VEGETATION MAPPING IN PANTANAL REGION USING THEMATIC MAPPER SENSOR: A PHYSIOGNOMIC APPROACH

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ABSTRACT

Thematic Mapper satellite images and 35mm aerial photographs were utilized in the physiognomic survey of the vegetation cover of the Pantanal Matogrossense National Park. Two dates were considered - dry and wet season - in order to evaluate the water level influence in the vegetation physiognomies identified. Visual interpretation and digital processing were considered; through the first, two vegetation maps (both seasons) were done and the second allows a quantitative study of the water level variations.

Note: This work was carried out with the agreement of the Brazilian Forestry Development Institute (IBDF).

1. INTRODUCTION

The vegetation classification systems may be distinguished through physiognomic, floristic and ecological criteria and by the combination of these. Since a classification system has been chosen, the boundaries of vegetation units are fixed through some of these criteria and they may be recorded on a map. This is the so called vegetation mapping which may be carried out by field work, early maps analysis, remote sensing products and so on.

The use of remote sensing products in the vegetation mapping of tropical regions has restricted the choice of the classification systems because the spatial, temporal and spectral changes are not always explained by physiognomic, floristic and ecological changes. Considering tropical areas, the physiognomic changes are the most perceptible via remote sensing products because they influence the vegetation reflectance and thus, the aerial photographs and orbital images appearance.

This work has the objective of evaluating the Thematic Mapper (TM) images and 35mm aerial photographs in the physiognomic characterization of the Pantanal Matogrossense National Park vegetation cover and its surroundings. Due to the seasonal changes, typical of that region, mainly caused by water level variations, a multitemporal study was carried out through digital processing in order to evaluate and quantify these variations and their influence on the vegetation physiognomies identified.

2. MATERIALS AND METHODS

2.1 - STUDY AREA

The Pantanal Matogrossense covers an area of approximately 100,000km, being flat to slightly undulated and most of it lies only at about 100m above sea level (PRANCE and SCHALLER, 1982). Figure 1 shows the national geographical localization of Pantanal region.

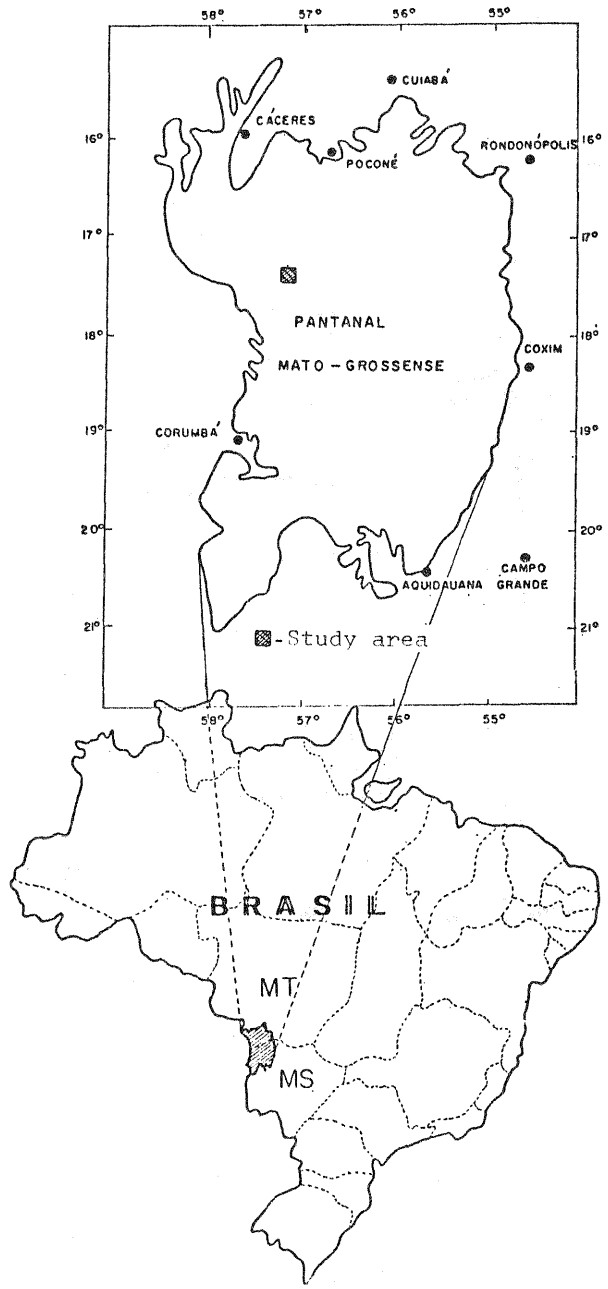

Fig. 1 - Geographical localization of Pantanal region.

This region is quite heterogeneous, therefore it is divided into several "Pantanais", each with its proper floristic and ecological characteristics which may be presented

cartographically (ADAMOLI, 1981). Figure 2 shows the Pantanal region divided into ten "Pantanais", and the Pantanal Matogrossense National Park localization, where this study was carried out.

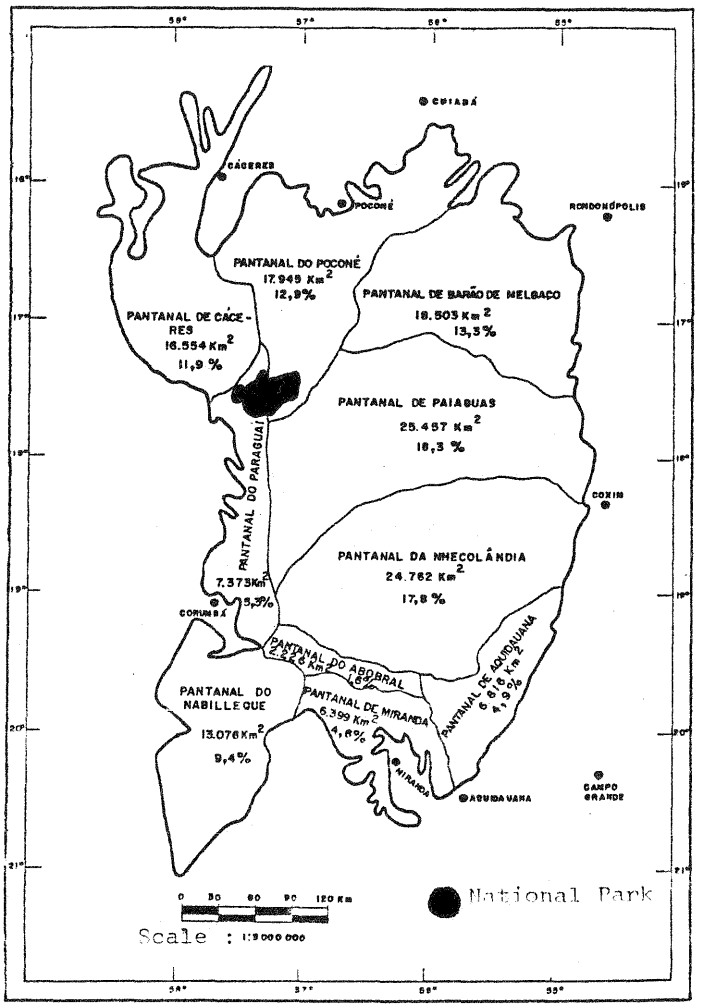

Fig. 2 - The ten "Pantanais". (ADAMOLI, 1981).

A large part of the area is flooded only during the crest of Rio Paraguai, and much nonflooded high ground is interspersed throughout the region. This mixture of permanent swamp, seasonal swamp and high ground has contributed to the richness of the vegetation (PRANCE and SCHALLER, 1982).

2.2 - ORBITAL IMAGES AND 35mm AERIAL PHOTOGRAPHS

2.2.1 - ORBITAL IMAGES

The following orbital images were utilized:

Orb.	Scale	Date	Data out-put	TM bands
227/72E	1:100,000	11/02/86	Paper(black/white)	3,4,5
227/72E	-	11/02/86	CCT	1,2,3,4,5 and 7
227/72E	1:100,000	04/11/87	Paper(black/white)	3,4,5
227/72E	-	04/11/87	CCT	1,2,3,4,5 and 7

2.2.2 - 35mm AERIAL PHOTOGRAPHS

An aerial survey mission was done with the aid of an airplane (L42 Regente) of the Força Aérea Brasileira (FAB). A platform to put an FXD Yashica terrestrial photographic camera (with 50mm lens) was used. The aerial photographs were taken by 3000 feet high, thus at 1:21,000 scale. The stereoscopic vision was not important because these photographs were used to check the vegetation cover physiognomy in orbital images selected points.

2.2.3 - PAPER ORBITAL IMAGES INTERPRETATION X FIELD CHECK

The orbital images were analysed through the conventional photointerpretation techniques. Some points belonging to each image patterns were selected mainly by TM5 band in dry season (11/02/86) and TM4 band in wet season (04/11/87), because both presented visual variety of patterns in each season, respectively.

2.2.4 - MULTITEMPORAL ANALYSIS

This task was carried out at the Image - 100 (Multispectral Image Analyser) of INPE using the CCT tapes.

Considering the 11/02/86 image, a 60x60km area was chosen in order to comprise the Pantanal Matogrossense National Park and its surroundings. The monitor scale was 1:200,000. A TM4/TM3 band ratio was done in order to enhance the vegetation cover. This ratio image and all the others (TM1, TM2, TM3, TM4, TM5 and TM7) were submitted to features selection algorithm, and a best discriminating three-band combination was indicated. Following, the maximum likelihood (MAXVER) classification algorithm was applied to this combination, trying to identify all vegetation cover categories. The result of this classification algorithm was a printout where each vegetation categories, including water and unclassified points, was indicated by a number. The 60x60km area was transformed into a matrix with 240x240 dimension, which was stored on a Burroughs 6800 computer.

The 11/02/86 and 04/11/87 images were matched and the same 60x60km area was chosen. The same procedure described above to the 11/02/86 image was followed. These two matrices were compared through a specific computer program.

3. RESULTS AND DISCUSSIONS

3.1 - VISUAL INTERPRETATION

Paper images of TM3, TM4 and TM5 bands were analysed in the two dates considered. TM5 band showed a diversity of patterns larger than others in the dry season image (11/02/86), while the same thing happened with TM4 band in wet season (04/11/87). It may be explained due to the fact that in the wet season almost all the whole area was flooded and because of that the TM5 band presented uniform dark tone. The patterns identified in the TM5 band image of dry season were compared with 35mm aerial photographs and in spite of existing more patterns than the vegetation cover types identified, they were identified as: 1-water, 2-inundated meadow, 3-wet meadow, 4-meadow, 5-bush-wood, 6-low-wood and 7-wood. The 35mm aerial photographs were considered excellent to the physiognomic evaluation of the vegetation of that area. The water presence was easily verified in the TM5 band image, but the vegetation cover categories were distinguished by small differences in the gray tones. These differences were correlated with height of stands because it was the main parameter verified during the flight over the area, and with 35mm photographs analysis. It is possible that image patterns have correlation with other parameters like crown closure, floristic composition, stand density, etc; but due to the lack of roads and the difficulty of specific points on the ground, they could not be considered. A dry season map was done.

The same seven categories were identified in wet season image (04/11/87) of TM4 band. It was easy to verify the water level variation. A map of wet season of the same area was done.

3.2 - DIGITAL PROCESSING

The TM3, TM5 and TM4/TM3 ratio bands of the 11/02/86 image were selected by features selection algorithm. The blue, green and red colors were designated for each TM band mentioned, respectively. The MAXVER classification algorithm was applied on this image (60x60km) and the same seven categories identified in visual interpretation were considered. Figure 3 shows bidimensional distributions of these categories.

From these graphs it is possible to see that the seven categories were best distinguished by TM5 and TM4/TM3 ratio bands.

Considering the image of 04/11/87, the TM2, TM5 and TM4/TM3 ratio bands were indicated by the features selection algorithm. Figure 4 shows the bidimensional distribution of the seven categories mentioned.

As shown in Figure 4, the TM5 band had a lowest contribution in classes separability, comparing with the others TM2 and TM4/TM3 ratio). This was confirmed in the visual interpretation.

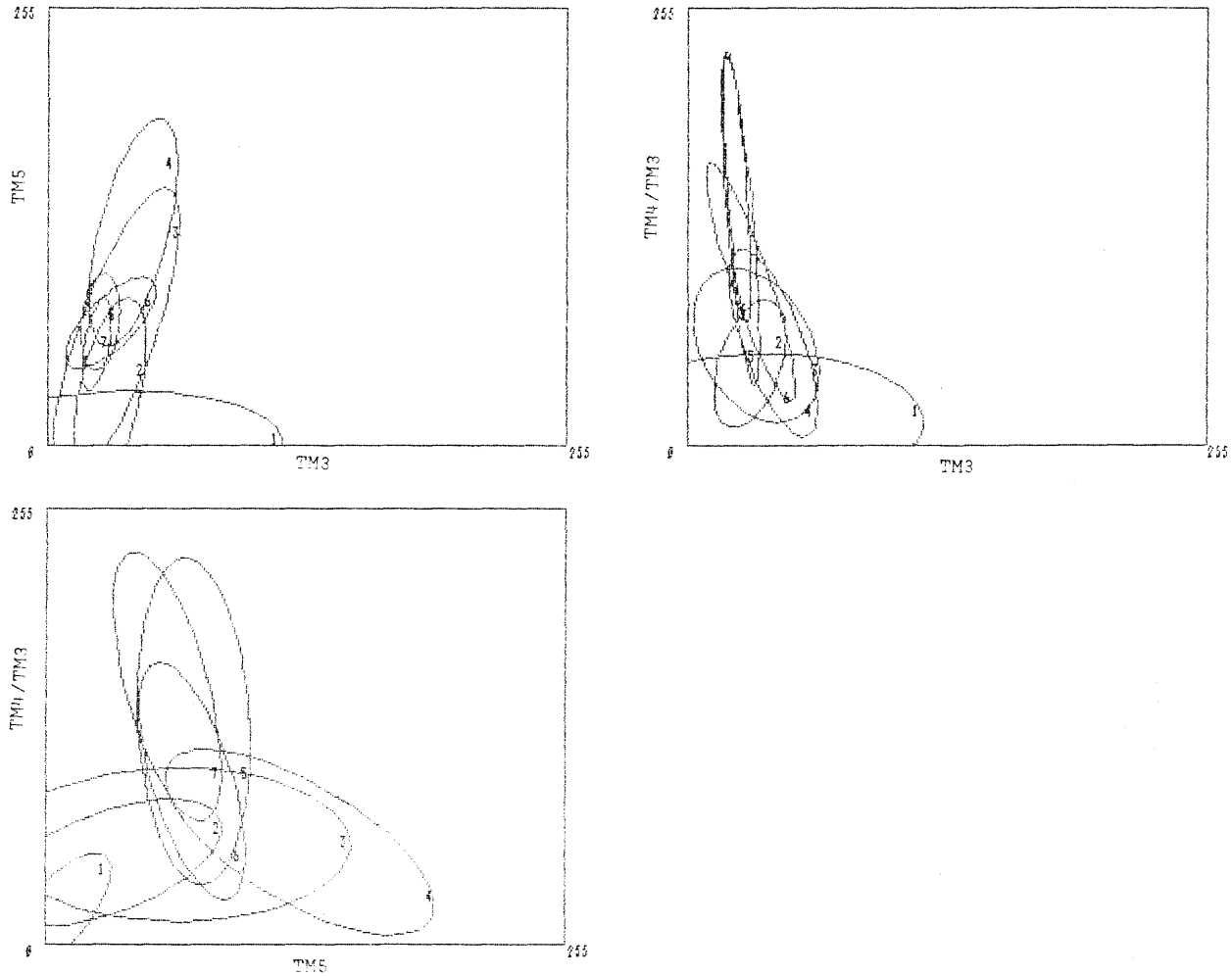

Fig. 3 - Distributions of digital values of the categories considered - Dry season.

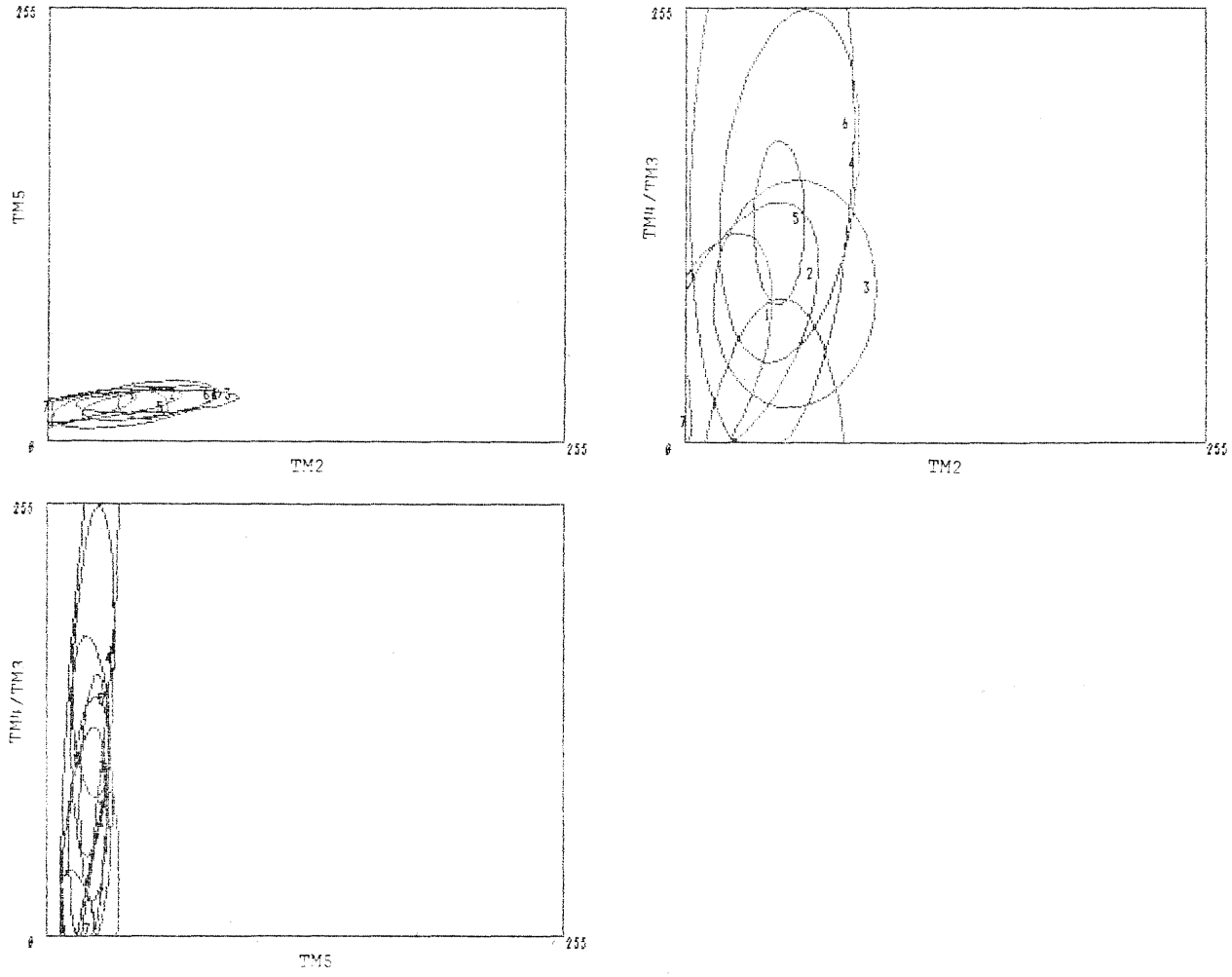

Fig. 4 - Distributions of digital values of the categories considered - Wet season.

3.3 - MATRICES COMPARISON

As mentioned in Section 2.2.4, two matrices resulting from MAXVER classification algorithm were stored on a Burroughs 6800 computer. These matrices were constituted by numbers related with 8 categories: the seven mentioned and other related with unclassified points. Then we had the numbers 0, 1, 2, 3, 4, 5, 6 and 7 as matrix elements. Each element of one matrix was compared with its respective element of the other matrix. The results of this comparison are shown in Table 1.

TABLE 1

RESULTS OF MATRICES COMPARISON

CATEGORIES	UNCHANGEABLED	11/02/86	04/11/87
		DRY	WET
0 Unclassified	76	1094	1251
1 Water	2877	5780	5388
2 Inundated meadow	2220	4893	10473
3 Wet meadow	4982	13077	15059
4 Meadow	865	10959	4544
5 Bush-wood	677	6240	2322
6 Low-wood	1246	5259	3485
7 Wood	527	1418	6198

The "unchangeabled" column indicates these elements which did not change in both dry and wet seasons. Considering the water category, the number of elements in both seasons are similar. It may be explained due to the fact that in spite of having increased its area, the vegetation cover made it difficult to see it and of course, it was not possible to quantify the increase of its area through visual analysis and digital processing.

Inundated meadow, wet meadow and wood were categories which presented a larger increase in their areas. In the case of inundated meadow and wet meadow, it is easy to understand what happened because their vegetation cover is constituted by herbaceous plants and it was possible to perceive the water presence, but the increase of wood category may be explained by a possible confusion between it and low-wood or bush-wood categories in the classification task. The meadow area decrease was caused by the increase of the other categories.

It was felt that this comparison task could be carried out on a Geographic Information System, where the two classified images could be compared. Despite INPE has a GIS running on experimental phase, it was not possible to use it in this work.

4. CONCLUSIONS

It was clear through this work that it is possible to use the TM images in order to classify the vegetation cover of that Pantanal area by its physiognomy. But the correlation with the images patterns and the structural parameters of the vegetation like crown closure and stand density, for instance was not evident. Height was identified as correlated with the images patterns because it was possible to evaluate it during the flight over the area and by 35mm photographs analysis. The other parameters could not be evaluated because the area covered by 35mm photographs was quite small compared with the whole area, besides being impossible to evaluate them during the flight. The water areas increase was not evident all over the area, being just possible in areas covered by herbaceous vegetation.

The TM5 and TM4 bands were considered the best in order to draw the vegetation cover boundaries in both dry and wet seasons, respectively, through visual interpretation.

The 35mm aerial photographs were considered a power tool for physiognomic evaluation of vegetation, mainly when one is working on an area like that considered in this work,due to the access difficulties presented in conventional field check.

5. REFERENCES

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