HIERARCHIZATION OF LANDSCAPE IN THE ISLAND OF SANTA CATARINA, SOUTHERN BRAZIL, BY USIN TM LANDSAT-5 AND MULTISPECTRAL SPOT IMAGES

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ABSTRACT

This paper presents the work's first stage data. Within this stage the TM LANDSAT 5 and SPOT satellites had been used refering to the study area localized at Santa Catarina island, Brazil. Digital classifications obtained within SITIM-150 were applicated on the images in order to determine the land use classes. Data refering to geomorphology, geology, road system, and drainage system were taken into GIS in order to integrate those data with the results of digital classification.

Introduction

The population growth in the city of Florianópolis, State of Santa Catarina administrative center, especially on the last two decades, promoted an expansion of the urban site and a consequent concentration on the city's border as well as a demographic pressure on natural resources bringing a whole sort of impacts. This way, the city has extended the space occupation toward the so called permanent preservation areas such as slopes, dunes and mangroves. In order to solve such problems it's necessary to develop a large plann able to lead the occupation forms. It seems that the heart of the problems is the lack of an environment's process global view. Actually, these ones are studied in closed compartments, and not in an integrated approach. Bertalanfy's system theory seems to be the best way ro integrante the studies. Under this point of view, the geossystem paradigm is adequate to hierarchize the landscape and so to definite its properties and attibutes.The geossystem "anthropocentric dimension", as defined by Penteado-Orellana (1983) accord's to Sotchava's geossystem definition (1977) who says that the geossystems "... are natural structures undergoing .... the social, economic and technological environments' impact". So, they are "... dynamic, open and hierarchizely organized systems" (id.). Monteiro (1981) asseverates that the basic principle that lead the research on geossystem is that the geographic space is a "Complex Singular System" which encloses physical and socio-economic aspects interacting between themselves.

This research had been carried out on the central-North part of the Santa Catarina island, State of Santa Catarina, Southern Region of Brazil. This region had been chosen due to intensive occupation that develops a meaningful amount of environmental problems.

The use of remote sensing techniques connected to field works is of a great meaning in such studies. A vast literature on the theme displays image treatment and classification methodologies as well as data

integration within the GIS. Considering the problems that the human occupation brought to Santa Catarina island and the need of preserving its natural resources, the aim of this work is the hierarchization of the island landscape by using the geossystem paradigm associate to the remote sensing techniques. This paper will present the results of the work's first stage.

Physical and socio-economic characteristics of Santa Catarina Island

Santa Catarina Island localizes in the Southern Region of Brazil, Florianópolis Country, between the parallels 27º10' and 27º50 South, and the meridians 48º25' and 48º35' (Caruso, 1983).

Founded in 1726, the city of Florianópolis detaches as an administrative center own to its position as the State of Santa Catarina's Capital, situated on Santa Catarina island. The city supports its economic activities on the terciary sector. Since the last two decades, the summer tourism activities has become the most important feature and gave to the city a meaningful touristic character.

Situated between the narrow fluvio-marine origin quaternary plain and the granitic origin coastal hill, that extends along the Eastern part of the State as a whole set of small hills since the continent inland part up to the island, the city expanded its net along the lowlands and occupied ecologically fragil areas, such as mangroves and dunes. That feature may be pointed out as the begining of the island's environmental problems. The real estate exploration has an important role in the occupation process.

The quaternary coastal plains present dune fields on its Eastside and mangroves on the other side, facing the continent. The first largely exploited by tourism and the latter pointy altered by the urban net expansion. Primarily, the quaternary is covered by the tropical rain forest (the so called Mata Atlântica - Atlantic Tropical Rain Forest), as well as beach vegetation, where one may see dunes field and mangroves. The island's central portion had been old small granitic islands connected by quaternary fluvio-marine sedimentation. Originally covered by the rainy forest, the island highlands are fastly occupied by the city's growing. The timber exploration, since the European civilization first came to the island, brought a deep modification on hill's phyto-fisionomy by making large clearings, now with secondary vegetation cover. The primary forest hardly is seen at the island,even so deeply altered. Exposed to a humid, dryless,weather with heavy rains all over the year, the maximum in Summer, the forest regenarate fastly, originating the secondary cover. The unprotected slopes are a land-slide hazard.

Methodology and materials

Materials

The first stage of this work utilized the WRS 220.79E TM LANDSAT 5 images, obtained on March 27, 1988, bands 3, 4 and 5 and the WRS SPOT images, of July 17, 1988, bands XS1, XS2 and XS3 both stored in CCT. The cartographic products had been the IPUF's (Instituto de Planejamento Urbano de Florianópolis - Florianópolis Urban Planning Institute) geology and geomorphology thematic maps, scale 1:50.000, and 1978-1979 aerial photographies, scale 1:25.000. The equipments used had been both the SITIM-150 (Sistema de Tratamento de Imagens - Image Treatment System) and GIS (Geographical Information System), developed by INPE (Instituto Nacional de Pesquisas Espaciais - National Institute of Space Researches), both available in LARS/SC.

Methodological devoloptment

Representative land use classes in the island:
- forest (represented bu natural vegetation cover and/or at regenaration stage);
- pasture and agriculture
- urban zone
- mangrove
- moving dunes and beaches
- fixed dune and sand bars.
- reforestation

Geomorphological units for information planns development within GIS:
- crystalline basement
- colluvial deposit
- eolian deposit
- lacustrine deposit
- marine deposit

Drainage net and road system selection corresponded to the scale 1:50.000.

The SITIM stage

The TM LANDSAT 5 and the SPOT satellites images had been divided into working modules, corresponding to the scales 1:30.000 for the TM LANDSAT 5 and 1:25.000, for the SPOT. Each module had been submitted to pre-processing basic procedures, with the remotion of the luminosity excess owned to the atmospheric light scattering. The water bodies had been isolated in the corresponding modules from the bands TM 4 and XS 3. The slicing algorithm in which the water bodies' gray levels were defined in the images histogram, had been utilized in the procedures. The slice to be subtracted had been determined through out the area area by erasing algorithm available within SITIM.

Digital classification

Initially, the modules for aplicating qhe classification represented the Santa Catarina island central-Noth part. The statistical and deterministical classifiers had been test due to the enviromental variability. The chosen one would be that which could present the best response sothat might be applicated to the other modules. The classifiers used here had been the maximum likelyhood supervised statistical classifier (Jensen, 1986), the parallelepiped deterministical classifier and the qray levels slicinq alqorithm. This last one, had been applied only in the SPOT imaqe.

1) The maximum likelyhood supervised classification - This classification envolved the followinq steps: sample acquisition; sample analysis, in which the qround truth most characterizinq ones have been selected; attribute selection and classification matrix acquisition,(the best combination between the most siqnificative classes performance in classification); and finally, the likelyhood classification itself.

2) Parallelepiped method classification - Supported by the 1:25.000 aerial photoqraphies and by the previous knowledqe of the studinq area, a visual analysis has been done. From this point, the channels had been selected as well as land use samples. Next step was to associate the imaqes' "pixels" with those ones obtained in the samplinq by the cursor, informinq the specific colors for each sampled class.

3) Grey levels slicinq method classification - The slicinq alqorithm had been applicated on the bands XS1 and XS2 by usinq the qray levels upper and lower limits rates. The land use classes most representative qrey levels have been analysed then. New intervals have been created by qivinq them colors as well, as a consequence, two new classified bands.

Imaqe X map reqisterinq

A 1:50.000 IPUF's cartoqraphic base had been utilized for selectinq the common points found on the imaqes and the map. The reqisterinq precision had been tested by usinq the second deqree polynomial equation.. Control points presentinq a lesser or equal 1 "pixel" precision had been considered. Each module had been reqistered separately considerinq the same precision rate.

The GIS staqe

The project area (27º45'00 S lat, 48º40'00 W lonq and 27º40'00 S lat., 48º20'00 W lonq.) had been defined firstly by usinq the IPUF's 1:50.000 cartoqraphic base. The qeomorpholoqical data were introduced int GIS by usinq the vectorial form. An imformation plann had been created containinq the followinq classes: crystalline basement; colluvial deposit; eolian deposit; lacustrine deposit; and marine deposit.

Those data identify the different relief forms found on the island, and had been extracted from the 1:50.000 IPUF's qeomorpholoqical map. The information planns created by the processinq encolses: 1) the study area limits; 2) the drainaqe net; and 3) the road net. The classified band corresponding to the 1:50.000 SPOT first module, coverinq qhe island central-North part was transfered under the raster form. This new classified band corresponds to the island's 1988 land use forms. The defined classes are: forest (containinq several staqes of the natural veqetation cover); pasture and aqriculture; manqrove; reforestation; movinq dunes and beaches; and fixed dunes (sand bars). The diqitalized data under the vectorial form had been polyqonallized and rastered for later crossinq amonq the data.

RESULTS OBTAINED ON 1st STAGE

The maximum likelyhood classifier presented on both SPOT and TM LANDSAT 5 imaqes adequate rates concerninq the classes urban zone, pasture/aqriculture and movinq dunes. The parallelepiped method displayed about 10% unclassified areas in each module, althouqh presented a suitable performance on the tarqets classification. The slicinq method showed a suitable outcome on band XS1 as well as on the others classifications. The classified band XS2, was chosen to inteqrate the data with de information plans within the GIS, referinq to qeomorpholoqy, road system, drainaqe system and the area limit. Those data allowed to outline some landscape hierarchizinq levels by dividinq it into two qreat spatial units: Crystalline Basement and the Quaternary Coastal Plain. This last one may be divided into four sub-units, as well, Eolian Deposits, Lacustrine Deposits, Colluvial Deposits and Marine Deposits.

Those two qreat units allow to visualize both natural and anthropic occupation forms on the island as well as the drainaqe system, deforestation areas, road net, preservation area occupation (dunes, manqroves, slopes) and so. The second staqe of this research will concern to the landscape study within a time/space approach. Also, it will be done a diqital

classification on an actual satellite image and detailed field works will be carried out. The data obtained in this 1st stage will be crossed with those ones that will be achieved for the 2nd stage. Climatic and socio-economic data, will allow to achieve a better characterization of the landscape units by visualizing the whole. That procedure will achieve to delineate the environmental problems, to diagnosis them and so to propose solutions to the emergency matters in the island.

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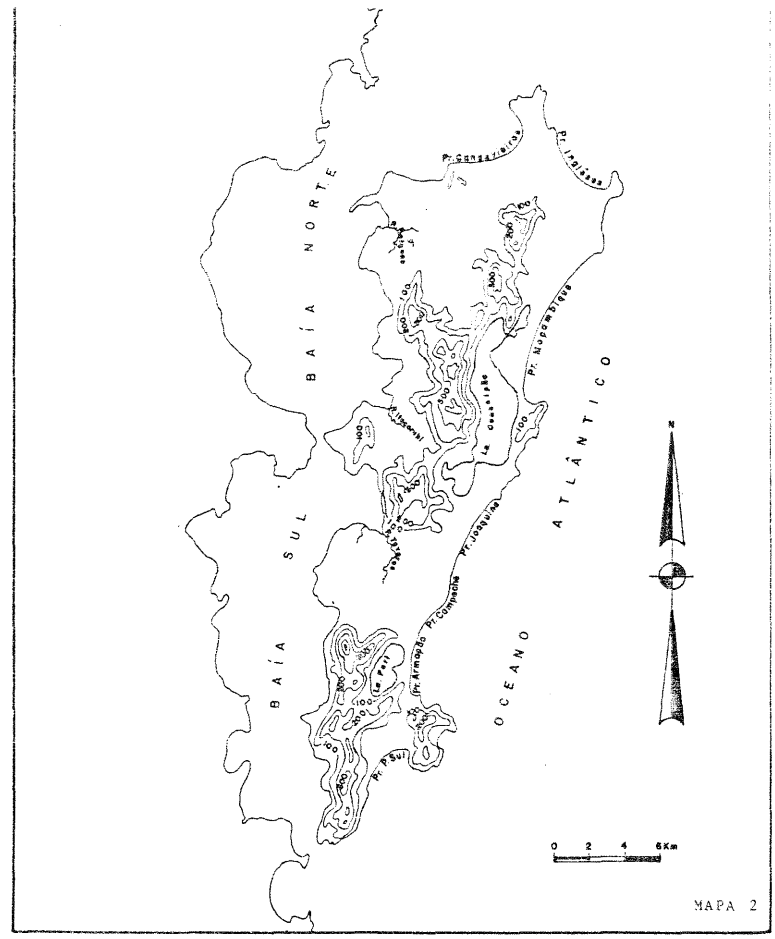
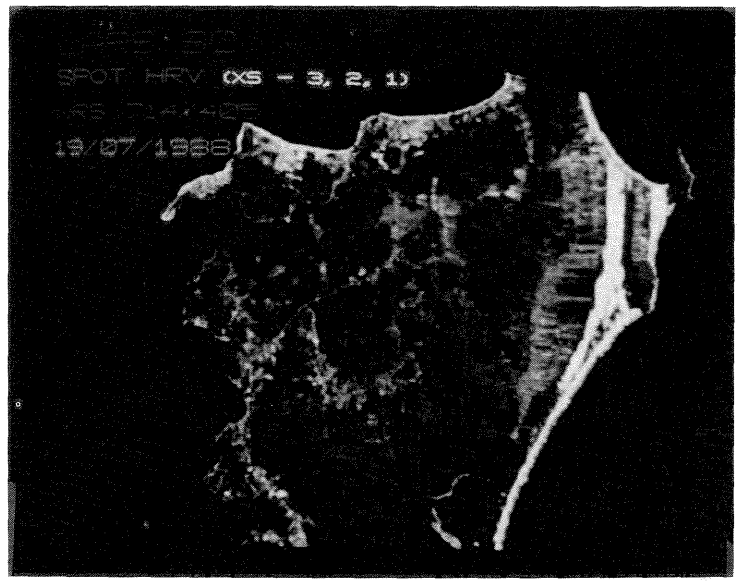
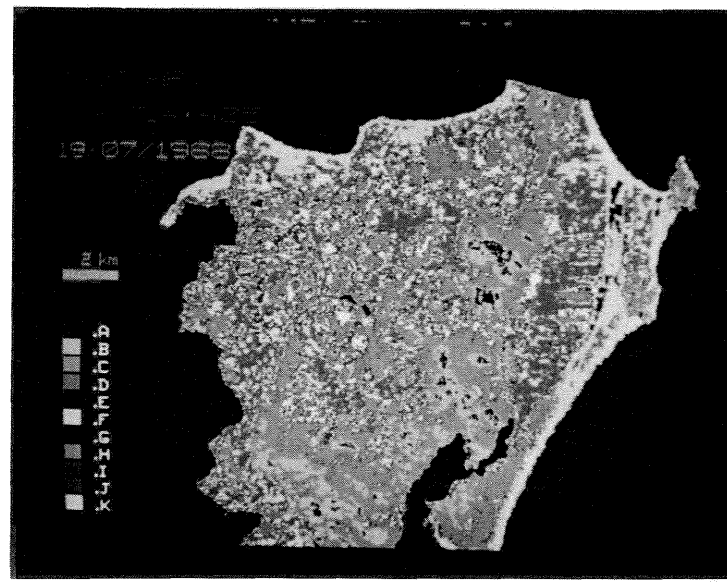
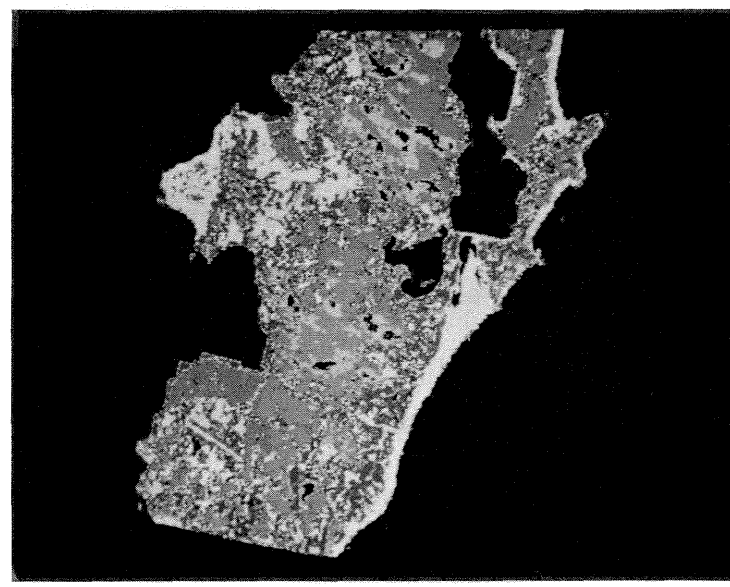


Location area map, from CARUSO,M.M.L. (1983).



Study area
Scale 1:200 000





THE GRAY LEVEL SLICING CLASSIFICATION

The seven representative land use classes, were extracted from eleven classes mentioned above.