

Application of Remote Sensing in Agricultural Land Use Change Analysis: A Case of Cocoa Farming in Juabeso-Bia District in Ghana Farming in Juabeso-Bia District in Ghana

Introduction

Africa is the world's leading producer of cocoa with Ghana being the second after Côte d'Ivoire. Cocoa farming in Ghana has a long history. Tetteh Quashie of Mampong Akwapim is believed to be the person to introduce the crop to Ghana in 1879 (Hammond 1962; Mckelvie 1962). The crop later aroused the interest of farmers and led to the birth of the industry. Cultivation spread rapidly along the Akwapim ridge and through out the Eastern region of Ghana, got to its peak in early 1930's, taking over the extensive oil palm plantations. Ten years later the production declined due to sever outbreaks of capsid pests and cocoa swol-



len shoot virus disease (CSSVD). Re-planting of new farms was made difficult due to degradation of the environment and loss of soil fertility. The cocoa farms were replaced by food crop farming centred on maize, cassava, plantain and vegetables. From that time, this area is characterized by decline in cocoa production, environmental degradation and out migration of farmers in search of virgin forest to culti-



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Classified mosaic land use/cover 2002/03

Classified mosaic land use/cover 1986







Cocoa farmers and his wife braking cocoa in the study area



An unsupervised classification was carried out using the broad clustering algorithm as a first step before the supervised classification. Six broad categories were generated as shown below

Analysis

The main analysis was change detection. CROSSTAB module was used to compare the two images above because of the qualitative nature of the images. Crossclassification calculates the logical AND of all possible combinations of land cover categories on two maps with two different dates with the focus on whether areas fall into the same class on the two dates or whether a change to a new class has occurred (Eastman et. al 2005).

vate cocoa. The western region where this research is being conducted is the current cocoa frontier. (As shown below)

Purpose of this study

To examine the spatial dynamics of cocoa farming by assessing the land use change

between 1986 and 2003 using satellite imagery with the focus on cocoa farms.

Methodology

Two Landsat ETM+ scenes were used taken into consideration data quality and availability.

These were path 195 row 55 and path 195 row 56 of Landsat Enhanced Thematic Mapper (ETM+). These were downloaded from the internet. Ideally, a mosaic of these 2002 and 2003 scenes, window out the study area would have been appropriate but a false colour composition (bands 5,4,3, RGB) and critical examination of reflectance value of each band in each scene shown variations which will affect the accuracy level of the classification if mosaic. However, the 1986 imagery were alright to mosalc

Table. 1 Satellite imagery characteristics

ID	WRS: Path/Row	Acquisition Date	Туре
034-249	2: 195/055	24/12/2002	BSQ



This was displayed alongside a false colour composition using bands 543 (RGB) in Idrisi and enhanced. A GPS reading of cover types taken during two weeks of field visit in December 2004 was superimposed on both images to select training sites.

Based on the four major land use/cover classes identified, at least 50 pixels were digitized on the image for each training site as shown below



Results

The Kappa statistics generated shows that between 1986 and 2002/03, the area has undergone drastic land use/cover changes (Overall Kappa 0.5288) with agriculture being the most pronounced (KIA = 0.1060).

Land use/cover change between 1986 and 2003



034-250	2: 195/056	14/03/2003	BSQ
013-790	2: 195/055	01/18/1986	GeoTIFF
013-791	2: 195/056	01/18/1986	GeoTIFF

Source: http://glcf.umiacs.umd.edu/index.shtml- Global land cover facility site.

Landsat ETM+ 2002, false color composition Bands: 5, 4,3 (Scene: Path 195; Row 55) showing window of the study area



Landsat ETM+ 2003, false colour composition Bands: 5, 4,3 (Scene: Path 195; Row 56) showing window of the study area





Landsat ETM+ 1986, mosaic of path 195; row



Classification scheme used for analyzing the imagery

ID	Class	
1	Deciduous forest	
2	Reserved forest	
3	Agricultural fields (mainly cocoa farms)	
4	Built-up / exposed surfaces	
5	Clouds/ shadows	

Due to the homogeneity of the vegetation in the area, it was difficult to differentiate between the natural vegetation and cocoa farms after examining a false colour composite of the imagery. Faced with such a complex situation, both unsupervised and supervised classification was

A signature, which contains the statistical information of the reflectance value of the pixels within each training site was development using six bands (1-5 and 7) thus, excluding band 6 which happens to be a thermal band and insignificant for the classification (Jensen 2000). After a satisfactory review of the signatures, they were classified using the maximum likelihood

Examples of signature derived from training sites



Agriculture mainly cocoa farms to built-up/exposed surfaces

In general, it can be observed that the whole area has under gone land use/cover change over the 17 years period as shown in white color in the left map above. In the south, the changes happened to be from reserved forest to agricultural land mainly cocoa farms.

In total, 293 sq km. had changed from reserved forest to agriculture and 105 sq km. from deciduous forest to agriculture

The zoomed area in the north shows that more of deciduous forest has turned into agricultural fields.

Conclusion

From the analysis, it is evident that tremendous changes in the land use/cover has occurred in the district and with remote sensing mainly satellite imagery and GIS techniques one is able to assess these changes in terms pattern and quantity.

This is part of a graduate project which is on going and therefore it would be expedient to further investigate as a way of validating this results and investigate the underlying driving forces. This is very important because the area happen to be the last frontier for the cocoa industry.

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performed on each of the imagery. For 2002 image, six unsupervised classes were generated using the broad classification module in Idrisi. Whereas for 2003, eight clustered generated.