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COMMISSION VII

SATELLITE LANDSAT-SKYLAB EVALUATION OF NATURAL RESOURCES OF THE ARGENTINE REPUBLIC AT SCALES 1:125.000 AND 1:250.000 IN MORE THAN 4.000.000 SQUARE KILOMETERS

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1. INTRODUCTION

In the poster session WG VII-1, you can see and discuss personally the results of the different inventories of natural resources, covering more than 1.000.000 Km2 of ARGENTINA, which were made using visual techniques of satellite interpretation.

First, a brief summary about the ARGENTINE REPUBLIC: Geographical situation: South America between latitude 21°46' S and 55°30' S and a longitude of 73°W and 53°W. Capital: Buenos Aires. Continental area: 2.776.665 Km2; Antartic territory and islands: 1.249.040 Km2. Comparison of continental areas: Argentina is 11.4 times larger than the United Kingdom, 11 times larger than West Germany, 9 times larger than Italy and 5 times larger than France. Population according to census of 1970: 23.250.000 inhabitants. Languaje: spanish.

The methodology used to carry out the different projects was developed by AEROTERRA S.A., a private company of ARGENTINA and was based in the last developments of the scientific community of the world adapted to the particular conditions of the different regions. The general objective was: "to have in the least possible time, an uniform up-to-date vision of the potential of natural resources at scales 1:125.000 and 1:250.000 in different thematic maps; in order to help the cuali-cuantitative diagnosis, and select the priority areas for an evaluation, development and rational use of the natural resources of the region in study."

Figure N° 1 shows the Argentine Republic and the regions of the different satellite projects made by AEROTERRA S.A. It is a reproduction of a satellite map of ARGENTINA.

2. INVENTORIES OF NATURAL RESOURCES

It is well known that the natural resources are the sources of economic, scientific and spiritual power, and must be preserved and increased for the benefit not only of this generation but of the coming ones. Its rational evaluation, constitutes a challenge to all of us.

An important key to international programs is the knowledge of the resources which are available for development. But it is very important to remember that if the principal economic goods are the natural resources, only, when these are identified and exploited, there will be a gain. There will be no income until the dam is built, the colonization is established or the lumber or copper deposits are operating.

The cycle for natural resources has been described as:"...an effort to obtain information which may be used to the maximum according to the moment's perspective, and at the same time assure thet any pertinent requisite of the study will be done in the future in the most adequate way..."

Like I said seven years ago in the 1st. Panamerican Symposium on Remote Sensing, in Panama, our generation has witnessed the facts of three great revolutions:

1) The unsatisfied aspirations,
2) The demographic explosion, and
3) The revolution of the technical gap, which emerges from the fact that scientific discoveries and their technological applications favour the richest countries, and leave the less rich countries further away every day.

This is changing the face of the world we live, and has made it imperative to focus world and national problems as a coherent and technical joint cooperation, in order to recover the time lost, to convert the centuries into decades, and to make our planet's resources serve the needs of individuals of any country of the world. This important objective of appropriate transfer of satellite remote sensing technology constitutes one of the main goals of the COMMISSION VII and of this report.

REMOTE SENSING TECHNOLOGY

Since the first photographs taken from a ballon, until the last images from LANDSAT-3, more than 120 years have elapsed. Their qualities and manufaction techniques have been improved day by day, and it is true, like it has been stated, that anything we can think of, can also be photographed.

Remote sensing is the process of taking measurements of an object from a distance without physical contact with it. Cameras, microwave instruments, spectroradiometers, infrared devices, radar, x-rays, multispectral scanners and the human eye, are all examples of remote sensing data collection systems. No single detector or sensor is capable of sensing and measuring energy at all wavelengths of the electromagnetic spectrum.

Remote sensing largely concerns with the measurement of electromagnetic energy which is reflected, scattered or emitted by objects receiving and then returning energy from the sun. Different objects return different kinds and amounts of energy. In remote sensing, detecting these differences enables identification of the earth surface features and conditions from the air and space.

Only 8 years have elapsed since when on July 23, 1972, the United States put in orbit the first LANDSAT. Since then and until december 1979, a total of 327.162 MSS scenes were acquired by the United States receiveng stations(LANDSAT-1: 144.812; LANDSAT-2: 147.549; LANDSAT-3: 34.802)-NASA, May, 1980-

LANDSAT DATA USED

Of the three earth resources data collection devices aboard the LANDSAT: the Return Beam Vidicon (RVB) camera system, the Data Collection System (DCS), and the Multi-spectral scanner (MSS); only this last from LANDSATS 1, 2 and 3, was used in the Argentine projects, and was complemented with the SKYLAB (sensors S-190A and S-190B), when available in the area of study.

In all of our jobs we used LANDSAT bulk images at scale 1:250.000 and special en-largements at scales 1:100.000 and 1:50.000 made from the 1:1.000.000 negatives. Most of the images came from EROS, and some from Brazil. In the months to come, we wil be able to buy these images from the new argentine receiving station.

Like you know, LANDSAT data are available in two formats, computer compatible tapes(CCT) and bulk images. A LANDSAT scene stored in a CCT contains 2340 scan lines, with 3240 points each line. A total of 7.581.600 pixels are contained in each LANDSAT scene covering 34.225 Km2. Each pixel or minimum element of groun re-solution (57 x 79)m. is .45 hectares (1.1 acres) and has a numerical reflectance value in each of the four bands.

This does not mean that he ignores all the other imagery, but in the interpreta tion of specific targets, he selects these three almost exclusively. Thus, when he desires to integrate and interpret effectively more than three images simultaneously, the human interpreter must be replaced by some automatic decision machine.

The main technique used during our visual satellite interpretation is known as multispectral-multitemporal analysis, and the analogy and convergence of evidence.

Analogy has been referred to, as the heart of photointerpretation. Analogy is always present, direct or indirectly in all the process of photointerpretation. The interpreter constantly compares and analyzes the photographic image which he sees, recognizes and/or interprets, with the image he beleives to have seen, recognized and/or interpreted in previous photographs, photointerpretation keys or ground studies. Analogy, is thus present at all times in the memory of the inter preter or in the key of another interpretation development.(VIOLA, 1963).

5.1. Multiband or Multispectral Analysis

The human eye is a great deal more sensitive to differences in color than it is to differences in brigthness. In this way there is a little doubt in anyone's mind that the image interpretation of a complex ground scene is greatly made easy by the use of color. Physiologists have told us that the normal eye-brain combination can detect some 7.5 million different colors, while it can sense only 200 different shades of grays. However, as often happens, the phenomenom to be detected is even too subtle to be "seen" on conventional color and color infrared films, so a new technique called multispectral photography is necessary.

Multispectral photography allows a photointerpeter to examine the spectral infor mation from several narrow wavelength bands, rather than looking at one broad band. These narrow bands are obtained by using different combinations of photographic films and filters, in order to get the better for a specific puspose.

5.2. Multitemporal Analysis

By using two or more images of different times, over the same area on the ground, we are making a multitemporal analysis. This will be very useful in order to create a multispectral-mutitemporal data set, so that both the spectral and temporal information may be used to aid in the analysis and classification of different ground cover types.

5.3. Multistage sampling techniques, are the way of using several types of remote sensing inputs (satellite, air-photographs and ground observations) in order to get better accuracy in the information of the different kind of natural resources.

'. THEMATIC MAPS MADE

It is important to remember that the inventories of natural resources had the following three characteristics: 1) They were strictly limited in time and funds; 2) They were oriented toward specific projects and 3) it was necessary to obtain the information rapidly and economically.

The amount of energy reflected by a material is a function of three factors: 1) how much of the sun energy reach to it; 2) how much is absorved by it; and 3) how much is transmitted by it.

Reflected energy from the earth is measured in four wavelenght bands by the LANDSAT's MSS. Two of these bands are in the visible portion of the spectrum (Band 4: .5-.6 microns; and Band 5: .6-.7 microns); and two in the near infra red (Band 6: .7-.8 microns and Band 7: .8-1.1 microns). When the sensor passes over an area, the ground surface is scanned in succesive strips or scan lines by the mirror. Each covered point is called "pixel or minimun element of ground resolution" and covers .45has. (1.1 acres), and the data has four relative radiance values. The assigned values range from 0 to 127 discrete radiance levels for the three lower bands (4, 5 & 6), and from 0 to 63 for Band 7.

It is important to remark that while photographic data collection systems tend to retain better spatial accuracy, optical mechanical scanner data have better spectral resolution, since the parameters of the detectors can be set for much narrower wavelength bands, and there is inherent registration between specrtal chanels.

It is well known that most of LANDSAT-3 MSS images have problem with the proper synchronization of scan lines, referred to as the "line-start anomaly", and are currently affecting 20 to 40 % of all LANDSAT MSS images being acquired. The MSS is equipped with a hardware feature that generates a line start pulse to activate the MSS detectors at the beginning of each mirror sweep. The problem ocurrs when this start pulse is either absent or of abnormally low amplitude, and as the detectors are not activated at the appropiate time, no data are acquired during the initial part of the scan. (LANDSAT Data Users Note, NASA-USGS, May, 1980).

Typically three types of images may be produced and used during the analysis sequence: 1) the reconstructed image, derived from the unaltered data; 2) the enhanced image, an improvement of the reconstructed image or a representation of data which has been improved in some way and 3) the classification image, representing the results of analysing the data (Focus Series, LARS 052977, PURDUE University, USA).

5. THE PROCESS OF INTERPRETATION USED

It is necessary to outline that in order to accomplish with all the tasks to be done in the short time of each project, it was necessary to do a great technological effort; starting with the selection of the images and the election of the most adequate people for each region, as well as the election of different methodological aspects which would fit better to the natural conditions of the studied regions.

All of the works were done in Argentina by more than fifty argentine technicians and scientists, using methodology developed by the company AEROTERRA S.A. and directed by engineer ALBERTO BENITO VIOLA.

The experience has shown that an interpreter using only the eyes can integrate and interpret only three separate images. When more than three images are given to work on, he conscientiously and unconscientiously selects the three images that he beleives will provide the better information, and concentrates his attention on these three. (CHARLES OLSON-USA- Meeting of Forestry Researchers, 1971).

It is impossible to describe each one of the inventories made, in the short space of this summary, for they cover more than 4.000.000 Km2. Anyhow, the inventory of Land Use is described, as it was common to all the projects. Any additional information about the other inventories, can be asked to: AEROTERRA S.A., Gorostiaga 2465, (1426) Buenos Aires, Argentina. TE: (01541) 771-5881, Telex: 21132 CODUL AR.

The main goal of the different projects was to obtain in the least possible time, an uniform, objective and up-to-date cartographic vision of the potential of the existing natural resources, in order to help the making of a cuali-cuantitative diagnosis of them, and the appropiate selection of priority areas which should be developed first.

The natural resources inventories were made during the period 1976-1979, and they included the following argentine Provinces: Buenos Aires (307.571 Km2); Santiago del Estero (135.254 Km2); Corrientes (88.199 Km2); Chubut (224.686 Km2); Formosa (72.066 Km2); Misiones (29.801 Km2) and the Pilcomayo River Basin in the border Argentina-Paraguay (206.500 Km2). - See Figure 1 -

The studies were carried on, by multidisciplinary scientific teams, in order to obtain different kinds of natural resources thematic maps, as well as black & white, color, and color infrared photomosaics, etc., in an average time of 150 days for each selected region.

The different thematic maps made at scales 1:250.000 and/or 1:125.000 were integrated specially by the LAND USE and HIDROLOGY inventories, and complemented with special maps, such as: GEOMORPHOLOGY; STRUCTURAL-GEOLOGY; HIDROGEOLOGY; EDAPHOLOGY; UNDERGROUND WATER; SOIL SALINITY; etc.

In this way, for example, the HIDROLOGICAL inventory of the Province of Buenos Aires, was complemented with additional information on: the ten existing phisiographic environments and the description of their main geomorphic features; the provincial hidrological balance (THORNTHWAITE method); weather classification; wind frequencies; LANDSAT enlargements up to scale 1:100.000 of the representative and/or critical hidrological sectors; etc. Table III shows the systems, basins and sub-basins detected in the different projects.

The system of classification used in the inventory of soil salinity, is a modification of the one made by the Soils Laboratory of the Department of Agriculture of the USA; known as "Classification of RIVERSIDE". This system was adapted to the particular conditions of the Province in study. It was adopted because it gives a direct information about the salt afectation of the soils, and permits to establish a relation between the salinity index and the vegetal species to be planted.

It is worth to outstand the non-traditional inventories that were made, such as: Development and Evolution of Land Use in Boundary Areas; Registration of Meteorological Phenomenoms (Tornados); Censal-Economic-Departamental Zonification; etc, and some additional works of investigation, such as: Automatic satellite maps, system IMAGE-100; vegetation map(Burma, World Bank); etc. All of these have contributed in the results that were obtained.

A great importance was given, in each project to the air-ground verifications or ground-truth, which were carefully planned. The areas were covered by air (8 to 10 hours for each project) and by land (7 to 15 days). These verifications permitted to obtain an 80% of confidence, in all the thematic maps produced.

7. LAND USE INVENTORIES

The impossible dream of up-to-date land use maps, appears closer to realization with the advancements in classification software and methodologies, the complementary use of satellite and aircraft imagery and data, and a variety of electronic devices.

In our Land Use classification system for the different maps at scales 1:125.000 (SKYLAB) or 1:250.000 (LANDSAT); we used the USGS classification system (ANDERSON, 1971, Circular 671), and the revision paper published in 1976 as USGS Professional Paper 964: "A Land Use and Land Cover Classification System for use with remote sensor data". We adapted Levels I and II to specific regions, and we had in mind the criteria established by ANDERSON to configurate the classification system. The minimum unit of stratification for LANDSAT images at scale 1:250.000 was fixed in 40 hectares.

In Table II, the synthesis of the pure and mixed units that were stratificated in the different inventories of Land Use-Vegetal Cover, can be seen.

Vegetation is a primary component of most land cover types, and the knowledge of regional phenological changes in vegetative cover is critical when selecting the better LANDSAT scenes for temporal analysis. This problem is more critical in countries like ARGENTINA where we do not have an organization like the EROS Data Center (USA). Therefore, it is very important for a company like AEROTERRA S.A. to have the microfilms stored and the plottings actualized, because the time that we need for this task together with the process of the chosen images, sometimes is the same given for a complete project. This year we hope to have this problem solved when the Argentine receiving station becomes operational.

Another problem that we have in this kind of job, is that in ARGENTINA like in other countries, it is almost impossible to get anything similar to the photographs taken by U-2 in infrared color at scale 1:100.000. This is a great disadvantage that our interpreters have in comparison with those of the UNITED STATES, because the resolution of these classes of images helps to improve the visual satellite interpretation of Land Use categories and the accuracy of the final results.

Two fundamental elements of inventory and data collection have been outlined in the Land Use: 1) baseline inventory and 2) monitoring change in selected areas. The baseline inventory is the initial one for any project; while monitoring changes involves updating the initial inventory in order to know the dynamic process of the region.

In special projects, several jobs derived from Land Use maps, were made, such as: 1) Regional quantification of Land Use changes; 2) economic stratification of Land Use; 3) Development of Boundary Areas; Development of Main Cities; 5)Comparison between economic and Land Use maps in several counties, etc.

FIGURE Nº 1

SATELITE MAPS OF ARGENTINA WITH

GEOGRAPHICAL SITUATION PROJECTS

(details to see TABLE I)

SCALE ORIGINAL: 1:500.000

STATE/REGION	AREA	SCALE	RIVER BASIN		RIVER BASIN (1,2 etc orden)
CUENCA RIO PILCOMAYO (ARG-PARAGUAY)	206.500 km²	1:500 000	—	2	33
CORRIENTES (ARG.)	88 199 km²	1.250.000	—	9	43
CHUBUT (ARG.)	224.686 km²	1:250.000	4 (endorreicos)	5 (Pacífico) 4 (Atlántico)	13 23
FORMOSA (ARG.)	72.066 km²	1:250.000	—	2	11
MISIONES (ARG.)	29.801 km²	1.250.000	—	3	62
PUNTO TRIPARTITO FRONTERA N.E. (ARG-PARAGUAY-BRASIL)	11.310 km²	1:250.000	—	—	—
SANTIAGO DEL ESTERO (ARG.)	135.524 km²	1:250.000		9	10
BUENOS AIRES (ARG.) SKYLAB	90.150 km²	1:250.000	10	9	9
BUENOS AIRES (ARG.) LANDSAT	307.571 km²	1:250.000	18	19	31

- HYDROLOGY (main projects) TABLE II

STATE/REGION	AREA	SCALE	CATEGORIES LEVEL 1-2	CATEGORIES LEVEL 2-3
CUENCA RIO PILCOMAYO (ARG.-PARAGUAY)	206.500 km²	1:500.000	8	18
CORRIENTES (ARG.)	88.199 km²	1:250.000	12	36
CHUBUT (ARG.)	224.686 km²	1:250.000	10	19
FORMOSA (ARG.)	72.066 km²	1:250.000	10	24
MISIONES (ARG.)	29.801 km²	1:250.000	7	23
PUNTO TRIPARTITO FRONTERA N.E. (ARG.-PARAGUAY-BRASIL)	11.310 km²	1:250.000	4	—
SANTIAGO DEL ESTERO (ARG.)	135.524 km²	1:250.000	10	9
BUENOS AIRES (ARG.) SKYLAB	90.150 km²	1:250.000	8	4
BUENOS AIRES (ARG.) LANDSAT	307.571 km²	1:250.000	8	18

- LAND USE (main projects) TABLE III

Nº	PROVINCIA O REGION	ESCALA	INVENTARIOS REALIZADOS	SUPERFICIE EN Km2	TOTALES PARCIALES	TIEMPO DE EJECUCION	COMITENTE
1	CUENCA DEL RIO PILCOMAYO	1:500.000	Hidrológico (2 hojas) Uso actual de la tierra (2 hojas)	206.500 206.500	413.000	6 meses	OEA-BID-PNUD
2	CORRIENTES	1:250.000	Hidrológico (3 hojas) Uso actual de la tierra-Ecológico	88.199 88.199	176.398	4 meses	INCYTH
2	CORRIENTES	1:500.000	Edafológico (1 hoja)	40.000	40.000	1 mes	INCYTH
3	CHACO	1:100.000	Mapas temáticos sistema imagen-100	4.000	4.000	2 meses	CFI-INCYTH
4	CUENCA INFERIOR RIO BERMEJO	1:500.000	Base planimétrico-hidrológico	34.225	34.225	1 mes	INCYTH
5	CUENCA RIO MOTOCO (Chubut-Río Negro)	1:50.000	Hidrológico estructural para emplazamiento central hidroeléctrica.	1.600	1.600	1 mes	IATASA-GOBIERNO DE CHUBUT
1	CUENCA INFERIOR RIO PILCOMAYO	1:500.000	Base planimétrico-hidrológico	34.225	34.225	1 mes	INCYTH
6	CHUBUT	1:250.000	Base planimétrico (5 hojas) Hidrológico (5 hojas) Hidrogeológico (5 hojas) Uso actual de la tierra (5 hojas) Desarrollo evolutivo de áreas de frontera (1 hoja) Zonificación departamental Alto río Senguerr (1 hoja) Polos de desarrollo (1 hoja)	224.686 224.686 224.686 224.686 18.340 22.327 2.118	914.539	6 meses	DIGID-CFI-PROVINCIA DEL CHUBUT
7	FORMOSA	1:100.000	Mapas temáticos sistema imagen-100	8.000	8.000	1 mes	CFI-PCIA.FORMOSA
7	FORMOSA	1:250.000	Base planimétrico (3 hojas) Hidrológico (3 hojas) Uso actual de la tierra (3 hojas) Areas de frontera (3 hojas) Polos de desarrollo: Formosa, Clorinda, El Colorado (1 hoja)	72.066 72.066 72.066 38.354 6.437	260.979	6 meses	PROVINCIA DE FORMOSA
8	MISIONES	1:1.000.000	Vegetación (banda angosta y realce temático)	34.000	34.000	1 mes	CFI-PCIA. DE MISIONES
8	MISIONES	1:250.000	Hidrológico (2 hojas) Base planimétrico (2 hojas) Geológico estructural (2 hojas) Geomorfológico (2 hojas) Uso actual de la tierra-tipos de vegetación (2 hojas) Edafológico (2 hojas) Areas de frontera (2 hojas) Polos de desarrollo (Posadas, Bernardo de Yrigoyen, El Dorado) (1 hoja) Zonificación Departamento Guaraní	29.801 29.801 29.801 29.801 29.801 29.801 13.579 4.808 2.776	199.969	5 meses	CFI-PROVINCIA DE MISIONES
9	SANTA FE-ENTRE RIOS	1:1.000.000	Inundaciones (banda angosta y realce temático)	34.000	34.000	1 mes	CFI-DIGID-SE.PLA.DE.
10	PUNTO TRIPARTITO FRONTERA N.E.	1:250.000	Desarrollo evolutivo del uso de la tierra (1 hoja) Variaciones Hidrológicas (1 hoja)	11.310 11.310	22.620	1 mes	INCYTH
11	SANTIAGO DEL ESTERO	1:250.000	Geomorfológico (5 hojas) Base planimétrico (5 hojas) Uso actual de la tierra (5 hojas) Salinidad de suelos (5 hojas) Secuencial Bañado (1 hoja)	135.254 135.254 135.254 135.254 28.000	569.016	8 meses	PROVINCIA DE SANTIAGO DEL ESTERO-CFI-DIGID-CRD
12	BUENOS AIRES (SKYLAB)	1:125.000	Hidrológico (6 hojas) Uso actual de la tierra (6 hojas) Secuencial hidrológico (1 hoja)	90.150 90.150 15.025	195.325	5 meses	SE.PLA.DE.-CFI-DIGID-DVPBA
12	BUENOS AIRES (LANDSAT)	1:250.000	Base planimétrico (10 hojas) Hidrológico (10 hojas) Uso actual de la tierra (10 hojas) Secuencial uso de la tierra (4 hojas) Secuencial hidrológico (2 hojas)	307.571 307.571 307.571 80.580 64.500	1.067.793	9 meses	SE.PLA.DE.-CFI-DIGID-DVPBA
13	EJE METROPOLITANO (Buenos Aires-Santa Fe-Entre Ríos)	1:250.000	Uso actual de la tierra (1 hoja) Hidrológico (1 hoja) Planimétrico base (1 hoja)	30.000 30.000 30.000	90.000	1 mes	SE.PLA.DE.-CFI-DIGID-DVPBA
			TOTAL DE TOTALES		4.099.689		

TABLE I: Main LANDSAT/SKYLAB inventories of natural resources made by or with methodology, direction and staff of AEROTERRA S.A.

AEROTERRA S.A. is the first argentine company dedicated to the evaluation, cataloguing and development of natural resources through the multispectral-multidisciplinary interpretation of satellite images, complemented with conventional airphotos. Since 1976, AEROTERRA has made more than 4.000.000 Km2 of selected natural resources inventories at scales 1:125.000; 1:250.000 and 1:500.000 of different regions of the Republics of ARGENTINA and PARAGUAY. These inventories were complemented with more than 15.000.000 Km2 of satellite mosaics in different combinations of film and scale. In the field of airphotointerpretation, AEROTERRA has improved the development of a methodology for urban actualization and regulation plans, which has been applied succesfully in more than 20 cities of Argentina.

AEROTERRA has also published more than two dozens of different reports and/or articles, in order to help in the important process of technology transfer.

Between its principal clients, the following can be mentioned: Organization of American States; Republic of Paraguay; Interamerican Development Bank; Goverments and Agencies of the following Argentine Provinces: Buenos Aires; Formosa; Chaco; Chubut; Santiago del Estero; Corrientes and Misiones; National Development Bank; Federal Investment Council; National Institute for Hidrological Science and Technique; United Nations Development Program (UNDP); Project TOG 72/004-UN(Togo, Africa). AEROTERRA also acts as exclusive representative in the Republics of Argentina, Paraguay and Uruguay of SCINTREX LIMITED of Canada, for their geophysical instrumentation and services.

It was conceived, established and organized in 1972 by engineer ALBERTO BENITO VIOLA, who has planned and directed, since then, all the projects of which the company took care. Eng. VIOLA completed his superior studies at the following schools: Army Technical School (1952-55); University of Tucuman (1956-57); University of Buenos Aires (1958); Soperior School of Strategy (1961); and made studies in "Photointerpreation and Remote Sensing" in the University of California (1962-63), Switzerland (1972); and EROS Data Center (USA, 1975).

Since 1964, Eng. VIOLA is professor of Remote Sensing in the University of Buenos Aires, having teached "photointepretation" in most of the argentine universities, specialized centers and superior schools of the Army, Navy and Air Force. He has given lectures on this subject in more than one hundred opportunities, specially invited by Provincial Goverments, Federal and Private Agencies, and by the Republics of: USA, SWITZERLAND, PANAMA and PARAGUAY.

Eng. VIOLA has written several articles and projects on Remote Sensing, and has officially represented ARGENTINA in more than 20 National and Inatrnational Congresses of Photogrammetry, Photointerpretation and Satellite Remote Sensing, having acquired many distinctions during his professional career.

Additional information about contracts, projects and/or works related with the subjects above mentioned, can be obtained from: AEROTERRA S.A., Gorostiaga 2465, (1426) Buenos Aires, Argentina. TE: (01541) 771-5881; Telex: 21132 CODUL AR.