, Ethiopia.

CSA (Central Statistical Authority) (2007*). Population and Housing Census Report of 2007*. Addis Ababa, Ethiopia.

CSA (Central Statistical Agency) (2012). *The 2011 Agricultural Sample Survey Report.* Ministry of Finance and

Economic Development, Addis Ababa, Ethiopia.

Ellis, E. (2010) Land to Use and Land to Cover Change. in: Encyclopedia of Earth (Eds). *Environmental Information Coalition, National Council for Science and the Environment*. Cutler J. Cleveland, Washington D.C.

Emadodin, L., Reiss, S., & Bork, H.R. (2009) A Study of the Relationship between Land Management and Soil Aggregate Stability: Case Study near Albersdorf, Northern Germany. *J. Agrie. Biol. Sci., 4*, 48-53.

FAO (1997) FAO's Land Cover and Land Use Activities.

Grepperud, S. (1996) Population Pressure and Land Degradation: The Case of Ethiopia. *Journal of Environmental Economics and Management*, 30: 18–33.

Kassa, G. (2003) *GIS Based Analysis of Land Use/Land Cover, Land Degradation and Population Changes: A Study of Boru Metero area of South Wello, Amhara Region* (Unpublished master's thesis), Addis Ababa University, Ethiopia.

Legesse, D., and Gashaw, W. (2008) *Flood Hazard and Risk Assessment in Fogera Woreda Using GIS & Remote Sensing* (Unpublished master's thesis). Addis Ababa University, Ethiopia.

Muluneh, A. (2010) Synthesis of Research on LUC Dynamics in the Ethiopian Highlands. *UNU-Land Restoration Training Programme*, Keldnaholt, 112 Reykjavik, Iceland.

Petit C C, Lambin E F (2001) Integration of Multi-Source Remote Sensing Data for Land Cover Change Detection .*International Journal of Remote Sensing*, 15: 785-803.

Prakasam. C. (2010) Land Use and Land Cover Change Detection through Remote Sensing Approach: A Case Study of Kodaikanal Taluk, *Tamil Nadu International Journal of Geomatics and Geosciences, 1*(2).

Rientjes, T. H. M., Haile, A. T., Kebede, E., Mannaerts, C. M. M., Habib, E., and Steenhuis, T. S. (2011) Changes in Land Cover, Rainfall and Stream Flow in Upper Gilgel Abbay Catchment, Blue Nile Basin, Ethiopia. *Hydrology and Earth System Sciences*, 15: 1979–1989.

Shiferaw, A. (2011) Evaluating the Land Use/ Cover Dynamics in Borena Woreda of South Wollo Highlands, Ethiopia. *Journal of Sustainable Development in Africa, 13*(1), 87-107.

Skole, D. L., & Cochrane, M. A. (2004) Observations of Land Use/ Cover Change in Regional Case Studies. In: Gutman *et al*. (Eds.). *Land Change Science: Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface*, Kluwer Academic Publishers, pp. 461.

Turner, A. (2009) Population Priorities: the Challenge of Continued Rapid Population Growth. *Philosophical Transactions of the Royal Society B: Biological Sciences, 364*(1532), 297-2984.

Turner, B. L., David S., Steven S., Gunther F., and Rik, L. (1995) Land Use and Land Cover Change Science/Research Plan. *The International Geosphere and Biosphere*, Sweden, Stockholm.

UNEP (United Nations Environment Programme) (1983). Ecology and Environment: What We Know About Desertification? *Desertification Control* 3, 2-9.

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