

A PROPOSAL FOR A PROJECT ENTITLED "ASSESSMENT OF FOREST
RESOURCES IN URUGUAY" SUBMITTED TO THE UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

René Antonio Novaes
David Chung Liang Lee
Pedro Hernandez Filho
Armando Pacheco dos Santos
Flávio Jorge Ponzoni
Instituto de Pesquisas Espaciais
Ministério da Ciência e Tecnologia
Caixa Postal 515, 12201-São José dos Campos, SP, Brasil

RESUMO

Esta proposta de projeto foi submetida a pedido da United Nations Industrial Development Organization (UNIDO). O objetivo principal deste projeto é coletar informações florestais básicas para o desenvolvimento, promoção e utilização de fontes alternativas de energia através do uso de recursos naturais do Uruguai e determinar o valor dos dados TM/LANDSAT como uma ferramenta eficiente no manejo das plantações florestais uruguaias. Treinar um grupo de técnicos uruguaios constitui o objetivo adicional deste projeto. Indicações são fornecidas sobre como cada tarefa será encaminhada e quais técnicas serão utilizadas em tarefas principais, como: mapeamento florestal e desenvolvimento de legendas, estimativa da exatidão de mapeamento e correção de área florestal, avaliação do volume de madeira e amostragem de campo e procedimentos de medição. São fornecidas ainda informações como: diagrama de fluxo com os passos do projeto, diagrama de barras das atividades e equipamentos específicos para determinadas tarefas. Os resultados dos específicos dos mapas e volume de madeira são mencionados em detalhes.

ABSTRACT

This project proposal was submitted by request of the United Nations Industrial Development Organization (UNIDO). The main objective of this project is to collect the basis forest information for the development, promotion and utilization of alternative sources of energy through the use of country's national resources and to determine the value of LANDSAT-TM data as an aid in efficient management of Uruguay's plantations. The additional objective is to train a Uruguayan technical team. Indications are given as to how each task will be accomplished and what techniques will be employed in performing main tasks such as: forest mapping and development of the map legends, map accuracy assessment and forest area correction, stand timber volume evaluation and field sampling and mensuration procedures. In addition, information are included concerning: flow diagram of steps of the project, activity bars diagram, required equipments for accomplishing tasks. The required specific results of maps and timber volumes are mentioned in detail.

1. INTRODUCTION

This project is to be found in the need to evaluate Uruguay's potential to develop a reforestation programme for energy purposes. To accomplish such an evaluation, it is necessary to first establish the spatial distribution of natural forest covering and to evaluate the stand timber volume of existing plantations. This information is to be obtained by the interpretation of LANDSAT-TM data in conjunction with field data. Given the frequency with which LANDSAT-TM images are generated (every 16 days) and the resolution (30m), these data, in conjunction with adequate ground surveys, offer the most cost-effective means of evaluating current timber resources and potential planting areas.

The project is to be based on techniques and procedures already developed by the Institute for Space Research (INPE).

2. AIM OF THE PROJECT

The aim of this project is to collect the basis forest information for the development, promotion and utilization of alternative sources of energy through the use of country's natural resources.

Specific objectives of the project are:

- 1) to generate maps of Uruguay's forested areas on the scale of 1:100,000, showing natural stands of timber with 50% canopy or a density greater than 200 trees/hectare;
- 2) to generate information of forest plantations on the same maps of item 1 above;
- 3) to generate a map of the forested areas of Uruguay on the scale of 1:1,000,000;
- 4) to compute the stand timber volume in plantations area;

- 5) to determine the value of LANDSAT-TM data as an aid in efficient management of Uruguay's plantations resources.

An additional objective is to train a team of eight Uruguayan technicians in the areas of interpretation and mapping of satellite images to obtain data on forest-covered terra in and forest mensuration techniques and methodology.

3. MAIN TASKS OF THE PROJECT

- 1) Forest mapping and development of the map legends: the method employed is based on the visual interpretation of unenhanced LANDSAT-TM imagery, using only the simplest instruments. Maps of the reforestation and natural forest cover will be prepared for the whole country at the scale of 1:100,000 (in 87 sheets), using a manual procedure by which interpretation keys derived from field reconnaissance, ground volume measurement and image analysis over the selected plots are extrapolated for the interpretation of the entire country.

The principal method in this task is to transfer directly the LANDSAT forest cover data to base maps on the scale of 1:100,000 and/or with Zoom Transfer Scope.

- 2) Map accuracy assessment and forest area correction: The accuracy of the interpretation map will be assessed by comparing a sample of the results with ground survey, using appropriate statistical techniques to design the sampling procedure and evaluate its results.

A two-stage sampling design is to be used to minimize the amount of field checking. Occurrences on the map of the classes of the mapping legend may be used as the primary sampling segment. Sample locations will be selected randomly by overlaying a dot grid of suitable density.

The results of checking the LANDSAT interpretation, in terms of the classes, will be shown in a confusion table with the errors (omission and commission) and overall accuracy.

When the accuracy of interpretation (forest map) has been sampled, the sample estimates of the proportion of each class, as shown in the confusion table, can be used to correct the estimated area of each class. The correction is calculated by a scheme for the adjustment of proportions.

- 3) Plantation stand timber volume evaluation: Multistage Variable Probability Sampling or Simple Random Sampling procedure is to be used to estimate the plantation stand timber volume. Which one is to be used depend upon the existing photograph's quality and quantity (1:20,000) which will be provided by Uruguayan Government.
- 4) Field volume measurement: In the last stage, field work will be carried out to determine the stand timber volume in the selected sample plots. The mean volume per hectare,

average stand height and basal area from the sampled plot will be estimated using the Strand's Vertical Line Sampling Method with the Spiegel Relaskop. The sample plot volumes will be then calculated and the total stand timber volume will be expanded back through the use of a statistical equation.

4. STEPS OF THE PROJECT

- 1) Flow Diagram: In order to achieve the objectives, the project is carried out through the steps described in the flow diagram (see Figure 1).
- 2) Bars Diagram: In order to clarify when and how long each activity takes, a Bars Diagram of the Uruguay Project was included (see Figure 2).

5. EQUIPMENT REQUIREMENTS

All required equipments are available at the Institute for Space Research (INPE).

- 1) A general purpose computer - Burroughs B6800.
This system is to be used for the calculation of accuracy assessment, forest area, error correction and field survey data handling.
- 2) Interactive image processing system - General Electric IMAGE-100. This system is used for the multispectral classification and image analysis for interpretation key development.
- 3) Zoom Transfer Scope.
- 4) Spiegel Relaskops.

6. SPECIFIC RESULTS

The project will cover the following specific results:

- 1) Eighty seven (87) maps on the scale of 1:100,000 with LANDSAT mapping base showing the spatial distribution of Uruguay's forest areas.
- 2) One (1) map on the scale of 1:1,000,000 with LANDSAT mapping base showing the spatial distribution of the forest covering of Uruguay.
- 3) Chart showing those areas of Uruguay covered by plantations.
- 4) Tables of volume data were to be generated per the "Departamento" and the statistical parameters (mean, variance, standard deviation, sampling error) will be calculated.
- 5) Final report containing the methodology employed for:
 - field sample selection and sampling procedures;
 - statistical analysis of field data;
 - interpretation of LANDSAT data;

- integration of LANDSAT and field-derived data.

The report will include conclusions and recommendations as to what, if any, additional work will be necessary to fully document the forestry resources of Uruguay.

- 6) In the final report a special chapter describing the training activities of the Uruguayan technicians and evaluating their performance will be included.

7. THE URUGUAY GOVERNMENT WILL PROVIDE THE FOLLOWING SPECIFIC ITEMS:

- 1) all existing data from the literature pertaining to the forest-cover in Uruguay;
- 2) acquisition of cartographic documents and appropriate aerial photographs (on the scale of 1:20,000 for the sampling purpose);
- 3) LANDSAT-TM images covering Uruguayan Territory (14 scenes with two bands each).

8. PROJECT'S SERVICES

To accomplish this project, the project team shall make available a minimum of 29.5 man-months of service as follow:

1) Project Area Services

The project team will consist of suitable qualified persons in the following fields:

- interpretation of LANDSAT data from the standpoint of forest-covered lands, forest mensuration procedure and practice (3 forest engineers specialized in remote sensing);
- system engineer (one).

9.5 man-months will be necessary to carry out the tasks in field work.

2) Home Office Services

20 man-months will be necessary to carry out the tasks at the contractor's home office in the analysis of LANDSAT and mensuration data composed of 15 man-months for the project technicians and 5 man-months for staff.

- cartography (two experts);
- forest mensuration procedure and practice (three forest engineers specialized in remote sensing);
- system engineer (one).

- 3) In addition to the project team, who will work full-time on the project, the contractor will provide the services of such home office personnel and technical facilities, such as computer hardware/software, as may be necessary for supporting the project team.

4) Training Obligations

At the begining of the period of Project Area Services, the contractor's team will initiate a training programme for the Uruguayan technical team. The Uruguayan

team will be required to observe and participate in all tasks defined in the contractor's responsibilities.

5) Reports

The contractor will submit interim and progress reports, eight copies of each in Spanish. The draft final report and the final report will be written in Spanish (10 copies) and in English (5 copies), which will be submitted to UNIDO.

- 6) At the end of the project, all the following materials will be submitted to the appropriate authorities in Uruguay through the UNIDO Resident Representative in Montevideo:

- all LANDSAT images (original and enlarged);
- all bands, films or prints;
- master copies of all submitted map sheets in chronaflex (herculene);
- two heliographic copies of each sheet of the maps on the scale of 1:100,000;
- five heliographic copies of the map on the scale of 1:1,000,000.

9. BIBLIOGRAPHY

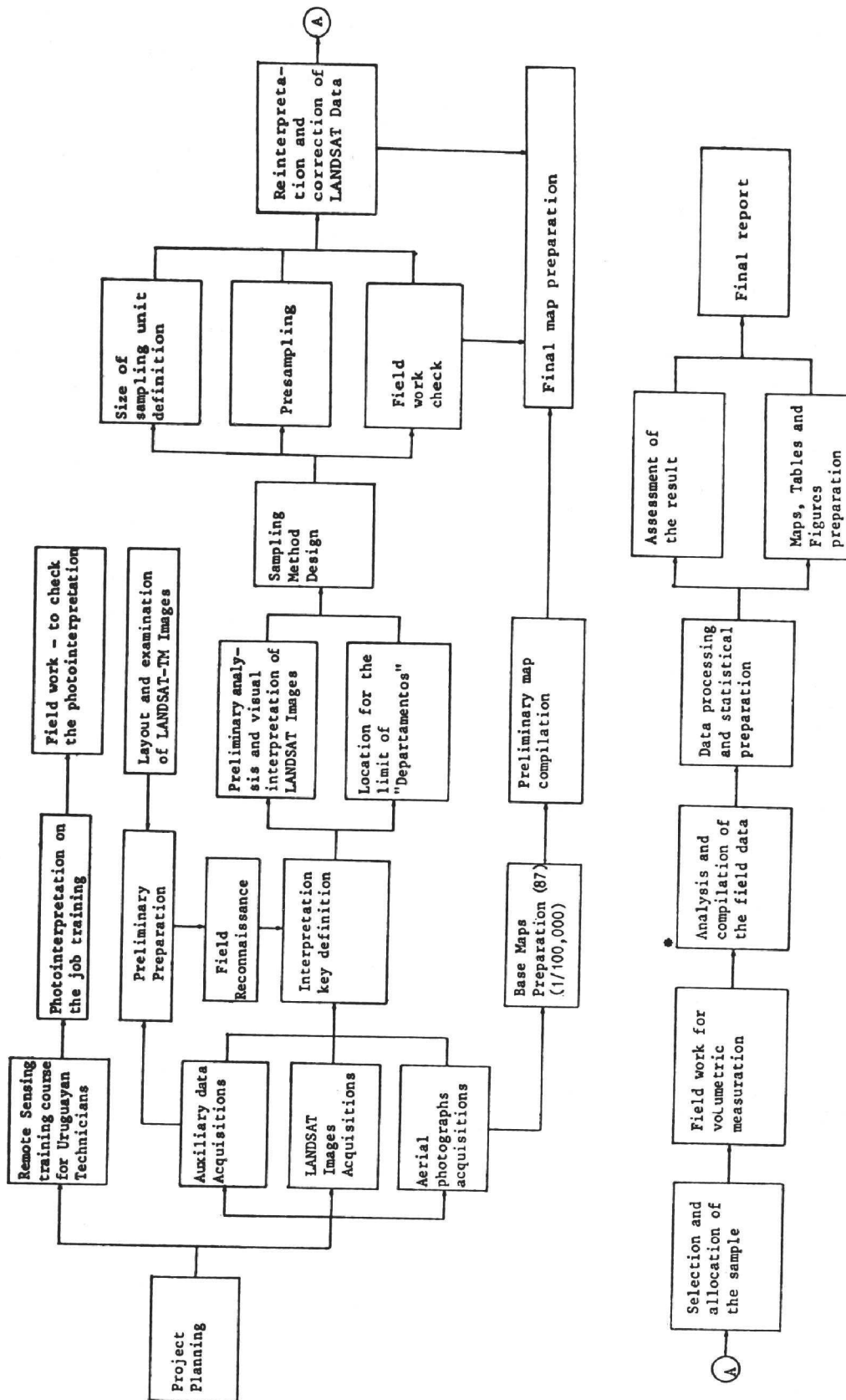
HERNANDEZ FILHO, P.; SHIMABUKURO, Y.E. & SANTA NA, C.C. - *Relatório das atividades do Projeto IBDF/INPE (sub-projeto Reflorestamento) durante o ano de 1978.* São José dos Campos, INPE, Dez. 1978. (INPE-1408-NTE/141).

HERNANDEZ FILHO, P.; SHIMABUKURO, Y.E.; MEDEIROS, J.S.; SANTANA, C.C. & ALVES, E.C.M. - *Relatório das atividades do Projeto IBDF/INPE (sub-projeto Reflorestamento) durante o ano de 1979.* São José dos Campos, INPE, Jan. 1980. (INPE-1664-RPE/104).

HERNANDEZ FILHO, P.; SHIMABUKURO, Y.E.; MEDEIROS, J.S.; ASSIS, O.R. - *Relatório das atividades do Projeto IBDF/INPE (sub-projeto Reflorestamento) durante o ano de 1981.* São José dos Campos, INPE, Jun, 1982. (INPE-2434-RTR/014).

LANGLEY, P.G. - *Multistage variable probability sampling: theory and use in estimating timber resources from space and aircraft photography.* PhD Dissertation, University of California, Berkeley, 1975.

WIANT JUNIOR, H.V. - *Elementary 3p sampling.* West Virginia, University Agricultural and Forestry Experimental Station, 1976.



* Main tasks of the project were mentioned in detail in section 3.

Fig. 1 - Flow Diagram of Uruguay Project.

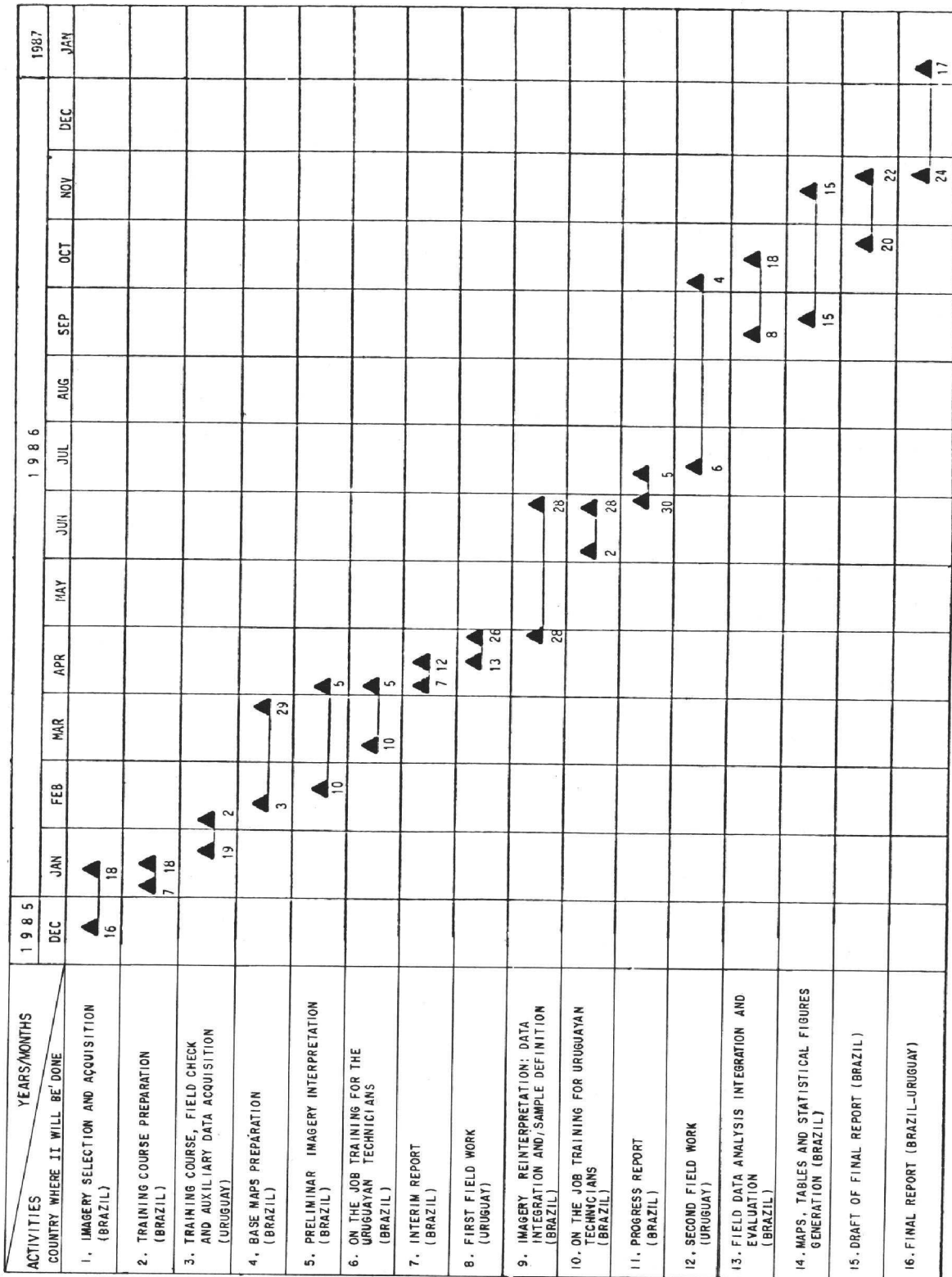


Fig. 2 - Bars Diagram of Uruguay Project.