

THE USE OF ORBITAL REMOTE SENSING DATA
FOR LOW COST GROUND-WATER SURVEY

Tomoyuki Ohara
Roberto Pereira da Cunha
Marx Prestes Barbosa

Instituto de Pesquisas Espaciais - INPE
Ministério da Ciência e Tecnologia - MCT
Av. dos Astronautas, 1758 - Caixa Postal 515
12201 - São José dos Campos - SP, Brazil

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ABSTRACT

A remote sensing survey of alluvial areas in the state of Pernambuco (Brazil) for water resource purpose is presented. Photointerpretation maps of alluvial occurrences (scale 1:100,000), show information obtained from LANDSAT/TM photographic images, including: identification of alluvial areas as a contribution to underground water research. Additional information include: updating of road system, agricultural activities, nucleus and/or rural properties, and maps containing the localization of existing water wells. Based on those information acquired through orbital remote sensing, the government may establish, in short time, emergency plans for water supply needs of the local population.

INTRODUCTION

The study is the result of the solicitation of Northeastern Development Superintendence (SUDENE - Superintendência do Desenvolvimento do Nordeste) to the Brazilian Space Research Institute (INPE - Instituto de Pesquisas Espaciais), in order to provide information of alluvial areas in the state of Pernambuco (Brazil), for water resource purpose, through orbital remote sensing techniques.

The needs of such surveys is decurrent of the arduous struggle which the Brazilian native population of northeastern region of Brazil engages ever year with regional climatic conditions. The levels of annual precipitation are not homogeneous, differing from microregion to microregion. Based on this, two fundamental activities may be developed for the management of the water resource:

- first activity - to dam, which permit the accumulation of big volumes of water, possibiliting the perenity, at times, engaged with public irrigation projects, as well as with the rural and urban supplies;
- second activity - ground water prospection in sedimentary basins, alluvial areas and in basement crystalline areas.

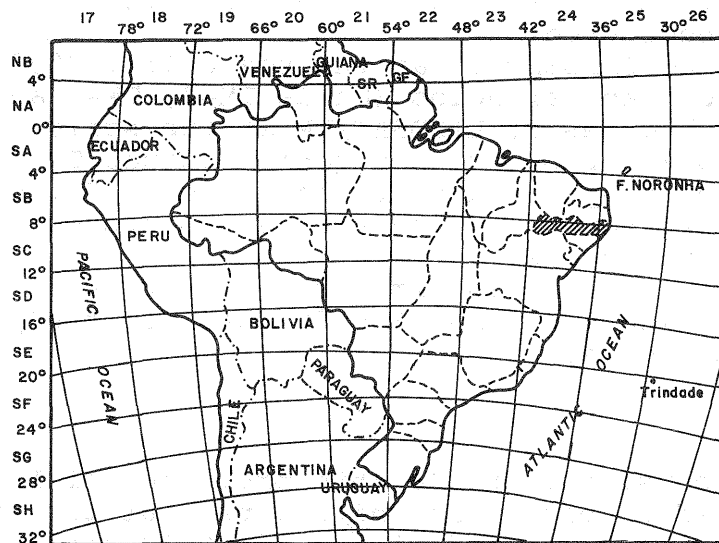
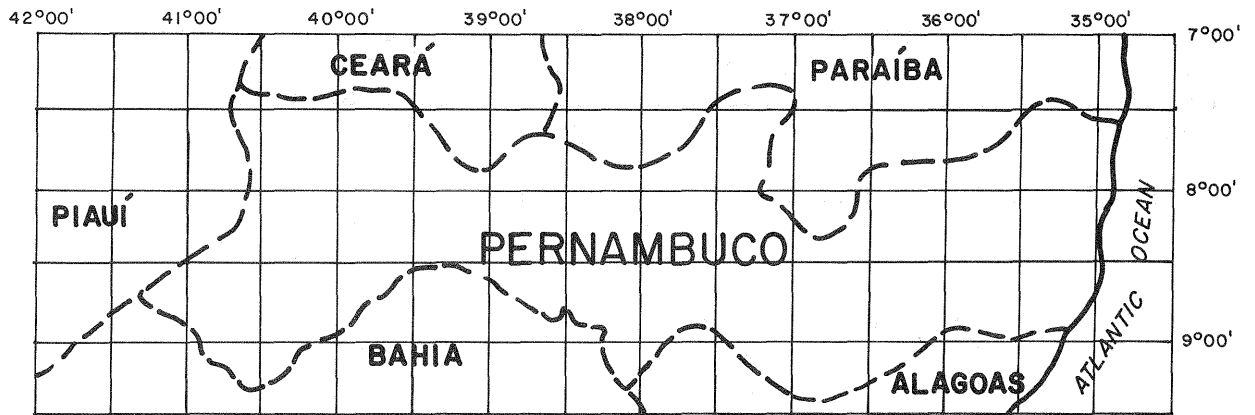


Figure 1 - Localization of the study area (Pernambuco state) on the Brazil.

Ground-water prospection is a process which requires relatively complex work, including for example, geological survey of the total area, additional to geophysical survey to select interested targets.

This report presents a low cost and expeditious alternative which focus on the localization of alluvial occurrences. These target areas for water resources search, represent favourable areas of captation and water storage.

The study includes the following phases:

- a) Identification and mapping of alluvial areas (as potential water sources);
- b) Mapping of the network of existing dams;
- c) Update of the road system;
- d) Synopsis of the areas with agricultural activities, nucleus and/or rural proprieties;
- e) Plot of existing water wells.

MATERIAL & EQUIPMENT

During the execution of the study, the following material and equipments have been used:

- a) Eleven scenes of LANDSAT/TM at the scale 1:1,000,000, on color positive transparencies (bands TM-2, TM-3 and TM-4);
- b) Twenty-five subscenes of LANDSAT/TM at the scale 1:100,000, on black-and-white photographic copies (bands TM-3 and TM-4);
- c) Fifty-eight topographic maps at the scale 1:100,000;
- d) Image Projector PROCOM-2 which allows the projection of positive transparencies;
- e) Light table to transfer information to overlays;
- f) Universal Plotting Table DZT 90x120 used for the plot of existing water wells.

METHODOLOGY

The methodology consisted on the interpretation of LANDSAT/TM images, reproduced on black-and-white paper, at the scale 1:100,000, and false-color and black-and-white positive transparencies at the scale 1:1,000,000. The positive transparencies were projected over topographic maps at the scale 1:100,000, through the use of the PROCOM-2 Image Projector. The information extracted from the images, were transferred to the lithographic films for later conjugated use with topographic maps.

The legend used on the thematic maps was defined jointly by INPE and SUDENE. The main aspects of the legend are discussed below:

1 - Alluvial areas

Alluvial areas delimited in the thematic maps (identified with the letter "a"), represent targets on LANDSAT/TM images which show spectral characteristics typical of alluvium material. These targets are denounced on LANDSAT images by a white color and a smooth texture. Their spatial distribution on images is in close relation with the drainage pattern. The spectral response of sand deposit is similar to the alluvial occurrences.

However, in some situations, when crystalline crops out on the river-bed, it may show similar spectral response which may lead to confusions.

Alluvial areas delimited on the thematic maps with letter "b" represent areas which include vegetal cover.

2 - Agricultural activities

Agricultural activities are represented by individual or agglomerated, small, medium and/or big rural proprieties, with intensive land use.

3 - Water bodies (ponds, dams)

Dark tone targets identified on band 4 of the LANDSAT/TM images were associated with water bodies. Bands 3 and 4 of LANDSAT were also used to check cloud shadows, relief and/or burned areas.

4 - Updating of the road system

Consideration was given to those sections of road which were not existent no topographic maps or have been misplotted.

5 - Nucleus and/or rural proprieties

It was considered those targets on the images whose characteristics show disconnected activities of land use. Accordingly a nucleus and/or rural proprieties may be represent one or more than one rural propriety, or also it may provide area of lack of vegetation as a result of anthropic activities.

6 - Water wells

Existing water wells, supplied by SUDENE, were plotted using a Universal Plotting Table DZT 90x120. The symbol convention used on maps for localization of existing water wells were based on reports of SUDENE.

RESULTS

The results of the study were represented in fifty-eight photointerpretation maps (scale 1:100,000), based on information obtained from LANDSAT/TM photographic images. These maps include: identification of alluvial areas as subvention to the underground water research; updating of road system; synopsis of the areas of agricultural activities, nucleus and/or rural proprieties; and maps containing the localization of existing water wells.

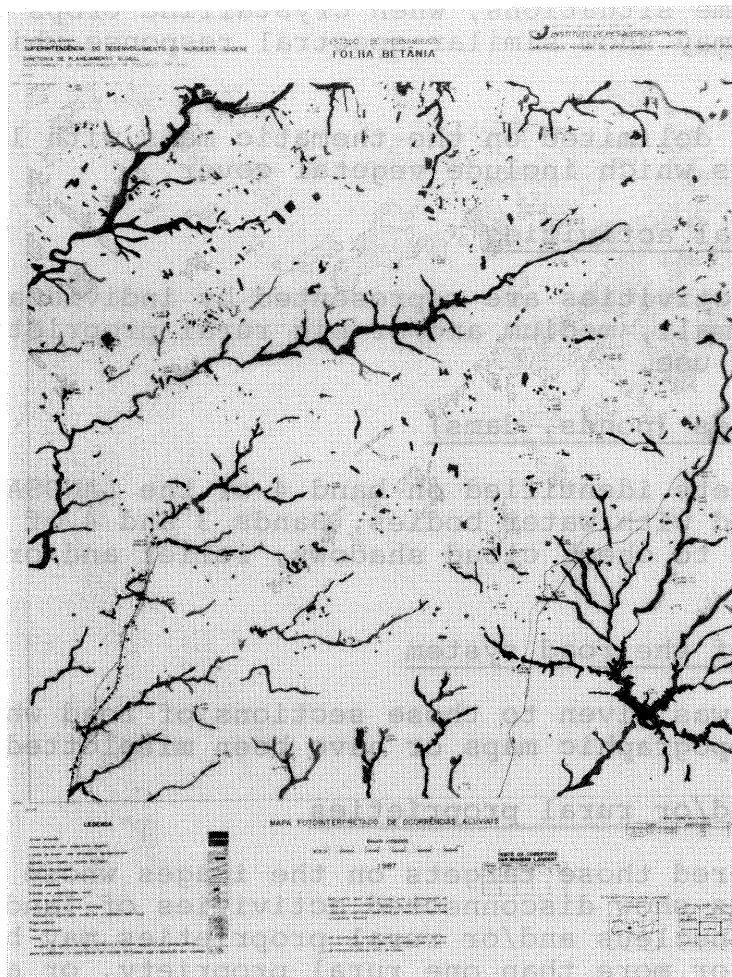


Figure 2 - The Betânia map representing the central region of the Pernambuco state.

Legend

- a
Alluvial areas
- b
Alluvial areas with vegetal cover
- Agricultural activities
- Nucleus and/or rural proprieties
- Existing water wells
- Existing road system
- Updating of the road system
- Water bodies (ponds, dams)

The Betânia map example (Figure 2) represents the central region of the Pernambuco State, and is limited by the co-ordinates of 8°00' to 8°30' of south latitude and of 38°00' to 38°30' of west longitude. Geologically the central region of the state is constituted for the predominance of the Archean Migmatitic-Gnaissic Complex and secondly for the non-differentiated Proterozoic metasedimentary rocks, relating to the Pajeú-Paraíba Folding System and for the Silurian-Devonian sedimentary rocks (Betânia Sedimentary Basin). Since to post-orogenic granitic bodies, considered of the superior Proterozoic, occur indiscriminately in the Migmatitic-Gnaissic Complex and in the metasediments.

In the Betânia map shows:

- a) Indication of several alluvial areas along of the principal drainages;
- b) Intensive land use occurring mainly in the half-north of the map (in small and medium areas);
- c) Large ponds in the southeast quadrant of the map (Navio River) and in the central-north extreme (Pajeú River);
- d) The adjusted of road network which inter-connects the cities of Betânia to Airi (southeast of map), Carqueja to Floresta (southeast of map) and short road section of Serra Talhada to Sítio dos Nunes (central-north extreme of the map).

FINAL CONSIDERATIONS

The study shows that the survey of large water source areas (e.g. alluvium in Pernambuco State), in relatively short time (about sixty days), is possible through the use of orbital remote sensing.

The study allowed to make fifty-eight photointerpretation maps at the scale 1:100,000 (30 x 30 minutes), which include the localization of existing water wells.

Based on the information acquired through orbital remote sensing, the government may establish, in short time, emergency plans for water supply needs of the local population.