

Space Mapping Technology in Support of the Project for Biodiversity Restoration of Degraded Cocoa Production Landscapes in West Africa

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Key words: Biodiversity Degradation of the rainforest by “no-shade cocoa farming; reversal management and space technology application

SUMMARY

Among the evidenced-based contributors to the global climatic change is the loss of the primary forest cover of the tropical rain forest through tree-cropping of the crop variety that requires no-shade. Particularly in Ghana and the Ivory Coast the no-shade type of cocoa farming has destroyed the multiple canopy rainforest and its associated multiple species. Space images show devastating expansion of this economy in the forest region of the Western Region of Ghana.

So disturbing is the degradation that Conservation International, UNDP and WCN, are putting together a ten-year program for biodiversity restoration of the affected lands, where replanting is due. The program needs the support of digital mapping for facilitating the use of space imageries for monitoring and evaluation. The project is a multi-discipline and multi-sectoral one which will need Geographic Information System for integrating the various data sets and use for spatial analysis to monitor and evaluate the changes.

In the initial study the use of satellite images and ancillary maps in digital format proved that digital maps could not be ignored. This paper presents what was done and the relevance of it to the sub-regional project which will cover the cocoa-growing countries in West Africa.

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1. THE OVERALL RISKS AND MITIGATION STRATEGIES FOR CONSERVATION OF GLOBALLY SIGNIFICANT BIODIVERSITY IN COCOA PRODUCTION LANDSCAPES IN GHANA

1. Risk: Changing climatic conditions make cocoa farming increasingly difficult in the region so that farmers abandon cocoa farming in favor of other crops.

Mitigation: While climate change is expected, it is considered unlikely that farmers will abandon cocoa farming in southwest Ghana over the next decade; moreover, farmers will attempt to mitigate climate change through appropriate use of shade, which is an element of this project.

2. Risk: The cocoa farmers in southwest Ghana are reluctant to adopt the biodiversity-friendly; multi-functional production landscapes based on “shade cocoa” and are reluctant to invest in maintaining farm productivity because of perceived higher short-term gains from little or un-shaded cocoa.

Mitigation: Given the presently very low overall yield levels, the project will demonstrate near and long-term benefits for farmers from using better agronomic practices and will show that yields can be increased while using biodiversity-friendly agro-forestry practices. The project will also promote biodiversity-friendly ways of income diversification through introduction of timber and non-timber trees in cocoa farms and linking farmers to the corresponding markets.

3. Risk: Increasing demand for cocoa in general (2-3% per year) and high-quality Ghanaian cocoa specifically will drive expansion of areas under cocoa also into forest, thereby annihilating biodiversity benefits through changing practices on existing cocoa farms.

Mitigation: This is a main reason why a farm-level project approach is insufficient for achieving real improvements for biodiversity in cocoa production landscapes. The project addresses it by aiming at the negotiation of conservation agreements with “spatio-political units” (communities, districts, ...) which include the conservation of forest and investments into existing cocoa farms (e.g. through extension services) that allow to increase cocoa output without expanding the area under production, or by expanding into already deforested areas (including previous cocoa farms). Also, the Government of Ghana is committed not to increase the cocoa area and focus on the rehabilitation of old cocoa regions.

4. Risk: World prices for cocoa decline because of factors at the global market level, leading to reduction of government revenues, which in turn affects the government's ability to maintain high cocoa prices and provide services for the farming communities and the production chain.

Mitigation: The project will promote crop diversification to reduce the over-dependence on cocoa as a source of revenue to the farming communities, thereby reducing their dependency on cocoa prices. The project will also work to maintain and increase the premium that Ghanaian cocoa presently obtains on the world market by adding an image of environment-friendliness to its high quality, thereby buffering Ghanaian cocoa to some extent from fluctuations of demand for cocoa on the world market.

5. Risk: The project impacts only a limited region and the recommended land use practices are not adopted more widely.

Mitigation: The project's strong level of support from government ministries and the Ghana Cocoa Board (COCOBOD) will enable its results to be integrated into national strategies for biodiversity, poverty alleviation, land rehabilitation and cocoa production. The centralized nature of Ghana's cocoa industry will support national-level promotion of successful practices. Partnership with the international industry and the Sustainable Tree Crops Program will provide channels for dissemination of project successes at a national (and international) scale.

2. DEMONSTRATION OF HOW SPACE MAPPING TECHNOLOGY CAN CONTRIBUTE TO THE PROJECT IMPLEMENTATION

This project cannot succeed without active understanding and effective participation of the project area communities. There must be a process for sensitizing them on need for the project. Space images are powerful apparatus for geo-visualizing the changes which have taken place due to the introduction of the cocoa variety which requires no shade trees.

Two multi-temporal images of the LANDSAT TM Regime were processed for selected localities and shown side by side in order to visualize the land cover changes indicative of the spread of the no-shade cocoa landscape vis-à-vis the loss of the original primary forest cover and its associated biodiversity. The images were 1990 mid-dry season (Dec/Jan) and 2000 beginning of rains (May). Generally, the colour-coded images could be explained with their associated cover types:

2.1 Deep Green Colour

Closed Forest of multilayer-canopy of trees, corresponding to Multiple-species plant population and hence rich biodiversity

2.2 Light Green Colour

Open Forest of single/double-layer canopy consisting of one or two dominant species. This category includes cultured species (cocoa without shade trees, oil palm rubber, other exotic species trees, secondary forest)

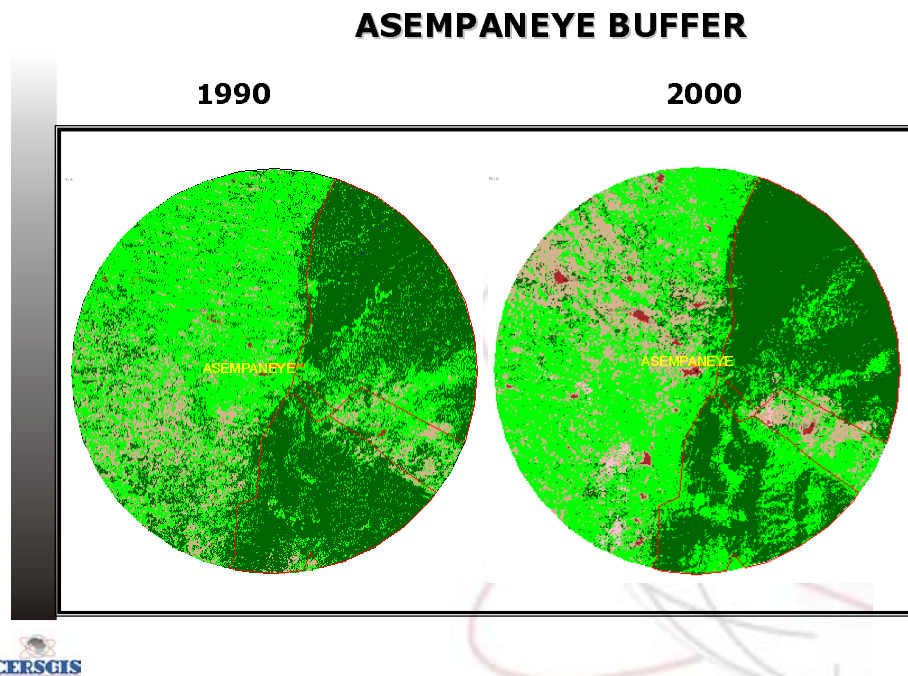
2.3 Brown Colour

Dried-up herbaceous and grass cover/cleared for cultivation but carpeted by dense weeds

2.4 Red/Reddish

Bare surface (built-up, excavations/mining scars, other surfaces devoid of vegetation cover)

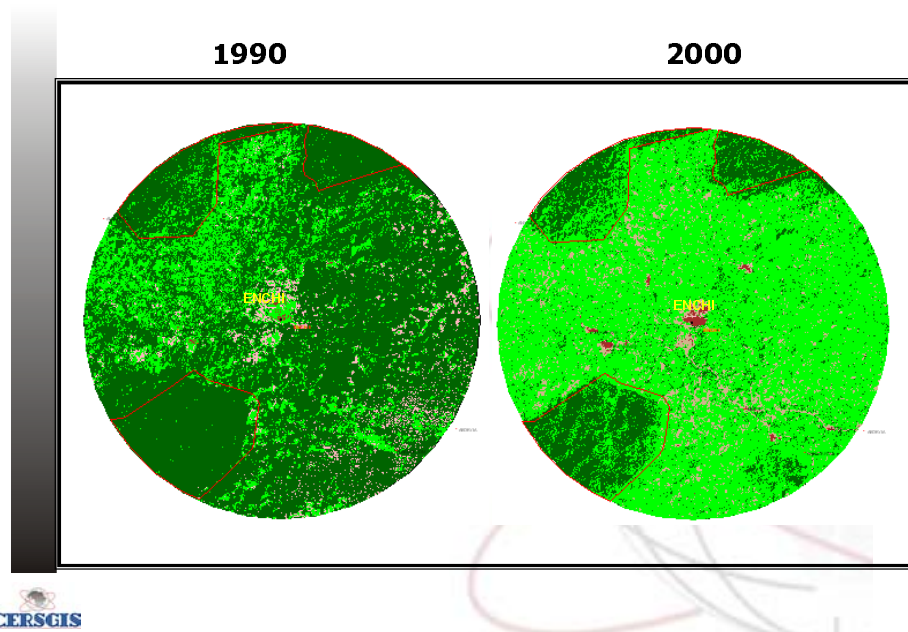
Image Map of Ten-Kilometer Buffer of Pilot Sites



Settlements have expanded remarkably evidenced by the distribution of the brown and reddish color patches. The deep green represents the category of primary forest cover and cocoa type that requires shade. Also in this category are sacred groves associated with settlements. The brown being in close association with the settlements may pass for bush-fallow farms and some plots under semi-mechanised cultivation of annual (grain) crops. The image portrays that pressure on the available land is increasing, leading to a pattern of encroachment into the closed forest in the southeastern and eastern sectors of the buffer. Asempanaye has been long associated with cocoa production.

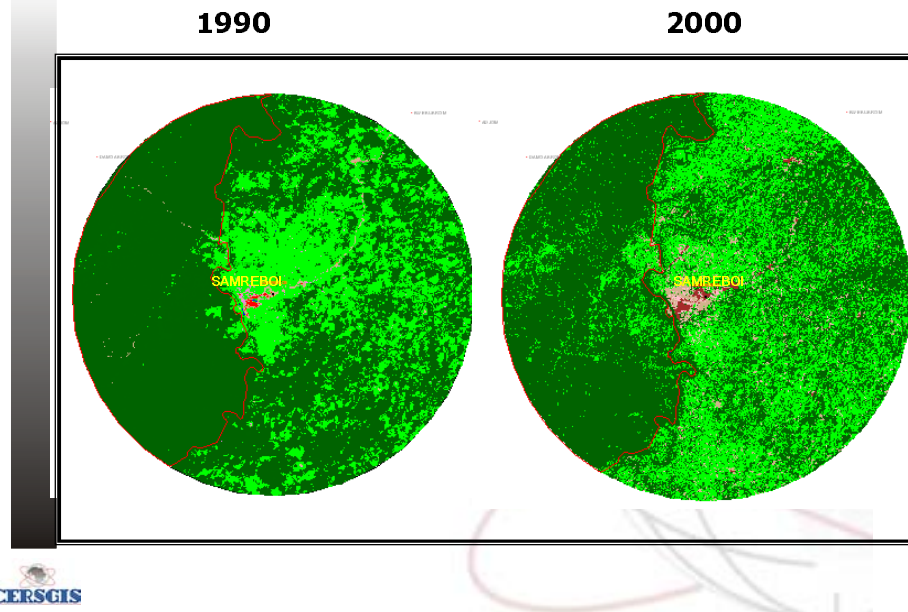
This buffer has suffered most from deforestation. The deep green block is the Bowiye Range, which appears to retain its multiple species and multi-layer structure. The patches of deep green scattered within the light green zone could be the class of old cocoa farms in association with remnants of closed forest, stream-associated riparian forest and settlement associated sacred groves

ENCHI BUFFER



This site shows a massive change from original tree cover of the multiple canopy/multiple-species closed forest to the single-canopy (mostly no-shade cocoa and oil palm farms). The forest reserves have been encroached upon significantly.

SAMREBOI BUFFER

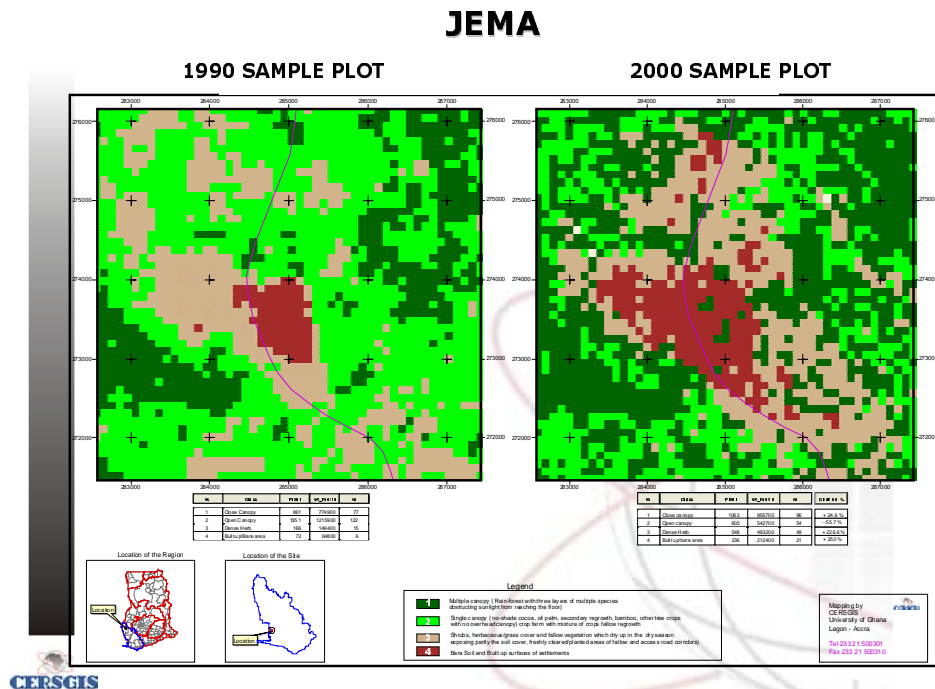


This represents an unusual but favorable restoration pattern – a reverse from degradation in 1990 to restoration in 2000. This is evidenced by the change from brown patches in 1990 to green intergrades in 2000. The Ground truth indicates that there were scars of logging which have been replanted to exotic species (Cedrella) carried out by the Company that has a concession there, namely: African Timber and Plywood Ltd. The cedrella plantations largely unkempt were overgrown with the native multi-species, thereby returning such places into multi-species and multi-layer tree cover of native and the exotic types. The immediate surroundings of the settlement (Samreboi) however have lost the 1990 green periphery due to settlement-associated land uses.

The loss of species is visually most significant in the Asempanaye, Wassa Akropong and Enchi buffers. Some restoration appears to have taken place in the Samreboi buffer. Around the settlement, however the loss of species may be thorough as the single canopy color category shows in the 2000 scene. Population growth effect on land in the Asempanaye area is evident. The deep green blocks are the reserves and parks, which contain multiple species. Though still extensive, they are being encroached upon as can be seen from the edges. Land pressure is becoming evident in the pattern of increase in the number of settlements and the encroachments into the closed forest. The extensive loss of the original cover means also loss of the riparian cover for the numerous streams in the region. Seasonal stream drought is becoming a significant in places which hitherto had perennial flow.

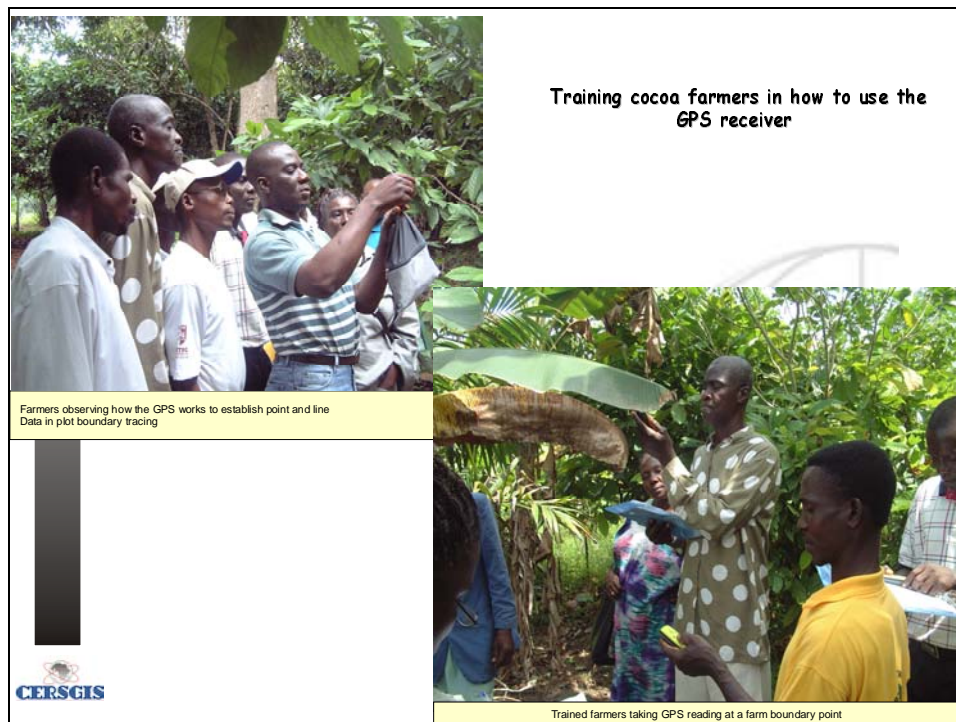
3. PIXEL-BASED VISUALIZATION OF THE COVER CHANGES

The dynamic dimension of the satellite image is the opportunity it affords for close up pixel-to-pixel analysis of the cover changes permitting quantitative analysis of the changes from one cover type to another and the ease of visualization offered for dialoguing with the local land users about the changes and ground-truth behind each cover type.



4. GPS APPLICATION

The hand-held receivers of the Global Positioning System are becoming user-friendly for even farmers with education to the first cycle level. It was tried in the pilot exercise and found reasonably effective. Point location of the farm and plot perimeter definition of the farm is possible with hand-held GPS, when there is not much canopy obstruction between the receiver and the over-passing navigational satellites. GPS data easily integrates with the satellite images and provides opportunity for tying ground-level biodiversity characterization of the farm to the pixels of the space/satellite image map. This facility will allow ground-level farm-related data and other resource management data sets to be tied to the pixel-based land cover, which will allow multiple-factor analysis.



5. CONCLUSIONS

The space images provide data in two dimensions, time and space. It is possible now to look at how the changes have occurred form year to year using the existing archived images (from 1975 to the present) and possibilities for comparison with the future ones (SPOT, ASTER, etc.)

The images were geo-referenced to the digital Topographic Maps of the region, which had afforded the opportunity for overlaying other GIS-data sets including population density maps developed from the Censuses of 1990 and 2000.

Scale changes can be manipulated within the limits of the pixel resolution of the original image. For the Landsat this was possible down to 30 meter resolution, which permits farm level pixel count of cover types for farms and plots more that 30m in size. It affords possibilities for monitoring farm level changes. Once it is possible to use historical and future data sets, temporal analysis of trends will be feasible for long term project with strategies like the cocoa biodiversity restoration.

Multiple-layering of the digital data sets including the topographic map, demographic data (locality-based population census data), pixel-based image map, GPS-collectible point data (farm-related biophysical, socio-economic, resource management information) is possible. Space technology has now made it possible to achieve all these at scales that range from the local to the regional/national levels. The cocoa sector rehabilitation program has recognized the practical relevance of the available facilities through the co-operative efforts of CERSGIS

and collaboration between it and Conservation International for the biodiversity restoration of the cocoa landscapes.

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