

CLASSIFICATION OF TEMPORAL BEACH ENVIRONMENT IN BOA VIAGEM - RECIFE - PE USING FUZZY LOGIC ANALYSIS

Luciana Maria da SILVA, Brazil and Rodrigo Mikosz GONÇALVES, Brazil

Key words: coastal zone, urbanization, thematic maps, shoreline, fuzzy logic.

SUMMARY

The evolution and urbanization in coastal areas has been changing social relations and morphological aspects of the environment. Part of the urban concentration at Recife municipality, capital of Pernambuco State, in Northeastern Brazil is inserted into the coastal zone. Recife according to 2010 census has a population of 1.536.934 inhabitants, distributed in an area of 220 km². Boa Viagem beach located in Recife has been urbanized near the shoreline, over the past 60 years nowadays there are many problems of coastal erosion. With about 7km of extension this district has been modified by anthropogenic processes. This paper goals to investigate the evolution of the beach environment by analyzing aspects of the years 1974 e 2005 using fuzzy classification modeling. For this propose was used high spatial resolution satellite images and orthophotos. For the study three thematic classes was named and between them are: exposed soil, buildings, vegetation. The results indicate quantitative information on thematic maps demonstrated the evolution of this classification in the beach and backshore and the model application through the classification coverage classes also are presented the determination of shoreline position in the selected area and the comparison with the Coastal Management Act of Pernambuco State. The applied method uses photo interpretation and temporal analysis according with linguistic variables characterize by the fuzzy approach. The advantages of fuzzy model in this case are to deal with uncertainties and the capacity to mathematically modeled generating as a product a local classification. Through the methodology used to identify changes over the beach environment, it is emphasized that the source of cartographic information, will serve as a fundamental tool for the analysis of spatial information and modeling.

Palavras-chave: zona costeira, urbanização, mapas temáticos, linha de costa, lógica fuzzy.

RESUMO

O avanço da urbanização em áreas costeiras vem mudando as relações sociais e os aspectos morfológicos do ambiente. Parte da concentração urbana no município de Recife, capital do estado de Pernambuco, no Nordeste do Brasil é inserido na zona costeira. Recife de acordo com o censo de 2010 tem uma população de 1.536.934 habitantes, distribuídos em uma área de 220 km². Nos últimos 60 anos, a Praia de Boa Viagem localizada no município de Recife vem sendo urbanizada próximo a linha de costa, atualmente apresentando muitos problemas de erosão costeira. Com cerca de 7 km de extensão este bairro vem sendo modificado por processos antrópicos. Este artigo tem como objetivo investigar a evolução do ambiente de

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praia, analisando aspectos dos anos de 1974 e 2005, utilizando a modelagem de classificação fuzzy. Para isso foram utilizadas imagens de satélite de alta resolução e ortofotos. Para o estudo foi nomeado seis classes temáticas, entre elas estão: solo exposto, edificações e vegetação. Os resultados indicam informações quantitativas em mapas temáticos demonstrando a evolução desta classificação no ambiente praial e a aplicação do modelo através das classes de cobertura de classificação também são apresentados a determinação da posição de linha de costa na área selecionada e a comparação com a Lei de Gerenciamento Costeiro do Estado de Pernambuco. O método aplicado usa fotointerpretação e análise temporal de acordo com variáveis linguísticas que são caracterizados pela abordagem fuzzy. As vantagens do modelo fuzzy neste caso são de lidar com incertezas e da capacidade de modelar matematicamente gerando no final uma classificação local. Através da metodologia utilizada para identificar mudanças sobre o ambiente de praia, destaca-se que a fonte da informação cartográfica, servirá como uma ferramenta fundamental para a análise da informação espacial e modelagem.

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1. INTRODUCTION

The Coastal Management Act of Pernambuco State (2010) which deals with instruments and occupation of the coastal zone in its Chapter V, Article 10 item 2º, proposes that for urban areas will not be allowed any kind of installations of new construction, urbanization or other form of land use in the coastal zone, in the range of 33 m (thirty-three meters), considered as "non aedificandi" or above this value when proven technical study, measured perpendicularly toward the mainland, from the maximum high tide line of syzygy current. Thus we can highlight the importance of the coastal zone that concentrates large economic and tourist potential. Along the coast of Boa Viagem is possible to observe works very close to the sea demonstrated that coastal urbanization continues in full activity.

The municipality of Recife has a large coastal area, but has undergone changes over time. One of the problems of rapid growth of Recife is the illegal occupation (substandard settlements) in the general low-income population that often proliferate in areas of environmental protection. The substandard settlements are always in constant change, it is extremely important to map these areas to quantify the inhabitants and develop the analysis of degradations and evolutions of these as tools to aid in urban planning, for more details on Heller and Teixeira (2005), Sánchez (2010), in addition to combat erosion in risk areas Hapke and Plant (2010), and in coastal areas Boak and Turner (2005).

In a study by Araújo et al. (2007) it was possible to analyze the occupation of urban beaches of Pernambuco, where the sector Metropolitan State 47% of its length indicated the simultaneous occupation of post-beach and beach. In this context, this paper aims to investigate the evolution of land use in a beach environment of the borough of Boa Viagem. To this end, we used satellite images of high spatial resolution orthophotos and for the purpose of extracting information to create thematic maps and analysis by occupation using fuzzy logic.

2. STUDY AREA

The Figure 1 presents a location map of the state of Pernambuco in the Northeast Region, Brazil, the expansion of the State and in particular a polygon that defines the cities of Recife and a polygon of Boa Viagem. The coast of Recife is formed by the beaches of Pina (1 km long coastal) and Boa Viagem (7.38 km long coastal) totaling approximately 8.5 km of shoreline.

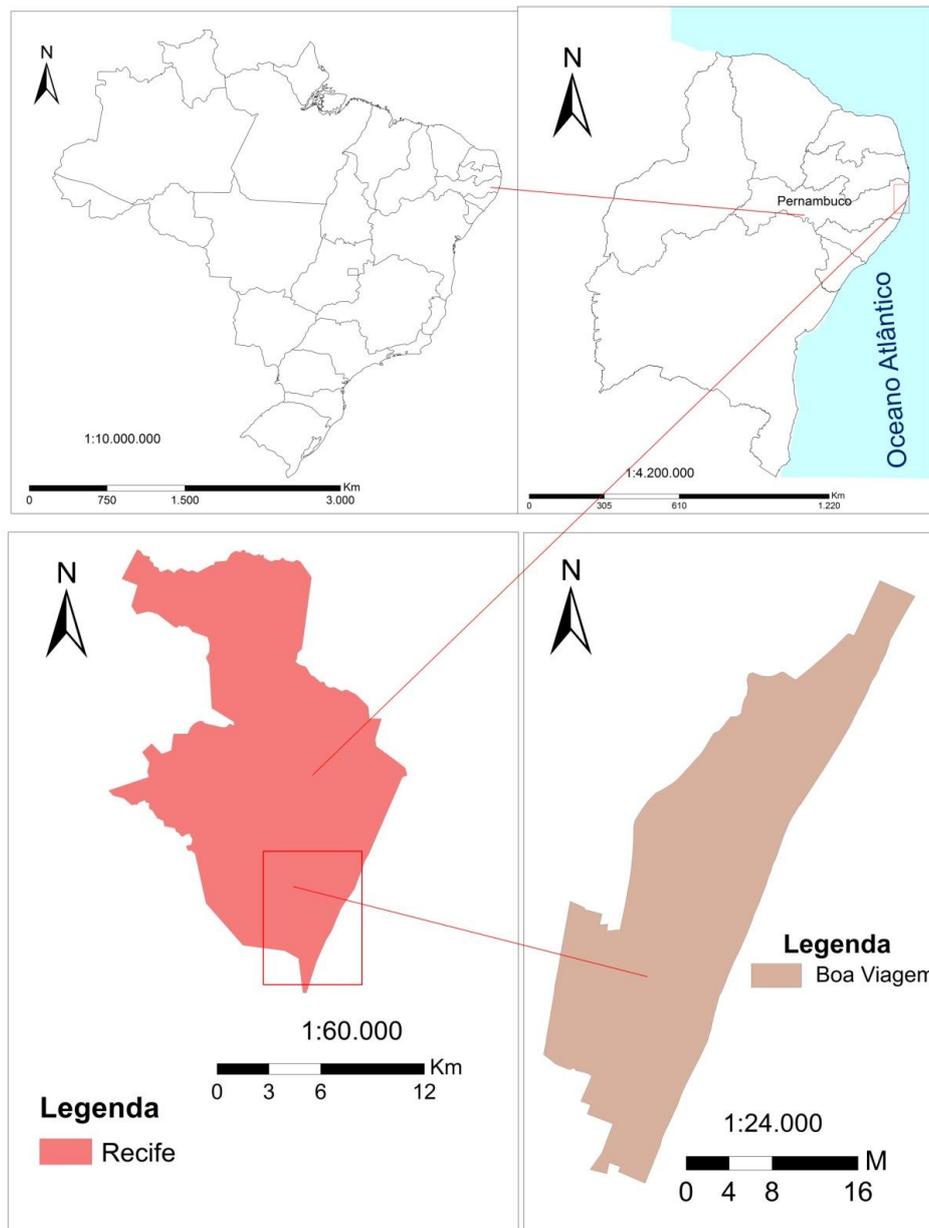


Figure 1- Location Map of the beach Boa Viagem

According to Manso, et al. (2006), the Pernambuco coast was delineated and sectorial basis of their geographical and political situation in 21 municipalities distributed in a range of 187 km. The coast of Pernambuco has low altitude, reaching, at several points below the average mean sea level.

The Beach Boa Viagem is oceanic and is located in the southern part of the city is part series of coastal ecosystems that extend another 7 km to the south along the beach Piedade (Jaboatão Guararapes), more details in Costa et al. (2008), bathed Atlantic Ocean.

In Edge Project (2002), the edge of Boa Viagem can be classified as "exposed with

consolidated urbanization" or "exposed to urbanization." In Smith (1991) and Morgan (1999) considers the edge as a city resort, or highly developed beach.

3. MATERIALS AND METHODS

Through Remote Sensing data was organized temporal cartographic information enabling redeemed create a geographic database to extract information from process indices of flooding spatial information beyond morphology along the wetlands. Was used as materials:

- Orthophotos format Tif '(1974) and Images of orbital satellites (Quickbird and 2005) that serve to represent spatial information in the process of coastal morphology vectorization.
- The ArcGIS 9.3 software for data processing in Shapefile format, preparation of thematic interpretation of cartographic features and geomorphology of coastal area.
- Matlab® software: Fuzzy Logic Toolbox ® is used to make the analysis of the results, where the input fuzzy enables quantitative analysis and Curve Fitting Toolbox® Tool will be used to make the analysis of the results by building a function.

According to Silva and Gonçalves (2012), to develop a model, you can choose a semi-quantitative approach, in which all the attributes, qualitative or quantitative, are encoded in linguistic variables using fuzzy logic according to their degree of influence on the vulnerability of the coast to erosion.

The classes used as input data in Fuzzy Logic are: vegetation, bare soil and buildings. Having as linguistic variables, respectively: high, medium and low, as shown in Table 1

Table 1 - Class used as input linguistic variables and their corresponding to use of Fuzzy Logic

Spatial Data m ²	Classes	Linguistic Variables		
		1	2	3
	Morphological characteristics and anthropogenic			
	Bare Soil	High	Medium	Low
	Buildings (Buildings and Improvements leisure)	High	Medium	Low
	Vegetation (foredunes and coconut)	High	Medium	Low

Source: Adapted from Silva and Gonçalves (2012)

As output we observed that the occupation of the land area is low, medium, high and very high.

4. RESULTS AND DISCUSSION

The Figure 2 represents the land use maps obtained for the years 1974 and 2005, respectively. Through the thematic maps obtained it was possible to quantify the area and the percentage for each class selected. Table 2 shows such figures, where was used to study the total area bounded by a space of 121.510 m².

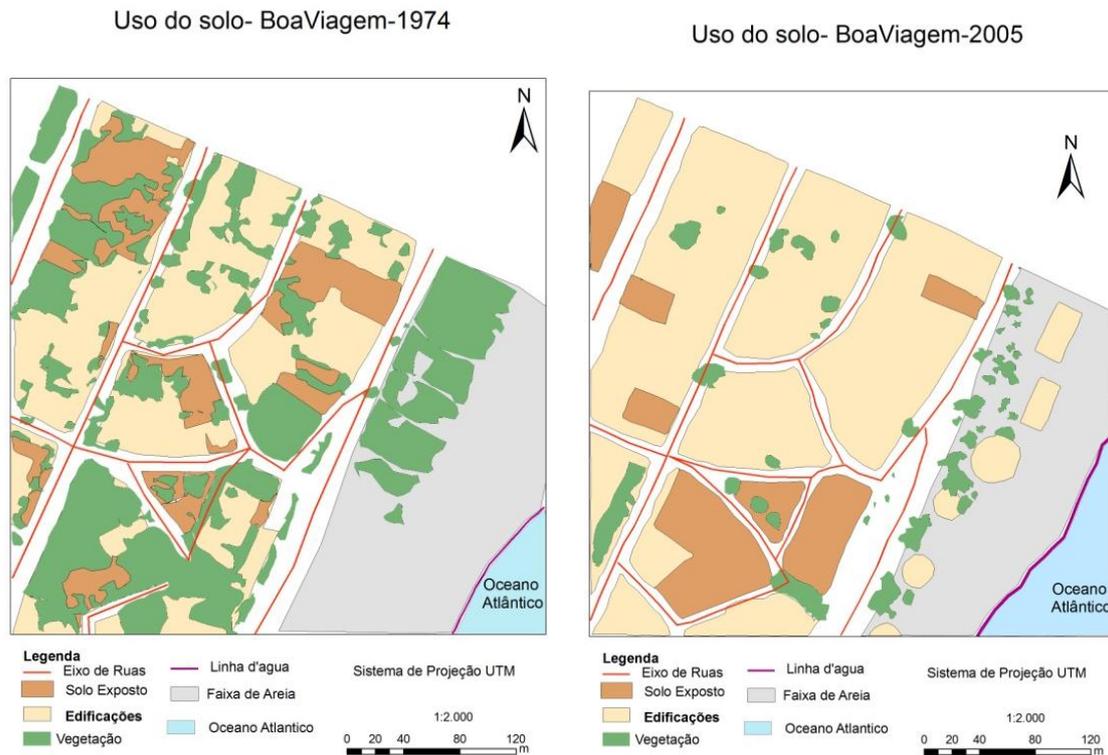


Figure 2 - Thematic Maps temporal area of study
Source: Sabia, et. al (2011)

Table 2 - Calculation of area and percentage land use - 1974 and 2005

Year	1974		2005	
	Area (m ²)	Percentage (%)	Area (m ²)	Percentage (%)
Vegetation	30.765	25	6.227	5
Bare Soil	11.635	9	13.279	11
Buildings	27.554	23	56.589	47

Through analysis of satellite images was possible to calculate the extent of classes, along the area of Boa Viagem. In which the calculation of classes shows that for the constructions 1974 had increased from 24% in 2005. The FisEditor occurred in the process of fuzzification, in which input variables were modeled mathematically by means of fuzzy sets, where each input variable is assigned to a linguistic variable. For both characteristics as was used to output the membership function gaussmf. After defining the membership function,

wrote to twelve (12) rules to associate the input variables and their linguistic variables to obtain the results in the output variable. In the rules was adopted and connective (minimum). The defuzzification process of generating an output fuzzy number, where the results are viewed through viewer's rule, as shown in Figure 3 is observed an increase in occupancy of approximately 62%.

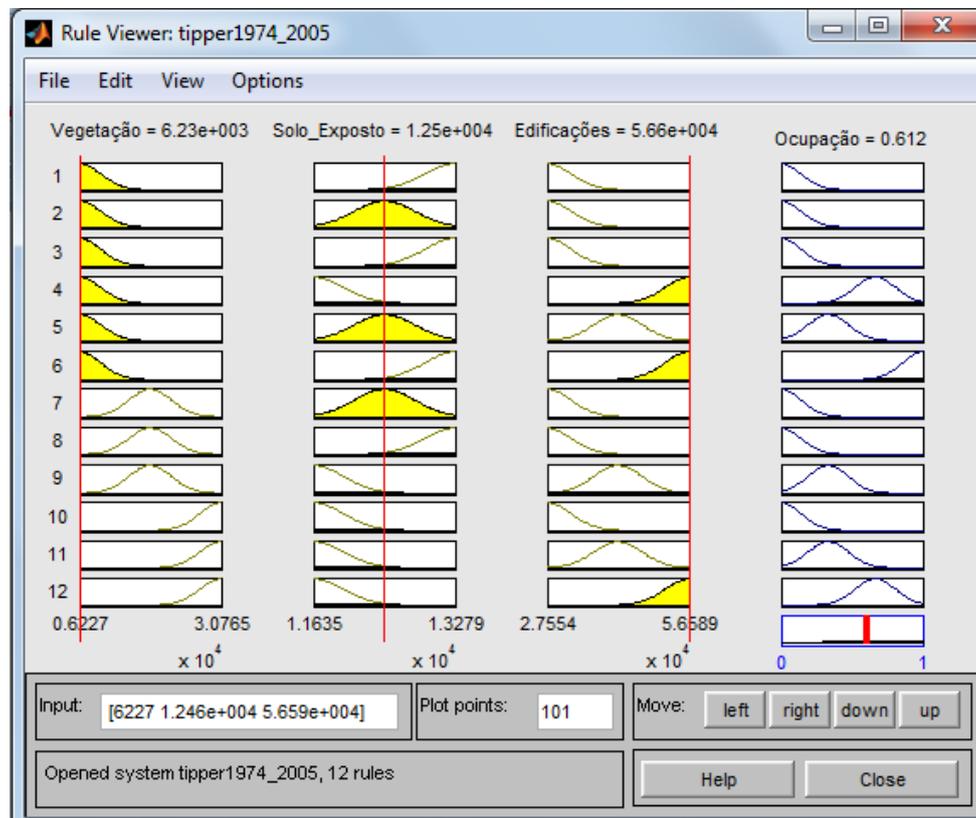


Figure 3 - Analysis of increased occupancy in Boa Viagem 1974 to 2005

In the analysis, it was observed that in the area delimited 1974 occupancy was approximately 15% because the area of vegetation was much more present. In 2005 there is a large reduction in vegetation while there is a large increase in buildings. Every decrease of vegetation in this area has a direct relationship with increasing occupancy. Since, when vegetation is torn give rise to exposed soil and then the constructions of large buildings. It was observed from the results that the percentage of exposed soil increased by only 2%, while the buildings increased by 24%, this shows that over time the exposed soil had given way to the buildings.

5. CONCLUSION

The Fuzzy logic has generated good results, besides the advantages in the interpretation of the occupation that is seen through the viewer rule and rules interpreted as the process of land occupation. Remote sensing was instrumental in obtaining the temporal and spatial data being used as the basis for assessing the degree of occupancy on fuzzy logic.

Through the methodology used to identify the characteristics of zoning, it is emphasized that the source of cartographic information, served as a fundamental tool for the analysis of spatial information. But there are still questions that need to be addressed and answered in what refers to increasing urbanization.

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BIOGRAPHICAL NOTES

CONTACTS

Luciana Maria da SILVA (Email: Luciana_maria15@hotmail.com).

Has Undergraduate Full Degree in Mathematics from the University of Pernambuco - UPE, BRAZIL (2008). Student Masters in Geodetic Sciences and Technologies Geoinformation in Federal University of Pernambuco, UFPE, BRAZIL.

Rodrigo Mikosz GONÇALVES (Email: rodrigo.mikosz@ufpe.br).

holds a degree in Cartographic Engineering from Universidade Federal Paraná (1999), master's degree in Electrical Engineering and Industrial Informatics by Federal University Technological of Paraná (2004) and doctorate in Geodetic Sciences from Universidade Federal do Paraná sandwich with period at the Institute of Geodesy of Karlsruhe, KIT, Germany (2010). He is currently associate professor of UFPE and permanent member of the Graduate Program in Geodetic Sciences and Technologies Geoinformation. He has experience in the field of geodesy, acting on the following topics: coastal mapping, monitoring and modeling of temporal geodetic data.