THE INTERNATIONAL COURSE ON REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS – AN EXPERIENCE OF SIXTEEN YEARS.

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ABSTRACT:

The objective of this paper is to present an assessment of the sixteen years of the *International Course on Remote Sensing and Geographic Information Systems* organized by the National Institute for Space Research (*INPE*) since 1985 and to establish new goals and policies that will certainly improve its quality. It is held in collaboration with the UN/OOSA, the UNU and a Brazilian funding agency, the *CNPq*. Primarily dedicated to professionals from Latin America, Caribbean and Africa, later on to professionals from the Latin America and Caribbean countries. In 2003 the International Course began to be coordinated by the Brazil Campus of the Regional Centre for Space Science and Technology Education in the Latin America and Caribbean, in partnership with *INPE, CNPq* and UNU, it was renamed to *International Course on Remote Sensing and Geographic Information Systems*, and its curriculum adapted to nine months long.

1. INTRODUCTION

The National Institute for Space Research (INPE) to attend a requesting of the UN/Office for Outer Space Affairs created the International Course on Remote Sensing in 1985.

It was a seven months long specialization course from 1985 to 2002, dedicated to professionals of natural resources area interested in working with remote sensing.

This course was held in collaboration with the UN/OOSA, the University of United Nations (UNU), the European Space Agency (ESA), and two Brazilian funding agencies, the *CAPES* and the *CNPq*.

Primarily it was dedicated to professionals from Latin America, Caribbean and Africa, later on to professionals from the Latin America and Caribbean countries.

In 1995, the UN/OOSA decided to establish Regional Centres for Space Science and Technology Education in the Latin America and Caribbean (Brazil and Mexico), Africa (Nigeria and Morocco) and Asia and Pacific region (India).

These Centres are affiliated to the United Nations and designed for education programs in Space Science and Technology in four areas: Remote Sensing and GIS; Satellite Meteorology; Space Science and Atmospheric; Satellite Communication.

The UN/OOSA has created a specific curricula for Remote Sensing and GIS, Satellite Meteorology, Satellite

Communication and Space Science and Atmosphere for these Centres.

In 2001, the Latin American and Caribbean Centre started its activities in their two *Campi (*Brazil and Mexico). The Brazil Campus was created in August 2002.

In 2003, the International Course began to be coordinated by the Brazil Campus, in partnership with *INPE*, *CNPq* and *UNU*. It was renamed to ***International Course on Remote Sensing and Geographic Information Systems***, its curriculum adapted to the curriculum proposed by OOSA/UN and the course was extended to nine months long.

It is oriented on the training of the uses of systems and techniques of images interpretation of orbital remote sensors and geographical information systems for the management of natural resources and environmental control. This objective has been achieved through the following programme modules:

- **Introductory Disciplines:** Their objective is to give fundamental information for the course development and for the group, such as The Brazilian Space program, INPE Space Activities, an Overview about Brazil, Space Law;

- **Fundamental Disciplines:** Their objective is to provide knowledge about the fundamentals of remote sensing, sensors systems and images characteristics;

- **Technical Disciplines:** Their objective is to develop a set of technical skills related to image interpretation, digital images processing, GIS, cartography and GPS;

- **Complementary Activities:** Seminars and lectures about remote sensing and geographic information systems applied to the natural resources. Technical visits to institutions involved with remote sensing, GIS and GPS activities. Likewise, to take notice on

the work market's areas. On this module is included the discipline *Methodology on Scientific Research* to fulfill the requirement of the National Council for Education for post graduation courses (*lato sensu and strictu sensu*).

- **Pilot Project:** Its objective is to undergo the concepts, methods, techniques and procedures learned during the theoretical courses to a real situation. Its target is to carry out the knowledge and skills acquired during the course approaching subjects related to the student training area under advisor supervision.

A table of the disciplines for each course module can be found at the following website:
www.inpe.br/unidades/cep/atividadescep/cursointernacional

Since its beginning in 1985, a regular assessment has been made every five years, and a new one was done in 2003.

Before doing the assessment all the former students were contacted and asked to update their personal and professional data. This information would be useful to update the Course database and keep a regular contact with them as well as delivering the questionnaires for this assessment.

The main objective of this paper is to present an assessment of the sixteen years of the *International Course on Remote Sensing and Geographic Information Systems*' experience for that it can be set new goals and policies that will certainly improve its quality.

2. METHODS

In order to assess this course, this work was divided into two main phases:

1) The updating of the course database: This task consisted of updating all former students' data of the course database. The objective of the updating of this database is to maintain more regular contacts with them in order to know their academic and professional progression as well as evaluating the impact of this course in their career along these years.

Since 2002 a hundred fifty nine forms were sent to them through emails, faxes and mail in order to know their new jobs, personal and professional addresses and other academic information that was missed in the course database. As this work is a continuous task, up to now eighty-four forms have already been received.

2) The elaboration and delivery of questionnaires: This task consisted of the delivery of 159 questionnaires for all the students who took part in this course from 1985 to 2003, through emails, faxes and mails. From the total, 64 questionnaires were received and make this assessment possible.

The information requested in this questionnaire include the main topics as described below, besides the name of the former student, year of the course conclusion, country, gender, age, course graduation, mastering and doctorate courses (area and institution):

- If they presently work with Remote Sensing and GIS (work period, area and activity). If not, the reason they stopped to work with this technology;

- If their work institutions are public or private, their names and their positions;

- If they had Master or/and Doctor Degree prior to participate in the International Course on Remote Sensing and GIS. If not, they are currently participating in some post graduation program (Master or Doctorate, area and institution);

- If the International Course on Remote Sensing and GIS has been important on their academic and professional career and the main reasons;

- If they teach or have already taught classes on remote sensing (name of the institution and if it is in graduation and/or post graduation courses);

- If they have publications in this area and the number of them;

- Finally, it was asked their opinion about the course, teachers, infrastructure and equipments, and the importance of this course to their professional career.

3. RESULTS AND DISCUSSION

The primary results that were gotten through the updating of the Course database show a general view of the present state of this course in the last sixteen years and can be seen in the following tables (1 to 5):

Area	Number
Administration	2
Computer Science	8
Architecture	9
Biology	10
Engineering (Aerial Photo Geodesic, Agricultural, Cartographic, Civil, Electric, Electronics, Environmental, Forest, Geological, Geodesy, Geographical, Geophysics, Software, Surveying,)	55
Physics, Photogrammetry	6
Geography	43
Geology	21
Oceanography	2
Zoology, Military, Statistics	3
Total	**159**

Table 1. The former students' graduation area

Country	Number
Algeria, Burkina Faso, Ghana, Senegal.	1
Argentina	13
Bolivia, Ethiopia, Chile	4
Brazil	49
Colombia	10
Costa Rica, Honduras, Panama, Paraguay	2
Cuba	10
Ecuador, Venezuela	7
Mexico	8
Nigeria, Dominican Republic, Uruguay	3
Peru	17
Kenya	5
Total	**159**

Table 2. The country of the former students.

Titles	Number	Prior to the International Course on Remote Sensing	After the International Course on Remote Sensing
Master	19	8	11
Doctor	4	1	3
Total	**23**	9	14

Table 3. Former students with Master and Doctor Degree.

Students in post graduation program	Brazil	Peru	Mexico	Cuba	
Master	4	1	-	-	
Doctor	4	-	1	1	
Total	8	1	1	1	**11**

Table 4. Former students in Post Graduation Programmes (Master and Doctorate)

Edition/Year	Number of Students
First (1985-1986); Seventh (1993)	7
Second (1987-1988)	8
Third (1989); Ninth (1995); Twelfth (1998)	11
Fourth (1990); Fourteenth (2000)	6
Fifth (1991)	9
Sixth (1992); Tenth (1996); Fifteenth (2002)	10
Eighth (1994)	13
Eleventh (1997)	12
Thirteenth (1999); Sixteenth (2003)	14
Total of former students (1985-2003)	**159**

Table 5. Number of former students per course edition.

Up to now 101 men and 58 women have attended to the International Course.

Primary considerations of these results can be done, as follows:

- Geography (43) and Geology (21) are the main areas of the students who took part in the course besides Engineering (55) which has a variety of sub areas;
- Brazil (49), Peru (17), Argentina (13), Colombia (10) and Cuba (10) are the countries of 62% of the former students;
- The course population for the period is composed of 63,5% of men and 36,5% of women;
- Twenty-three professionals have already gotten their diploma in Post Graduation Programmes, 19 are Masters and 4 are Doctors. From this total 14 have gotten their Master and Doctor diplomas after participating in the International Course;
- Currently, there are 11 professionals from Brazil, Peru, Mexico and Cuba studying in Post Graduation courses;
- The performance of these students in each course edition has been very good around the average of 9.0.

After analyzing these primary results, it was discussed the need and the importance of searching more complete information about the academic and professional career of these former students.

The main objective of this task is to assess the current procedures, which have been taken to improve the course quality or even to establish new guidelines and goals to be reached. A secondary objective is to follow their career and to keep their data updated in order to inform them about news and events in the Remote Sensing and GIS area.

In order to get this extra information, 159 questionnaires were sent to these professionals. From this, 64 professionals have returned them. This representative sampling of 40% allowed knowing more detailed information about their academic and professional life, as follows.

The number of former students who answered the questionnaire can be seen per year of course conclusion, in table 6:

Year	Number
1985-1986; 1994	3
1989	6
1990; 1995	1
1991, 1992, 1996, 2000	2
1993; 1999	5
1997, 1998	7
2002	8
2003	10
Total	**64**

Table 6. Number of professionals/year of course conclusion.

This table shows that at least one former student in each course edition has answered the questionnaire. Therefore, there was not a representative in the second edition of the course, 1987-1988, designed for African students.

It is important to state that in 2001 the International Course on Remote Sensing and GIS was not held due to the modernization and improvement of its Computer Science Laboratory.

These former students came from Argentina (7), Bolivia (2), Brazil (22), Chile (1), Colombia (7), Cuba (5), Dominican Republic (1), Ecuador (2), Mexico (5), Peru (7), Uruguay (2) and Venezuela (3). Among them, 44 are men and 20 are women, and they are in the following age group: 26 to 30 (12), 31 to 40 (28), 41 to 50 (19), 51 to 60 (2) and 60 to 69 (3).

They are graduated on the following areas: Administration (1), Agricultural (1), Agrology (1), Architecture (1), Biology (4), Computer Sciences (5), Engineering (Aerial photo geodesy, Agricultural, Cadastral, Cartographic, Civil, Environmental, Forest, Geodesy, Geological, Geophysics, Surveying, Zoo technician) (26), Geography (17), Geology (6), Military (1), and Oceanography (1).

Regarding their academic progression, 23 have already gotten their Master Degree in the following areas: Environmental Management, Environmental Sciences, Forest and Ecology Sciences, Geological Sciences, Sustainable Development, Natural Resources, Technical Cadastre, Underground Exploration, Geosciences, Geodynamics, Geography, Tourist Administration, Irrigation and Drainage, Forest and Environmental Handling, Agricultural Production, Water Resources and Remote Sensing.

They have studied in Post Graduation Programmes in Research Centres, Public and Private Universities from Brazil, Colombia, Ecuador, Mexico and United States.

In addition, 6 former students have gotten their Doctor Degree in the following areas: Agricultural Sciences, Computer Sciences, Engineering, Geography and Remote Sensing Applied to Natural Resources, and they have studied in Post Graduation Programmes in Public and Private Universities from Argentina, Brazil, Colombia and Mexico.

The following information is related to the importance of the International Course on Remote Sensing and GIS in their professional and academic career. Currently 92% of them are working with Remote Sensing, GIS, and most of them for a long time: 3 months to 5 years: 18; 6 to 10 years: 26; 11 to 15 years: 4; 16 to 20 years: 3; 21 to 25 years: 4 and 26 to 30 years: 2.

They have been working in the following Remote Sensing and GIS areas: Agriculture, Computer Science, Digital Images Processing, Division of Environmental Protection (*SIPAM*), Economical Ecological Zoning (*ZEE*), Education, Environmental Geology and Geomorphology, Environmental Impact, Forest Monitoring, Geography Teaching for Grammar and High School Students, Geological Cartography, Geology applied to Remote Sensing, Geosciences, *INPE's* Image Generation Division, Land Use, Landscape Ecology (coastal zones), Meteorology, Natural Disasters, Natural Resources and Environmental Studies, Natural Resources Handling in Indigenous Communities, Protected Areas in Amazonian, Reforestation, Researches for Oil Geological Exploration, Satellite Images and Aerial Photos Interpretation, Sea and Coastal Zones Researches, Territorial Ordering, Urban Planning and Water Resources.

They have been developing the following Remote Sensing and GIS activities:

- Analysis and evaluation of the landscape changes made by the human activities in coastal zones;
- Biophysical component of planning, soils and evaluation;
- Coordination of the use of satellite data in different projects and GIS applications;
- Costal morph dynamic;
- Crops operational forecasting;
- Database handling;
- Development of research projects;
- Diagnoses and evaluations of the changes of the natural resources;
- Digital images processing;
- Environment monitoring and cultural patrimony;
- Environmental licensing of forest and agriculture companies;
- Geological cartography;
- Geomorphological mapping and soil use for environmental diagnoses;
- Geo-referencing of information;
- GIS Management and Development;
- Glaciers and Climatic changes;
- Images visual interpretation using supervised and non-supervised methods and, images processing using improvement techniques and filters;
- Management of environment using Remote Sensing and GIS;
- Management of water resources;
- Mapping for city cadastre;
- Mapping of land sliding and flooded areas;
- Monitoring of forested and deforested areas and fire aiming the sustainable development of the Legal Amazonian, water resources and pollution;
- Remote Sensing and GIS specialist;
- Research projects users;
- Researches on soil and environmental hazards caused by the process of desertification;

- Searching of military targets (aerodromes, bridges and industries);
- Soil use in water basins;
- Student on Master Course Programme;
- Studies of reservoirs;
- Studies of the environmental impact, handling plan for conservation units and protected areas;
- Studies on the climatologic phenomena on the Venezuela;
- Teaching and research;
- The updating of the Bolivia Forest Mapping;
- Vegetation cartography.

Therefore, 8% of them have not been involved with this technology in their work anymore, as follows: 6 months to 3 years: 3 students; 10 years: 1 student.

The main reasons of quitting to work with it are:
- Change of job,
- The current institution does not work with this technology,
- Difficulty to set up a necessary structure to work with Remote Sensing and GIS,
- Change to a new professional career.

Most of them (75%) work in public institutions as Universities, Space and Scientific Research and Technology Centres, Grammar and High Schools, Municipalities, Oil Company, Museum, Ministries and so on.

About 25% work in private institutions as Foundations, Agricultural Companies, Universities, Environmental Consulting Services, Geological Services Companies, Remote Sensing and GIS Companies, and so on.

Regarding to their position in these institutions it can be found a variety of them, like:

- Computer science and Resources Analyst;
- Environmental Analyst;
- Agricultural Engineer;
- Biologist;
- Consultant of Remote Sensing and GIS;
- Coordinator of Remote Sensing and GIS Division;
- Director;
- Geographer;
- Geography Teacher Assistant;
- Geologist of explorations (Remote Sensing and GIS applications);
- GIS Manager;
- Managers (Agricultural and Forest Projects; Images Processing and Interpretation; Practical Works; Studies; the Brazilian Institute of Statistics and Geography Agency; and Regional Manager);
- Remote Sensing and Geo-referencing Team Leader;
- Research Technical Assistant;
- Researcher;
- Scientific Technician;
- Specialists (Environmental; Hydraulics and Satellite Images);
- Students of post graduation courses in Master and Doctorate;

- Teacher in Universities;
- Technician in exploration and development of geological-oil projects;
- Technologist.

About 87,5% of the former students who answered the questionnaire had gotten their Master or Doctor degree after studying in the International Course. Just 12,5% of them have already had their Master (7) and Doctor (1) degree before studying in this course.

Currently 8 former students from Bolivia, Brazil and Peru are studying in Master Programmes in the following areas: Geography (Human, Coastal Oceanography and Sea Geology), Environmental Management, Local Development, Monitoring of Agricultural Resources and Remote Sensing, Theology.

Besides 10 former students from Brazil, Mexico and Peru are studying in Doctorate Programmes in the following areas: Biology, Ecology, Education, Environmental Geology, Geodynamics, Geography, Local Development, Remote Sensing applied to Agriculture, Social Sciences, Sustainable Development, Territorial Planning and Water Resources.

In fact, the International Course database is not completely updated and the current information about this matter is that **19** former students have gotten their **Master degree**, **4** former students have gotten their **Doctor degree**.

The International Course on Remote Sensing and GIS has been important to the academic and professional career of all former students and they have justified its importance according to the comments below:

- This course allowed developing their professional activities with larger competence and quality;
- The knowledge and experience acquired during this course together with their advisors was fundamental for their current activities;
- This course was the first opportunity to be in contact with the Remote Sensing and Geoprocessing methodology for most of them. They intend to start their Doctorate Program shortly, motivated by the knowledge acquired during this course.
- The use of the *SPRING*, Geo-processing software, allowed them to get technical qualification and now they can participate in another GIS Programmes in Europe;
- Some recent former students believe that new Market opportunities will appear. For one of them the course made possible to prepare a tutorial to be used in the Geography teaching, using computer sciences resources, remote sensing and GIS;
- Due to the knowledge and the experience acquired in the course it will be possible to develop research activities in areas of interest;
- It allowed improving the academic curriculum and having an idea of how to manage research projects;
- It supplies new tools of space and geographical analysis in the use of the natural resources for the sustainable development;
- This course allowed to open new doors for his current profession in a wider way, and offered him the opportunity to compete with good professionals in the area;

- It was learned how to develop other technologies and the employment of GIS in the Geology and other areas linked to the Sciences of the Earth (risks, geological mapping);
- Their career were based on the knowledge acquired during this course, updating and incorporating new technologies on their activities and creating a work team of high level that generates internal products or for third;
- Due to their participation in the International Course now can exchange ideas with researchers in other institutions;
- Some of them intend to continue their studies in Remote Sensing and GIS;
- This course allowed developing knowledge and abilities in photo interpretation and recognition of geological risks in satellites images;
- It represented a new step in the professional development, opening the knowledge for new technologies and new professional relationship in the area;
- It allowed analyzing the problems of the environmental disasters, the urban growth and its impact in a more complete way;
- This course allowed improving the professional career and the company position of most of them;
- As environmental consultant and specialist in natural resources aspects, Remote Sensing and GIS has been an important tool in the analysis of the land use, through the satellite images for some subjects such as transportation of agriculture production in highways.

About 67% of the former students teach or they have already taught classes on Remote Sensing, 29% of them have never taught classes on Remote Sensing and 4% have not answered this question.

From those who teach or have taught these classes, they have done mainly in Universities, Research Centres, Public and Private Institutions from Argentina, Brazil, Chile, Cuba, Colombia, Mexico, Peru, Uruguay and Venezuela.

They have done it in graduation courses (58%), and specialization courses and other company training and qualification courses (42%).

About 75% have publications in the Remote Sensing and GIS area, 21% do not have it and 4% have not answered this question.

Table 7 shows that from the 75% of the former students who answered positively this question, 34 have up to 10 publications in the Remote Sensing area, 4 have up to 15 publications and so on, as can be seen:

	Number of Former Students	Number of Publications
	34	1 to 10
	4	10 to 15
	1	20
	2	25
	2	30
	1	46
	4	Did not answer the question
Total	48	

Table 7. Number of former students with publications in the Remote Sensing area.

About 98% of them have evaluated the International Course on Remote Sensing and GIS as a very good course. The teaching staff of this course was evaluated by 96% of them as very good. About 39% considered the course infrastructure and equipment very good, 35% considered them good and 23% considered them regular.

The main reason of those who considered the course infrastructure and equipment as regular has commented that:

- There was not a room with equipments exclusively to the students; they had to deal the schedule with the Remote Sensing researchers or students of other post graduation courses;
- Due to the reduced number of computers, some of them had to accomplish their disciplines exercises as well as the final practical project using their personal computer and they felt prejudiced for it.

Here should be mentioned that most of these considerations are about the period before the expansion of the course laboratory in 2001.

More than 98% of the former students have considered this course as very important for the progression of their professional career.

Before finishing this research, some former students have made several comments about the importance of this course for their career as well as some suggestions:

- The International Course on Remote Sensing and GIS made possible to develop technical knowledge and the coexistence with INPE community allowed acquiring good human principles;
- After the course, it was possible to supervise graduation students, Remote Sensing, and GIS training courses as well as participates in several projects of this area.
- Some of them suggest publishing the monographs of all students during these 16 years. It could be made by Internet or available at *INPE´s* library for any user.
- This course is very important to the professionals who live in developing countries and need to be qualified in this technology mainly for the development of the Latin American countries.
- It makes possible the dissemination of Remote Sensing to people who live far from the big technological centers, becoming an important tool in the research and planning processes.
- Considering the enormous growth of the Remote Sensing and GIS technology, it can also contribute to space analysis in studies of the society as social and cultural changes in Doctorate Program in Anthropology;
- It allows a deeper knowledge about the Remote Sensing and GIS technology to the professionals of private companies and consequently better work opportunities;
- Some of them suggest that their practical work theme should be related to their country and evaluated by the *INPE´s* advisor and the student company manager;
- It was considered the lack of fieldwork during the development of the practical work and its importance to the final project.

4. CONCLUSIONS

The International Course on Remote Sensing and GIS has been important and decisive to the current profession of all former students.

It makes possible the dissemination of Remote Sensing to people who live far from the big technological centers, becoming an important tool in the research and application processes.

It attends a significant number of professions interested in the use of this technology.

Most of these specialists have been working with the Remote Sensing and GIS technology for more than 5 years in private and public institutions, and universities.

In addition, this technology has been disseminating by them in graduation courses and other company training and qualification courses.

This course has motivated about 30% of these specialists to continue their studies in Post graduation Programmes. Now 23 of them have Master or Doctorate degree and 11 have been studying in some Post graduation course.

Their performance during the International Course have been quite satisfactory and fulfilled all objectives and requisites of it.

Consequently, it has been raising the course level year by year and positioning it in a very good concept.

In addition, its teaching staff is composed of qualified professionals of the Remote Sensing and GIS area of the National Institute for Space Research and other Brazilian and foreign institutions. Most of these professionals have been involved directly with the applications of this technology for more than 20 years.

However, the former students have commented about the lack of equipments and an adequate room to attend their needs during some course editions.

Firstly, it is important to point out that INPE, a government institution, depends on the government's resources to make improvements in its facilities and to modernize its equipments.

Unfortunately, this is not always possible and depends on the economical conjuncture of the current government.

Therefore, in 2001 it was finally possible to accomplish the modernization of the Computer Science Laboratory and the equipments through the Brazilian funding agency, the *FAPESP*.

According to the students, in the 2002 and 2003 editions, the course infrastructure and equipments have been attending their needs, satisfactorily.