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LAND COVER CHANGE ANALYSIS OF HO MUNICIPALITY OF GHANA

Kofi Sarkodie

Department of Geography Education, Faculty of Social Science, University of Education, Winneba, Ghana

Abstract

The study examines land cover change pattern in the Ho Municipality. Landsat 7 and 8 images were downloaded from earthexplorer.usgs.gov/ for the analysis from 2003 to 2015. ERDAS Imagine, ESRI ArcGIS 10.1 and Google Earth softwares were used to classify and analyse the data. The results showed natural and semi-natural vegetation, bare areas and artificial surfaces were the land cover types in the municipality. There was a positive increase in land cover of natural and semi-natural vegetation and bare areas. The study also revealed a decline or a negative change in land cover for artificial surfaces. Finally, human and natural factors were found to be the contributing factors of land cover change in the municipality.

Keywords: Land cover; Land cover change; Landsat; ESRI GIS 10.1; superimposed

1. Introduction

Forests constitute one of the world's most important valuable natural resources and play a key role in global ecological balance. These resources have been and are being degraded and depleted worldwide. Depletion in forest area threatens the sustainability of agricultural production systems and endangers the economy of the country. Land use and land cover changes are dynamic spatial issues and in order to have a sustainable development these changes need to balanced. Meyer and Turner (1994) explain why "land use" and "land cover" are not identical terms. Land cover denotes the physical, chemical, or biological categorization of the terrestrial surface, for example, grassland, forest, or concrete, whereas land use refers to purposes associated with that cover—raising cattle, recreation, or urban living. Land use relates to land cover in various ways and affects it with various implications. According to Xiubin (1996), land cover changes refer to conversion and modification of vegetation, changes in biodiversity, soil quality, runoff, erosion, sedimentation and land productivity.

Land cover can change due to natural or human factors. Natural factors such as flooding, drought, forest fire and volcanic eruption result in the change of the land cover. Human factors such as population pressure, level of poverty and economic and institutional structures of resource use are indirect causes of land cover change. Land use type changes from forest to agriculture or from agricultural to settlement or from agricultural to industrial or commercial are the results of changes in human activities. On the other hand, the nature of soil such mineral content, texture, wetness, as well as topography also influence land cover change. Therefore, the interaction of human and biophysical influence the dynamics of land cover change.

Several studies have been conducted in land cover changes. These studies tried to look at the causes and some possible effects of the change on the economy. There has been a widespread significant change in the land cover of Ghana. Areas which used to be covered by vegetation are now been used for settlements due to population increase. The forest reserve has also decline over the past two decades. This has created a serious challenge to indigenous farmers. Ghana's territory of land and inland water areas cover a total of 238,539 km² has seen a decline in size due to human and natural factors. Ghana's landscape has been categorized into land use classes such as small- and large-scale farming, forestry, wood fuel, cattle grazing, urbanization, tree plantations of exotic and indigenous species (cocoa, rubber, timber), and game/park reserves in order to provide the mentioned goods and services (Agyarko, 2001).

In Ho Municipality, the issue of land cover change is not a new phenomenon. Due to migration and migration coupled with natural factors have also cause a change in the land cover. Settlements and agricultural activities have influenced the change. In the rural areas majority of the people engaged in agricultural activities and that has led to such change and development of settlement due to pressure on housing in the areas (GSS, 2010).

The aim of this paper is to understand the land cover patterns in Ho Municipality from 2003 to 2018). This study examines the land cover patterns within each year; assesses the rates of change within the individual land covers identify the drivers of the land cover change.

2.0 Methods

2.1 Study setting

The study was conducted in Ho Municipality in the Volta Region of Ghana. The Municipality is located between latitudes 6˚20'N and 6˚55'N and longitudes 0˚12'E and 0˚53'E. The Municipality shares boundaries with Adaklu and Agotime-Ziope Districts to the South, Ho West District to the North and West and the Republic of Togo to the East. Its total land area is 2,361 square kilometers thus representing 11.5 percent of the region's total land area. Ho is its capital town. It has a population of 180,420 representing 10.9 percent of the region's total population. About 68.6 percent of households in the Municipality are engaged in agriculture (GSS, 2021). The general relief of the Municipality is made up of both mountainous and lowland areas. The mountainous areas are mostly to the north and northeast which are part of the Akuapim-Togo Range. The notable areas are Awudome stretch in the southwest and Matse and Klefe in the northeast. The lowland areas are to the South of the Municipality. The general drainage pattern is southwards and dominated by rivers like Tsawe (Alabo) and Kalapa, which flowinto the lower Volta or Avu Lagoon. Generally, the mean monthly temperature in the Municipality ranges between 22˚C and 32˚C while annual mean temperature ranges from 16.5˚C and 37.8˚C. In effect, temperatures are generally high throughout the year which is good for crop farming. The rainfall pattern is characterized by two rainy seasons referred to as the major and the minor seasons. The major season begins from March to June while the minor season is from July to November. Mean annual rainfall figures are between 20.1mm and 192mm. The highest rainfall occurs in June and has mean value of 192mm while the lowest rainfall is in November averaging about 20.1mm (GSS, 2020).

2.2 Source of data

Secondary data was used for the study. Landsat 7 and 8 images were downloaded from earthexplorer.usgs.gov/ for the analysis from 2003 to 2018. The classification and analysis of land cover change was done using two Landsat satellite images, thus, Landsat 7 and 8 TM. These images were selected in the dry season so as to be able to appreciate the change since they were in the same season but different years.

2.3 Software and data preparation

The ERDAS Imagine, ESRI ArcGIS 10.1 and Google Earth softwares were used. The Landsat data satellite images for the years stacked and sub setted by laying the district shapefile and the Ho Municipality was selected for classification. The subset images were later classified by into unsupervised classification of 50 classes. The Google Earth software was used to classify all the 50 classes by using the FAO Classification Scheme. From the study, three different classes were arrived at, namely, Natural and Semi-Natural vegetation, Bare Areas and Artificial Surfaces as shown in Table 1.

Table 1: Land cover types identified in Ho Municipality and their descriptions

Land cover type	Description
Natural and Semi-Natural Vegetation	Natural vegetation refers to areas where the vegetation cover is in balance with the abiotic and biotic forces of its biotope. Semi natural vegetation is not planted by humans but influenced by human actions.
Bare Areas	Areas that do not have an artificial cover as a result of human activities. These areas include areas with less than 4% vegetation cover, included are bare rock areas, sands and deserts.
Artificial Surfaces	This class describes areas that have an artificial cover as a result of human activities such as construction (cities, towns, transportation), extraction (open mines and quarries) or waste disposal

Source: Adapted from FAO Land cover Classification Scheme

Supervised classification was then performed on the three images and different colours were used to present each class and the area field was added to calculate the area for each class. The supervised images were overlaid using the matrix union tool to compare the change in the land cover over the 15-year period. A classification accuracy assessment was further performed on the 2003, 2015 and 2018 images. Finally, maps were produced from the supervised layers using ArcGIS (Version 10.1) software (see Figure 1 and 2).

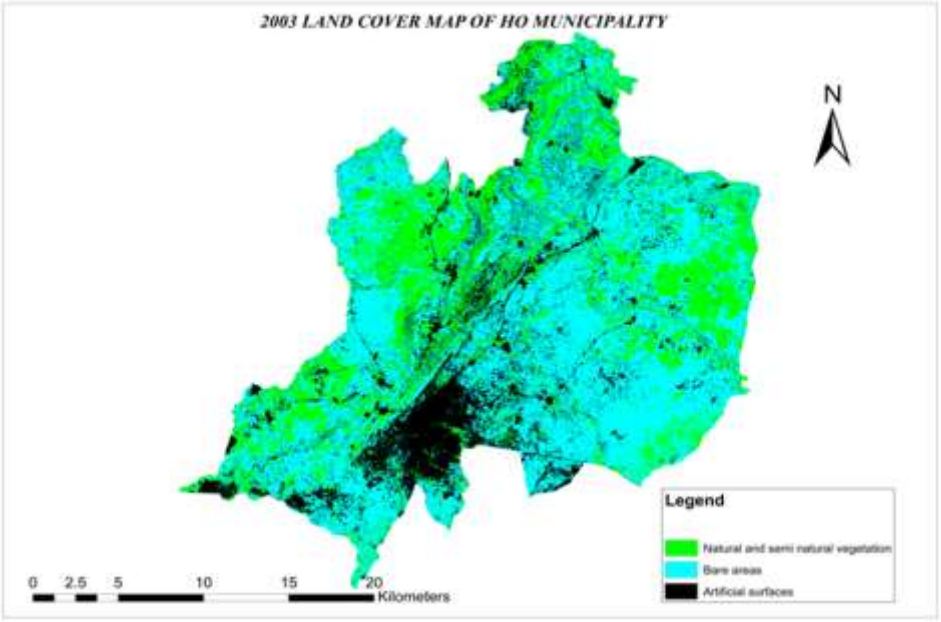

Figure 1: Land cover map of Ho Municipal

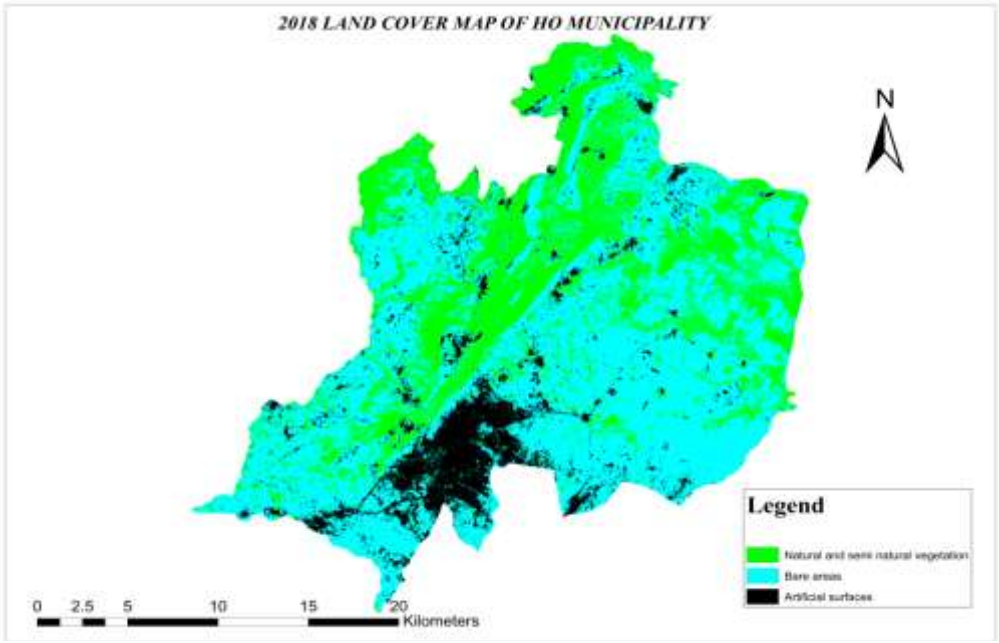

Figure 2: Land cover map of Ho Municipal

3. Results

Area covered by the land cover types and their total land area for 2003 and 2018

After classification of the three images, different land covers were produced. These land covers include natural and semi-natural vegetation, bare areas and artificial surfaces as shown in Table 2.

Table 2: Land cover type for Ho Municipality for 2003 and 2018

Land Cover Type	2003(Area in acres)	2018(Area in acres)
Natural and Semi-Natural Vegetation	37474.4	42236.3
Bare Areas	79448.8	84799.4
Artificial Surfaces	24604.6	14492.1
Total	**141527.8**	**141527.8**

Source: Adapted from FAO Land cover Classification Scheme

It can be deduced from Table 2 that, there were some changes in the land cover between 2003 and 2018. In some parts of the municipality, there was an appreciable change for natural and semi-natural vegetation while artificial surfaces have a decline in change between 2003 and 2018. This can be influenced by both human and natural factors as pointed out by Long (2006). Although, three images were processed and finally classified, the analysis focused on two (2003 and 2018) which showed appreciable change between the fifteen period.

The total area covered by natural and semi-natural vegetation was 3, 7474.4 acres in 2003 and changes to 4, 2236.3 in 2018. Bare areas also covered a total land area of 7, 9448.8 acres in 2003 and also changed to 8, 4799.4 acres. However, artificial surface saw a decline in the area covered in 2003 from 2, 4604.6 to 14492.1 in 2018 (see Table 2).

Rate of change of land cover between 2003 and 2018

Results in Figure 3 shows the rate of change of land cover types between 2003 and 2018. Natural and semi-natural vegetation saw an increase from 3, 7474.4 acres to 4, 2236.3 acres representing a 12.7 percentage change (see Table 3 and Figure 3).

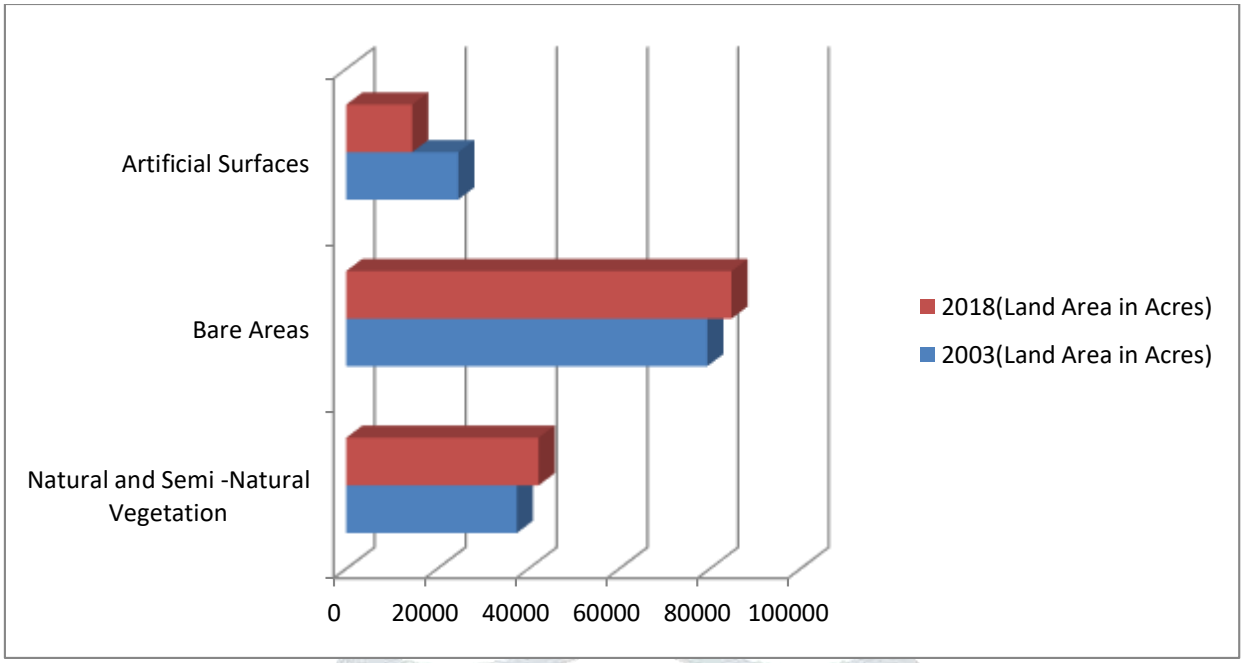

Figure 3: Rate of land cover change in the Ho Municipality between 2003 and 2018

Bare areas on the other hand also had a 6.7 percent change from 7, 9448.8 acres to 8, 4799.4 acres. However, there was a negative change in artificial surface from 2, 4604.6 acres to 1, 4492.1 acres representing a negative 41.1 percent. It can be deduced from the results that, the Ho Municipality land cover for bare areas increased due to an increased in human activities such as farming and the climatic conditions of the areas. It caused most of the vegetated areas to be bare over the fifteen-year period. It can be said that, the negative change in the artificial surfaces was as a result of the afforestation programme embarked on within the municipality by government. Also, the results revealed that the area did not see a major developmental projects in terms of roads, settlements and others within the period under consideration.

Table 3: Rate of land cover change between 2003 and 2018 in Ho Municipality

Land Cover Classification	Change from 2003 to 2018 (Figure)	Percentage change (%)
Natural and Semi - Natural Vegetation	4761.9	12.7
Bare Areas	5350.6	6.7
Artificial Surfaces	-10112.5	-41.1

Author's construct, 2022

Overlay analysis

An overlay analysis was conducted by the researcher. Thus, the two superimposed classified imaged were overlaid using the matrix union and this is presented in Figure 4. The results of the overlaid map showed a changed in the land cover types to other types. For instance, artificial surfaces changed to natural and semi-natural vegetation, from natural and semi-natural to bare areas, from bare to artificial surfaces, from bare to natural and semi-natural vegetation. However, some of the land cover types did not exhibit nay change (see Figure 4).

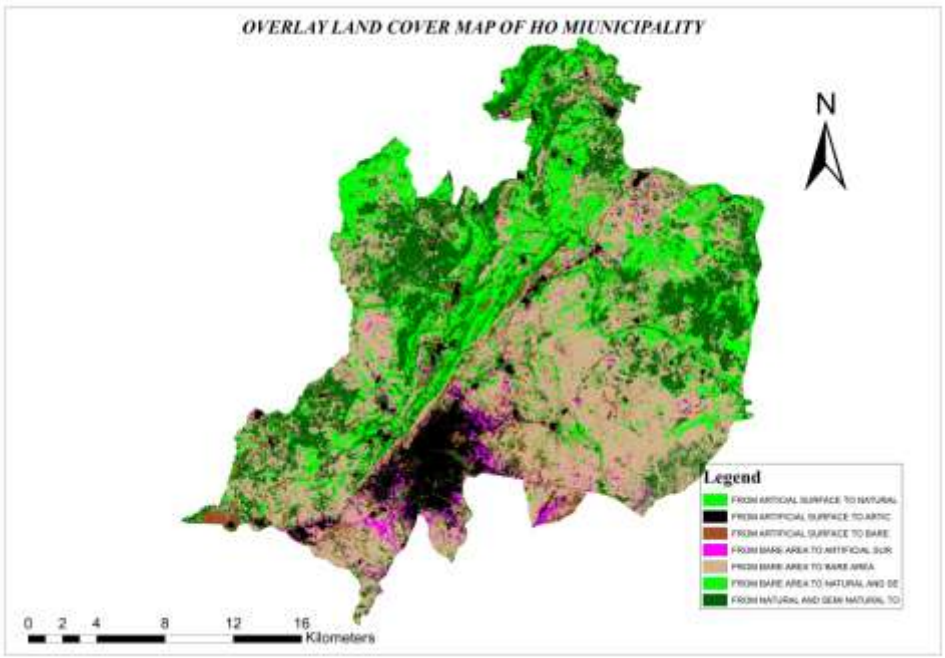

Figure 4: Overlaid map

Source: Authors' Construct, 2022

4. Summary of findings

The major findings of the study are stated below.

- Three major land cover types were identified, namely; natural and semi-natural vegetation, bare areas and artificial surfaces.
- The study also revealed a positive increase in land cover of natural and semi-natural vegetation and bare areas.
- There was a decline or a negative change in land cover for artificial surfaces.
- Again, it was discovered that, the change in the land cover was as a result of both human and natural factors.

5. Conclusions

The major land cover and land uses classified for the area between 1986 and 2017 included natural and semi-natural vegetation, bare areas and artificial surfaces. Human activities and low amount of rainfall coupled with the climate of the area impacted on the change of the bare lands. From the findings, it showed a loss in artificial surfaces over the 15-year period. It can be concluded that land cover change is evident in the municipality due to human and natural factors.

6. Recommendations

- The government should intensity the afforestation programme to check the rate at which vegetated areas are turning to bare lands within the municipality.
- Again, farmers in the municipality should be given the needed education on good farming practices so that, their activities could not harm the vegetated lands.
- The researcher recommends that, further studies should be carried out in the municipality to fully ascertain the rate of change for about 30 years.
- Finally, other GIS soft wares should be used in predicting land cover change.

Conflict of Interest Statement

The author declares no conflicts of interest.

About the Author

Kofi Sarkodie is a student at the Department of Geography Education at the University of Education, Winneba. He possesses a Master of Philosophy degree in Geography with Education and a Bachelor of Arts in Social Science Education (Geography Major and Political Science Minor) from the University of Education, Winneba, Ghana. His research interests and publications are on Population, Environment and Development and Medical and Health Geography.

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