ITAMARACÁ ISLAND LAND USE MONITORING WITH LANDSAT-TM MULTIDATE SCENES

Héber Rodrigues Compasso
Professor Adjunto

Departamento de Engenharia Cartográfica-DECART
Universidade Federal de Pernambuco - UFPE
Rua Acadêmico Hélio Ramos s/n - Cidade Universitária - Recife-Pernambuco - Brasil, CEP 50741

Cilene Gomes Compasso
Geographer

Departamento de Informações Geoambientais
Fundação de Desenvolvimento da Região Metropolitana do Recife - FIDEM
Rua do Riachuelo, 105 - 4º andar, Boa Vista, Recife-PE

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ABSTRACT:

On the Island of Itamaracá, approximately 40 km from Recife, the natural features of Atlantic Forest and Mangrove Areas are menaced by the rapidly expanding urban occupation due to its function as tourist and weekend resort of nearby metropolis. The results of monitoring this process using LANDSAT-TM Imagery are exposed and discussed.

KEY WORDS: Change Detection, Classification, Image Processing, Land Applications, Landsat Pattern Recognition, Renewable Resource.

1. INTRODUCTION

The Itamaracá Island, at the extreme North Eastern Brazil, bathed by the Atlantic Ocean, approximately 40 km from Recife, is a very important tourist resort of the state of Pernambuco thanks to its short distance from the capital and existence of good and confortable hotels, being more and more better; quiet and warm water beaches in its hole extension by the coastal; historical monuments, Atlantic Forest reserves and great extension mangrove areas. Except by the rainy months of june to agost it's possible to enjoy throughout the year the breeze that gives an undulant movement to its predominant coconuts trees crowns, turning the temperature more pleasant.

With so much temptation it is comprehensible that a number each time bigger of vacationists take the Island to them, to build their own vacation houses.

Because of this, a rapidly expanding urban occupation is taking place with the natural cut off coconut palms, others cultivated areas and even forest areas.

Then an increasing real-estate expansion with an offer each time bigger of land parcel to sell, constitute a real seduction to the vacationists.

This paper intend to measure this process of urban extension in a short time period between two images of LANDSAT satellite of 1984 and 1988 years.

Its objetive is to call the attention of the governmental institutions, charged with the environmental control, and at the same time to put this tool to their extent, analyzing its vantages and limitations in order to make possible an efficient governmental performance so as to keep the land occupation flux within compatible environmental preservation.

The "Fundação de Desenvolvimento da Região Metropolitana do Recife"(FIDEM), charged of the Recife Metropolitan Region development, having the Itamaracá Island within its jurisdiction, has done several photogrammetric surveys with update mapping purpose including topographic and thematics maps to be used by itself, in its planning purpose, and by the others governmental institutions.

Together with the "Departamento de Engenharia Cartográfica" of the "Universidade Federal de Pernambuco" look for new Remote Sensing technologies applications just to solve such kind of problems.

2. THE STUDIED AREA

The Fig. 1 shows the area location which is reached by car, from Recife, in 50 minutes. Itamaracá with 58,325 km² and 12,000 inhabitants is situated at northward Recife Metropolitan Region. Some of its inhabitants live there and work at the metropolis but the most population is floating. The Fig. 2 is the two years natural colored compositions with LANDSAT-TM, 1, 2 and 3 bands, showing the Island with high tide (1988) and low tide (1984). These scenes refer to the satellite 214 orbit, 65 point and D quadrant. It's possible to see some clouds in both images. This area is particularly difficult to photograph just because it is very cloudy during almost the hole year. Only a few

days, from october to january,present good conditions to photograph. These scenes, in their totality are 30% to 40% cloud covered.

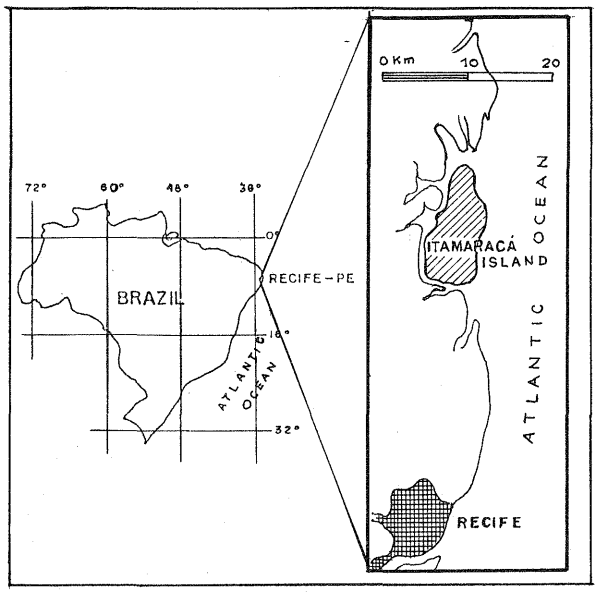

Fig. 1: Study Area Location

3. THE TECHNIQUE USED

To perform the classification the authors used the software from ERDAS 7.4 (EARTH RESOURCES DATA ANALYSIS SYSTEMS Version 7.4) which is available at the "Universidade Federal de Pernambuco".

In the first step all statistics from the 6 bands (1, 2, 3, 4, 5 and 7) were determined in order to chose the three less correlationed bands for processing over then the site choice for the supervised classification.

In spite of the software used gives means for this selection, like, for instance, through the histograms analysis it was developed by the authors a software that was called CCM (Correlation Coeficient Matrix) which gives the list of the 3, 4 and more bands combinations less correlated and the one of these sets which should be considered the best for the final classification.

In this study the 1, 4, 7 bands combination was determined for both years.

After performed the training sample choice of the classes, their statistics were determined and the CCM again used to know, for each class, what was the best bands combination (less correlated).

For the first classes used with two sets of samples for 1984 scene it was found : Beach (1,4,5 and 1,4,5), Forest (1,3,4 and 1,3,4), Mangrove (1,4,7 and 1,4,5), Water (1,5,7 and 2,4,7), Naked Soil (3,4,7 and 3,4,5), Mud (4,5,7 and 1,4,7), Urban Area (1,4,7 and 2,4,7), Shadow (1,4,7 and 3,4,7), Cloud (2,4,7 and 1,4,7), Sugar Cane (3, 4, 7 and 1,4,7), Coconut Palms (1,3,5 and 1,3,4) and Sand Bank (2,4,7). The 1,4,7 combination had the bigest frequency (7) followed of 2,4,7 with 4.

Analyzing the three first combinations of 3 bands whose diferences in its correlation coeficients sum were very small, the authors found results that agree with the mencioned above, confirming again the 1,4,7 like the best frequency and also showing it in Forest and Naked classes as a second place. Almost the same results were found in the 1988 scene. The final classes used in the classification included, in the VEGETATION AREA, the SUGAR CANE and COCONUT PALMS. The principal aim of this study was monitoring the FOREST, MANGROVE and URBAN AREA classes and the effect of this last one over the vegetation like a hole.

For this reason, the 1, 4, 7 combination could be the best one, even for the final classification. In spite of this, it was performed several classifications with three diferent bands, like 1,4,5 2,4,7 and with more bands also. The results , compared to the work realized by FIDEM with 1.30.000 aerial photograph of 1984 and 1988, confirmed the 1,4,7 combination realy the best one.

It was used the Maximum likelihood classification available in ERDAS/7.4 after performed the preliminary parallelepiped classification for testing the training samples.

All the normal means available in the software used for this kind of work were used in order to find better results,like the bi-dimensional histograms analyzing , contingency matrix, classification accuracy table, probability image file and finnaly , where the statistical frigidity difered from the reality, it was used filtering and manual correction, based in ground truth, in pixels blocks or pixel by pixel .

Those who works with computer classification know that although the training sample is perfectly chosen, based in ground truth , they have not always a normal distribution and in most case the small reflectance differences within even into one class , caused by the solar incidence in topography, the diferent stages of the same vegetation specie, the frequency in number of objects (trees, houses, etc); the variety of classes within a pixels - all this call for more attentin in performing this work through the best bands chosen and good and representation samples.

In this study, because of these problems, some of SAND BANK pixels were confused with CLOUD and vice versa; FOREST topography shadown with MANGROVE; clouds SHADOW with MANGROVE and URBAN AREA with NAKED SOIL and vice versa.

As much as more manual corrections have to be made, there is some loss of the vantages of computational means.

Normally working in a 512 x 512 pixels screen, the authors consumed 4 to 5 hours to perform all the work of classification,

with the software used. Depending the manual correction amount, this time may be triplicated.

4. THE RESULTS

The Table 2 gives the results of the comparative classifications from the two scenes which maps are in the Fig. 3.

The BEACH reduction of -0,56% accurred in 1988 was due to the high tide at the moment the scene was taken, occuring the contrary in the 1984 scene, where the tide was low. For the same reason there was a reduction in the SAND BANK (-1,11%) and MUD (total) classes in the 1988 image,with the growing WATER class (+10,82%).

The MANGROVE class is very well conserved, showing also a false +1,71% increase. This was due to the occurrence of clouds and its shadows, predominant at this class in the 1984 scene.

It is possible to see this by comparing the two images of Fig. 2. As already mencioned, this area at extreme northeastern Brazil is particularly limited for this kind of work because the clouds high incidence.

The FOREST class comprises in this study the remaining Atlantic Forest, which some of them have been constituted as ecological reserve; arboreal vegetation with small size and low density and coconut palms with high density. This class was the most immolated with -2,89% decrease.

Unfortunatly a part of this felling was over one set up reserve called "LANÇO DOS CAÇÕES" (Fig. 2).

The VEGETATION AREA class which comprises low density coconut palms, and shrub vegetation; sugar cane and other subsistence cultivations, has a low variation of -0,18%. This was also due to the 1988 window scene that was one little bigger than 1984 one (+1,86%).

The NAKED SOIL (+1,14%) and URBAN AREA (+1,34%) class confirm the increased occupation of green areas.

An interesting confirmation of these effects may be observed from Fig. 4 that shows the two years thermal images. There is an temperature elevation in the 1988 scene compared to the 1984 one. In these images it is possible to associate hot places with lighter tones. As less is the vegetation cover, the higher is the temperature.

It must be said that a sunny day in the 1988 scene and a rainy one in 1984 could made this difference. Unfortunatly there were no temperature and pluviometric data for comprove it.

5. CONCLUSIONS

The increasing images satellite development, regarding better and better resolutions and an offer of richer options over the eletromagnetic spectrum, permit to use this technique with sucess in monitoring the geographic environment so as to give the governamental agencies the possibility to interfere in time and in an efficient and conscientious way.

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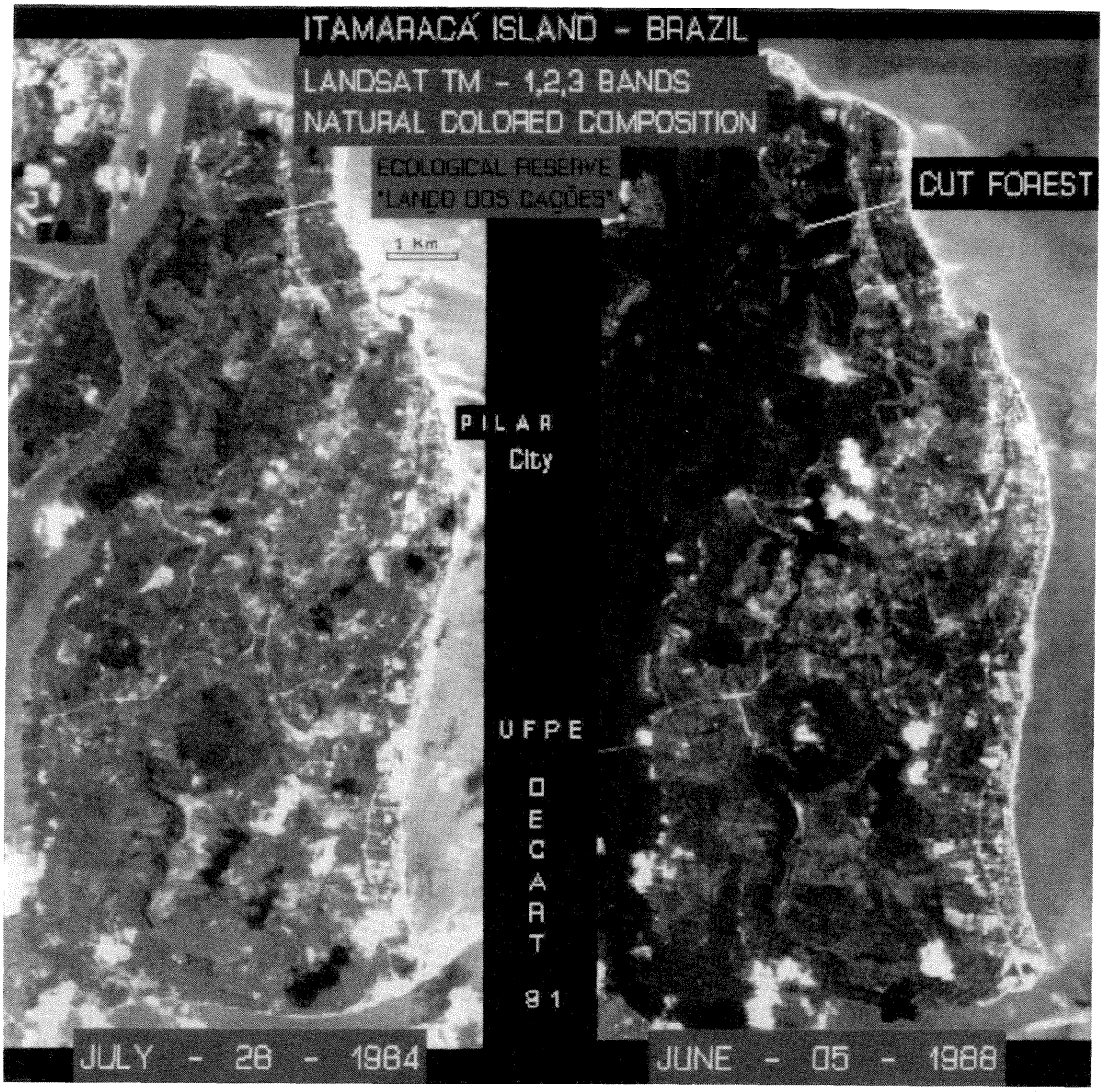

Fig. 2: Visible colored composition with bands 1,2,3 showing the partial "Lanço dos Cações" Reserve felling. (Unfortunatly the monochromatic prints of this paper do not do justice to the hues diferrences so much important to identify ground variations as can be seen in the colored ones).

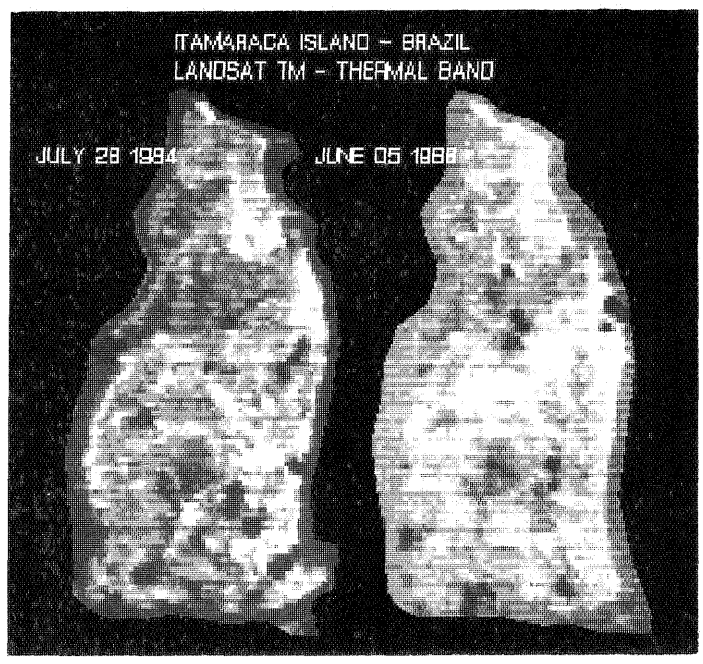

Fig. 4: Comparative thermal bands (6) showing the higher temperature in the 1988 scene.

TABLE 2 - COMPARATIVE CLASSIFICATION

CLASSES	1984 ha	1984 %	1988 ha	1988 %	VARIATION %
BEACH	167,22	1,74	115,11	1,18	- 0,56
FOREST	1026,54	10,70	763,20	7,81	- 2,89
MANGROVE	1034,73	10,80	1.222,92	12,51	+ 1,71
WATER	2143,71	22,35	3.241,62	33,17	+10,82
MUD	655,29	6,83	-	-	- 6,83
NAKED SOIL	485,91	5,07	606,69	6,21	+ 1,14
URBAN AREA	482,22	5,03	622,53	6,37	+ 1,34
SHADOW	235,89	2,46	154,17	1,58	- 0,88
CLOUD	449,55	4,69	208,35	2,13	- 2,56
SAND BANK	182,61	1,90	77,22	0,79	- 1,11
VEGETATION AREA	2726,64	28,43	2.760,03	28,25	- 0,18
TOTALS	9590,31	100,00	9.771,84	100,00	+181,53 ha + 1,86%

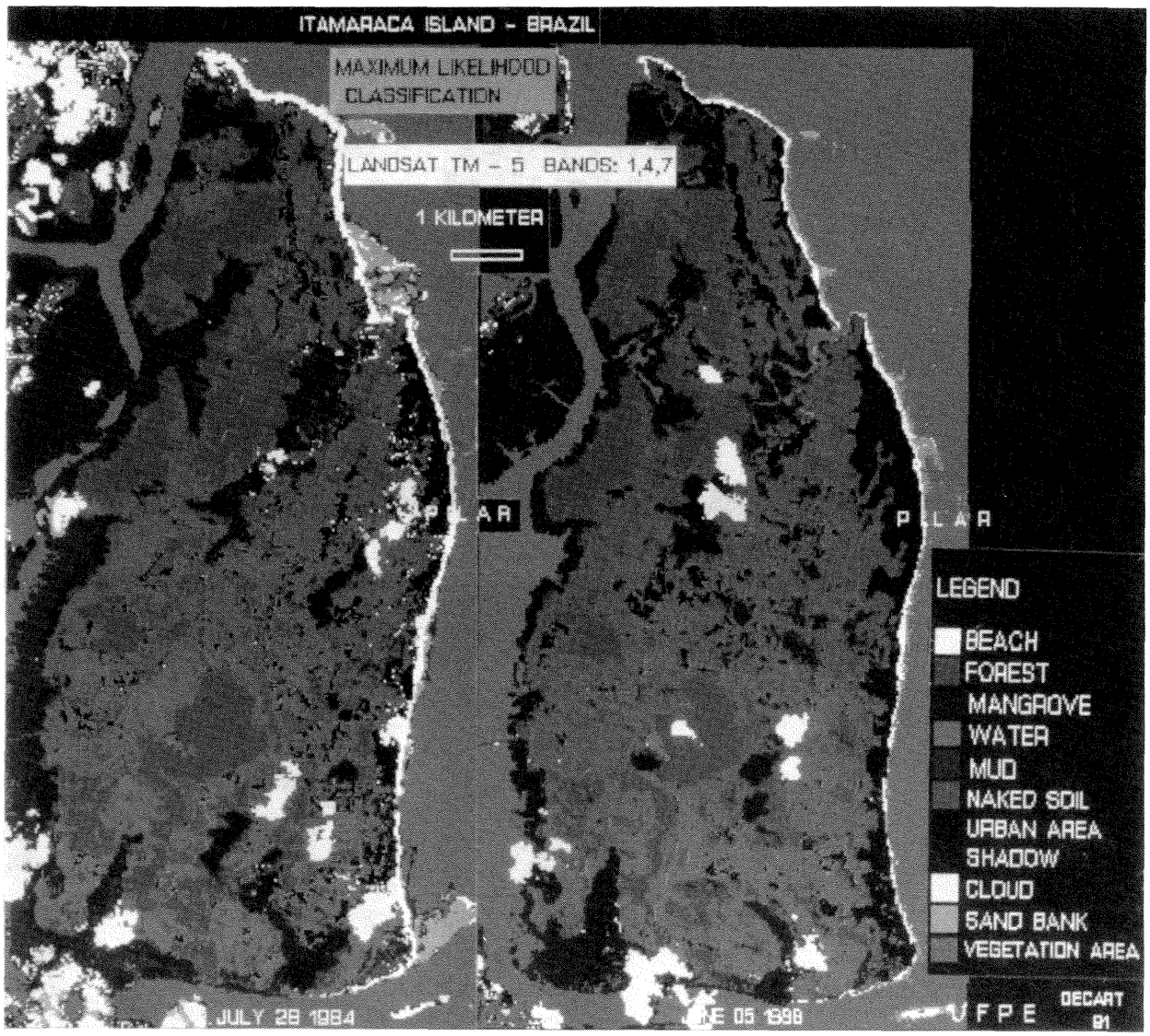

Fig. 3: Comparative Maximum Likelihood Classification of the Two Years Scenes