

## EVALUATION OF LANDSAT-TM DATA FOR GEOMORPHOLOGICAL MAPPING

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### ABSTRACT

The objective of this study is to evaluate LANDSAT-TM data to perform geomorphological mapping in an semiarid environment. The test site is located at the Rio Parnaíba Valley Piauí and Maranhão States NE-Brazil. Data sets of TM (bands 3, 4, 5, 7) were digitally analysed using the following algorithms: linear contrast stretch, principal components and IHS transformations. Different color composites were obtained. Finally a discussion is made on the usefulness of digital processing techniques using TM data to discriminate geomorphological units.

### 1. INTRODUCTION

A geomorphological map can contribute to solve environmental problems, by providing information for rational use of terrain. The evaluation and analysis of landforms is of great interest to soil studies, land capability assessments and land management in general.

The LANDSAT imagery register the land surface configuration and tone differentiation. The visual perception of the relief is determined by the patterns of the watershed divides and drainage channels, together with steepness and length of valley slopes (Donker & Meijerink, 1977). The visual impression of the relief is represented by the differences and variability of gray tones.

In this study enhancement techniques were applied to LANDSAT-TM data in order to increase the impression of the relief by enlarging the gray tone contrast. A scene from the semi-arid region in NE-Brazil was used as a test site (Figure 1).

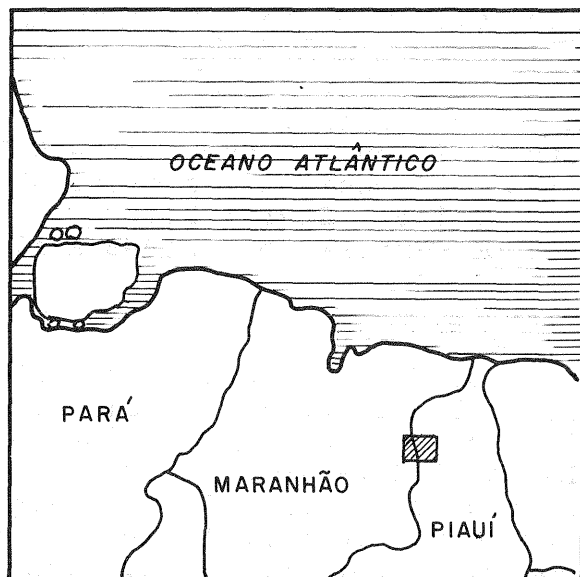


Fig. 1 - Location of study area within NE-BRAZIL.

## 2. METHODOLOGY

In this study LANDSAT TM bands 3, 4, 5 and 7, referring to the dry period (August 6, 1986) were used. These bands were enlarged to 1:50.000 at the Image Analyzer from INPE. The following enhancement algorithms were applied to these data: linear contrast stretch, principal components and IHS transformations.

Different color composites were obtained both by linear contrast stretched bands, and by the first three principal components.

The three independent parameters Intensity (I), Hue (H) and Saturation (S), describe any color vector composed by primary colors: red (R), green (G) and blue (B). In this study the IHS/RGB transforms were applied, using the following equations, according to Dutra & Meneses (1986, 1987).

$$I = R+G+B \quad (1)$$

$$H = (G-B)/(I-3B) \quad (2)$$

$$S = (I-3B)/I \quad (3)$$

$$R = \frac{1}{3} I (1+2S-3SH) \quad (4)$$

$$G = \frac{1}{3} I (1-2S+3SH) \quad (5)$$

$$B = \frac{1}{3} I (1-S) \quad (6)$$

Initially a pre-processing algorithm was applied, in order to equalize the Digital Number of all TM bands used. Then using equations (1) to (3) the IHS components were obtained. I and S were linearly equalized in order to occupy the entire space of attributes. At last equations (4) to (6) were applied in order to obtain the RGB inverse transformation.

### 3. DISCUSSION OF RESULTS

The results of this study are presented at both Figure 2 and Table 1. The IHS composites improved textural and spectral characteristics of the image. Being so, landform and land use/land cover patterns were also enhanced. The visual discrimination of these landforms was better improved by IHS transformations, as compared to linear contrast stretch (CS) and Principal Components (PC).

The low discrimination of geomorphologic units, when using the PC transformation is due to smoothing of the texture and by the reduced spectral contrast.

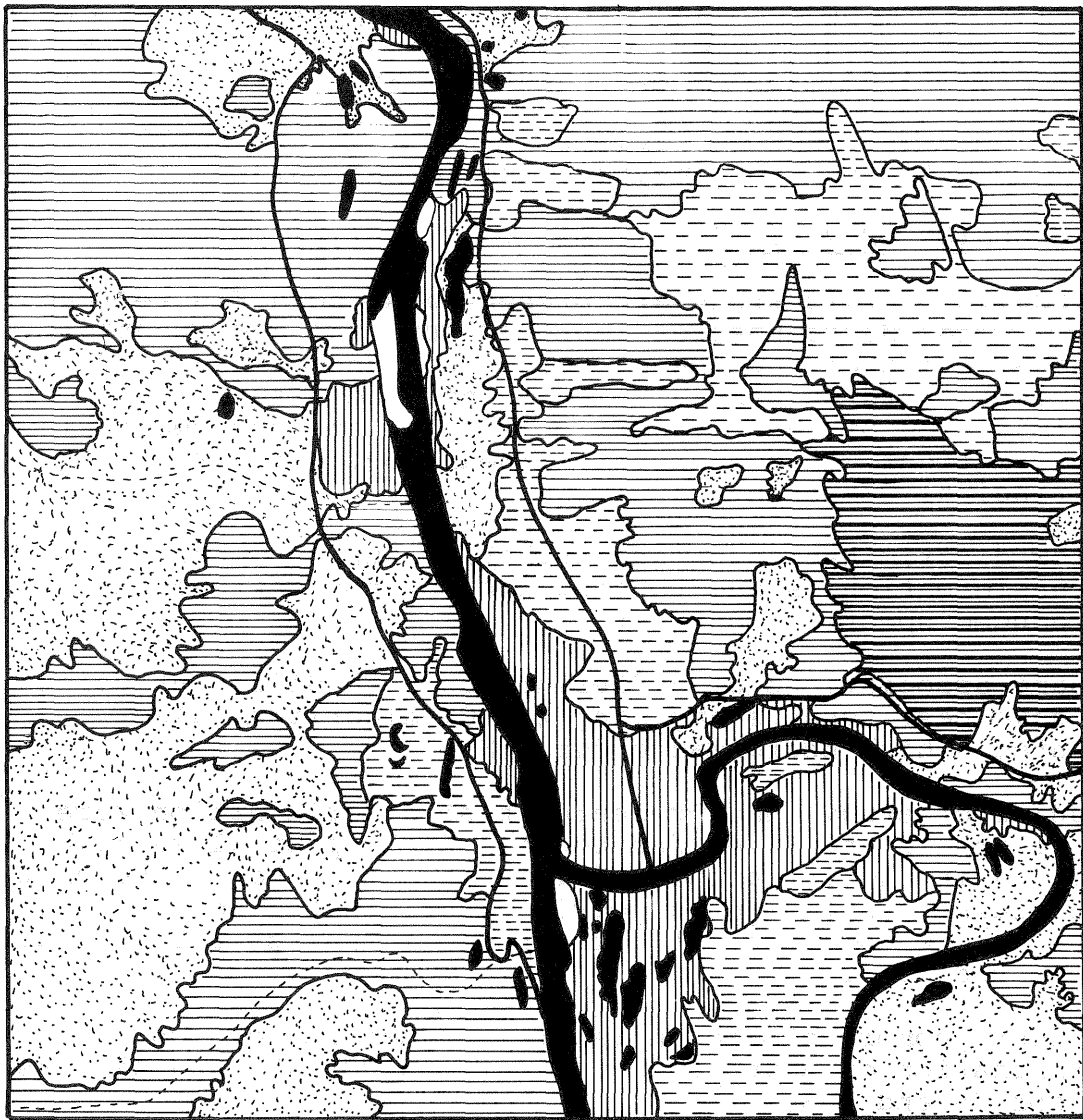
The same associations of different bands to different colors that gave best results applying the CS algorithm, also presented a high performance for IHS.

The units of study that presented best discrimination were river channels and lakes due to its' high spectral separability specially in the infrared bands. On the other hand, the unit flood plains was medium to poorly discriminated because the boundaries to the adjacent geomorphologic units were not sharp in some sections.

All other geomorphologic units present medium to high discrimination only at band combinations RGB 453 and 457, as well for CS and IHS.

### 4. CONCLUSION

In this work, it was shown that IHS transforms contribute to better discriminate landforms in semiarid environments. At future studies other enhancement techniques, as well as remote sensing data sets (e.g. the stereoscopy capability of SPOT) from different geographical areas (humid environments) will be tested.



Escala 1:100.000

1000 0 1000 2000 3000 4000 5000 6000 7000 8000 900 m

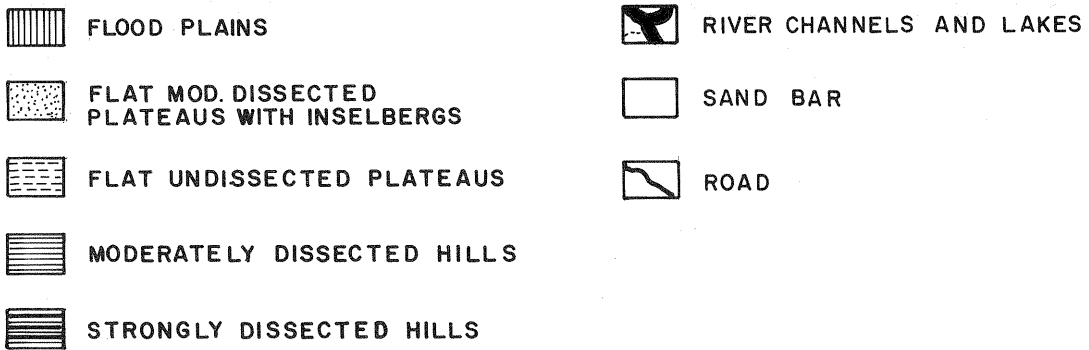


Fig. 2 - Geomorphological units.

TABLE 1  
EVALUATION/COMPARISON BETWEEN GEOMORPHOLOGIC UNITS AND COLOR COMPOSITES

ENHANCEMENT ALGORITHMS	COLOR COMPOSITES RGB	GEOMORPHOLOGIC UNITS					
		RIVER CHANNELS AND LAKES	FLOOD PLAINS	FLAT UNDISSECTED PLATEAUS	FLAT MOD DISSECTED PLATEAUS	MOD DISSECTED HILLS	STRONGLY DISSECTED HILLS
LINEAR CONTRAST STRETCH	435	G	P	M	M	P	M
	453	G	M	G	G	M	G
	457	G	M	G	G	M	G
	543	G	P	M	M	P	M
	547	G	P	M	M	M	M
	743	G	P	P	M	P	M
PRINCIPAL COMPONENTS	123	G	P	P	N	N	P
	132	M	P	N	P	N	P
	213	G	N	N	N	N	P
IHS/RGB	453	G	M	G	G	G	G
	543	G	P	G	G	G	M
	457	G	M	G	G	G	G

N = none; P = poor; M = medium; G = good

## 5. REFERENCES

DONKER, N.H.W.; MEIJERINK, A.M.J. Digital Processing of LANDSAT Images to Produce a Maximum Impression of Terrain Ruggedness. ITC Journal, (4):25-31,1977.

DUTRA, L.V.; MENESES, P.R. Aplicação da transformação IHS para realce de cores em imagens LANDSAT. In: SIMPÓSIO LATINO-AMERICANO DE SENSORIAMENTO REMOTO, I, Gramado, RS, Anais, Agosto 1986, pp.675-681.

DUTRA, L.V.; MENESES, P.R. Realce de cores em imagens de sensoriamento remoto utilizando rotação de matiz no espaço IHS. In: SIMPÓSIO BRASILEIRO DE TELECOMUNICAÇÕES, V, Campinas, SP, Setembro 1987, pp. 205-212.