

# AN EDUCATIONAL PROGRAM FOR TECHNOLOGY TRANSFER BETWEEN SPAIN AND SOUTH AMERICA

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## ABSTRACT:

This paper shows the current state of development in a project of technology transfer between Spain and several South America countries. There are already three years collaborating in this subject and it is a small sample about how international relations are improving the educational quality in Remote Sensing in both sides of Atlantic ocean. International cooperation in Earth Observation lets an educational project where the transfer of technology is becoming from multiple focus. The aim is to bring a increase in the availability and utilisation of data, product and services, not only in terms of volume and variety, but also in the geographical spread of the users. Mainly the activities of this project are an interchange of teachers and reseachers for short and middle time, where they use to teach several workshops. Both directions are been used: Spaniard teachers are going to South America carring information and methods of learning in Remote Sensing; and as a feedback, american teachers must go to Spain showing procedures for researching in Remote Sensing. In a second task a distant-learning network is been developing to offer on-line access, hipertext CD-Rom and other material to spread the project towards other spanish-speeched countries. The objetives of the first period is completely gotten. More than 800 students have participated in this inniciative for last three years. Now a more ambitious program is almost ready: An academical network where students from Spain and South America can work altogether in a sinergical method of learning remote sensing.

## RESUMEN:

Se muestra el estado de desarrollo de un proyecto de transferencia tecnológica entre España y ciertos países de América Latina. Son ya tres los años colaborando juntos, y se configura como una pequeña muestra de cómo las relaciones internacionales están mejorando la calidad educativa en Teledetección a ambos lados del Atlántico. La cooperación internacional en la observación de la Tierra se constituye en un proyecto educativo donde la transferencia tecnológica viene desde múltiple focos. El objetivo máximo es conseguir incrementar la disponibilidad y utilización de los datos, de los productos y de los servicios, pero no solo en términos de volumen y variedad, sino también en el espectro geográfico de los usuarios. Principalmente las actividades del proyecto son el intercambio de docentes e investigadores durante periodos de corto y medio plazo, en los que se imparten cursos y talleres. Se utilizan dos vías, profesores españoles llevan información y métodos de aprendizaje en Teledetección a América del Sur, y como contra partida, investigadores americanos proveen a personal español de procedimientos de investigación en Teledetección. Otra línea abierta es el desarrollando de una red de aprendizaje a distancia, ofreciendo acceso on-line, CD-Rom y otros materiales, para expandir el proyecto a otros países de habla hispana. El objetivo para el primer periodo está completamente conseguido. Más de 800 estudiantes han participado en esta iniciativa durante los últimos tres años. Ahora un programa más ambicioso está casi preparado: La idea es permitir que estudiantes de España y Sudamérica colaboren mutuamente bajo una misma red académica de aprendizaje en Teledetección.

## RÉSUMÉ

Ce communiqué porte sur l'avancement du projet relatif au transfert de technologie entre l'Espagne et plusieurs pays d'Amérique Latine. Cela fait déjà trois ans que cette collaboration existe sur ce sujet. Il s'agit ici de présenter un extrait sur la manière selon laquelle les relations internationales améliorent la qualité éducative de la Télédétection de part et d'autre de l'océan Atlantique. La coopération internationale de l'observation de la Terre est menée à travers un projet éducatif où le transfert de technologie vient de plusieurs foyers. L'objectif principal est d'augmenter la disponibilité et l'utilisation des données, des produits et des services, d'une part en terme de volume et de diversité, et d'autre part au niveau du spectre géographique des utilisateurs. Les activités principales de ce projet sont les échanges entre professeurs et chercheurs sur des périodes à court ou à moyen terme, présentées à travers des

cours ou des ateliers. Deux principes sont utilisés : des professeurs espagnols apportent des connaissances et des méthodes d'apprentissage de Télédétection en Amérique du Sud, et, en contre partie, des professeurs américains doivent aller en Espagne afin de présenter des procédures de recherche sur la Télédétection. En parallèle, un réseau d'apprentissage est développé à distance, proposant un accès « on-line », des CD-ROM et autres matériels, afin d'étendre le projet à d'autres pays hispanophones. L'objectif pour la première période est atteint. Plus de 800 étudiants ont déjà participé à cette initiative durant les trois dernières années. Aujourd'hui un programme plus ambitieux est quasiment finalisé. L'idée est de permettre aux étudiants d'Espagne et d'Amérique Latine de travailler ensemble sur un même réseau académique d'apprentissage de la Télédétection où la langue espagnole sera le lien entre tous.

## 1. INTRODUCTION

Earth Observation datasets are a necessary condition to the provision of a large number of information services which provide economic benefits.

South America is a huge region where remote sensing has a special interest. They are countries with a lot of resources and they are in a period of development. But Remote Sensing has a low repercussion in this areas.

Similar to the rest of the world, scenarios, estimates of socioeconomic impacts, quantitative statistics, trends and forecasts are demanded at various geographical and temporal scales. Quantitative assessment and control are required in support of industrial and commercial activities (agriculture, insurance, construction, tourism,...). But today, after thirty years since the launch of the first satellite of land resources, Earth Observation still remain largely an unknown tools in several countries.

In other hand, spacial agencies have put their focus on the development of space hardware and imagery rather than the development of services where operators and specialist could analyze the datasets. High-level operational information services are needed, and not simply space data or satellite images.

International cooperation lets an education and training project where the transfer of technology is possible from multiple focus: The aim is to bring an increase in the availability and utilisation of data, product and services, not only in terms of volume and variety, but also in the geographical spread of the users.

The impulse requires that Earth Observation data, software, methodology reach out as far as possible (researchers, students, teachers, scientifics,...) giving a shift from the current technology-pushed to an user-oriented approach.

University of Salamanca in Spain, working together other universities in South America, wish to improve the level of knowledge and utilization of Remote Sensing in these developing countries. It is seen like a rush today, giving knowledge and skills, to prepare specialist in Remote Sensing who can carry out independent project in the future.

## 2. THE BEGINNING

### 2.1 Complementary Courses in Remote Sensing

Remote Sensing and Earth Observation are an important source of information for Cartography, Biology, Geography, Forest, Agronomy, Civil Engineering and other sciences of Earth. But

time is limited in regulated courses, and teachers sometimes have to omit several knowledges to focus in more important ones.

Four years ago, several teachers from University of Salamanca decided to make a workshop for divulgating Remote Sensing between students who were interested in this area.

So they made a course called *Applied Remote Sensing* where a theoretical and practical curriculum was involucred.

People from government and academical institutions were our lectures giving information on Remote Sensing in several disciplines (Hidrology, Geology, Cartography, Environment...), and showing real examples where Earth Observation Satellites and Imagery had been used succesfully. See Table 1 for details of whole program.

Introduction to Remote Sensing
Resources of Remote Sensing on the Net
Visual Análisis of Image in Remote Sensing
The CORINE Program: A Land Cover map.
Remote Sensing in Geology
The GeoRadar and its Applications
Evaluation of hidric parameter in rivers with Remote Sensing methods
High resolution imagery applied to agricultural environment
Image Map and Imagery Databases
Integration of SIG and Remote Sensing dataset
Review of Remote Sensing software

Table 1. Some of the lectures taught along the course.



Figure 1. Training kits for the students including Cartography, software demo, practical and theoretical booktexts, imagery and spreadsheets of the sessions.

In the practical skill, a hand-on tutorial was prepared to introduce how to use imagery dataset.. See Table 2 for details of whole program.

A complementary material was facilitated to the pupils including cartography, books and two CD-Roms with spreadsheets, electronic tutorials, demos of software, sample images,... (Perez, C., 2003, Muñoz, C., 2003). See Figure 1.

Introduction to PCI Geomatica
Importing and Exporting Data
Basis Analysis of the Image
Using Histograms
How to buy and download Remote Sensing imagery
Convolutions and Filters
Classification Techniques and Applications
Techniques and Applications of Geolocation
Advanced Analysis of Image
Introduction to fusion of sensors
Principal Components Analysis

Table 2. Planning for practical curriculum.

## 2.2 Summer Courses in Remote Sensing

This first workshop was a huge success and new people started to be interested in it. People from our university and other Spanish universities were demanding this kind of courses. They wished a way to learn remote sensing in theoretical and practical stuffs. This kind of workshops was not very extended in Spain indeed.

Some months later, we decided to open our workshop to people from all of the universities and also to professional staff working in remote sensing areas who wanted to update their knowledge.

This new course was celebrated in the summer period to help people coming from other provinces. The workshop was full-time for a week. The planning was similar to the previous edition with the same lectures. A heterogeneous collection of students applied the workshop: biologists, mathematicians, physics, engineers, agronomers,...

These kind of courses called complementary and summer courses have been done for seven times. The test of quality showed a high satisfaction between the assistance.

Edition	Date		Location
1 <sup>st</sup>	February 2001	CC	Ávila
2 <sup>nd</sup>	July 2001	SC	Salamanca
3 <sup>rd</sup>	November 2001	CC	Ávila
4 <sup>th</sup>	February 2002	CC	Ávila
5 <sup>th</sup>	July 2002	SC	Salamanca
6 <sup>th</sup>	July 2003	SC	Salamanca
7 <sup>th</sup>	July 2004	SC	Salamanca
8 <sup>th</sup> (approved)	September 2004	SC	Ávila

Table 3. Complementary Courses (CC) and Summer Courses (SC) inside University of Salamanca.

## 3. COURSES IN PEROU

### 3.1 Genesis of the network

In 2002 the Agencia Española de Cooperación Internacional (AECI) an institution depending of Foreign Affairs Ministry, financed the collaboration project between Universidad de Salamanca (Spain) and Universidad Nacional Mayor de San Marcos (Perou).

This project lets to teach a new workshop in the Faculty of Physics of Lima (Perou). The name of this new course was *Photogrammetry and Remote Sensing*. People from Laboratory of Remote Sensing of this faculty, teachers and other interested people could apply this course with a great success.

The target of this course was teachers and researchers in different areas. The aim was to divulgate remote sensing and photogrammetry, to do people can use this tool in their particular discipline and for doctors can spread the knowledge towards university students.

This Peruvian course was a first glance to know what the situation of South America countries is in relation to Remote Sensing. They have a huge necessity to use remote sensing and they know this discipline is a good tool for them. But their academic status is economically low and they can not afford the learning of their personal. Prices of licenses for software, fares for imagery, specific good books or professional training courses are impossible for a high number of university, institutions and citizens in general.

With this genesis, it was borned the idea to create an international academic network where people from Spain could go South America to show the state of the art in Remote Sensing and Photogrammetry; and specialist from South America could visit Spain to learn and show their improvement to students and researchers in Spain.

Since this moment, this project the collaboration between Spain and Perou has been in different aspects of research and teaching. Several papers have been submitted in Spanish and South American conventions of remote sensing (Rojas, J., 2003, Perez, C. 2003).

### 3.2 First interchange 'go and return'

A new project was been done in 2003-04 period.

Two workshops were celebrated in Perou with Spanish teachers. In July and August 2003, the basic course of remote sensing was repeated, and an advanced course called *Analysis of Imagery in Geotechnologie* was created. Personnel from several geographical national institutes were students in both courses.

Moreover, a collaboration into an investigation to make cartography of vegetation indexes in Perou was finished and the experience has been published in several reviews (Rojas, J., 2003, Perez, C. 2003, Muñoz, A.L., 2003).

This second year in Perou was a chance to contact with researchers in other countries. From Bolivia and Argentina there were people wishing to enter in this inter-atlantic cooperation. So it is a challenge to more people going into the

project. People from different spanish universities could go to Perou, Bolivia and Argentina, and viceversa.

In relation to people coming from South America, in summer of 2004, a reseacher from Perou is waited to go Spain and to teach a workshop of ASTER dataset for students and proffesionals who are interested in callibration and applications of this data.

The experience of this collaborator who has been working in the Laboratory of Remote Sensing in Perou, will be an extraordinary opportunity for create a small laboratory of Remote Sensing for researching with ASTER imagery.

## 4. THE FUTURE

### 4.1 Six universities altogether

Next step in this project is pending to approval yet. It would be coming for 2005. Three south american universities and three spanish universities are working to create a sinergical network where teachers can visit every university and teach a brief and specific workshop in each of them.

We are thinking in specific courses of Radar, Lidar, Thematic cartography, Hyperspectral imagery, Quantitative assessment and control in Remote Sensing, Digital and Close-Range Photogrammetry, new advances in GIS,...

Year	Joint-Venture	Student Target	Place	Teache rs From	Course Name
2001	USAL	Students from Salamanca Campus	Avila (Spain)	USAL and others	Applied Remote Sensing
Summer 2001	USAL	Students and Professionals from Spain	Salamanca (Spain)	USAL and others	Applied Remote Sensing
Summer 2002	USAL-UNMSM	Peruvian students and docents	Lima (Perou)	USAL	Applied Remote Sensing
Summer 2003a	USAL-UNMSM	Peruvian students and professionals	Lima (Perou)	USAL	Applied Remote Sensing
Summer 2003b	USAL-UNMSM	Peruvian students and professionals	Lima (Perou)	USAL	Analysis of Imagery in Geotechnolog y
-- Future --					
2005-2006 (pending )	USAL-UNMSM-UNSA-UNSJ	Bolivian Peruvian Argentinian Spaniards students	Spain Perou Bolivia Argentina	USAL UNMSM UNAS UNSJ	<i>under consideration</i>
2006-2007 <i>under consider.</i>	E-Learning bimodal program	All of the countries which want to participate	Global	Global	<i>under consideration</i>

Table 4. Evolution of the Academical Network and forecast.  
 USAL=Universidad de Salamanca (Spain), UNMSM= Universidad Nacional Mayor San Marcos (Perou), UNSA= Universidad Nacional San Andres (Bolivia), UNSJ=Universidad Nacional San Juan (Argentina)

In the summer of Europe is winter in South America. So that is the period when spanish teacher would travel Perou, Bolivia and Argentina teaching the same specific course in every country and collaborating in different small projects in each hosted university.

In the summer of South America is winter in Europe. So students, teachers or reseachers from Perou, Argentina and Bolivia could travel Spain getting information and knowledge from specific doctorate courses, or teaching their investigation lines from their countries.

### 4.2 Developing a distant method of working

South America community has several deficits in the access to the information and the high-tech sector. There are no much people understanding english in this countries. Technical books are mainly written in english, so they have an important challenge to develop an adecuate knowledge.

They have a big desire to can study abroad but like english as a second language is not spreaded enough, their only one solution is to study in Spain or other latinamerican countries.

In other hand, the economy of this countries is not so high to can support a lot this weight.

A possibility to solve this problem is to create a distance course where people from developing countries can get the knowledge from a more technological and advaced country avoiding go abroad.

Several alternatives were under consideration:

1. To make a e-learning program: Students must study using Internet technology. They are clients and all of the material is inside a server.
2. DVD or CD-Rom authoring: Students get all of the information in a disc which is sent to their address. They can learn using hipertextual tutorial and all of the material.
3. A bimodal and presencial method: Both previous alternatives are present plus a presencial teaching also.

Internet broadband is not socialized in South America. People have access on the Net but not plain fare. Dial-up or access from a cybershop is a serious problem when several materials have a long size (gigabytes of imagery and software to the practical activities).

The third alternative is the more adecuate. It has the same advantages of the previous choose, but it avoids their disadvantages:

- Traditional surface postal is used to send CDs/DVDs and textbooks to all of the pupils in the program (South american mainly but spaniards also),
- Internet is used to update the curricula, to facilitate the interchange of ideas between teachers and students via chats or other forums, to follow the evolution of pupils with autocheck test,...
- During the year several presential workshops and tutorials of training are developed in some universities. The human touch is always an important way to motivate and resolve several doubts. Similar to the previous workshops visitor teachers are from

Spain and other latin countries, and they are moving across different universities abroad for two weeks normally.

An easy and inexpensive access to this program is seen as a critical element. Continuity can be guaranteed because a community of users has expressed a suitable demand and a mechanism to support new pupils and institutions.

This program is in a initial fase yet. The labor of creation of multimedia contents is low and it spends a lot of time. Didactical and pedagogical criterions is not always linked to the authoring software methods.

Four training experiences had become last years (Perez et al, 2003), but there is a long trail to reach good results yet.

<b>Option One: e-Learning Program</b>	
<i>Pros</i>	<i>Cons</i>
Easy to update the curricula  Communication in Real-time between teachers-students and student-students	No everyone has access to internet  No useful for a huge volume of information (imagery and software of RS)
<b>Option Two: Authoring Program</b>	
<i>Pros</i>	<i>Cons</i>
Easy to use  Net is not necessary  No problem with volumen of information	Difficult to update  Difficult to resolve problem in the distance
<b>Option Three: Bi-modal and presential workshops</b>	
<i>Pros</i>	<i>Cons</i>
Avoid the cons of above  Teachers and students keep the touch for workshops	No available yet!

Tabla 5. Pros and cons for different alternatives for education in the distance.

## 5. CONCLUSIONS

These three years of collaboration show how the technology transfer is making a sinergical way in Remote Sensing and Photogrammetry. Three years is time enough for up to 800 student got benefit of this collaboration . Every year, more and more institutions wish to join.

This project is not only an educational project. Our collaborators and students are working together or independently researching and developing new projects: Indexes of vegetation, image map, temperature of soil and sea, thematic cartography, three-dimensional modelization...

Future of project is optimistic. Results were good in the first period and a more ambitious program must be developed. New countries, new universities will be cooperating next years.

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