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ANALYSIS AND CRITICAL ASSESSMENT OF THE CURRENT AND NEAR FUTURE PLANS OF THE BRAZILIAN SATELLITE APPLICATIONS PROGRAM AND ITS ROLE IN THE GLOBAL SPACE PROGRAM

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9. Authorship *Nelson de Jesus Parada*

Responsible author [signature]

13. Authorized by
[signature]
Nelson de Jesus Parada
Diretor

14. Abstract/Notes

The purpose of this presentation is first to briefly analyse the Brazilian application satellite programs (remote sensing, meteorology and communications), their current status and near future plans. Second, based on the gained experience and on the available information, try to critically discuss some aspects which in our opinion are of great importance for the existing and prospective user countries.

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1 - INTRODUCTION

The purpose of this presentation is first to briefly analyse the Brazilian application satellite programs (remote sensing, meteorology and communications), their current status and near future plans. Second, based on the gained experience and on the available information, try to critically discuss some aspects which in our opinion are of great importance for the existing and prospective user countries.

2 - BRAZILIAN APPLICATION SATELLITE PROGRAMS

2.1 - REMOTE SENSING

The Brazilian remote sensing activities started in 1968. However, it was during 1970 that two important studies were done at INPE. The first one was related to the installation of a LANDSAT receiving and processing station in Brazil and the second was dedicated to the survey of mineral resources of part of the Amazon region (about 44,000 km^2) using a side-looking radar as the main source of information. These initial studies gave birth to the two major existing remote sensing programs in Brazil: the Satellite Remote Sensing Program, whose leading organization is INPE, and the Radar (RADAMBRASIL) Program, whose leading organization is the National Department of Mineral Production (DNPM).

The Radar Program has as objective to systematically survey the natural resources of the whole national territory in a level of detail compatible with a 1:1,000,000 scale, focussing on geology, geomorphology, soil, agriculture aptitude, ecology and potential land use.

The Satellite Remote Sensing Program has as main objectives the reception, processing and dissemination of remote sensing data (today basically LANDSAT data) and the development of new methodologies for the application of these data in the survey and monitoring of natural resources (mineral, agronomical, forest, hydric, oceanographic), observation of the environment, monitoring of land use, map and thematic cartography, regional and urban planning, polution, disaster forecast and monitoring, among others. Special emphasis is given to projects related to national priorities which today include Agriculture and Energy.

The transfer to the user community of the know-how, technology and related methodology developed in the processes is a constant preoccupation in the Program. Besides offering on-the-job training, especialized seminars and graduate courses, INPE always forces the participation of the user institution in the methodology development phase for the transfer to be more effective.

The main available facilities are a LANDSAT tracking and receiving station located at Cuiabá-city covering, consequently, great part of South America as shown in Figure 1; a LANDSAT processing station located at Cachoeira Paulista and distribution centers located at different cities; all operational meteorological satellites (GOES and TIROS-N) receiving and processing stations located at São José dos Campos, two automatic image analysis systems and a two-engine Bandeirante aircraft equipped with several sensors.

Since the beginning of the Satellite Remote Sensing Program, in 1973, the number of images produced and the number of users have grown steadily. In terms of image production, Brazil is the second in the world and the number of users (mostly institutions) has already crossed the 1,400 mark, some of them are foreign (see Tables 1 and 2 for details).

Up today a great number of application methodologies (more than 200) have been developed, mainly by INPE (which has an application remote sensing multidisciplinary group of about 100 experts) in the areas shown in Table 3.

Today, remote sensing is a reality in Brazil. Due to the spectacular utilization of remote sensing satellite data, two further steps were already taken by the Brazilian Government.

The first one is the decision to upgrade the existing LANDSAT reception and processing stations to receive and process MSS and Thematic Mapper data from LANDSAT-D satellites as well as SPOT data. Commercial contracts have already been signed by INPE with the French Société Europeenne de Propulsion (SEP) and with United States Scientific Atlanta for that purpose. For Thematic Mapper data, the receiving station will be operational by next August and the processing facilities by March 1983.

The second is related to the project, construction, integration and operation (all done by INPE with the effective participation of Brazilian industries) of two remote sensing satellites, which will be launched by a Brazilian launcher in the 1987-1990 period. They will have a near-polar circular heliosynchronous orbit of approximately 650 km and total mass of about 250 kg. The remote sensing camera will use CCD detectors and the images will be produced in four channels with near 50 meters resolution, which have today the following characteristics:

Channel 1: visible: 0.45-0.52 μm
- discrimination of baresoil/vegetation
- continental waters
- coastal zones; sedimentation and currents
- forest resources

Channel 2: visible: 0.53-0.59 μm
- green peak of vegetation

industry. Over 20 units were built and installed at several institutions in the country and have been systematically upgraded (some of them, for example, received an S-Band adaptation kit, designed and built at INPE's facilities in 1979, which allows for the direct reception of WEFAX signals transmitted by the geostationary satellites). A VHRR/VTPR receiving station was also developed for the NOAA satellites. The high resolution images (900 meters on the ground) in two channels (visible and thermal infrared) found useful applications in both meteorology and oceanography. A receiving station for the SMS/GOES satellite was later developed and integrated. Data in the infrared (1978) and in the visible channel (1980) are produced by a laser beam recorder. The upgrading of the VHRR/VTPR station in 1980 enabled it to receive the AVHRR/TVOS signal, including images in four channels.

The Institute is presently providing images to several users (including operational centers) in the form of paper copy or through transmission by telephone lines.

Besides the vast experience in the design, construction and integration of station for the reception and processing of data from meteorological satellites (APT, VHRR/VTPR, SMS/GOES, WEFAX), another effort was done in the development of new systems devoted to the extraction of information from them in almost real time, with the use of computers and man-machine interactive systems. An Image Storage and Display Unit, designed and built at INPE's laboratories, is the first step towards the development of an Interactive Image Processing System, to be accomplished by the end of 1982.

The Brazilian Satellite Data Collection Platform Program coordinated by INPE makes use of two networks: one for low-orbit satellites (TIROS-N) and the other for geostationary satellites (SMS/GOES).

For the first one, an ARGOS/DCP prototype developed by INPE is now undergoing final tests. Ten units will then be built by

Channel 3: visible: 0.61-0.69 μm - chlorophyll absorption

Channel 4: infrared: 0.79-0,90 μm - biomass: fitossanity studies

It is worthwhile to mention that a great effort is now underway in Brazil on the design and development of low-cost image processing systems to be utilized by the user's community. Also, aircraft and satellite microwave, optical and infrared sensor systems are being constructed.

2.2 - METEOROLOGY

At INPE's facilities, in Brazil,

- meteorological satellite imagery of high and low resolution, at least in two channels (visible and infrared);
- radiation data for the determination of vertical temperature profiles, as well as of water vapor content;
- WEFAX broadcasting of messages, maps and images; and
- relaying of data collected by remote data collection platforms (ARGOS and GOES systems)

are today operationally received.

Using specific receiving and processing stations developed and operated by INPE, data are being received from all meteorological satellites accessible to the Brazilian territory (geosynchronous satellites SMS/GOES and sun-synchronous satellites of the TIROS-N family).

The activities in this field started in 1967 with the design and construction of an APT station for the reception of low resolution visible imagery; this prototype was then given to a private the Brazilian industry. The required software for the reception and decoding of the ARGOS signals has already been developed. Basic meteorological and hydrological data are the ones that will be collected by the platforms at the begining. Later on, more general environmental data (including geographical ones) will also be obtained. The ARGOS/DCP are compatible with those that will be used by the Data Collection Brazilian Satellites. These satellites, in number of two, are presently being designed by INPE and are scheduled to be launched (by a Brazilian launcher) in the 1987-1990 period.

For the geostationary satellites, a pilot network using imported DCP is presently being installed in the Amazon region (for the PHCA/UNDP Program). The reception of the transmitted data will be done at INPE's meteorological satellites receiving center. Also two different DCP prototypes are being developed by INPE (nonprogrammable and programmable DCP). After their industrialization, they will integrate the GOES/DCP network.

2.3 - COMMUNICATIONS

Brazil has not yet established a well-defined direct reception satellite communication program.

However, a pilot project - called SACI project - was performed in Rio Grande do Norte State under INPE's responsibility, a few years ago.

During the key phase of the project - December 1974 to May 1975 - the United States ATS-6 satellite received every day, during 30 minutes, the signals transmitted directly from INPE's Headquarters in São José dos Campos and retransmitted them to a ground receiving station in Natal, which finally retransmitted the signals to TV sets installed in the schools involved in the experiment. More than 2,000 teachers and more than 25,000 students were trained in the project.

INPE's effective participation in the SACI Project finished later on, when the ground segment of it was transferred to the Federal University of Rio Grande do Norte and Education Secretary of Rio Grande do Norte.

The experience gained with the SACI Project showed that the effectiveness of an instruction system based on Educational Technology and using mass communication media is larger than the effectiveness of the conventional education system.

Furthermore, the use of communication satellite in Education proved to be feasible and extensions of the pilot project are now under study by Brazilian authorities. Some additional information about this will be given later in another section of the Seminar.

3 - IMPORTANT REMARKS AND CONCLUSIONS

Research and technological development on Space Application have been carried out in Brazil for more than one decade. The experience acquired during that period has confirmed that the benefits provided by this new technology are enormous, helping the governmental and private sectors of the society to establish efficient planning and procedures for policy and decision making.

Significant results have been obtained with the use of remote sensing techniques in a wide range of applications. Soil mapping, survey of potential areas for agricultural expansion, crop identification and area estimation, crop forecasting, mineral and oil exploration, monitoring and evaluation of reforestation, natural vegetation mapping and reforestation, cartographic applications, fishing charts and land use are some important examples which are nowadays reaching an operational stage in Brazil.

The meteorological satellite data, beside its use in many important conventional applications, allow for the realization of basic research in numerical modelling of the atmosphere, thus improving weather and climate forecasting and climate variations simulation. It is important to observe that meteorological satellite data have a great importance for South America, as they are the important source of information about the oceans, which play an important role in the meteorologic and climate characteristics of that region.

Although an aggressive program on satellite communications has not yet been established (when compared with the satellite remote sensing and meteorology program), this does not mean that Brazil does not recognize the importance of this area for education, health care, agriculture and other applications, thus contributing for the social and economical development of the country.

However, problems related to the uncontrolled use of direct reception of TV signals should be solved before a national program is defined. And for this reason, an international coordination and legislation is highly desired in this field.

It is important to observe that it is not by hazard that Brazil has a large and important program on space applications. Territory integration and the necessity of obtaining low-cost reliable periodic information about it are key factors responsible for the massive utilization of data collected and/or transmitted by the so-called application satellites, in the areas of meteorology, remote sensing and telecommunications.

The Brazilian territory is not yet well-known, mainly with respect to its natural resources. With an area of a little over 8,500,000 square kilometers, it presents large regions of difficult access and low population density (for example, the Amazon Forest occupies a surface of about half of it), making hard, if not impossible, to study or to teach it by conventional methods. The dynamical character of the processes that contribute to the social and/or economical development of the country and/or to its security asks for a data collection system that presents four basic ingredients: can be applied to the whole territory; has a low cost/benefit ratio; has an almost real-time data utilization character and can be used many times (periodically, if possible). These are the basic characteristics of the application satellites.

Consequently, Earth observation satellites, which allow the periodic survey of large areas very rapidly and at relatively low cost, became an effective tool for Brazil to increase the knowledge about its renewable and nonrenewable resources, its weather and climate, and to monitor the modifications that take place on its environment.

However, there are some important factors, such as spatial resolution, characteristics of the transmission medium (between satellite and ground), sensor properties, sun-ilumination, among others, that hinder the utilization of the Earth observation satellites on several applications. Special attention has been given by many countries in order to solve these limitations.

One can easily argue that the utilization of the data collected and/or transmitted by the application satellites in areas where there exists an effective conventional ground data collection and/or transmission system is very limited (this is probably true for small area developed countries or states). Even for these cases, the information obtained and/or transmitted by the satellites will be of great importance for up-dating, in a very low cost basis, the existing system, or for use as a back-up system.

On the other hand, for the earth or environmental observations satellites data to be properly and efficiently used by any country, it is necessary that:

- the data are available,
- there exist trained personnel to use the data.

If these requirements are not fulfilled, then the increase of knowledge of one country - the one that acquires the data and uses them - about another country will be a natural consequence of the process.

Countries that can afford satellite program and/or receiving and processing ground stations and/or training program will very easily solve the problem, but it will continue to exist for the other countries.

So, the United Nations and the participating countries should do their efforts in order to provide an optimal, noncommercial worldwide coverage and distributing system, giving to all nations the possibility of obtaining periodical data about their own territory in a low-cost and almost real time basis, as it is presently done for the meteorological satellites (it should be observed that remote sensing and meteorological satellites are special classes of the Earth or environmental satellites). It is a necessary and urgent step to be taken, since a trend to transform the low-cost reception of remote sensing satellite data into a profitable commercial business has been observed. If this is confirmed, the utilization of the data by developing countries will be seriously jeopardized.

About training programs, it is important to note that for the transfer of know-how and technology to be the most effective, the content of them should definitely include the development of methodologies based on local themes or problems. For that reason, national and regional training programs should be implemented with priority.

Multi or bilateral programs among developing countries in both training and development of application methodologies are desirable, and Brazil is firmly committed to participate in those programs.

Another point that should be emphasized is the growing number of current and proposed satellite programs. Distinct sensor systems and increasing resolution are the main characteristics that distinguish them, thus making it impossible, for a large number of countries, to decide in which one to participate or, even if the decision is made, to continue the upgrading of their receiving systems in order to follow the next generation of satellites.

An international coordination is highly desirable in this area, in order to assure the continuation of a given program and to produce the necessary standardization. Also, it is important to define which are the basic relevant satellite data that should be made available for all countries, in order to establish the principal characteristics that an ideal international system should present. Even if such system cannot be made operational, the knowledge gained in the process will serve as guidelines for the decisions that will have to be taken in that area.

Besides, the different satellite sensor systems with resolution that are becoming better everyday produce an amount of data that in a very near future will hardly be handled, even by especialized application personnel in the way it is being done today. The combination of the digital satellite data together with other digitized conventional data to generate digital geographic or even more general information systems should be a constant preoccupation for those who intend to obtain useful and up-to-date information, and probably this will be the main concern of everyone that will be working in the area in the forthcoming years.

There is no doubt that application satellite will continue to play an important role in the next decade. However, international regulation and effective coordination should be implemented in such a way that all nations can profit from the pacific use of outer space.

TABLE 1

NUMBER OF IMAGES DISTRIBUTED PER YEAR

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
IMAGES	323	1,230	2,094	7,564	10,045	18,049	19,051	11,400	8,602	6,098
CCT	-	10	55	141	132	141	146	176	176	125

TABLE 2

NUMBER OF USERS

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
TOTAL NUMBER OF USERS	3	27	69	156	301	646	1161	1045	1313	1402
BRAZILIAN USERS						502	935	902	1143	1201

TABLE 3

APPLICATION PROGRAMS

AREA	PROGRAM
Agronomy and Forestry	Crop Survey Soils Survey Natural Forest Survey Deforestation Reforestation
Geology	Regional Geological Mapping Mineral and Oil Exploration
Oceanography and Hydrography	Marine Fishing Charts Physical Oceanography Hydrography
Geography	Potential Land Use Actual Land Use Urban Area Expansion
Environment	Pollution in Water Bodies Sedimentation in Water Reservoirs Desertification
Cartography	Mapping Aeronautical Charts

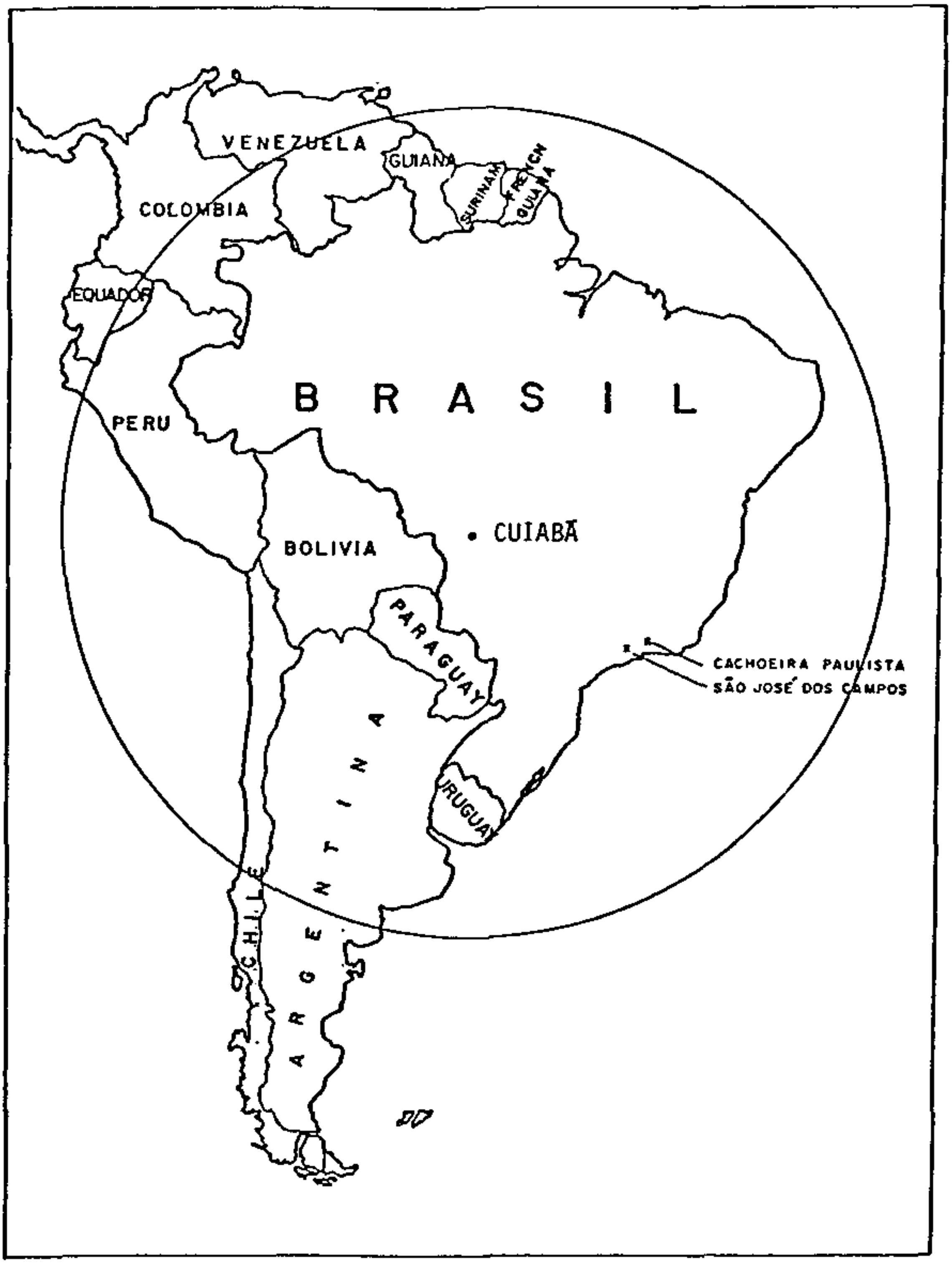

Fig. 1 - LANDSAT Cuiabã ground station coverage.