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SLAR MOSAIC INTERPRETATION FOR FORESTRY PURPOSES

A case study of the interpretation of a SLAR mosaic of Nigeria without additional information

by

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Abstract

The SLAR user, on receiving a mosaic and its corresponding interpretation map for forestry purposes, may for several reasons obtain a wrong impression of the possibilities and restrictions of SLAR. To emphasize the importance of additional background information and the need for groundtruth data, the author has selected as a case study a SLAR mosaic, scale 1 : 250,000, of a tropical rainforest region in Nigeria. The three main elements visible on SLAR mosaics - drainage, humen influence and physiographic features - were interpreted and mapped. Afterwards these maps were compared with the recently compiled vegetation and land use map of the same region. The conclusions are that the interpretation of a small scale SLAR mosaic can give important information about the three main elements, but without additional information and groundtruth data an accurate map for forestry cannot be compiled.

Introduction

Side Looking Airborne Radar (SLAR) is a well-known, tried and tested system of obtained small scale images of vast tropical rain forest regions. Especially for those regions where climatic conditions may hamper complete coverage within a certain time limit, SLAR is often a more reliable technique for small scale mapping than conventional small scale aerial photography or the use of Landsat image data. Projects like RADAM in the Brasilian Amazon, PRORADAM in the Colombian Amazon and, more recently, the SLAR coverage of Nigeria have shown on a worldwide base the importancy of this remote sensing technique.

For the interpretation of SLAR images for forestry purposes, the interpreter may have to his disposal additional material such as aerial photography, topographic maps, "obsolete" forest type maps and information about the vegetation from forest inventories or other sources. Logically these data are a must if the interpreter is not yet well trained. However, even a well trained SLAR interpreter will have problems adjusting an existing forest type classification to SLAR interpretation with its properties and limitations. Moreover, a SLAR project is generally not

carried out for one single purpose such as forestry alone, but as a multidisciplinary tool which may be used for a variety of purposes including thematic mapping for geology, geomorphology, soil survey and land use. With good interdisciplinary co-ordination one may take advantage of the possibilities of interchange of valuable data and a better directed field control.
However, a point easily overlooked is that to accomplish the extrapolated data from the other disciplines, the system for forestry interpretation may be too complicated. Also it is possible that because of a tight time schedule or lack of funds the field control is not adequate to obtain the required accuracy for small scale mapping.

To emphasize of this Congres the importance of having additional data, prior information and groundtruth data, the author has selected as a case study a SLAR mosaic of a tropical rain forest region of Nigeria. The three main elements visible on SLAR mosaics - drainage patterns, humen influence and physiographic features - were interpreted and mapped in an attempt to demonstrate the possibilities and restrictions inherent to this remote sensing material, with the condition that no additional data or prior information would be used. In this way the user, on receiving a SLAR mosaic and its corresponding interpretation map for forestry purposes, obtains an impression of the possibilities and restrictions of SLAR. The author has ten years' experience in this type of work in tropical rain forest regions in Latin America and South-East Asia.

Material

For the case study, the SLAR mosaic NB 31-8S, (south-look) of Nigeria was selected, covering at scale 1 : 250,000 an area of 1,550,000 ha between the co-ordinates of 4°30°E-6° and 6°-7°N. The only reason that the south-look mosaic was preferred to the north-look mosaic was that with the north direction up the radar shadows were falling towards the observer in such a way that a correct 3-dimensional impression was obtained. Bands of lighter and darker tone were faint in the along track direction (E-W). The rather coarse halftone (raster) print of 5 dots/mm made visual enlargement with a magnifying glass unnecessary. It was impossible to indicate with any accuracy the near range and far range parts of the original SLAR strips. Individual SLAR strips were not available, which means that the characteristics of special features could not be interpreted simultaneously in the near and the far range parts of the strips or under stereoscopic observation.

Interpretation

Three of the elements visible on SLAR mosaics, namely drainage patterns, human influence and physiographic features, are particularly useful for forestry purposes. They reveal important basic information for forest and vegetation type mapping, planning an inventory or land use and future timber exploitation or for other forestry purposes like forest reserves, natural parks or watershed management for erosion control. Interpretation maps were made of all three elements. Afterwards these maps were compared with the recently compiled vegetation and land use map, sheet NB 31-8 of the Federal Department of Forestry, Nigeria; based onto SLAR and supported by detailed field studies.

1. Drainage patterns

Large bodies of water like the sea, an estuary, lakes and main rivers are easily detectable by their black tone and smooth texture. Swamps, former river courses and oxbows in the wet land, border areas dividing wet and dry land, the pattern of gallery forest along streamlets in grassland and strongly curved rivers are easily detectable. The smaller rivers and streams with an east-west alignment in the dryland with small topographic height differences and in the low hill regions are more easily detectable than the rivers and streams with a north-south alignment. For the latter the general course can be predicted but an accurate delineation is difficult. In the high hill region and even more pronounced in the mountainous region the pattern of the drainage is difficult to establish. The presence of radar shadows and the high reflection of the slopes towards the radar beam prevents the delineation of a reliable pattern of the partly visible drainage. In places it may be difficult to distinguish between small lakes or recently burned areas. A road with many curved stretches can give the same impression as a river.

2. Human influences

The straight line pattern of humen influences is clearly visible if tonal differences are present and if the abrupt change in height between lower vegetation and high forest is towards the radar beam (thin line of high reflection) or away from the radar beam (thin dark line of radar shadow).
Generally the alignments in the east-west direction are more clearly detectable than those in the north-south direction. The city of Benin has an overall light tone; other areas with a light tone will not be mistaken for a city if no roads are visible nearby. Villages can not be detected if their location is not already known. The main roads with their straight line configuration can generally be delineated accurately; however, in some parts, even with an east-west alignment, too many changes in the natural vegetation may prevent delineation of the main roads. Smaller roads and tracks are not visible on this SLAR material. In the dryland region of terraces and low hills the plantations, permanent agriculture or grassland are delineable if the area is large enough and its limits are straight lined. Tonal differences within these areas may indicate the type of plantation or agriculture, but even the broad separation between forestry - and crop plantations is not accurate due to the influence of the slope aspect of tone.
In the high hill and mountainous regions the delineation becomes more difficult and because of radar shadows or high reflectance of the hillslopes towards the radar beam differences in vegetation due to human influence will be unpredictable. The biggest problem is the detection of the small areas of agriculture classified as shifting cultivation and a possible differentiation between secondary forest and natural low forest types of the dryland regions. Individual patches smaller than 5 ha may not be detectable at this scale of 1 : 250,000. Some of the boundaries of the forest reserves were clearly detectable.

3. Physiographic features (zones)

Normally the tropical rainforest is heterogeneous in species composition and diameter distribution. Of all the species in the heterogeneous forest types only a few have an actual commercial value. The presence of these commercial species can either be dispersed throughout the forest or more or less grouped according to special growing conditions. These conditions are mostly related to topography, stagnating rainwater, impermeable or sandy soils, human influences (shifting cultivation) and the influence of salt water near the coast. As on small scale SLAR mosaics the individual tree is not visible it is not recommended to use interpretation systems bases on the delineation according to species, tree height, crown closure or grown diameter or even volume. The topographic height differences under a dense tropical rainforest are better reflected on SLAR images than on aerial photographs.

The delineation between flooded (wet land) and non-flooded (dry land) areas is fairly easy to delineate accurately on SLAT and is important in view of species composition and exploitation methods. The delineation of the dryland forest into classes or ruggedness of the terrain may have a correlation in species composition and volume; even when there are no significant differences in species composition or volume according to inventory data, this delineation into ruggedness classes gives important information for the exploitation of the forest.

As a guideline and example, the SLAR interpretation system recommended for the tropical rainforest in Colombia (according to physiographic features) was used:

Zone

M - Coastal plains

M_0 - Forest vegetation on beach ridges or dunes

M_1 - Mangrove forest

M_2 - Forest on former beach ridges

M_3 - Swamp forest on swales (lower parts)

A - Alluvial floodplains and low terraces liable to inundation

A_0 - Forest on the natural levees

A_1 - Low swamp forest

A_2 - High swamp forest

A_3 - Forest on low terraces

B - Terraces and low hills

B_0 - Streamlet forest with swamp conditions

B_1 - Forest on nondissected terraces

B_2 - Forest on undulating terrain or dissected terraces

B_3 - Forest on low hills

C - Strongly dissected high hills and sloping remnants

C_0 - Forest on steep slopes along the streamlet

C_1 - Forest on high hill ridges

C_2 - Forest on hill slopes

C_3 - Forest on sloping remnants

D - Mountainous forest

Special vegetation types

P - Swamp

S - Humid savannah

R - Vegetation on rock outcrops

Y - Shifting cultivation and other human influences

For the interpretation of this SLAR mosaic, adjustments have to be made:

a) The coastal region, actual and former, covers a large area; the limit with the floodplain is clear and differentations into sub-classes may be possible: mangrove forest, backwater swamps, low forest on former sandbanks (beach ridges) and human influences. An accurate delineation of these sub-classes depends on additional data.

b) In general the limit between wet land and dry land can be delineated with a certain degree of accuracy. In particular the limit between low terrace liable to inundation (floodplain) and the nondissected terrace of the dry land is difficult to establish. The topographic height difference between these two types of terrace is small, but the species composition and volume of commercial species may differ considerably. For the same reason the limit between the floodplain forest and the streamlet forest with swamp conditions is difficult to interpret.

c) In the terraces and low hills zones some differences in ruggedness can be interpreted, but even for the east-west alignment those differences are not clear enough as a base for a ridged classification.

d) The limit between low hills and the zone with high hills is a subjective one. The sub-delineation in the high hill zone is not well defined.

e) The limit between the high hill zone and the mountainous zone can be regarded as fairly accurate. Sub-delineation within the mountainous zone is not recommended for this type of interpretation.

Without additional information the next physiographic zones can be delineated: Coastal plains (M), Floodplains (A), Terraces and low hills (B), Strongly dissected high hills (C) and Mountainous (D), with the possibility of some sub-delineation in the M, A and C zones without an accurate classification.

Conclusions

The interpretation of a small scale SLAR mosaic can give important information about the drainage patterns, human influences and physiographic features for delineation into main physiographic zones, but without additional information and groundtruth data a reliable map for forestry purposes cannot be compiled.

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