

VISIBLE, INFRARED AND SYNTHETIC APERTURE RADAR DATA FOR DETECTING ENVIRONMENTAL CHANGES: THE PANAMAZONIA PROJECT

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ABSTRACT

In order to monitor environmental changes within the boundaries of South America tropical forest a cooperative project among the Amazonian countries was started some months before the 92 UN Conference on Environment and Development. A selected team of Remote Sensing Specialists was trained both in image analysis, GIS integration and management procedures. Images were derived from LANDSAT Thematic Mapper and SAR-ERS 1 instruments. More than 300 images were distributed to Panamazonian countries and a temporal approach ranging between 84-88 and 88-90 was adopted in order to have some preliminary results of the annual rates of deforestation in South America. The first results arose from Bolivia and French Guyana. Small spots of clearcuts appear in the vicinities of Kourou and Cayen in French Guyana. Deforestation figure of Bolivia is 3 times lower then the numbers issued elsewhere in the literature. Results from Ecuador, Peru, Suriname and Guyana are still to come because there is a lack of dedicated hardware to undertake the project. Besides deforestation some new features have been detected. These new features are mostly found within the Brazilian Amazon and they are indicating significant expansion in ore/oil exploitation and gold mining

1. THE PROJECT

PANAMAZONIA Project is a joint effort of South America countries facing the monitoring of the Amazonia Forest through the use of remotely sensed data and wall-to-wall procedure in a computerized data set. Forest clear-cutting in Brazil have been evaluated since 1989 by means of GIS and LANDSAT frames. The methodology used to monitor deforestation and to measure the rates of deforestation from year-to-year in Brazil is now being transferred through Panamazonia Project to others South American countries as: French Guyana, Suriname, Guyana, Venezuela, Colombia, Ecuador, Peru and Bolivia.

2. THE PROCEDURES

The project was designed back in May 1991 and three main topics were then established: i) Training of a technical team to develop the Project within each Panamazonia country; ii) Selection, acquisition and generation of color infrared LANDSAT prints at 250.000 scale of two periods (1984-1988) and (1988-1991); iii) Transference of GIS technology and implementation of a computerized data base in those countries where these procedures were not available. After 14 months the

Project had assured working teams in all Pancountries. These teams were trained and acquainted with remote sensing and GIS technology.

3. THE FRAMES

LANDSAT frames (more than 300) were acquired through the Brazil/Ecuador receiving stations. Additional frames (80) were acquired from EOSAT. The frames are all Thematic Mapper color composite of bands 3B4G5R in 250.000 scale and mostly are from the dry season. Some exclusive hard rain areas have been analysed through SAR-ERS-1. These are include: Parakaima Mountains between Brazil and Venezuela; Amapa Region along the low waters of the Amazon River and the coastal zone between the Amazon and Paramaribo. These images are now being analysed by the technical teams.

4. PRELIMINARY RESULTS

First results were achieved by knowing more precisely the boundaries of tropical forest in South America. Taking into account the bright signature of the forest in band 4 the ecosystem comprised by the Tropical Rain

Forest in South America (excluding Brazil) is 2,500,000 square kilometers large and even a little greater when all the measurements shall be completed. This huge system is covered by 156 nominal LANDSAT full frames.

In order to have a complete coverage of each country in two periods the Project requested 350 images INPE-Brazil (270), EOSAT-USA(80) and Cotopaxi-Ecuador (2). the number of images that were distributed to Panamazonia countries. Just 28 images from both periods (7% of the images) were not available due to excessive cloud coverage (limit of clouds: 40%)

Typical patterns of deforestation widely distributed in Brazil have not been found in others South American countries. This is the case of the large farmlands widely spread in the Brazilian Amazonia. They were not depicted elsewhere in the Panamazonia countries. The fish ribbon-like pattern of landuse widely distributed also in Brazil is not found too. Out of Brazil the settlers work in smaller sites. Growing settlements can be found in Bolivia (Cochabamba and Santa Cruz de la Sierra), Peru (Pucalpa and Iquitos), Ecuador (Napo Headwaters), Colombia (Guaviare and Caqueta Headwaters).

The partial results indicate that the numbers for deforestation in South America issued elsewhere (e.g. FAO, Friends of Earth) for Bolivia between the periods of 1984 to 1991 were 300% overestimated. Other partial results of Peru, Colombia and Venezuela are indicating that the numbers for the deforestation in South America must be reviewed. This revision must be done taking in account new technological capabilities as GIS and orbital all weather Remote Sensing devices.

5. NEW FEATURES

Spectral and temporal attributes of Remote Sensing data have shown new features mostly within the Brazilian bounds. These features are indicating an expansion in ore/oil exploitation and increased actions of gold miners.

Waterscape changes for instance that were detected in Xingu and Tapajos rivers are due to the digging of gold bearing alluvia. Coarsed sediments digged and washed out from the alluvial banks are changing clean and fresh-water rivers into turbid and muddy streams. Images have shown that typical digging signatures are drifting from the exhausted gold gravels of Carajas-Serra Pelada to the North of Mato Grosso State and to the South of Para State.

Environmental damages otherwise are not the case for the large and well planned projects of ore exploitation such are Pitinga (Tin), Trometas (bauxite) and Carajas (Fe, Mn, Ni, Au). These projects have grown without significant damages except for those due to the

exploration for the surrounding overburden. Shortwave infrared images of those sites have shown no impacts in the waterscapes that surround the open pitch mines

Brazilian Oil Company has recently measured giga cubic meters of gas in the headwaters of Tefe River in the State of Amazonas and potential oil trappings have also been mapped. Geophysical and Geological prospecting have let some surprising features within the forest and they were clearly registered in the images as delta wing-like patterns.

Except for spectral bands, the temporal attributes are the key elements to monitor the land and the waterscapes of the Panamazonia countries. To track timely and effectively the environmental changes in this region one must to gain high experience in analysing and integrating the data collected by current all weather Remote Sensing satellites. That is the coming purpose of the Panamazonia scientific team.

6. SELECTED BIBLIOGRAPHY

ENRIC, 1994. A Source Book on Tropical Forest Mapping Through Satellite Imagery: the Status of Current International Efforts. Environmental and Natural Resources Information Center (ENRIC). Arlington, VA-USA

FAO, 1988. An Interim Report on the State of the Forest Resources in the Developing Countries. Forest Resources Division. Rome

Girou D.; Lamotte G., 1994. Guyane Francaise-Projet Panamazonia 1993. Ecole Nationale de Genie Rural des Eaux et des Forets (ENGREF). Centre de Kourou. Kourou, Departement du Guyane, France.

INPE, 1994. Technical Cooperation and Training within the Panamazonia Project: a Proposal to UNEP. Brazilian National Institute of Space Research (INPE). Sao Jose dos Campos, SP, Brazil

Martini P.R., 1992. Panamazonia Project: an Executive Report. Sociedad de Especialistas Latinoamericanos en Percepcion Remota SELPER Newsletter 8 (1) pp.8-12.

Martini PR, 1993. Panamazonia Project to Monitor South America Tropical Forest. In: Memories of VI Latin America Remote Sensing Symposium, Cartagena de Indias, Colombia, pp. 25-29.

Melo Wilches H., 1993. Proyecto de Monitoreo de la Influencia Humana en la Deforestacion de la Cuenca del Amazonas. In: Abstracts of VI Latin America Remote Sensing Symposium, Cartagena de Indias, Colombia, p.169.

Myers N., 1989. Tropical Moist Forests: Present Status of Selected Countries (Areas in km²). Table #15.1. Max Planck Institute Report on Tropical Forests.

Quiroga J.C., 1992. Desbosque de la Amazonia Boliviana. Centro de Investigaciones de la Capacidad de Uso Mayor de la Tierra CUMAT. La Paz, Bolivia.

Salcedo R.; Meneses C., 1993. Deforestacion en el Bosque Lluvioso Tropical: Una Perspectiva Multitemporal- Proyecto Panamazonia Caso Venezuela. Servicio Autonomo de Geografia y Cartografia Nacional SAGECAN. Caracas, Venezuela.