THE CARTOSUR PROJECT - THE CARTOGRAPHIC CHALLENGE OF THE END OF THE CENTURY

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ABSTRACT:

The National Cartography of Venezuela and other government agencies have been doing enormous effort into the completion of the cartographic coverage of the territory located south of the Orinoco River. However, difficulties have been found due to cloud coverage and accessibility limitations as well as the high economic cost of such field operations which have to be carried out in order to obtain the basic information.

Currently, those efforts are aimed to the assessment of our own experiences obtained in surveys performed in some sectors of the above mentioned territory. The purpose of that evaluation is to find new alternatives, taking into account Technological advances recently produced in the field, namely, Radar Interferometry, which, in our opinion, is probably the most convenient answer to the problem of data acquisition.

INTRODUCTION:

Venezuela is lacking of Basic Cartography for approximately 26% of its territory south of the Orinoco River, equivalent to approximately 216,000Km2, which implies Geopolitical Limitations such as:

- Inventory projects, exploration, evaluation and protection of natural resources and the biological and ethnic diversity.

- An accurate demarcation of our international boundaries with the neighbouring countries of Colombia, Brazil and Guyana.

- The narcotics trade control, illegal mine operations and an active surveillance of international borders.

In the sixty (60) years of the National Cartography's existence, great economic and human efforts were made to obtain photographic and cartographic coverage of this area south of Venezuela. Nevertheless, obtaining precise basic cartography was met with some difficulties due to poor weather conditions which were against all hopes of obtaining quality aerial photography, also the inaccessibility to the region due to notable escalating costs of operations for the establishment of ground control points.

Estimates of costs associated with obtaining photographic coverage, and proper field operations were carried out. The availability of budgetary resources only would allow us to have the aerial photographs, but even allocating all economic and human resources necessary, it is still difficult to set a deadline for the outcome of this product.

For these reasons and at the light of national interests, we have considered alternative studies which permits within a short-term a cartographic georeferenced base of high accuracy and uniformity for this vast region, based on newly developed technologies for the gathering of territorial information and its cartographic processing.

Photo No:1 Fuel Transportation

Photo No:2 Operation Limitations

Technologically speaking, it is required to know the real possibilities and limitations of every sensor currently available and its performance in the kind of complex environments we are referring about.

This, necessarily implies to think of multi-sensor options, were combined use of optical and microwave sensors be applied, having a stable element the data coming from either Landsat-TM or SPOT for instance, and as the variable for the multitemporal analysis data obtained by spatial and/or airborne radar.

An element considered of high importance for the execution of this Project is considered to be the contribution of radar interferometry, because it represents the most valid option not only according to the current technological advance in this field, but also taking into serious consideration the logistics implied in such an effort.

Digital Elevation Models (DEMs) will have to be used to allow the geometric correction of data because it is not feasible obtaining altimetric and planimetric information using conventional methods. They can result both extremely expensive (10 to 15 times more costly) and logistically too complex.

I. GENERAL OVERVIEW

The huge territory located south of the Orinoco River formed by the states of Bolivar, Delta Amacuro and Amazonas, comprises Guayana Region; an area of approximately 492,200 Km2., which includes a 2,800 Km. long border line of orographic and fluvial

nature which separates Venezuela from the three following countries: Colombia, Brazil and Guyana.

At planetary scale, The Guayana Region is part of the most ancient territory on earth. It belongs to the Guayana Shield, whose Precambrian origin has a characteristic vegetation of tropical rainforest, widely known by its ecological fragility. The most important biological diversity on earth is also present in this region.

This region holds the most important reservoir for Venezuela of natural resources represented by forestry, minerals (gold, diamonds, bauxite, iron ore), and the highest concentration of hydraulic and hydroelectric power, which demands wise decisions for its administration and conservation.

The potential of the Guayana Region has been the object of permanent evaluation by Government Officers of the Ministries of Environment and Renewable Natural Resources, Energy & Mines, as well as the Venezuelan Corporation of Guayana (CVG).

Priorities have been established for the making of inventory plans, as well as the exploitation and conservation of resources available in the region. However, in order to go ahead with the economic planning for the region's development, we have to be efficient in the obtention of basic information of the land, which eventually will allow a better knowledge of its dimensions, borders, and physical and cultural characteristics.

It is a real need to propose a definite solution to overcome the absence of a systematic cartographic coverage in that area located south of the Orinoco River. That means a very important challenge both, from the logistic and technological stand point.

Logistically speaking, we are referring to a territory with little or none facilities for overland communication, with rigorous climatic conditions, notable for its high precipitations (between 4000 and 5000 mm) with hot and humid temperatures (26° to 32° C), with the combination of a very high and dense vegetation foilage between 30 to 50 m.

A highly complex topography that varies from the great floodplains of the Casiquiare River to the Tepuys (mesetas) and mountains of the region.

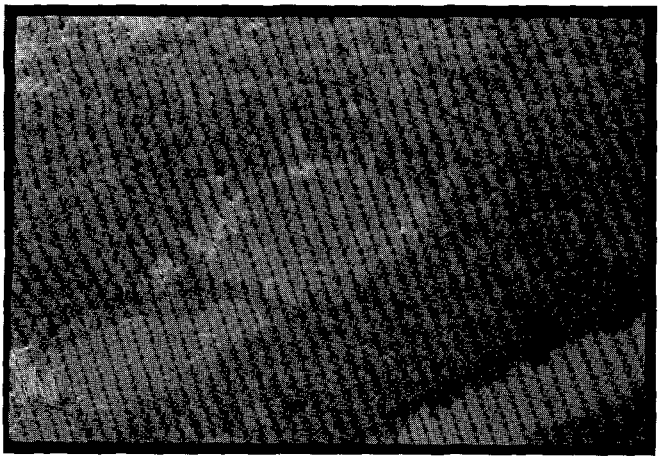


Photo No:3 Cultural Features

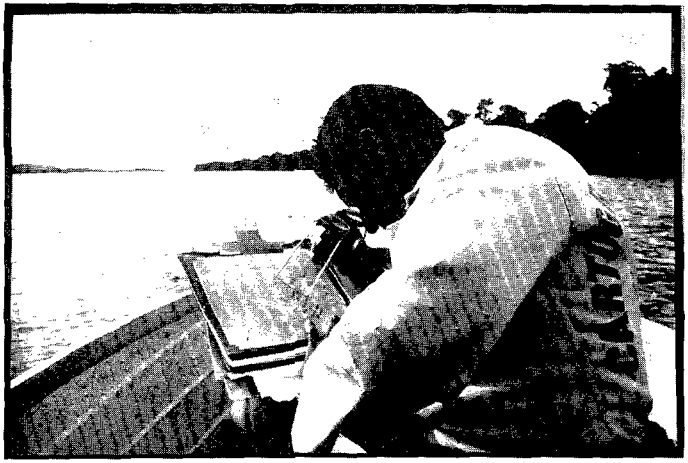


Photo No:4 Field Classification

II. BASIC DATA AVAILABLE FOR THE REGION

2.1 Regarding the air photographic coverage of the region, approximately 70% of it has aerial photographs taken at scales ranging from 1:50,000 to 1:150,000, which were obtained during the 70s and 80s. Most of this data lack the quality necessary to produce topographic maps.

2.2 Radar (SLAR) at scales 1:100,000 and 1:250,000 between 1972 and 1977.

2.3 Complete Landsat-MSS coverage from 1972 to 1981.

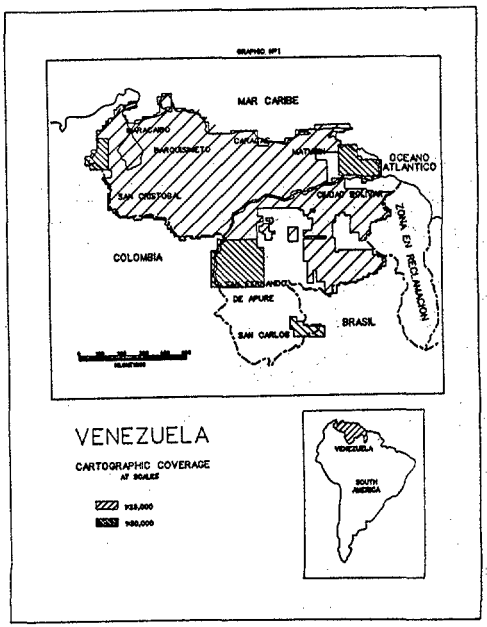
2.4 Sixty (60%) percent of Landsat-TM digital data (cloud cover is a major constraint).

2.5 Geodetic Network: figure No.3 shows the network established during 1992 and 1993 using GPS. Planimetric accuracy of 2.7ppm, (WGS84) was obtained.

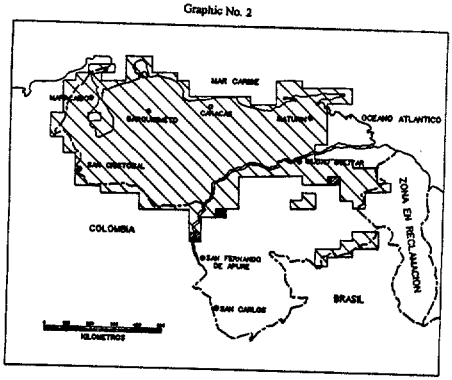
2.6 Leveling network does not exist.

2.7 Circuits of local gravimetric network have been established to the south of Amazonas as well as in Bolivar State.

2.8 The Cartographic coverage is shown in figures 1 and 2.



Graphic No. 2

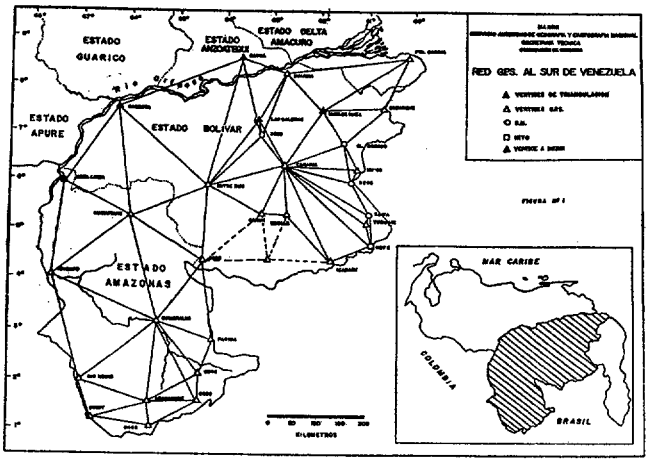


VENEZUELA
CARTOGRAPHIC
COVERAGE AT
SCALE 1:100,000

PUBLISHED

BEING PROCESSED

Graphic No. 3



III. MAPS SERIES TO BE PRODUCED

The scale of 1:100,000 is ideal to have initial and uniform coverage for the entire region. It will be used for planning and monitoring purposes

Consequently, the Institution has received countless requests of updated cartographic information, not only at this scale but also at 1:250,000. However, those areas close to international borders will require scales of 1:25,000 or higher.

The proposed maps series will fill the gap of geographic data at the time that will be used as the basis for the Guayana Geographic Information System.

Taking into account the past experience in the production of topographic maps, applying the methodology of aerophotogrammetric surveying on one hand and the generalized use by the customers of Landsat-TM and radar products currently available, on the other, it has been foreseen the quest of alternative solutions to generate that basic cartographic product which in turn will satisfy the user needs.

The series will contain the raster data provided by the Thematic Mapper sensor, as well as vector data (hidrography geographic names and other cultural features).

The accuracy of this series both, planimmetrically as well as altimetrically will heavily rely mostly on the ground control points (GPCs) that could be gathered.

IV. CONCLUSIONS

Today, The National Autonomous Service of Geography and Cartography through the CARTOSUR Project, has concentrated its strength in the assessment of the following alternatives:-

a) Completing the air photographic coverage.
Even if the financial and logistical resources would be made available for this purpose, it wouldn't be possible to precise the time required to obtain a good quality coverage.

b) Photogrametric surveying at 1:50,000 and 1:25,000.
Will depend on high quality air photographs and a supplementary GPS network.

c) Map Images
The production of this series will depend either, on a homogeneous GPC network or a DEM, to make it possible the geometric rectification of the imagery.

d) As a result of the experience in South American Radar Experiment (SAREX '92), where airborne radar data (C-Band) was obtained at 6 and 20m. resolution, five

flight lines were flown at narrow, wide and nadir modes. It was concluded that this type of data offer a good input for the interpretation and identification of fine details on the fields.

e) At this moment, we are in the process of evaluating three (3) technical proposals with the purpose of producing the topographic maps of the region, having radar imagery, GPS and radar interferometry as the basic source of data. Although it is known that this one, probably will be the right path to follow, its high cost becomes a very important constraint to make it realize.

f) A joint pilot project with the Cartographic Institute of Catalunya (Spain) is underway to know the advantages of ERS-1 data to develop applications in rainforest regions.