

## REMOTE SENSING IN BRAZIL

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### ABSTRACT

Given the size of its territory, Brazil is very much concerned with the potential of remote sensing resources. The National Institute for Space Research (INPE), for instance, has followed the Amazon forest's deforestation rate through the use of remote sensing technologies. As a developing country, Brazil considers that increasing technical assistance from developed countries is needed in order to compensate the imbalance of the geographical distribution of technology. According to the Brazilian point of view, one of the ways to implement this assistance is by updating the United Nations Principles Relating to Remote Sensing of the Earth from Outer Space, which is the only international text in existence on this issue. Nonetheless, private companies from developed countries currently carry out the majority of remote sensing activities. Obviously, such companies are not interested in transferring technologies to developing countries. They prefer to keep developing countries as their customers. In this context, joint ventures between developing countries that have space programs have become a feasible

way to improve remote sensing technologies.

### INTRODUCTION

Remote sensing, one of the great benefits of space technology for mankind, can be defined as any space activity which uses equipment on board space vehicles to obtain information about the Earth's environment or natural resources.

Unfortunately, there are still many obstacles to the dissemination of remote sensing technologies in developing countries. The major problem is lack of investment in research and infrastructure, which causes enormous disparities in resources. In some developing countries the majority of the population has no access to the Internet, for instance.

As a huge country, Brazil obtains many benefits from remote sensing applications, such as deforestation assessment (especially deforestation in the Amazon); control of bush fires, mining and agriculture; and urban planning, among others.

The National Institute for Space Research (INPE) is the Brazilian governmental entity that carries out most of the remote sensing programs. Obviously, the high cost of building and maintaining a remote sensing program has been an obstacle to the spread of this technology in Brazil. Despite a large number of well-documented successful

uses of remote sensing by INPE, its full potential has yet to be achieved.

### **BACKGROUND**

In the early seventies, while the National Aeronautics and Space Administration (NASA) was starting studies with sensors on satellites, INPE was also taking its first steps toward remote sensing technologies. At first, INPE undertook its remote sensing activities by borrowing aircrafts from NASA but, in 1971, it bought its own aircraft equipped with aerophotogrammetric instrumentation. INPE also built an earth station in Cuiabá in order to track the Earth Resources Technology Satellite (ERST-1), the original name of the NASA Landsat Program. At that same time, a processing image system was installed in Cachoeira Paulista. In 1973, despite its modest structure, INPE started operating a remote sensing system in large and small scale.<sup>1</sup>

The use of earth observation satellite data received considerable impetus in November 1978, when INPE held the First Brazilian Symposium on Remote Sensing in São José dos Campos, a meeting which subsequently became a regular event, held every two years. It was at this meeting that INPE presented the first data obtained from satellite images of the deforestation of the Amazon.<sup>2</sup>

The U.S.A. launched a second generation of remote sensing satellites, Landsat 4 and 5, in July 1982 and March 1984, respectively. These satellites contained significantly improved technical features as compared with those launched during the previous decade. Between 1980 and 1983, INPE personnel participated in the design and development of a reception and data processing system for the new satellites,

subsequently installed at INPE's laboratories in Cuiabá and Cachoeira Paulista.

In 1981, a statistical study carried out in the U.S.A. and published by the countries involved in the Landsat system, showed that Brazil was the third greatest user of images from this satellite, after the U.S.A. itself and Canada. In 1982, this extensive use of satellite images led INPE to develop the Interactive Image Processing System (SITIM). The design of SITIM equipment was based on the prior experience of INPE with the Image Analysis Unit (UAI), a system developed by INPE in the late seventies, and used for the interpretation of meteorological satellite images.<sup>3</sup>

The French remote sensing satellite, Spot, was launched in January of 1986, and in 1985, before its launch, INPE made preparations to receive the images from this new satellite. In 1988 INPE started working with Spot data, after adapting its signal reception and image processing systems in Cuiabá and Cachoeira Paulista respectively, thus providing a new option for end users of satellite remote sensing data.

### **REMOTE SENSING APPLICATIONS IN BRAZIL**

Currently, INPE is involved in some noteworthy earth observation programs, including:

(a) Reception and dissemination of Landsat images: INPE has been active in Landsat data collection and dissemination continuously since 1974, resulting in one of the largest archives of remotely sensing data in the world. Among the numerous applications developed in Brazil, the annual comprehensive assessment of deforestation in Amazon stands out as

one of most extensive uses of Landsat data ever.

(b) Development of the China-Brazil Earth Resources Satellite (CBERS): for environmental observation the CBERS-1 satellite with a 20-meter resolution was launched in October 1999 and continues to relay photo images. The CBERS-2 satellite is scheduled for launch in October 2003, with two follow-up satellites (CBERS-3 and 4) to be launched later in this decade. These will have improved spectral and spatial resolution

(c) Reception and Dissemination of Radarsat: Brazil has been actively engaged in the Radarsat program since its conception. By agreement with the Canadian Center for Remote Sensing (CCRS), field research was undertaken in Brazil in 1992, enabling Brazil and Canadian researchers to explore ways of using active sensor data in a tropical environment.

(d) High-resolution images: currently, high-resolution images that used to be available exclusively for military purposes, have been disseminated without restrictions. Among the existing commercial systems, three should be mentioned: the Indian Resources Satellite (IRS), with a 4 to 5 - meter space resolution; the Ikonos, with a 1 - meter space resolution; and the Quick Bird, with a 61 - centimeter resolution. In Brazil, it is possible to obtain images of almost all commercial systems through INPE<sup>4</sup>, systems representatives, or the Internet.<sup>5</sup>

Without a doubt, societal benefits from remote sensing are especially important in large countries such as Brazil where long-term monitoring of environmental and urban patterns play a very important role in public policy issues.

Two of Brazil's programs with global impact follow.

### **Surveillance of the Amazon Rainforest**

At the request of the Brazilian government, INPE has used satellite imagery to make a systematic study of Amazon deforestation since April, 1989.<sup>6</sup>

INPE's projects related to the Amazon include the use of remote sensing satellite images for deforestation surveys; the evaluation of the environmental impact of informal mining activities, including the associated unauthorized construction of small dams and landing strips; the monitoring of indigenous reserves; and geological studies. Satellite images have also been used by INPE in the localization of forest and bush fires, and in research into the water cycle in tropical rainforests. Computer modeling is used to study the effects of deforestation on climate. The atmospheric consequences of burning are analyzed by means of measurements both within and outside the affected areas.

Since July, 7<sup>th</sup> 2003, INPE has made digitalized data regarding the deforestation of the Amazon Rainforest available on its homepage<sup>7</sup>. One of the novelties of this site is that it shows the place and the rate of deforestation with a high level of precision. The INPE site shows, for instance, that the rate of deforestation in the Amazon city of Novo Progresso increased from 225 km in 2001 to 767 km in 2002. The rates of deforestation in the Brazilian municipalities within the Amazon will be collected and a general view of the Amazon Rainforest deforestation will be defined and be made available at the end of this year.<sup>8</sup>

Other information about water cycles, consequences of burning and deforestation, and the environmental

impact from mining can also be found on INPE's homepage.

### **Education in Remote Sensing**

In an effort to disseminate some of its expertise in remote sensing, INPE held its first international course in remote sensing, from August 1985 to July 1986, which was attended by technical personnel from other Latin American countries. The creation of this course had been suggested during the United Nations Conference on the Peaceful Exploitation of Space (UNISPACE 82), in Vienna. The course aimed to promote competence in remote sensing techniques among professionals from developing countries where there is a marked lack of trained personnel. The First International Course in Remote Sensing gave rise to a continuing series of annual courses for African and Latin American countries, offered by INPE with the support of the United Nations.<sup>9</sup>

INPE has also been developing basic courses in the use of remote sensing for public and private high schools. As a result of a joint venture with the Society of Latin American Experts on Remote Sensing (SELPER), INPE has given courses and produced CD ROMs and training materials as well.

Finally, INPE maintains MSc and PhD programs in remote sensing in order to prepare specialized personnel.

### **DIFFICULTIES**

As was said, the full potential in remote sensing has yet to be achieved in Brazil. According to INPE's Director of Earth Observation, Dr. Gilberto Câmara, there are three major problems to be solved: lack of data, lack of tools, and lack of expertise.<sup>10</sup>

### **Lack of Data**

Dr. Câmara stated that the possibility of accessing timely and appropriate spatial data is a major challenge in developing nations. In his words, *"the current trend in developed nations is to consider that their countries' taxpayers should not subsidize the use of spatial data by the developing nations. Therefore, such nations are increasingly dealt with as customers of the developed countries' commercial sector"*.

However, this situation, according to Dr. Câmara, *"provides a singular opportunity for nations that have developed independent remote sensing programs. If programs such as IRS (India) and CBERS (China/Brazil) adopt data policies that allow for unrestricted distribution of products without additional licensing costs [it would create] a major opportunity for cooperative programs in Earth Observation within the developing world"*.

Hence, lack of data from developed countries and its private companies could be compensated by the establishment of close cooperation among developing nations that have remote sensing programs.

### **Lack of Tools**

Spatial data requires tools for computer analysis. These tools require technical expertise for their use, and have largely been developed by a small number of companies and institutions. Of course, companies from developed countries are not interested in sharing their knowledge, because this might put their profits in risk. They prefer to keep developing countries as their customers. There is very limited effort in developed countries to develop an open-source

geographic information system and image processing software.

INPE has developed SPRING, a geographic information system and image processing software freely available on the web, coupled with extensive documentation, training material, and books.

SPRING is an example of how developing nations can help each other.

### **Lack of Expertise**

Dr. Câmara said *“traditionally, academic institutions in the developed world have provided a major basis for producing qualified personnel for using geoinformation technology in the developing world. In many cases, graduates of these institutions have initiated their own research groups in their native countries. Such an interchange is most needed and useful and it is hoped that it is maintained and enforced in the years to come. However, it must be recognized that such a mechanism can only account for a limited part of the enormous demand for expertise building on the developing world”*.

There has been substantial progress in all aspects of geoinformation technology in the developing world. In the words of Dr. Câmara, *“by establishing joint projects, and using open source and non-restrictive copyright policies to the greatest extent possible, developing nations are in a position to establish a strong network of co-operative institutions, that would be fully capable of realizing the full potential of geoinformation technology for the betterment of mankind”*. By combining their expertise, developing countries can respond adequately to the challenge of disseminating remote sensing techniques

in their territories, and to create professional competence in this area.

### **INTERNATIONAL REGULATION**

Remote sensing activities are currently underregulated from the international point of view. The only international text on this issue is completely outdated: Principles Relating to Remote Sensing of the Earth from Outer Space approved by the United Nations General Assembly Resolution 41/65 in 1986. This Resolution has become outmoded due to the innumerable technological advances in the sector that have occurred over the last 16 years.

In the 42<sup>nd</sup> Session of the UN/COPUOS (United Nations Committee on Peaceful Uses of Outer Space) Legal Subcommittee, held in Vienna, 24 March to 4 April 2003, Brazil submitted a Working Paper<sup>11</sup> in order to show how ineffective the current regulation is. Brazil sustains that an in-depth study should be conducted in order to update the Remote Sensing Principles and to analyze the viability of elaborating a specific Convention on Remote Sensing.

Since private companies currently carry out the majority of remote sensing activities, some of the mentioned Principles no longer have any practical effects. As an example, Principle XII establishes that the State under observation by remote sensing satellites has the right of access to primary data, on a non-discriminatory basis and for a reasonable price. However, this does not occur nowadays. The technological and scientific purposes of remote sensing have been forsaken to business.

Lack of regulation works in favor of private companies from developed countries, but does not contribute to the

dissemination of remote sensing techniques in developing countries.

### CONCLUSION

There is currently a stalemate in regard to revising the Remote Sensing Principles. COPUOS must approve all proposals by a unanimous vote of its members. Some developed countries represented in COPUOS have refused to approve revision proposals because such reforms could jeopardize the profits of their private companies. Thus, Brazil has been unsuccessful in its attempts to approve its proposal for promoting an in-depth study in order to update the Remote Sensing Principles and to analyze the viability of elaborating a specific Convention on Remote Sensing. Brazil needs the full support of all developing countries and enlightened developed countries to pressure recalcitrant members of COPUOS to think globally for the benefit of mankind. The benefits to mankind are far greater than the current profits of a few multinational companies.

Since the support for legal reform may be difficult to gain from developed countries, cooperation between developing countries that carry out space programs seems to be the best short-term solution. CBERS – China and Brazil Earth Resources Satellites - is a successful example of this kind of cooperation. But more data and expertise could be shared through universities and space agencies. Developing countries can also do more through joint education and training projects.

### References

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- <sup>2</sup> De Oliveira, Fabíola – “Pathways to Space”, Contexto, São Paulo, 1991, page 60.
- <sup>3</sup> De Oliveira, Fabíola – op. cit. – page 63.
- <sup>4</sup> See INPE’s homepage ([www.inpe.br](http://www.inpe.br)).
- <sup>5</sup> Mussi, Raimundo F. – “Remote Sensing and its Regulation” – Brazilian Magazine of Aerospace Law, June/2003, #86, pages 8-11.
- <sup>6</sup> De Oliveira, Fabíola – op. cit., page 81.
- <sup>7</sup> See “[www.obt.inpe.br/prodes](http://www.obt.inpe.br/prodes)”.
- <sup>8</sup> INPE News, #20, May/June 2003, page 3.
- <sup>9</sup> De Oliveira, Fabíola – op. cit., page 72.
- <sup>10</sup> Câmara, Gilberto – “Frameworks for Sustainability of GIS and Earth Observation Technologies in Developing Countries”, presented at the 18<sup>th</sup> International CODATA Conference, Montreal, Canada, October 2002.
- <sup>11</sup> “Why is an International Convention on Remote Sensing of the Earth from Outer Space Necessary”, written by Prof. José Monserrat Filho, Vice-President of the Brazilian Society of Aerospace Law.