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Impact of Urban Expansion on the Agricultural Land Use a Remote Sensing and GIS Approach: A Case of Gondar City, Ethiopia

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Abstract
Urbanization is an unavoidable phenomenon which ultimately converts the agricultural land into urban land which may impact the farmer's livelihood, agricultural production and consumers of the surrounding area negatively. In the present study GIS and Remote sensing approach is used to analyze the phenomena of agricultural land transformation into urban land use. The change detection method has been applied to realize the problem. The findings show that there is loss of farmland and displacement of the households who had been involved in farming. In general the higher rate of urban expansion, leads to the higher loss of agricultural land. The major corrective measures could be improvements on the spatial planning which could balance the land demand of urban areas and shrinking of agricultural land in and in the fringes of Gondar city.

Keywords*: GIS, Remote Sensing, Spatial Planning, Change Detection*

1. Introduction

Urbanization is an inevitable part of economic development. Urbanization results into changes in the landscape, specifically the proliferation of concrete and impervious surfaces, and the displacement of agriculture and forestland. Understanding these interactions between human activities and their consequences in landscape, is especially important in areas of the world that are experiencing rapid change, where the cumulative impacts of development may be realized too late to trigger mitigation measures. The combined effect of primary cities and over urbanization are the main cause for the reduction of productive agricultural land which is the backbone of the developing country's economy. This very rapid growth area experience large rural-urban fringes, where the intermingling of land use such as rural settlement, modern residential place, industries urban based agriculture out town retailing and service centers occur. This assumption of economic activities, often have a profound effect on peri-urban area. (Rabinson, 2003).

Changes in land use and land cover can have wide-ranging environmental consequences. These include loss of biodiversity, changes in emissions of trace gases affecting climate change, changes in hydrology and soil degradation. Moreover, changes in land use and land cover can influence the vulnerability of people and places to environmental perturbations by, for example, influencing the spread of infectious diseases, interfering with the migration of species and affecting the risk of natural hazards (Meyer and Turner 1992).

The transformation process creates several problems through the expansion of urban land use at the expense of food production. Losses of agricultural land to other uses were undoubtedly substantial in developing countries. In the world with limited food supplies the loss of farm land development is a series of concern. (Khan, 1900).

Collecting, analyzing and maintaining data about the rapid and un-controlled pace of urbanization can be considered as the major pitfalls of African governments. This has resulted a proliferation of informal and illegal tenure arrangements (Mobogunja, 1992).

Food security is a major challenge of many African countries, yet but cities with greater size are those which situated in the most productive agricultural areas, where they can produce the surplus product to provide reasonable food and industrial inputs to that particular area in particular and the country in general (Clark, 1982).

Since Gondar is found in developing countries, that are Ethiopia, it has been experiencing rapid agricultural land use transformation to urban land use due to extensive urban expansion.

The general objective of the study is to assess the impact of urban expansion on the agricultural land use Remote Sensing (RS) and Geographic Information system (GIS).

In recent years the world have been experiencing rapid urban growth because of rapid increase in world population and the irreversible flow of people from rural to urban areas. Especially in the larger towns and cities of the developing world the rate of population increase has been constant and nowadays many of them are facing unplanned and uncontrolled settlements at the densely populated

sites or fringes .To prevent from such occasions urban planners need detailed updated map, for through planning and management. However, most city planners could not get such maps and often they have been using old data which is not relevant for current decision making.

The growth of cities and towns are considered as one of the process of development. Cities are centers of civilization, generating economic development and social, cultural, spiritual and scientific advancements.

At the onset of the twenty first century, Africa faces major challenges which include rapid urbanization without meaningful industrialization of the country's economy. The current rate of urbanization in Africa, exceeding 5.4% per annum in most countries is related to western cities at the end of the 19th c .

2. Urbanization in Ethiopia

The history of urbanization in Ethiopia goes back to the Axumite. During this time, there were many towns where commerce had flourished with buildings and constructions of high standard. Centuries later, these urban centers began to shift to Lalibela and Gondar. Much of the urban history to Ethiopia following the Axumite period was characterized by the absence of fixed urban centers. This trend continues up to the end of the 19th c. In fact it continues until Addis Ababa was selected as a fixed political and commercial center by Minelik II (Kebede, 1994).

Like most African countries on Ethiopia large scale urbanization is a fairly a recent phenomenon. However, the history of towns developing in the country extends back to the Axumite Kingdoms of 14th c, when Axum, the first political and religious center in the north of the country, was established. Despite this long urban history however, Ethiopia remains one of the least urbanized countries in sub-Saharan Africa.

Prior to 20thc, the establishment and growth of the Ethiopian cities are said to be in response to indigenous political, religious, economic as well military strategic, requirements. Despite its failure to build a well organized and large size urban settlement, the constant shift of the location capital cities of the empire during this period had accounted for the establishment and growth of a number of towns, particularly in north Ethiopia. For instance Axum, Lalibela, and Gondar found in the 4th c, 11th c and 17th c, respectively are some of the urban centers that served as capitals of nations. The factors that contribute to the growth of urbanization in Ethiopia include the establishment of central government, the introduction of modern means of transport and communication, schools, hospitals and modern business, Ethiopia's contact with the outside world and the establishment of large number of industries and organized farms as intensified process of urbanization in Ethiopia (Muluneh, 2003).

3. Study Area Analysis

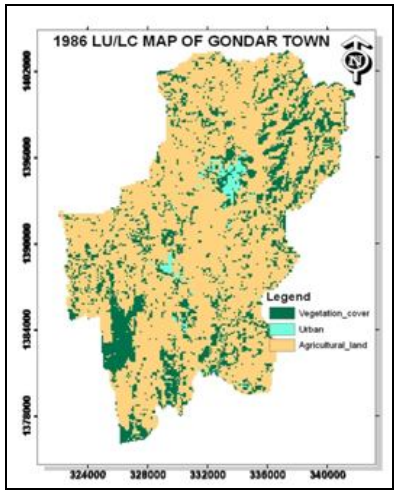
Gondar is sometimes referred to as the camlet of Africa, because of the beautiful castles and places, built in the 17th century when it was the capital of Ethiopia. Today Gondar is the administration capital of north Gondar zone.

Gondar town rose to prominence after Ethiopia went through a long period without fixed capital and emerging in the 17th century at the largest settlement in the country. It was an important administrative commercial, religious and cultural center of Ethiopia and was noted for the skill of its craft men (Endalkachew, 2005).

The town retained its pre-eminence until the middle of the 19th century, when Emperor Tewodros II moved his sent of government to Debere Tabour and latter to Meqdela. As a result Gondar decline in importance and was subsequently looted in the 1880's by Sudanese Derbushes. Beginning from its historical development, now the town has 21 kebeles from its historical development, now the total population of 194 194 (Gondar town administrative journal, 2006:2) as its population increase the size of the town become large and large and also expand creates a new metropolitan of the town (Ibid, 2006:3).

Urban agriculture gets more attention to be practiced on the town's fringe. Here among the activities which start operation include seedling station, protected, public forest, organizing fire and construction wood processing groups and identifying places for horticultural development like Eshte vegetable producing association in Kebele 18 (Ibid, 2005).

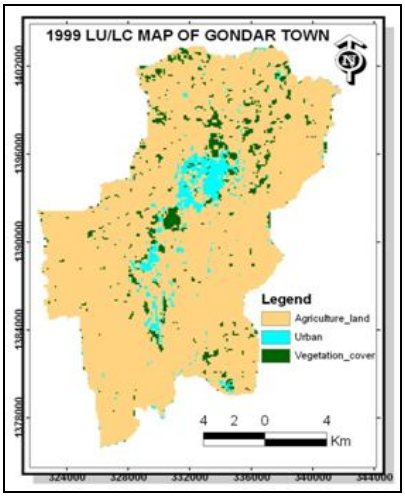
Land use transformation in the urban fringes of Gondar city, mostly occurs from agricultural land to urban land use. This occurs due to the following main reasons: urban population growth mainly because of rural-urban migration, urban-urban migration, industrialization and an investment in housing construction like condominium in the rural urban fringes. Agriculture in fringes becomes inevitably influenced by urban penetration of encroachment which results the loss of farm land. This considerable loss affects the production and provision of agricultural production to the city and the surrounding the city.



No	Lu/Lc	Area/ km^2	Percentage (%)
1	Agriculture	285.14	50.71
2	Urban	57.89	10.30
3	Vegetation	219.2609	38.99
Total area		562.2909	100

Table 1: LU/LC of Gondar City in 1986
Source: Landsat Image, 1986

As indicated the above table, which is obtained from the 1986 Landsat satellite image , three land use/land cover classes have been taken for the purpose of the research. These are: agricultural land, urban and vegetation cover which covers an area of 285.14km^2, 57.85km^2 and 219.2609km^2 respectively from the total area of 562.2909 km^2 which is calculated/ quantified by using ERDAS IMAGINE software.

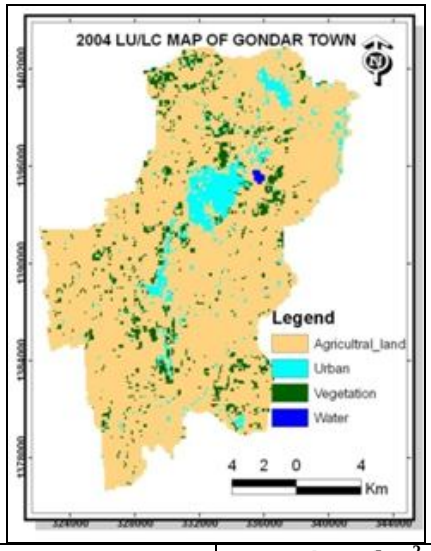


No	Lu/Lc	Area/ Km^2	Percentage (%)
1	Agricultural land	266.846	47.46
2	Urban	171.21	30.45
3	Vegetation	124.2309	22.09
Total		562.2909	100

Table 2: LU/LC of Gondar City in 1999
Source: Landsat Image, 1999

According to the data on the table 4.2, which is obtained from landsat image of 1999 three land use land cover classes have also been taken to see how much area is covered by each of these classes. Therefore, agricultural land covers 266.846km^2, urban covers 171.21km^2 and vegetation also covers 124.2309 km^2 from the total areas of 562.2909 km^2 of the city.

Therefore, by comparing the results from the two satellite images (1986 and 1999) one can conclude that, still the area of agricultural land is greater than other land use land cover classes but it becomes shrinking as compared with the previous area which was obtained from the 1986 landsat image. In contrast to this the area of urban is increasing as compared to agricultural land and vegetation cover.



No	Lu/Lc	Area /km^2	Percentage (%)
1	Agricultural land	261.015	46.42
2	Urban	277.47	49.35
3	Vegetation	23.3748	4.16
4	Water	0.4311	0.08
Total area		562.2909	100

Table 3: LU/LC of Gondar City in 2004
Source: Landsat Image, 2004

As it is shown above, which is found from land sat 2004, four land use land cover classes have been taken because Angreb Dam was constructed and it has to be considered here since it occupy a certain amount of land. Agricultural land (261.015km^2), urban (277.47km^2), vegetation (23.3748km^2) and water also comprises 0.4311km^2 with the total area of 562.2909km$^{2.}$
Generally, all the above three tables show that urban areas are increasing from time to time; whereas the area of other LU/LC classes have become decreased due to the increasing rate of urbanization.

Years	Lu/Lc	Area /km^2	Δof 1986/99 (area/ km^2)	Percentage (%)
1986	Agricultural	285.14		
1999	Agricultural	266.846	18.294	3.3142
	Total	551.1986		
1986	Urban	57.89		
1999	Urban	171.21	113.32	49.46
	Total area	229.1		

Table 4: LU/LC Changes of Gondar City between 1986/99
Source: Landsat Image 1986/99

As it indicated on table 4, the change of the two satellite imageries that are Landsat 1986 and 1999, urban area has increased by 113.32km^2 or by 49.46% within 13 years. In contrast to this agricultural land is decreased by 18.294km^2 or 3.3142% with same year interval. This shows that urban expansion in Gondar city increased at a faster rate and at the same time agricultural land also has diminished at a faster rate.

Years	Lu/Lc	Area /km^2	Δof 1986/99 (area km^2)	Percentage (%)
1999	Agricultural	266.846		
2004	Agricultural	261.015	5.831	1.105
	Total	527.861		
1999	Urban	171.21		
2004	Urban	277.47	106.26	23.68
	Total area	448.68		

Table 5: LU/LC Change of Gondar City in 1999/2004
Source: Landsat Images, 1999/2004

Table 5 also shows the horizontal growth of urban area and reduction of agricultural land through time., The transformation (Δ) of agricultural land to urban area between 1999 and 2004 is 5.831 km^2 or 1.105 % within five year interval; that means about 1.105% of agricultural land is transformed to urban area within five years interval. At the same time, the rate of urban expansion between 1999/2004 is 106.26km^2 or 23.68% which means within five years, the area of the city has increased by 106.26km^2 of 23.6%. From this we can conclude that about 21.25km^2 of agricultural land has been consumed by urban areas in each year.

4. Findings

The study was conducted to identify the impact of urban expansion on the agricultural land use of Gondar city. This study shows that there is considerable land use land cover change around Gondar city. Among these land use the impact exerted on agricultural land is much more than that of the other land uses. This resulted from the intensified land use transformation due to urban land use encroachment especially that of new residential development in to the fringes of the city.

Regarding to the socio economic impacts exerted, it could be seen from two basic dimensions. The first one is the impact of urban expansion on the agricultural land because land is the most important economic base for the rural residents. But, as urban expansion consumes agricultural land use farm lands become smaller and smaller. Small farm lands cannot produce enough to feed themselves and their families and provide for the market. The other social problems are the displacement of the people to urban areas which in turn highly affects urban population conditions. Accordingly, decreasing in agricultural land holding and food production ranks at the top of the problem imposed on rural societies.

According to the major findings of the study, which was obtained from the changes of 1966 and 1999 and 1999 and 2004 land sat imageries; the rate of urban expansion over the agricultural land use is 113.32 km^2 within 13 years interval and 106.26km^2 within 5 years intervals respectively. This shows that still the rate of urban expansion is increasing rapidly from time to time. This resulted in the reduction of agricultural land.

Generally, one can say that the higher rate of urban expansion, leads to the higher loss of agricultural land.

5. Recommendations

In the analysis part we observed the impact of urban expansion on the agricultural land use in Gondar city. The impact is great and continuous. Thus, to tackle the problem exerted on both rural and urban residents, the following mechanisms are recommended by the researcher.

- One of the causes of horizontal expansion of the city is rapid population growth resulted from natural increase and rural-urban and urban-urban migrations; therefore improvements in the spatial planning and urban planning should get considerable attention.
- The city is expanding horizontally and its impact is clear. Hence, the planners should consider vertical development of the town.
- Improve the land management knowledge and skills of the city planners to balance the increasing land demand and the loss of agricultural land.

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