CARTOGRAPHIC APPLICATIONS OF REMOTE SENSING FOR ENVIRONMENTAL MONITORING IN TWO CASES: HIGH TENSION ELECTRICITY TRANSMISSION LINE CORRIDOR AND OIL PRODUCING COASTAL ENVIRONMENT

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Spatial information from a processed high resolution satellite imagery provides a good cartographic information at medium scales adequate for planning at both local and regional levels. In developing economies of Africa, the problems of lack of vital spatial information in near-real time mode, for impact assessment of land-based projects or processes, is being solved with satellite imageries. In this paper two cases have been presented to show how thematic cartography has been utilized through digital image processing and visual interpretation of the environmental impact assessment. One was for the pre-project description of the high voltage transmission line (HVTL) which was to traverse a Guinea Savannah zone in Nigeria. The other, also in Nigeria, was in connection with an oil-producing coastal region. In the former SPOT XS data was used, while for the latter SPOT P was utilized. In both cases the objectives were to present cartographic results.

INTRODUCTION

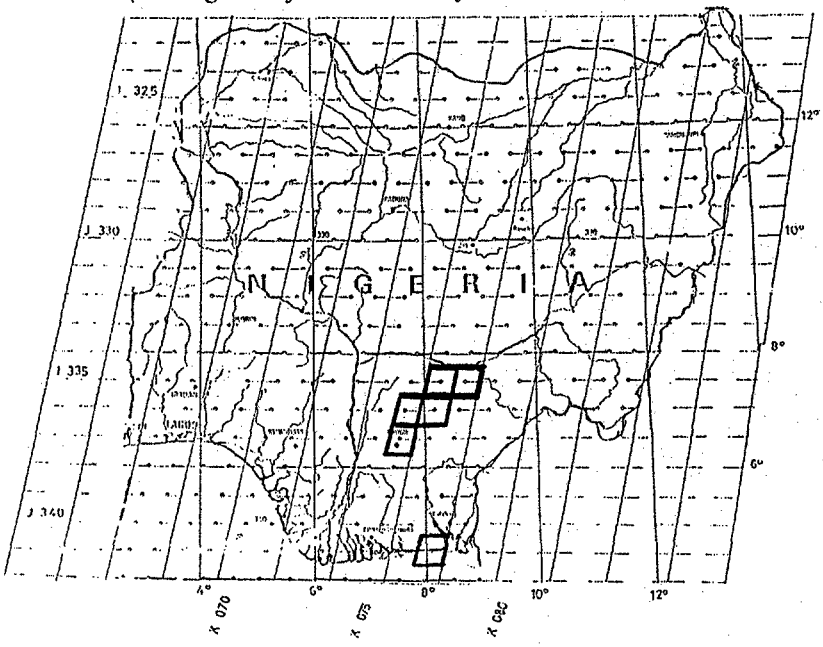
Environmental monitoring for impact assessment has become a very lively issue in African countries, partly because it is tied to funding of development projects. Following the Rio Conference, African Governments have strengthened their national environmental agencies, giving them more powers to monitor land-based socio-economic activities. In some countries it has become even mandatory to produce an impact assessment report, as a condition for the release of funds or permit to go ahead with the project.

The dilemma in this is that most often the vital spatial data are not readily available in useable form. The solution to this has so far been to depend on satellite imageries for landcover and landuse infromation which are direct or indirect indication of the environmental quality of the environment in the zone of interest.

The objective information from the satellite imagery is of course a simple line map derived from the interpretation. In the two cases of this presentation, the final maps were landcover maps.

The Satellite Data:
SPOT data were used for the two cases. The locations of the two project zones and their SPOT scene which were used are in the south-eastern sector of the country one in the transition between the southern rain forest and the Guinea Savannah belts and the other in the coastal rainforest belt east of the Niger delta.

SPOT GRS (Showing Inset of Scenes Selected for the two Cases)



For the HVTL Corridor study, SPOT XS data were available. The most suitable scenes were of the following dates:

- K075 J337 Imaged 24/12/86
- K075 J336 imaged 15/12/90

- K 076 J336 imaged 15/02/90
- K 077 J335 imaged 19/12/86
- K 076 J335 imaged 15/02/90

The SPOT data used for the second case (K077 J341) was in Panchromatic mode imaged on 27/01/89 An XS would have been ideal but all the archived ones were cloud-covered. However due to its superior spatial resolution of 10m the Panchromatic data showed better the objective information.

Case 1:
A 250-km corridor to be proposed for a high voltage electricity transmission line route

The proposed corridor was to contain the existing highway close to which could be the "right of way" for the transmission line. The land cover description was expected to give clues to wet lands, including surface water, flood plain swamps and marshes that could be crossed by the line, national and state protected areas, agricultural areas, and built-up zones. Information leading to the topography was to be included.
Given the elongated nature of the interest zone, segmentation was considered the most practical way of presenting the objective information. These segments were conceptualized as subscenes of 10km x 10km within which was to be laid the proposed corridor. The entire length of the 250km distance took forty two such subscenes (Annex. 1).

The activities performed to obtain the final results (Annex 2) ranged over initial digital processing, print-out at the appropriate scales, interpretation, and final maps drawing. The final documents were forty-two segmented corridor maps which were put in transparent overlays, each one corresponding to its subscene image. Two of these sub-scenes interpretation of the land cover and land use map have been presented (Annex 3 and 4). The index map served as a guide for the use of the forty-two subscene maps and imageries. The legend that went with the forty-two subscene maps was a common one.

Common Legend for the Landcover/Landuse Information

S	Mainly built-up compact or open.
SB	Dispersed settlements and surrounding country of woodland/shrub with scattered farm plots, iron-stone pans.
BS	Predominantly short bush, with scattered farm plots and open bare spaces.
MS	Mixture of economic trees, shrubby thickets and few isolated homsteads
SMB	Complex combination of cultivated areas, bare soils/burnt-up areas, with some rural dispersed settlements.

M	Predominantly forest/bush; with scattered traditional farm plots, combination of tree crops and annual crops, farm huts.
FM	Mainly forest or bush cover, with tree/arable crop underneath and
FMS	Protected trees over dispersed homsteads and associated agro-forest crops
FMB	Complex combination of bush, cultivated areas, burnt-up areas or bare spaces.
B	Mainly bare soils, burnt-up surfaces, eroded or marginally cultivated gravelly soils/porous soils under grazing or very marginal cultivation.
D	Very shallow depression/flat surface, under dense tree/shrub cover.
BU	Built-up for some kind of industrial use.
E	Eroded steep slopes in Enugu landscape.
W	Water body.
V	Valley gallery forest/flood plain shrubs.

Case 2:

Zone of possible impact from an on-shore oil processing plant

The zone of interest was a coastal environment of an on-shore oil pre-processing plant. To enable an environmental sensitivity index map to be prepared for the impact zone of the pre-processing plant, it was desirable to obtain a land cover map. The proposed extent of the interest zone was fifteen to twenty kilometre radius of the on-shore pre-processing plant. The data used was SPOT Panchromatic. The final scales for the presentation were:

(a) 1/200,000 for the global map;
(b) 1/50,000 subscene with overlay of the interpretation;
(c) 1/25,000 subscene with overlay of the interpretation. This scale was for the principal township and the on-shore pre-processing plant, and a few other key areas of special interest.

To achieve these, nine activities (Annex 2) were performed. The final general map which was produced in multi-colour has been converted into gray-tone for presentation in this paper (Annex 5). For the objective of using the map for sensitivity index analysis, it was considered meaningful to have a landcover information tied to physio-ecological units. This conceptualization which led to the legend. The results of the interpretation were identification of four major physio-ecological zones. For each of them the landcover/landuse classes were also identified and delineated.

Physio-ecological Zones and associated Land-cover/Land-use Information

P. Cover types of the Coastal Plain	***C. Coastal belts***
P1 Settlement and associated landuses including farmland	C1 Settlements, other built-up or installations
P2 Mainly cultivated	C2 Cultivated beach ridge
P3 Cultivated upland and forested lowland	
P4 Forested upland and lowland	***R. Riverine***
	R1 Cultivated
B. Cover types of the Old Beach ridges (i) High ground (ii) Tidal flats	R2 Freshwater swamp forest of the plains and valleys
Bh.1 Settlements and associated landuses, including farmlands	R3 Brackish forest of valleys under tidal influence
Bh.2. Alternating bands of cultivated upland and forested lowland	
Bh.3. Alternating bands of forested upland and lowland	
Bt.4 Brackish swamp forest of the tidal flats	
Bt.5 Degraded brackigh swamp forest of the tidal flats	

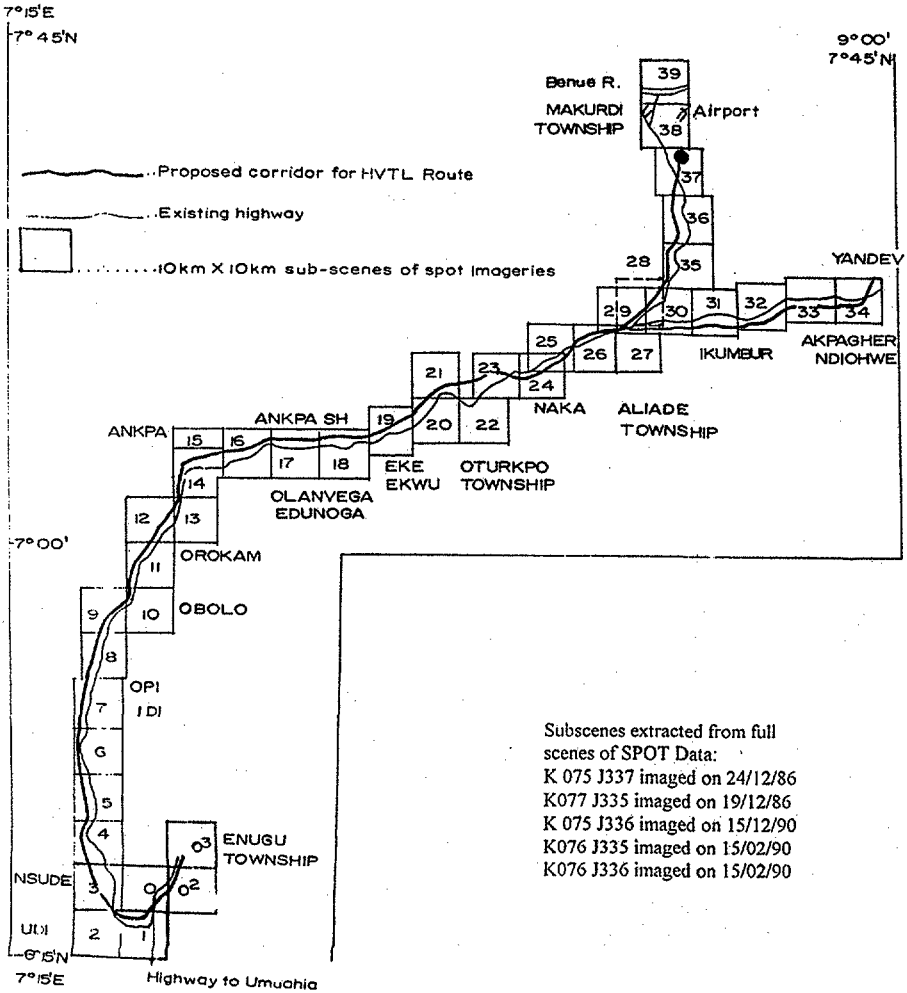
CONCLUSIONS

The rapidity with which the objective maps could be finished to meet the stated request did prove that space image cartography has become recognised as a very important tool for environmental monitoring.
For cost-effective purposes, the combined use of satellite imageries and the existing topographic maps of 1/50,000 and 1/100,000 scales could reduce the cost of field observations to a large extent. The segmentation into subscenes printed at 1/50,000 in 20cm by 20cm format matched very reasonably the topographic maps without further geometric correction.

The limiting factor was however image quality. For the Corridor project, while the year for consideration was 1991, the archived data which were accessible and of the quality suitable were those acquired between 1986 and 1990. The case was more serious for the coastal environment project the reporting date of which was 1994. Yet the most suitable data was 1989. Multispectral image could have been more suitable for both marine and terrestrial ecological units differentiation.

ANNEX 1

INDEX MAP OF FORTY-TWO SUBSCENS (10KM x 10KM IMAGERIES OF SPOT DATA) COVERING THE 250KM CORRIDOR FOR THE PROPOSED HIGH VOLTAGE ELECTRICITY TRANSMISSION LINE.



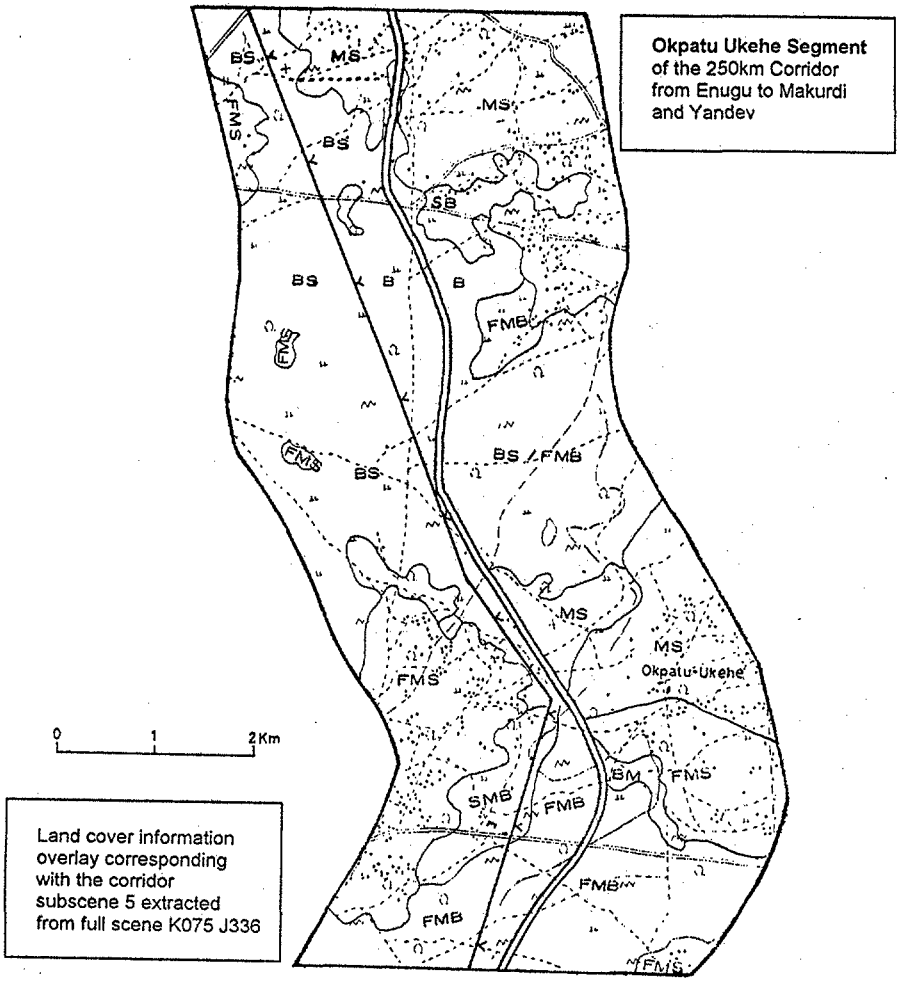
Subscenes extracted from full scenes of SPOT Data:
K 075 J337 imaged on 24/12/86
K077 J335 imaged on 19/12/86
K 075 J336 imaged on 15/12/90
K076 J335 imaged on 15/02/90
K076 J336 imaged on 15/02/90

ANNEX 2:
CHAIN OF ACTIVITIES FOR THE THEMATIC CARTOGRAPHIC CONVERSION OF THE SATELLITE DATA

CASE 1 LAND COVER MAPS OF THE 250KM HVTL CORRIDOR	CASE 2 PHYSIO-ECOLOGICAL AND ASSOCIATED LAND COVER/LANDUSE MAP OF THE ENVIRONMENT OF THE ON-SHORE PRE-PROCESSING PLANT
1. Load at a time each full CCT scene (SPOT XS). Enhance the standard false colour composite image. 2. Print work image at 1/100,000 for synoptic or global viewing of the existing highway. 3. Define the position of the corridor on the work image. 4. Define subscene segments to contain the proposed corridor and print out the enhanced subscene images at 1/50,000 scale. 5. Match the subscene prints with corresponding topographic maps using the latter as reference for interpretation. 6. After scanning all the subscenes, develop an interpretation scheme which applies to the entire corridor's diverse conditions. 7. Carry out interpretation of the subscenes at 1/50,000 scale using the scheme Place the porposed corridor after the interpretation. 8. Transfer the information onto a topographic base map containing topographic information. 9. Convert the redrawn map to transparent overlay to match an underlay which is final standard composite subscene imageries at the same scale.	1. Load the full (SPOT P) scene from the CD-ROM supplied. 2. Enhance the image by contrast manipulation and scan through the full scene to ease conceptualization of the interpretation scheme and scale of interpretation. 3. Decide on a global scale of 1/100,000 for the work image and print subscenes for mosaic as work image. 4. Reproduce on transparent film the existing topographic maps to match the scale of the work image. This eases the process of feature identification for the imagery. 5. Using the illumination of a light table overlay the transparent topomap on the image mosaic and observe the physiographic zones and land units within them. 6. Conceptualize the legend for interpretation of the land cover types within the physiographic zones identified. 7. Produce a final interpretation at 1/200,000 scale and apply multi-colour scheme for the final map. 8. Print Subscene imageries of localities For each locality subscene overaly the imagery a transparency of the landcover interpretation. 9. Produce index map of the locality 18 subscenes and the interpretation overlays.

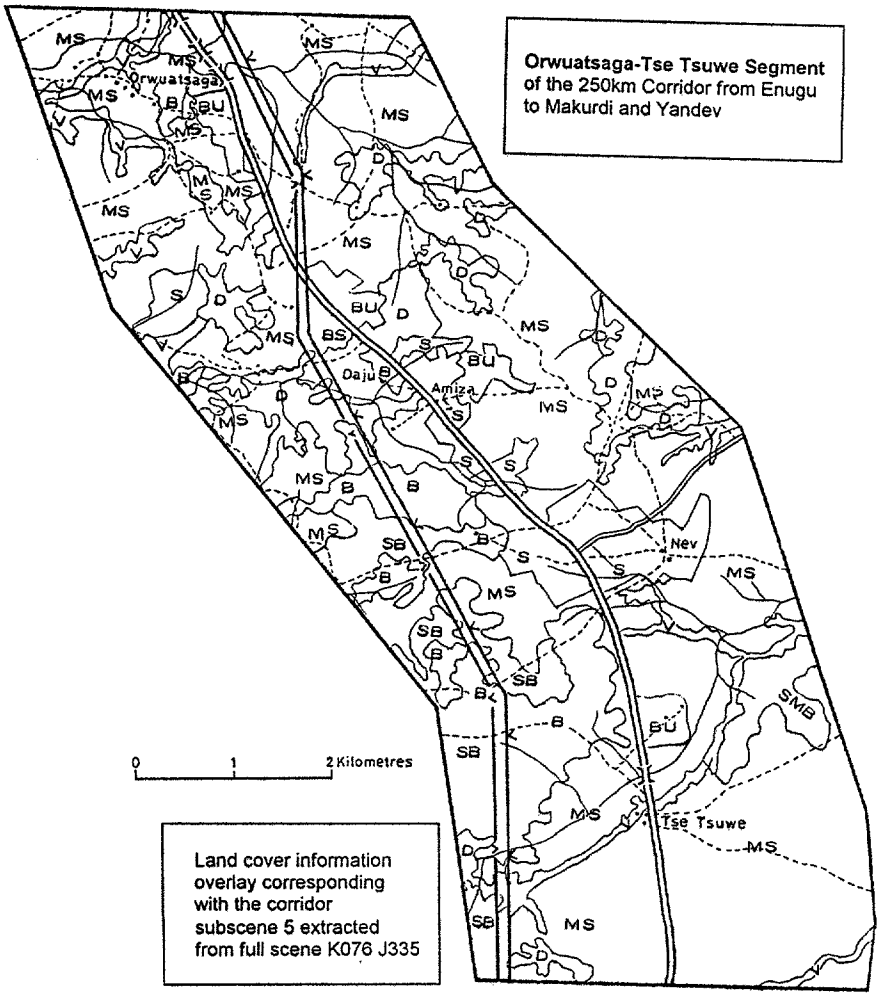
ANNEX 3

PROPOSED HIGH VOLTAGE ELECTRICITY TRANSMISSION LINE CORRIDOR FOR LANDCOVER INFORMATION AND DERIVED FROM COMBINATION OF SATELLITE IMAGERY AND TOPOGRAPHIC MAP



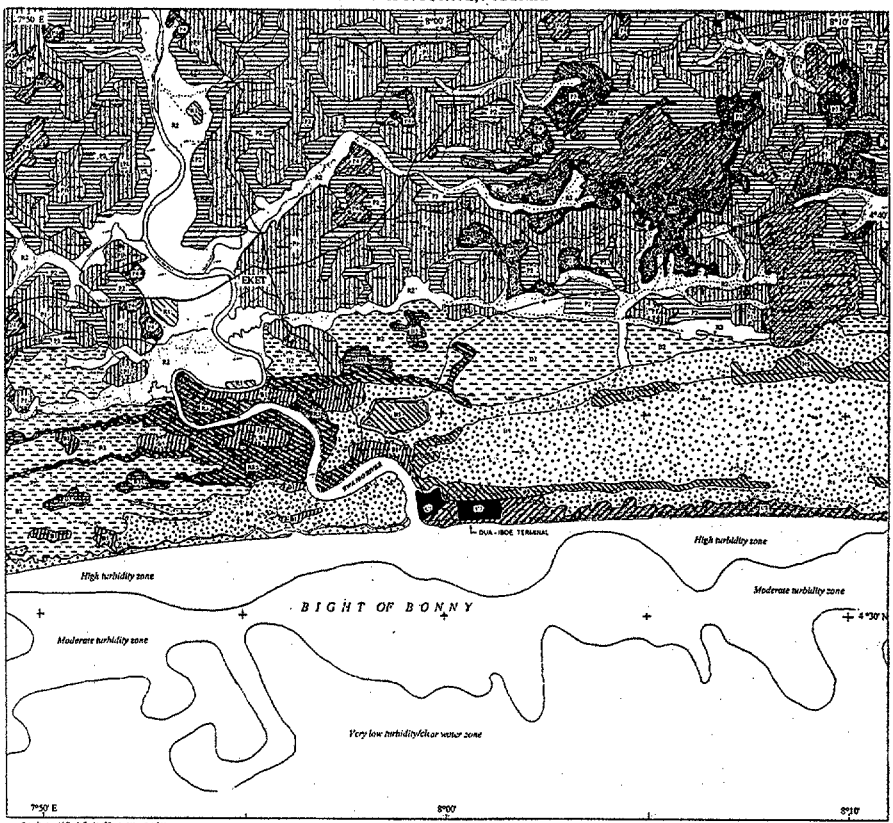
Original Document Presented as a Transparent Overlay Superposed on its Corresponding Colour Composite Imagery of SPOT XS Data

ANNEX 4:
PROPOSED HIGH VOLTAGE ELECTRICITY TRANSMISSION LINE CORRIDOR FOR LANDCOVER INFORMATION AND DERIVED FROM COMBINATION OF SATELLITE IMAGERY AND TOPOGRAPHIC MAP



Original Document Presented as a Transparent Overlay Superposed on its Corresponding Colour Composite Imagery of SPOT XS Data

LAND COVER/LAND USE IN THE EKET - MOBIL QUA IBOE TERMINAL AREA IN AKWA-IBOM STATE, NIGERIA.



Consultants : (i) Triple E - Josef Rosas Associates, Lagos
In Regional Centre For Training in Aerospace Surveys (RECTAS)
Ile-Ife, Nigeria July, 1994

Scale : 1 / 200 000

0 2 4 6 8 10 Km

Client: Mobil Producing Nigeria

A. Coastal Plain

P1 Settlements and associated landuses including farmlands
P2 Mainly cultivated
P3 Cultivated upland and forested lowland
P4 Forested upland and lowland

B. Coastal Barrier

Bb.1 Settlements and associated landuses including farmlands
Bb.2 Alternating bands of cultivated upland and forested lowland
Bb.3 Alternating bands of forested upland and lowland
Bt. 4 Brackish swamp forest of the tidal flats
Bt. 5 Degraded brackish swamp forest of the tidal flats

C. Coastal belt

C1 Settlements, other built-up or installations
C2 Cultivated beach ridge

B. Riverine

R1 Cultivated
R2 Freshwater swamp forest of the plains and valleys
R3 Brackish forest of valleys under tidal influence

Approximate limits of Stubbs Creek Forest Reserves
River water bodies, visible in the imagery
Limits of Forest Reserve visible on the Satellite imagery

Sources: (a) SPOT Imagery (Panchromatic mode) XT1 241 date January 27, 1986,CNES
(b) Topographic maps: Nigeria 1/50 000 series: Opobo SE Sheet 339, Calabar, SW Sheet 316 SW
(c) Field information collected in July 1994.