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CARTOGRAPHY AND REMOTE SENSING IN THE AMAZON
THE SIVAM PROJECT

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ABSTRACT

The purpose of this paper is to prsent some ideas about the cartography and remote sensing applications in the Amazon region, in the SIVAM Project conducted by the Brazilian Air Force and the future launch of the CBERS - The China Brazil Earth Resources Satellite.

The Amazon represents 54% of the Brazilian territory, that is approximately two million square kilometers, 30% are not mapped in the systhematic maps scales: 1:25.000, 1: 50.000 and 1:100.000 and without a geodesy network observing the Index - Map of the Brazilian Institute of Geography and Statistics - IBGE. The warm and humid conditions, rain forest and cloud covery do not support the photogrammetric activities and remote sensing activities.

The Amazon Region Maps produced by the RADAM Project, from 1970 Age in militar geopolitics named Amazon Operation are very old and were in small scales - the radar images maps are in 1:250.000 scale and thematic maps are in 1:1.000.000 scale. Those maps were produced by airbone side-looking radar SLAR data. The Brazilian Amazon needs changing for territory manegement. These photos present the Urucu Base, in the jungle in the State of Amazonas, from the PETROBRÁS - the Brazilian Oil Company.

The Cartography Institute of the Brazilian Air Force - ICA that has only forteen years, is producing image-maps (12) in the 1:500.000 scale, (5) in the 1:250.000 scale due to the lack of cartographic documents in the Amazon region. Its product has satisfyed throuh sucess. The Director of ICA is Lieutenant Engineer Alison Vieira de Vasconcelos. The former Director of ICA is Lieutenant Colonel Engineer Nei Erling, nowadays the President of the Brazilian Society of Cartography - SBC.

Nowadays the Secretary of the Strategic Affairs - SAE and the Brazilain Air Force Ministry have another geopolitcs with the creation of the Amazon Protection System - SIPAM and the Amazon Vigilance System - SIVAM worried about the Brazilian society, recommending the sustainable development, indian land demark and protection, natural reserves, environmental control, public health (tropical injuries), cartography and remote sensing.

The Brazilian Air Force - Força Aérea Brasileira - FAB will map the Amazon region using the airbone synthetic aperture radar - SAR from the Mac Donald Detwiler - Canada fixed to the airplanes EMB - 145 from Aeronautic Brazilian Enterprise - EMBRAER, located in São José dos Campos, São Paulo State.

The question of a solution of the lack of systematic mapping in the Amazon is importante in the direction of making viability to demark and to vivify the terrain frontiers and principaly to provide informations for the sustainable development in this region, moreover in accordance with SILVA (1991) “Cartography is ecology, because is the scince that permits through its methods, actions, precisions technics materialized on the earth surface and by means of graphics representations to demark, to develop, to monitor and to protect the ecosystems and its respective people. It can not have ecologycal mentality without cartographic mentality”.

Since the 60 Age the Brazilian Air Force fixed goals into the aeronautical field (the Pró-Alcool Project) and will give to the Brazilian society the SIVAM project. The Brazilian society waite the charts that will be produced by the FAB that will complete the lack of maps in the Amazon region.

The document named “Subsídios Técnicos para a Elaboração da Relatório Nacional do Brasil”prepared to the Rio United Nations Conference On Environment And Developing - UNCED 92 did not discuss the cartographic activities to the Amazon. It is impossible to study some place without up-date maps. The geographic space needs definition from cartographic technics for having its limit established and guarantee the national sovereignty.

On discussing the sovereignty concept and the national interesting the Minister of the Military Supreme Court Lieutenant Brigadier Sérgio Xavier FEROLLA (1994) told us at the National War College - Ëscola Superior de Guerra - ESG: “The Brazilian Constitutions ordains as the state principles of sovereignty and the national autodetermination. The nationality and citizenship do not exist out of its principles. These principles pride strategies to the Nation - State understood as a historical category and politic institution, economic and social.

However, the national sovereignty principle accompanying the historical evolution. It is not limited to

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the geographical question, to the territorial limits only, as it was in the past; they have been produced by frontier policies, military or diplomatic staff.

Nowadays, it is certain that sovereignty involves scientific socialeconomic vision, technology, politic and culture that has starting point to the national interest and as goal the permanet consolitation of the Country, it historical continuation and progress for the national economic system particularly in the developying nations, that had been considered viable by the geographic exuberance and by the potential of sustainable growth, as the case of Brazil".

The Minister Ferolla former commander of ESG that has been produced the Brazilian Doctrine during last 46 years founded in 1949 to train upper-level officers and sellected civilians to perform executive doctrines and advisory functions in the Brazilian State, introduced to us the Fifth National Power Expression - the Science and Technology. The other is Social, Military, Economic and Psychosocial. The commander of ESG is the General of Army Expedito Hermes Rego Miranda.

Considering the tropical area and its continental dimensions of the Amazon that represents a significant challenge to the Brazilian Air Force in its cartographic and remote sensing activities. The FAB will create the Brazilian Monitoring System where the cartographic and remote sensing products will be:

- MSS - detailed thematic mapping fixed to the EMB - 145 Brazilian airplane
- SAR - fixed to the EMB - 145 Brazilian airplane - Cartographic up-date;
- New maps;
- Digital elevation models - DEM's;
- Radar image - maps.

The SAR characteristics are:

- high spatial resolution;
- positioning error 100 m;
- mapping producing in the scales: 1:25.000, 1:50.000, 1:100.000, 1:250.000, 1:500.000 and 1:1.000.000.

The SAR is able to operate night and day in two bands: X for cartography and L to the biomass available.

The SAR parameters are:

- spatial resolution - 3,6 and 18 meters;
- scanner range - 10/20, 20/40 and 20/120 km;
- operation altitude - 6 000 m;
- X band (3,0 cm) - interpherometric capacity;
- L band (25,0 cm) - multipolarization capacity.

The SAR applications are:

- for X band - digital elevation models - DEM"s, mapping, vigilance, civilian defense support;
- for L band - biomass available, land use, geology survey and swampy areas determination

The Radar imagery are:

- Air/air mode:
  - scanner - 360º;Reach - 70 km, DP=90%, Radar Cross Section = 2,0 m;
  - Variable beam in elevation;
  - scanner angular speed - 18º/seg
  - moving target indicator;
  - tracking: accompanying until 30 aim moveables.
- Surface - air mode/ Search track in large areas (X band):
  - scanner - 360 º in sectors of 60 º/ 120º
  - distance resolution - 6,0 m / 18 m;
  - azimuth resolution - 0,2 mrad / 0,42 mrad;
  - reach - 92 km;
  - width from scanner area - 60,0 km;
  - scanner speed - 6º/ seg
  - MTI - Moving Target Indicator;
  - Tracking: Accompanying until 30 aim imoveables.

The Multispectral Scanner performance parameters are:

- FOV: 86º;
- IFOV: 1,25 / 2,5 mrad:
- Operation altitude : 0 - 4600m;
- . spectral range: 0,42 - 12,5 m;
- . (VIS) bands: 1 - 5;
- . (IVR) bands: 6 - 10;
- . (IVT) bands: 11.
- . scanner frequency: 6,25; 12,5; 25 scan./s.

The MSS applications are:

- land use;
- hydric resources;
- vegetation;
- agriculture production;
- Ecological Economic Zoning - ZEE support to the sustainable developing controlled by SAE;
- burning forest;
- deforestation;
- indian s land mapping and
- mapping and identification of non-regular areas.

The MSS spatial resolutions are:

pixel

- 1000 m - 1,25 - 2,5 m;
- 2000 m - 2,5 - 5,0 m;
- 3000 m - 3,75 - 7,5m;
- 4000 m - 5,0 - 10,0m.

The airbone SAR may be applied with satellite data, because the boarding processing is real time and digital maps are acceptable in format .like LANDSAT 5 and 7, SPOT 1,2 and 3, ERS-1, JERS - 1, RADARSAT and future launch CBERS- China Brazil Earth Resource Satellite using of the SPRING sotware developed by INPE - National Institute for Space Research in 1998.

The SIVAM Project will increase the INPE capacity on receiving remote sensing satellite data from LANDSAT, SPOT, ERS -1, RADARSAT and CBERS by the duplication of the antenna reception and increasing the capacity of images recording at INPE - Cuiabá , Mato Grosso do Sul State and increasing the capacity of images processing at INPE - Cachoeira Paulista, São Paulo State.

The former President of ICA/ACI D.R. Fraser TAYLOR (1994) mentioned seven strategies used by China in its mapping activities. The last one is related to

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remote sensing as such: Ïn the processing of remote sensing imagery, China has an impressive record and has been quite innovative. It has developed its own platforms and has launched its own satellites. In addition there has also been an innovative combination of labour intensive and capital intensive technology. Extensive field checking of images using thousands of people has helped to develop a better image analysis potential".

In an effort to provide a suitable answer to this challenge, China and Brazil agreed on July 6, 1988, to start a cooperative program to develop two remote sensing satellites. This joint China - Brazil Earth Resources Satellite - CBERS Program pools the technucal skills and financial resources of the two countries to establish a complete remote sensing system that ais both competitive and compatible with present international needs with the agreement - Chinese Academy of Space Technology - CAST and National Institute of Space Research - INPE.

The CBERS - 1,2,3 and 4 satellites are designed for global coverage and include cameras to make optical observations and a data collecting system to gather data. They are unique systems due to use of on board sensors which combine features that are specially designed to resolve the broad range of space and time scales involved in the monitoring and preservation of ecosystem.

The CBERS satellites will enhance and complement the existing remote sensing systems in an effort to improve our knowledge about the Earth environment and resources. A unique characteristic of CBERS is its multi-sensor payload with different spatial resolutions and data collecting frequencies.

The Wide Field Imager - WFI has a ground swath of 890 km which provides a synoptic view with spatial resolution of 260m. The Earth surface is completely covered in about 5 days in two spectral bands: 0,66 mm (green) and 0,83 mm(near infra-red).

The high resolution CCD camera provides images of a 113 km wide strip with 20m spatial resolution. Since this camera has a sideways pointing capability of + 32 degrees it is capable of taking stereoscopic images of a certain region.In addition, any phenomenon by the WFI may be "zoomed"by the oblique view of the CCD camera with a maximum time lag of 3 days.

The CCD camera operates in 5 spectral bands:

0,51 - 0,73 m (pan)
0,45 - 0,52 m
0,52 - 0,59 m
0,63 - 0,69 m
0,77 - 0,89 m

The two spectral bands of the WFI ((0,63 - 0,69 m and 0,77 - 0,89 m) are also present in the CCD camera to allow complementing the data of two types of remote sensing images. A complete cycle of the CCD camera takes 26 days.The spatial resolution is 20m.

The Infrared Multispectral Scanner(IR- MSS) operates in 4 spectral bands:

0,50 - 1,10 m(pan)
1,55 - 1,75 m
2,08 - 2,35 m
10,40 -12,50 m

such as to extend the CBERS spectral coverage up to the thermal infrared range. It images a 120km swath with a resolution of 80 m (160 m in the thermal channel). In 26 days one obtains a complete Earth coverage that can be correlated with the images of CCD camera.

The CBERS includes a data collection system for real-time retransmission of environmental data gathered on the ground and transmitted to the satellite by small autonomous stations. The data from thousands of these stations located anywhere on Earth are directed at the same time to processing centers and to -users by means of transmissions in different frequencies.

The CBERS satellite is composed of two modules. The payload module houses the optical and electronic systems used for Earth observation and for data collecting. The service module incorporates the equipment that ensures the power supply, the control, the telcomunications and all other functions needed for the satellite operation.

The 1100 W of electrical power needed to operate the on-board equipment are obtained through solar panels that are deployed when the satellite is in orbit and that are continuously oriented towards the sun by automatic control. To provide the stringent pointing accuracy needed by the sensor systems that will take high resolution images from a distance of about 800 km, the satellite is equipped with a sensitive attitude control system that is complemented by a set of hydrazine thrusters which are also used in eventual satellite orbit correction maneuvers. The internal data used to monitor the satellite health are collected and processed by a distributed computer system before being transmitted to the Earth. An active and passive thermal control system provides the appropriate environment for operation of the sophisticated on-boar equipment.

CBERS has a sun-synchronous orbit at an altitude of 778 km, completing about 14 revolutions per day. The local solar time at the crossing of the Equator is always at 10:30 A.M. thus providing the same sola illumination conditions for comparing images taken in different days.

It takes 26 days for the satellite to revisit the same Earth location. This is the time necessary to image the entire Earth with the CCD and the IRMSS cameras that have narrow fields of view. On the other hand, using the WFI camera which is able to take images that are 900 km wide, the time required for global coverage is 5 days.

The sideways pointing capability of the high resolution CCD camera combined with the type of satellite orbit provides stereoscopic vision capability for given region with an interval of 3 days between the two elementary images.

The CBERS satellites will be launched by Chinese rockets of the Long March series from the Shanxi Launch Site in China.The image receiving stations and the processing centers in Brazil and in China provide the main network for image reception. Stations in other

countries may be established to extend the CBERS coverage potential.

The Commission of the Coordination of the SIVAM - CCSIVAM and IBGE signed one agreement about U$$ 1,500,000 in August ,1997. The IBGE will give the cartographic bases to the systhematic maps, thematic maps and data bases to the SIVAM.

Brazil needs maps see MORAES (1991), Fator GIS (1995) and in accordance with the former Minister of the Brazilian Air Force Lieutenent General Mauro José de Miranda GANDRA (1994) speaking about the consideration of the Brazilian cartographic panorama and technology:

"In realty the ideal situation for the solution of Brazilian cartographic problems will be combined use of data from aerial photographies and various remote sensing platforms: to visible until infrared and the airbone microwaves and satellite microwaves in the National Cartographic Policy in order to make better use of the synergism and completion with them by the use of the image digital processing and geoprocessing technics available nowadays".'

"Mis au service de la cartographie, les satellites d 'observation de la terre lui fornissent un outil d 'une puissance inégalée et encore peu exploitée. Cette puisance exceptionnelle tient*, évidemment, aux qualités bien connues de l ímagerie satellitaire: automaticité, ubiquité , actualité, pouvoir de synthèse. Elle explique, du même coup, les préalables qui s'appliquent à son exploitation: développement du savoir-faire, développement des outils matériels et logiciels, développement même de l'information sur le potentiel de tout ce secteur technologique. C'est pourquoi l órganization de colloques internationaux en matière de cartographie satellitaire ("spatiocartographie") est une nécessité permanente pour favoriser les échanges internationaux et la diffusion des applications déjà réalisées ou envisagées Consciente deces enjeux, et conformément à son rôle de promotion de la coopération scientifique et technique entre les nations, l'Association Cartographique Internationale (ACI) a mis en place, dès 1980, une commission consacrée à la "cartographie thématique dérivée de l'imagerie satellitaire". Jean DÉNÈGRE (1991)*

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