

BRAZILIAN REMOTE SENSING COMMUNITY: HISTORICAL, GEOGRAPHICAL AND ECONOMICAL ASPECTS

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Abstract:

Since 1968 the National Institute for Space Research (INPE) in Brazil has been working on remote sensing. After 24 years, the number of remote sensing users registered at INPE data base is around 3000 people. This paper presents a study of the historical, geographical and economical aspects that determine the distribution of remote sensing community in Brazil and its behavior during the past fourteen years. In this study the following topics are analysed: papers presented in the Brazilian Remote Sensing Symposiums, training courses that have been developed since October 1985 and user questionnaires. With this piece of information, it was possible to identify that 50% of Brazilian Remote Sensing Community is located in the Southeast region. The Southeast and South regions together represent 80% of Brazilian Remote Sensing Community. Both these regions represent only 25% of the country area, but they are the richest and most developed regions in Brazil.

KEY WORDS: Brazilian Community, Remote Sensing.

1. INTRODUCTION

Since 1968 the National Institute for Space Research (Instituto Nacional de Pesquisas Espaciais-INPE) in Brazil has been working on remote sensing.

In 1973 Brazil started tracking the LANDSAT satellite through the installation by INPE of a complete system of collection, processing and imagery generation. INPE is one of the most important satellite image distributors in the world. Researches in remote sensing in INPE study the process of extracting information from images of terrestrial surface obtained from remote sensors installed on board aircraft or satellites.

Main activities in remote sensing are undertaken through the following areas: agriculture, forestry/vegetation, geology, environmental analysis, cartography, imagery processing, basic researches in digital image processing, and remote sensing.

One of the main concerns of the remote sensing area is the transfer of knowledge and methodologies developed in INPE to different sectors of the national community, and Latin American and African communities. This is done through regular graduation courses, regional laboratories, symposiums and training courses.

After 24 years, the number of remote sensing users registered at INPE data base is around 3,000 people.

In the past 14 years, INPE held 6 Brazilian Remote Sensing Symposiums, each one in a different region of the country. In these symposiums the participants number is usually around 500 people.

In September 1988, 3000 questionnaires were mailed to Brazilian remote sensing community.

2. METHODOLOGY

To develop this study, three kinds of information were considered, as follow:

a) The information obtained through the users questionnaires:

In September 1988 a questionnaire was mailed to 3000 remote sensing users, and 336 answers to this questionnaire were sent back until January 1989. This represents just 11% of the total amount, but through the questionnaires it was possible to have basic information about the Brazilian Remote Sensing Community. The following pieces of information were obtained through the questionnaires:

- profession;
- institution (private, public, university);
- when the user started to work on remote sensing;
- city where the user office is located;
- region where the user developed his researches;
- research subjects;
- user age.

b) The information obtained through the papers presented in the Brazilian Remote Sensing Symposiums-BRSS.

Through the Symposiums registration books and proceedings, it was possible to get the following pieces of information:

- paper subjects;
- author origin (city and State);
- author institution;
- number of presented papers / symposiums.

c) The information obtained in training course files:

The pieces of information were obtained in the training course files from October 1985 to December 1990. From these files it was possible to get the following pieces of information:

- total trainees / year;
- total training / year;
- total training / state;
- total trainees / state;
- total trainees / remote sensing application area;
- total trainees / profession.

3. RESULTS

With the information obtained through the questionnaires, it was possible to have the first profile about the Brazilian Remote Sensing Community.

In 1988 the Community had the following characteristics:

- 62% of Brazilian Remote Sensing users were living in the Southeast region (São Paulo, Rio de Janeiro, Minas Gerais and Espírito Santo States). From this amount, 45% were living in São Paulo State, the richest and most developed State in Brazil where INPE is located. 5% were living in Rio de Janeiro, the second most important State in Brazil (Figure 1).

- 73% were living in the Southeast and South regions (Paraná, Santa Catarina and Rio Grande do Sul States). These two regions represents only 30% of the country, but they are the richest and most developed regions in the country. Besides this, the distance between the South region and INPE headquarters is not very far.

- 8,4% of the remote sensing users were living in Brasília, capital of Brazil, in the Central-West region. The most important public institutions that work on remote sensing, like the Ministry of Agriculture, the Secretary of Mines, the Secretary of Environment, etc, are located in Brasília.

- 5,3% were living in the North region, the least developed region in Brazil, that represents 50% of the country area. The distance between INPE headquarters and this region is very far.

The users were asked in which country region they had developed studies with remote sensing data in the past five years. It was possible to identify that:

- 29% developed studies in the Southeast region;
- 19% developed studies in the South region;
- 18% developed studies in the Northeast region;
- 17% developed studies in the North region;
- 17% developed studies in the Central-West region.

As to their professional life, it was possible to identify that:

- 74% of remote sensing users were represented by:

- geologists (20%);
- geographers (19%);
- agronomists (15%);
- forest engineers (11%);
- cartographic engineers (6%);
- biologists (3%).

- 26% of the remote sensing users were represented by: physicists, civil engineers, electronic engineers, electric engineers, architects,

oceanographers, statisticians, navy officers, agriculture engineers, system analysts, army officers, mechanic engineers, survey engineers, university professors, lawyers, zootechnics, chemist engineers, project engineers, veterinarians, ecologists, psychologists and mathematicians.

It was a surprise that so many different kinds of professionals were involved with remote sensing. The expectancy was that just the professionals with a background in natural sciences were working on remote sensing.

Till 1988 the remote sensing users had basically developed projects in the following application areas:

- land use - 15%;
- vegetation - 13%;
- environmental analysis - 11%;
- cartography - 9%;
- water resources - 9%;
- agriculture - 8%;
- geology - 8%;
- geomorphology - 7%;
- digital image processing - 6%;
- pedology - 5%;
- urban studies - 4%;
- meteorology - 2%;
- military targets - 1%;
- oceanography - 1%;

In this item, the fact that the users were usually involved with more than one application area had to be considered.

The kinds of remote sensing data used by these professionals were:

- aerial photography (BxW) - 26%;
- aerial photography (color) - 7%;
- aerial photogtaphy (IR color) - 9%;
- aerial photography (IR BxW) - 3%;
- LANDSAT / RBV - 5%;
- LANDSAT / MSS - 20%;
- LANDSAT / TM - 13%;
- SPOT - 8%;
- GOES - 3%;
- NOAA - 3%;
- RADAR / AM - 1%;

In this item, it had also to be considered that the majority of the users used more than one kind of remote sensing data.

In 1988, 83% of the remote sensing users got their graduation between 1968 and 1987; 15%, between 1948 and 1967; and just 17% were attending undergraduate courses.

From this amount, 65% got their graduation after 1973, when INPE started tracking the LANDSAT satellite.

40% had a master degree; 19% had a doctor degree; 1% had a specialization degree; and 0,3% were substitute professors.

Usually, these professionals were working in the following institutions:

- private companies - 14%;
- public institutions - 62%:
 - a) federal - 68%,
 - b) state - 31%,
 - c) municipal - 0,5%;
- university - 23%:
 - a) federal - 43%,
 - b) state - 48%,
 - c) foundation - 9%.

74% of the users were between 26 and 45 years old, what means that these users were children or teenagers when the first satellite (Sputnik) was launched in 1961. These professionals grew up in the satellite era.

In Brazil, professionals in this range of age are looking for new challenges and new technologies, because they are developing their professional lives.

5% were between 20 and 25 years old. Probably these professionals were beginning their professional life.

18% of the users were between 46 and 65 years old. These users probably had a well structured professional life or were going to retire; so, they were not interested in new challenges.

83% (267) were men and 17% (54) were women. Probably this relation has changed, because year after year more and more women are getting involved with remote sensing.

With the results of the first phase of this study, it was decided to analyse this community in more details. For this purpose, the data collected in the Brazilian Remote Sensing Symposiuns (BRSS) were analysed.

The I^o Brazilian Remote Sensing Symposium was held in 1978, in São José dos Campos, where INPE's headquarters is located. The II^o BRSS was held in 1982, in Brasília, capital of Brazil, Central-west region. The III^o BRSS was held in 1984, in Rio de Janeiro, Southeast region. The IV^o one was held in 1986, in Gramado, South region; the V one was held in 1988 in Natal, Northeast region and the VI^o one was held in 1990, in Manaus, Amazônia, North region.

Usually the participants number is around 500 people. The VI^o BRSS, at which there were 802 participants, was held jointly with the I Latin American Remote sensing Symposium. Up to now this was the most important BRSS, which was attended by many participants from neighbouring countries. The VI BRSS was held jointly with the ISPRS International Symposium on Primary Data Acquisition.

The majority of papers presented in the BRSS were from environmental analysis area. This area embodies the following application areas: land use, watershed management, geomorphology, urban studies and regional planing.

Besides this application area, the areas of geology, vegetation, digital image processing and agriculture were identified as very important ones as well.

In the BRSS, the following applications areas were considered for paper: presentation: geology,

cartography, environmental analysis, agriculture, vegetation, meteorology, oceanography, basic research in remote sensing, digital image processing education, institutional, GIS, sensor system and hydrology.

The papers presented were divided into two classes:

- a) Papers from INPE (dependent papers):
 - papers written by INPE researchers;
 - papers written by INPE researchers and external researchers;
 - papers written by INPE remote sensing master students;
- b) Papers not from INPE (independent papers):
 - papers written by external researchers;
 - papers written by INPE ex-employees;
 - papers written by INPE ex-remote sensing master students;

Since the I^o BRSS, the majority of papers presented were from INPE, because it is the most important institution in remote sensing in Brazil. Fortunately in three symposiums (II^o, V^o, VI^o) the balance between INPE papers and external papers tends to maintain an equilibrium, specially in the V Symposium, where the difference between INPE papers and external papers is just 4%. These results mean that at each symposium more and more researchers from different Brazilian institutions are getting involved with remote sensing. We hope that this balance changes in the future and the number of external papers will be higher than the number of INPE papers.

What region the paper authors were from was also analysed. 87% of the paper authors in the BRSS were from Southeast and South regions, and since the first symposium these regions have been the most representative. In spite of all INPE efforts to enhance the remote sensing activities in all Brazilian regions, the Southeast and South regions are still the most representative.

These results are in accordance with the ones obtained in the first phase, where it was concluded that 73% of Brazilian Remote Sensing Community were living in the Southeast and South regions.

It is interesting to point out that in the VI BRSS, held in Manaus, in Amazônia, the symposium theme was the Amazonian region. The index of papers authors was: 67% from the South, 65% from the Southeast, 1% from the Central-West, 7% from the North, 5% from the Northeast and 3% from Brasília. The VI BRSS was the only one that had a specific theme. In this symposium only papers were about Amazônia, and from this amount just papers authors were from Amazonian region. It is important to notice that the large distance between Manaus and the rest of the country, the difficult economic situation in Brazil in 1990, and the lack of experts in remote sensing in the Amazonian region were the reasons for the lack of participants from all Brazilian regions.

After this second phase, the data about the training courses were analysed. It was possible to identify that from October 1985 to December 1991, 996 people were trained, of which 919 were Brazilian and 58 were from Mexico, Paraguay, Argentina, Colombia and Ecuador.

From this amount, 344 (36%) trainees were from Southeast and South regions; 250 (25%) were from São Paulo State, the richest and most developed State in Brazil. 152 (16%) trainees were from North region; 142 (15%) were from Northeast region; 126 (13%) were from Central-West region; 99 (10%) were from South region; there is no identification about the origin of 15 trainees (1%).

Once again the Southeast is the most representative, specially in 1988, 1989 and 1990, when 55% of the trainees were from this region. It has to be pointed out that in 1988 and 1989 the training courses were concentrated only in the South region. In 1988 the South region represented only 4% of the trainees, and in 1989 17% of the them were from the South region.

In 1986 and 1987 the most representative regions were the Northeast (45%) and North (38%) ones, because the training courses were concentrated in these two regions. But the Southeast region represented 24% of the trainees in 1986 and 135 in 1987.

In 1990, 48 (26%) out of the 185 trainees trained by INPE were from Central-West region, because INPE held a very important training course in this region. But in this year 96 (52%) trainees trained by INPE were from Southeast region.

It is interesting to point out that it is irrelevant if the training courses are held in INPE headquarters or not, for the Southeast region has always a very high representativeness in the courses.

These trainees were basically trained in four main remote sensing application areas, namely:

- natural resources - 177 (18%);
- agrarian surveys - 136 (14%);
- land use - 134 (14%);
- water resources - 104 (11%);

The training courses about natural resources usually embody the following application areas: land use, vegetation, agriculture, geology, geomorphology, etc.

INPE has held training courses in many application areas, as namely: cartography, environmental analysis, coastal zone, digital image processing, GIS, soil, SAR, urban studies, etc.

4. CONCLUSION

In this study it was possible to concluded that:

- It is evident that the majority of Brazilian Remote Sensing Community is concentrated in the Southeast and South regions. There is a lack of remote sensing users in the North and Central-west regions, that could benefit most from indigenous remote sensing capability, as these are the least developed regions in the country. In spite of INPE efforts to transfer technology to these regions, it gets stuck with the lack of funds and infrastructure.

- The Southeast region is the richest and most developed region in Brazil, that is the reason why the majority of remote sensing users are concentrated there. The remote sensing technology is very useful for the country development, but this technology is very expensive and it is

necessary to have a very good infrastructure to develop the studies, and the only region that could support this is the Southeast region.

- Besides this, there is a lack of universities in the North and Central-West regions. 70% of Brazilian universities are concentrated in the Southeast and South regions, and the best Brazilian universities are located in São Paulo and Rio de Janeiro States (Southeast region) and, as we know, the universities are the most important institutions for technology transfer programs.

- INPE, as the most important remote sensing institution in Brazil, has to develop a more detailed study about the remote sensing community in order to plan and develop a right transfer technology program in the future. This program has to be shared with the institutions from different Brazilian regions to consider the regional necessities and to avoid the concentration of experts in the most developed regions and the lack of experts in the least developed ones, that need remote sensing technology for their development.

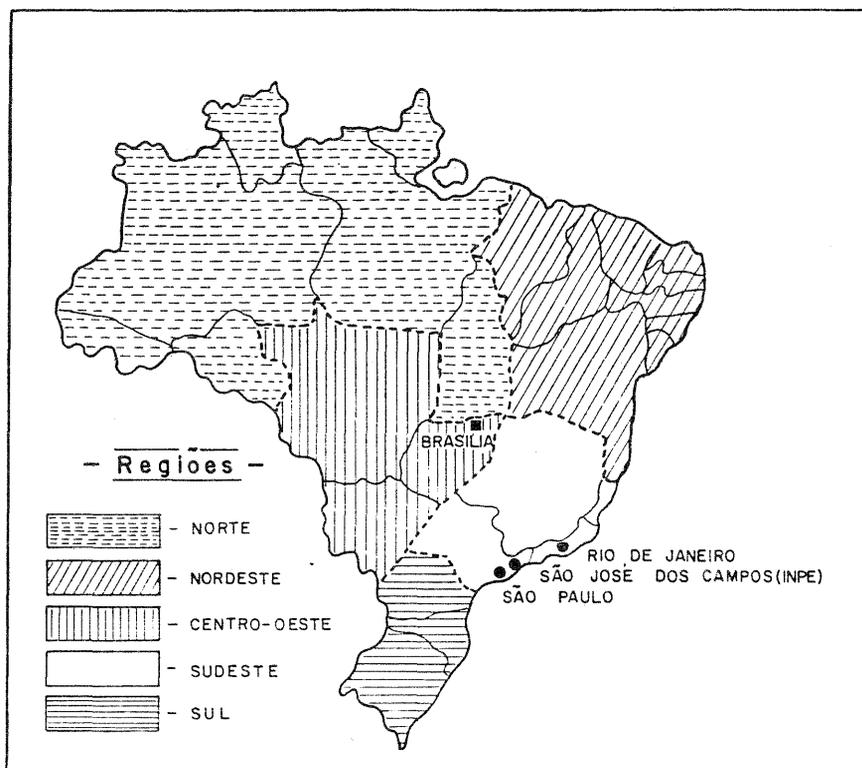


Figure 1 - The Brazilian regions