

## THE USE OF AN IMAGE REGISTRATION TECHNIQUE IN THE URBAN GROWTH MONITORING

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### ABSTRACT

This paper describes the use of an Image Registration Program in the studies of the urban growth. This program implemented in the IMAGE-100 (Multispectral Image Analysis System) permits a quick identification of growing areas with the overlap of the same scene in different periods, and with the use of adequate filters. The city of Brasília, Brazil, was selected for test area. The dynamics of Brasília urban growth was analysed with the overlap of scenes dated June 1973, 1978 and 1983. The results showed the utilization of the Image Registration Technique for the monitoring of the urban growth.

### 1. INTRODUCTION

On account of their synoptic and temporal characteristics the LANDSAT Satellite data allow the monitoring of urban growth on an overall and dynamic basis.

This paper presents the study of the urban growth of Brasília, Brazil, from 1973 to 1983 where the Image Registration Technique was used. This technique is one of those available in the Interactive Multispectral Image Analyser (Image-100), which combined to the use of adequate filters permits the superposition of scenes taken in different occasions. So this technique makes possible the identification and location of urban growing areas. The interpretation of the data was completed with the use of aerial photographs, suitable fieldwork and with research made in the available bibliography.

In 1957 Lucio Costa (Costa, 1970) elaborated the plan of Brasília which was inaugurated in 1960 as the new capital of Brazil. Brasília was an effort to lead Brazilian national development towards inland.

Figure 1 shows the test area which was delimited in accordance to the working scale of the images and the purpose of the present paper as well.

### 2. METHODOLOGY

Viewing the objective of the present study and due to the available supply of MSS/LANDSAT data, it was possible to use 1973, 1978 and 1983 CCT's (Computer Compatible Tapes) of the test site. The tapes were then put to analysis in the General Electric Image-100 System. The three selected images corresponded to the region dry seasons and every 5-year interval between the data was considered highly appropriated to the nature of the present study - the identification of urban growth.

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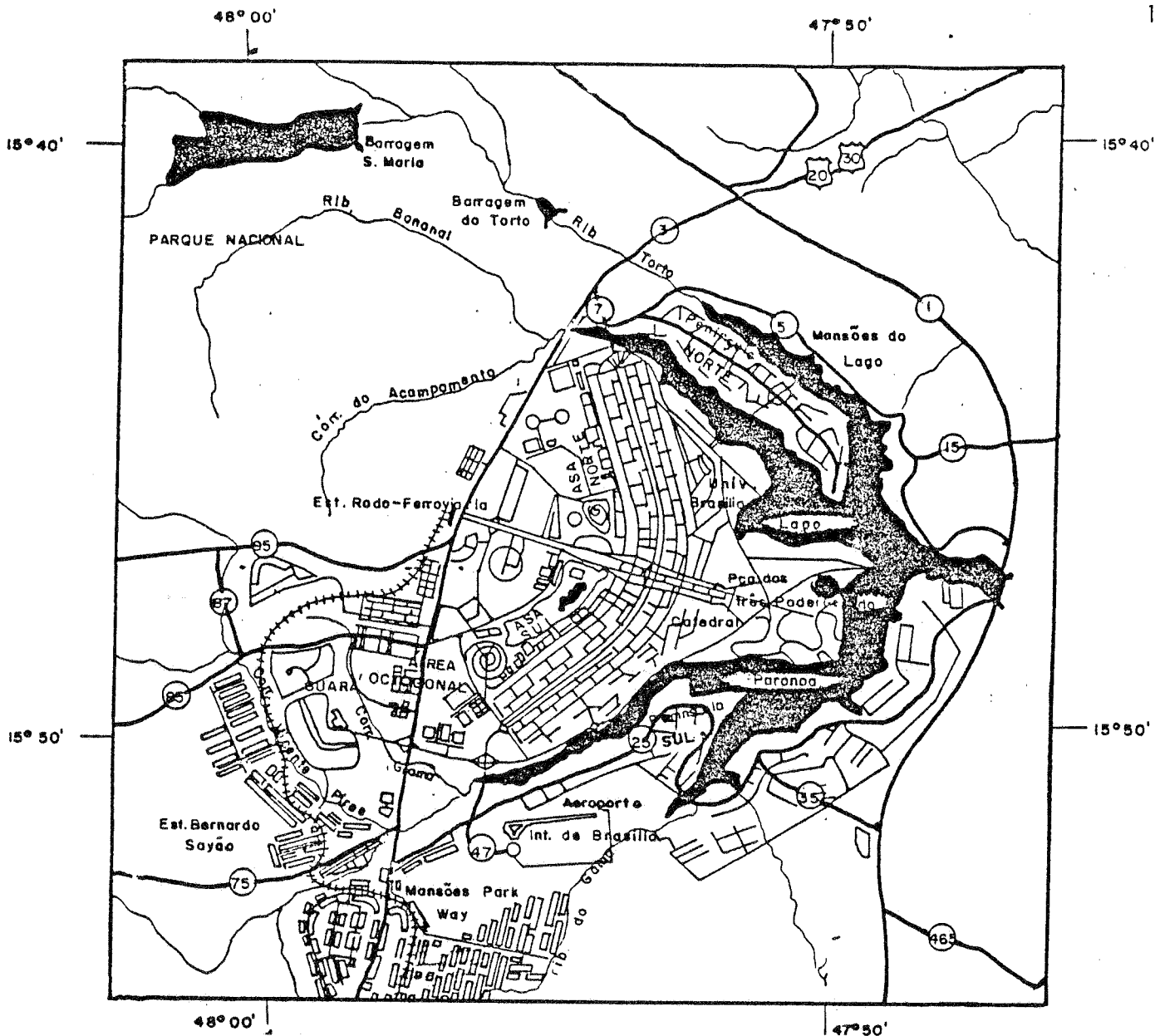


FIGURE 1 - TEST AREA - BRASÍLIA, BRAZIL

LEGEND:

FLOW OF WATER



BARRAGE

LAKE AND LAGOON

RAILROAD

PAVED ROADS



SCALE

5 km



The study was approached in the scale of 1:100,000, which is in accordance to the purpose of this study and also to the present spatial resolution of the MSS/LANDSAT System.

The core of the methodology used for this study was the utilization of the Image Registration Program developed by the Digital Image Treatment Laboratory at CNPq/INPE. Through this program the Image-100 superposes the time-progressive-taken images and performs the necessary geometrical transformations to correct the differences between the MSS images produced by the different satellites, in order to coincide the corresponding picture elements (pixels).

This study used the MSS 5 channel which is the most adequate to identify urban areas. When the Image Registration Technique was used, blue and green (cyan) filters were associated to the former image as well as a red filter to the latest image of the pair.

Figure 2 shows the procedure to obtain the multitemporal color composite. The resulting image viewed on the screen of the Image-100 was a color composite, analysed as following:

- a) The unchanged areas, considering the two passages of the satellite, showed a neutral color composite in which the bright gray values corresponded to urban areas or bare soil, while the dark gray values corresponded to vegetation or water.
- b) The changed areas are shown in cyan or red. If they are shown in cyan it is because the changes were from a high to a low value of target reflectance between the two passages, and so it was concluded that bare soil was substituted by vegetation. The areas presented in red correspond to changes from low to high values of target reflectance interpreted as the substitution of vegetation for bare soil or urban area.

CYAN FILTER					
RED FILTER					
SUPERPOSITION	red	black	cyan	white	

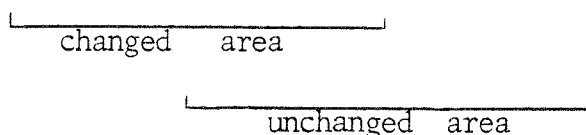


FIGURE 2 - MULTITEMPORAL COLOR COMPOSITE OBTAINED WITH THE AUTOMATIC REGISTRATION OF TWO PASSAGES AND DIGITAL FILTERING (ADAPTED FROM EYTON, 1983).

The identification process of the urban growth areas was fast with this interpretation key, and its precision can be checked by means of aerial photographs and appropriate field survey.

### 3. RESULTS AND DISCUSSION

The obtained photographic layouts from channel 5, in the 1:100,000 scale, corresponding to the 1973, 1978, 1983 plus the three color composites resulting from the register of the 1973-1978, 1978-1983, 1973-1983, images pair are present in Oliveira et al (in printing).

The visual interpretation of these color composites helped the identification, in each one of the composites, of the unchanged areas which appeared in gray and of the areas where there was urban development between the two passages which appeared in red color. By this means it was possible to identify:

- 1) the diffuse residential densification in certain areas such as "Península Norte", "Península Sul", and "Mansões dos Lagos";
- 2) some blobs of constructions in "Asa Norte";
- 3) the expansion of the urban nucleus in the outskirts called "Guará I" and "Guará II";
- 4) the growth of the urban invasion (slum) in the area of "Barragem do Paranoá" which became twice as great as it had been;
- 5) finally the settlement of the housing area "Octogonal" which had not been formerly proposed in Pilot Plan elaborated by Lucio Costa.

The resulting color composite from the superposition of 1973-1983 image enhanced the urban growing tendencies as well as other ground changes shown in the other, intermediate paired composites. The 1973-1983 image also clearly enhanced the environmental alterations caused by the urban growing of Brasília. The extraction of material for building purposes was evident, as well as the soil erosion caused by it.

In temporal analysis some soil alteration phenomena are better identified by the intermediate paired composites. Therefore, the largest urban invasion in Brasília, which happened in "Barragem do Paranoá", occurred in the period of 1978-1983 since no growth in this area was presented in the 1973-1978 image.

The evaluation of the Brasília urban growth in the 1973-1983 period could be completed with the three color composite analysis plus the photographic mosaic consultation and fieldwork as well.

### 4. CONCLUSIONS

The Image Registration Technique complemented with the use of adequate filters prove to be precise to obtain analytic data about a city dynamic growing.

The color composites easily identified *when* and *where* the urban expansion phenomenon occurred and by the color discrimination those areas where the growth took place were spotted from those where there was no growth alteration.

The bounding of the altered areas of Brasília in the analyzed period, with the register of the satellite data, reduced the fieldwork which could be directed to those specific sites to verify whether they really corresponded to the urbanized areas.

During the present study there were some difficulties which are to be approached in future researches. Firstly, to compare the Brasília urban structure in the mentioned periods, LANDSAT 1, 2 and 4 data were used and these turned the superposition of the images difficult, which took longer due to the geometrical differences in the results of the MSS sensor system. Secondly, if a preprocessing of the different images had been undergone viewing an equalization of the various gray levels, there could have been a better definition in the variation of the color in the color composites.

It is also important to mention that the choice of Brasília may have simplified the use of the Image Registration Technique because Brasília is a planned city with a rational primary urban network. And this turned the image photointerpretation easier. It is advisable to apply this technique to a nonrational organized city.

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