



Process for the identification of land use in environment preservation areas in the municipality of São José dos Campos – SP

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ABSTRACT

The present article deals with the urbanization process in the Paraíba do Sul river basin, covering social occupation under consideration of the legal provisions for areas surrounding water resources. The study has the purpose of assessing the Environment Preservation Area, called APA Banhado, in the city of São José dos Campos, a municipality belonging to the Metropolitan Region of the Paraíba Valley and the Northern Sea Shore (RMVPLN) in the state of São Paulo, Brazil. The research carried out made use of materials and information collected from aerial images obtained from remote sensing databases maintained by public offices, and the provisions of the APA Banhado implementation law. In order to extract information from satellite images, the methodology proposed by Moreira (2011) was applied, which suggests an automatic software classification in the Geographical Information Systems (SIG), with visual interpretation. The maps generated from the classification of the APA Banhado were based on reference data from the years of 1995, 2000, 2005, 2010 and 2015. The results revealed conflicts between the environmental legislation and the land use, which prompted the possibility of generating basic data capable of incorporation into public planning policies and the preserved area environmental management, including a revision of concepts under the environmental preservation, as a future safety water reserve for the metropolitan region of the Paraíba Valley – SP.

Keywords: environmental sciences, urbanization, water safety.

Processo para identificação do uso da terra em áreas de preservação ambiental no município de São José dos Campos - SP

RESUMO

O presente artigo aborda o processo de urbanização sobre a bacia do rio Paraíba do sul, considerando a ocupação social, pautado nos parâmetros legais, nas vizinhanças de recursos hídricos. O estudo tem como objeto de avaliação a Área de Proteção Ambiental (APA) denominada Banhado, na cidade de São José dos Campos, município da Região Metropolitana



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do Vale do Paraíba e Litoral Norte (RMVPLN), São Paulo, Brasil. Para a realização da pesquisa foram utilizados materiais e informações de imagens aéreas, obtidas através de banco de dados de sensoriamento remoto de órgãos públicos, e as diretrizes da lei de implantação da APA do Banhado. Para a extração de informação das imagens de satélite, foi aplicada a metodologia proposta por Moreira (2011), que sugere uma classificação automática em *software* em ambiente de Sistemas de Informações Geográficas (SIG), com interpretação visual. Os mapas gerados de classificação da APA estadual do Banhado foram subsidiados por dados de referência ano 1995, 2000, 2005, 2010 e 2015. Os resultados obtidos são considerados conflitantes, entre a legislação ambiental e o uso do solo na área de estudo, propiciou a possibilidade de gerar subsídios passíveis de incorporação a políticas públicas de planejamento e gestão ambiental da área protegida, com a revisão de conceitos sob a ótica de preservação ambiental, como uma futura reserva de segurança hídrica, para a região metropolitana do Vale do Paraíba – SP.

Palavras-chave: ciências ambientais, segurança hídrica, urbanização.

1. INTRODUCTION

The state of São Paulo had in the last years a population growth of 4.6 million inhabitants (IBGE, 2019). In 2010 the population was of 41.2 million inhabitants, rising to 45.9 million in 2019. Subject to the same trend, the Metropolitan Region of the Paraíba Valley and the Northern Sea Shore (RMPVLN), with a an approximate population of 2.3 million inhabitants, corresponding to 5.5% of the state of São Paulo, have grown in the same proportion, mainly in high-density municipalities, as the cities of São José dos Campos, Jacareí, Taubaté and Caraguatatuba.

The São José dos Campos municipality, headquarters of RMPVLN, had 629,900 inhabitants in the year 2000, with a population growth of approximately 713,000 in 2019, an average growth of 9,000 inhabitants per year. As a result of this growth, according to the Regional Development Ministry (2019), the city presents a total housing shortage in the order of 21,000 homes, this data is based on studies on the updated housing shortage of the state of São Paulo prepared by the Foundation of the State's Data Analysis System - SEADE (São Paulo, 2019).

As consequence of urban expansion in São José dos Campos, as well as other Brazilian cities as well, is mainly improper land management or irregular occupations, with disregard of the municipal organic laws (Brito and Souza, 2005).

The city of São José dos Campos is an example of what Salgueiro (2019) defines as a fragmented city, where building is carried out according to immediate and individual interests, even over environmental preservation areas (APA), with variable impacts in the case of this municipality. An example of this is the Environmental Preservation Areas (APA) due to these areas direct relationship with the urban zone roadway system.

Therefore, in the entire city, fragmented areas that became fragile when not legalized by the public offices and may turn into speculative areas prone to irregular occupation under the population growth pressure, thus transformed into vulnerable areas as, for example: river banks, seasonal flooding areas, stream banks, slopes and farming areas as well.

Using these state indexes as reference, this work had the goal presents the occupation methods under development in the Paraíba do Sul river's neighboring lowlands, in the RMVPLN. The study has identified the land use in the fragmented plots of land belonging APA Banhado, with reference from the years of 1995, 2000, 2005, 2010 and 2015, within the urban area of the city of São José dos Campos. By focusing on this lowland area of the city and its role as an environmental preservation area, the study also allowed other analogies concerning

the same kind of problems in APA, which should be identified in the first place as areas of safety water reserves.

2. MATERIAL AND METHODS

This study used information from aerial images collected from the remote sensing databases of: Brazilian Institute of Geography and Statistics (IBGE), Regional Development Ministry; Geographic and Chart Institute of the state of São Paulo (IGC); Department of Water and Electric Power (DAAE); São José dos Campos's city hall and the Google Earth images.

The applied methodology was supported by the use of geoprocessing tools and remote sensing results, and used as an action flowchart the stages (Figure 1).

The specifications of each image can be identified in the flowchart, together with data from each year (1995, 2000, 2005, 2010 and 2015), corresponding scenes and satellites.

For the extraction of information using satellite images, the methodology proposed by Moreira (2011) was applied, which suggests an automatic software classification in the environment of Geographic Information Systems (SIG). In addition to a later visual interpretation that consisted in extracting terrestrial surface information based on specter information obtained by observing the image, for refinement and adjustment of the results intending an improved classification.

Concerning the study, the development of the methodology intended the identification of the anthropic actions in the Banhado Preservation Area in the city of São José dos Campos- SP.

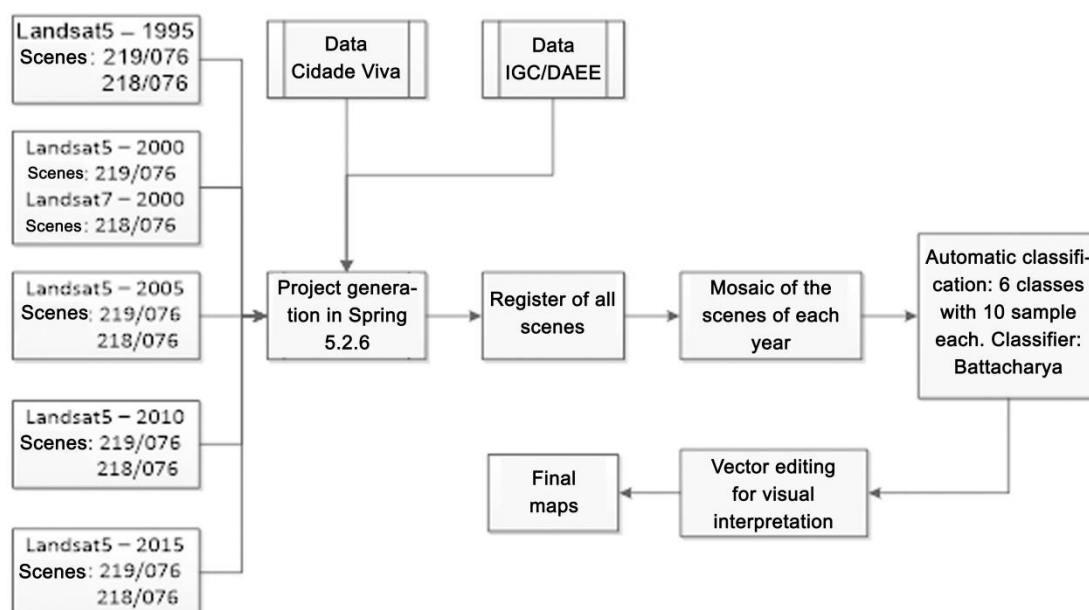


Figure 1. Flowchart of the information extraction process of the images per period 1995, 2000, 2005, 2010 and 2015.

3. RESULTS AND DISCUSSION

The Banhado APA was created by Law n. 11.262/02 (SÃO JOSE DOS CAMPOS, 2012), with an area of 9,1000 ha. According to the Florestal Foundation (SÃO PAULO, 2016), the Banhado APA was implemented with the purpose of protecting the Paraíba do Sul river flood plains, in the Metropolitan Region of the Paraíba Valley and the Northern Sea Shore - SP.

In the shape of polygons, the area corresponds to the flood plains formed by sediments transported by the Paraíba river and its tributaries, where 11 abandoned meanders and terraces can be found, thus creating a scenery that contrasts with the urban landscape of the city of São

José dos Campos, an area for reloading of underground aquifers, with the characteristics of a huge natural retention basin, factors that make it an essential area of water resources preservation (Dias et al., 2008).

The state legislation limited the Banhado APA into three perimeters: perimeter I – refers in the neighborhood of the Rhodia S/A plant; perimeter II – refers to the areas adjacent to the Lineu de Moura Avenue, in the Urbanova district, and perimeter III - the Banhado APA area adjacent to the inter-municipal border with the city of Jacareí (São Paulo, 2016). Precisely located in the coordinates: latitude $23^{\circ}10'57.68''$ S; longitude $45^{\circ}53'59.16''$ W; altitude of 560 m above sea level (Figure 2). The Paraíba do Sul flood plains can be identified in blue, between the municipalities of Jacareí and Guaratinguetá; in the area highlighted in yellow is the APA limited by the three perimeters: I, II and III, according to state Law n. 11.262/02.

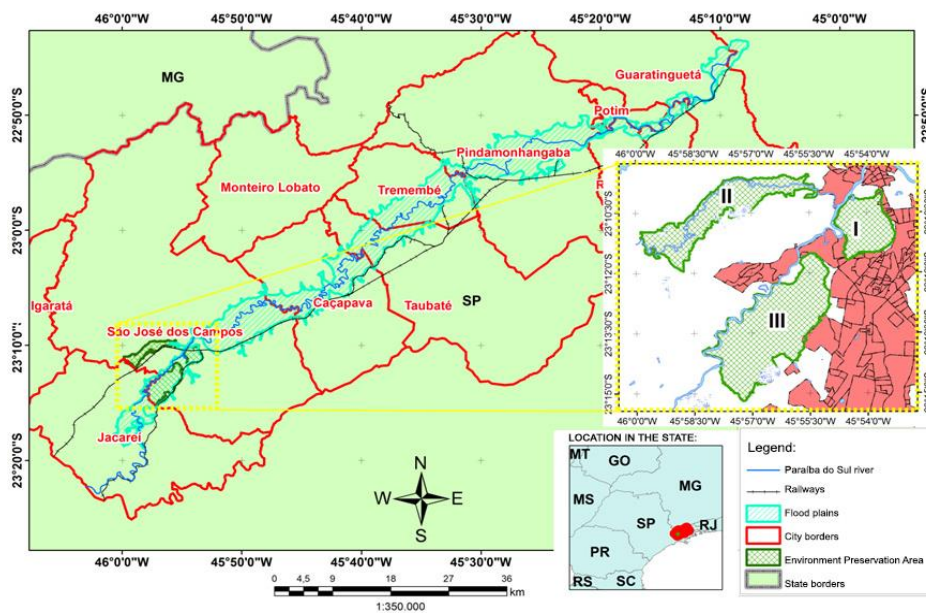


Figure 2. Map of the localization of the state's Banhado APA, São José dos Campos, São Paulo, Brazil.

The images used to identify the anthropic actions in the Banhado APA were specified with the data of the year, corresponding scene, satellite and acquisition date, as shown in Table 1.

As a result of information extracted from satellite images, by adapting the Moreira (2015) methodology, an interpretation key was developed for the study area: Class of use: 1.1. bodies of water; 1.2. farming; 1.3. bush; 1.4. pasture; 1.5. exposed soil. 1.6. urban pressure. Based on the class of use, the image's color and texture were defined for the classification and detection of the uses proposed in the study.

A project was developed in SPRING 5.2.6 Geographic Information System (INPE, 2003) for the processing of the acquired orbital images, and the importation of the representations was carried out. The automatic sorting into categories used the Battacharya classifier that presented the measure of the Battacharya distance used to measure the statistic separability between a pair of spectral classes, all this followed by the researcher's interaction (Mather, 1999).

The automatic classification procedure was adopted only for the first year of the time series, 1995, and this classification was used as basis for the later years, in which the borders and classes were updated visually year after year; therefore, the urban expansions, farming and pastures were more easily highlighted.

After the generation of the classification maps for all years of the time series, from 1995 to 2015, editing was carried out with the use of the essential editing tool, the SPRING matrix

editing, with adjustment to the limits of the desired class, including areas omitted due to inconsistent borders. Therefore, the classification maps for the state's Banhado APA were generated for the years of 1995, 2000, 2005 and 2015.

Table 1. Orbital images used to identify the anthropic actions in the Banhado APA.

<i>INFORMATION OF THE ACQUIRED ORBITAL IMAGES</i>				
<i>Year</i>	<i>Scene</i>	<i>Satellite</i>	<i>Dates</i>	<i>Distance Resolution</i>
1995	219/076	Landsat5	28/June/95	30 meters
	218/076		09/Sept/95	
2000	219/076	Landsat5	29/ Sept /00	30 meters
	218/076	Landsat7	26/ June /00	
2005	219/076	Landsat5	20/April/05	30 meters
	218/076		12/March/05	
2010	219/076	Landsat5	13/Febr./10	30 meters
	218/076		06/ Febr./10	
2015	219/076	Landsat8	10/Jan./15	30 meters
	218/076		19/Jan./15	

Source: Landsat, 2015

In addition a classification was introduced to encourage the important discussion. According to Soares-Filho and Garcia (2003), the General Anthropic Pressure Indexes (IPAG) are based on the exploitation of information from different sources and, based on the impacts caused by the anthropogenic action on the preservation area. A classification proposal was prepared which classified the higher pressure impacts on the Banhado APA: (Type A) urban pressure – characteristics: generated by random urban speculation, is identified by demographic concentration and economic development; (Type B) anthropic pressure (farming, pasture and exposed soil) – characteristics: generated by farming, cattle raising and extraction of vegetation, with economic development approach (Figure 3).

However, the most significant changes in the thematic classes took place in the year 2000, with considerable differences regarding farming and pasture, mainly in perimeter III. It is possible to note that, with respect to the year 1995, an exponential growth of 483.24 ha took place in the year 2000 in the farming class inside the APA, but there was also a significant increase in bush, of approximately 180.35 ha, close to water streams.

In the year 2005, another significant change could be observed with respect to the year 2000, for the urban pressure class. Perimeter III shows an increase in occupation due to the urbanization process. However, when compared with the pasture class between 2000 and 2005, an increase of 895.05 ha could be detected in these five years; this means a change to 1,601.56 ha of areas destined to pasture, with the corresponding reduction in farming areas, which in the year 2000 occupied 1,663.21 ha of the APA land, a significant reduction of 817.79 ha.

In the year 2010, surprisingly, no significant land use changes were registered in the Banhado APA land, its use classes have maintained vary close characteristics regarding the 2005 time interval, as shown in the mosaic of figure 3. However, it must be pointed out in this study that the APA has a natural resources protection role, according to the state legislation, and that in the year 2010 there was a significant loss of 59.57 ha in bush area.

The mosaic shows that in the year 1995 perimeters I and II, had most of their surface occupied by pasture, as opposed to perimeter III in the same period, which presented the predominance of farming, including an already distinguishable exposed soil area.

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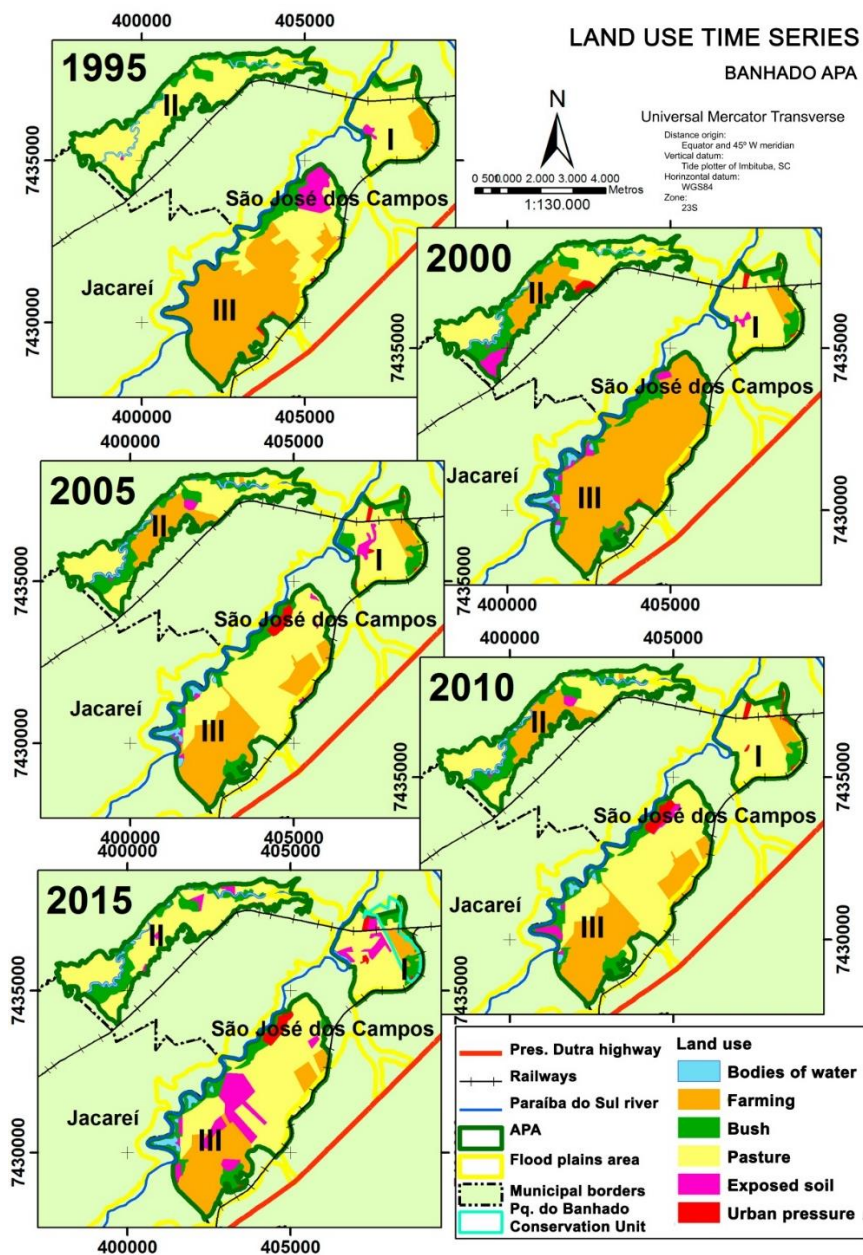


Figure 3. Mosaic of the five thematic maps with land use identification, time series (1995, 2000, 2005, 2010 and 2015).

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In the last mosaic of the year 2015, larger change situations were identified, probably due to the delimitation of the Banhado Municipal Park (2012), municipal Law no. 8756/12, of São José dos Campos. In perimeter III, the exposed soil has increased after a period of use as pasture in 2010, which has previously already replaced the farming use. Among the areas that showed the largest changes, between 2010 and 2015, is the farming area, with a reduction of 360.78 ha, giving place to other uses, mainly to exposed soil, which has increased by 234.35 ha, therefore without vegetation cover. On the other hand, the same perimeter has presented an increase of 10.85 ha in the water body class, which can possibly be based on the flood period seasons, caused by a possible increase in rainfall (CEPAGRI, 2015).

4. CONCLUSIONS

Between the years of 2000 to 2005, a significant reduction in farming areas took place in the perimeters, particularly in III of the APA, which remained practically unchanged until the year 2015. But, an increase in the urban pressure area was observed in perimeter III during 2005.

An evolution took place in the exposed soil thematic class during the year 2015, which can be partially explained by anthropogenic action, consisting in the use of land for pasture plantation, added to the water shortage occurred in the years 2014 and 2015 in the region.

The area mapped in this study was limited, as the zone subject to floods in the Paraíba do Sul river fluvial system, according to the geotechnical chart parameters for São José dos Campos (2010) supported by the Brazilian Geological Service, as a flood plain affected by annual or periodical droughts, meaning an area naturally susceptible to flooding. Presently, the large extension of this APA, as well as the flood plains along the river basins, represent a reserve capable of segmenting or mitigating natural risks or artificial accidents. If, on one hand, legal environment losses were ascertained, on the other hand the study has contributed to encourage additional research about the interest in facing the area as a natural resource that contributes to the water safety of the RMVPLN, mainly concerning sudden oscillations in the instantaneous meteorology conditions.

Based on the analysis of the results obtained from the land use interpretation in the APA Banhado the land activity interaction dynamics could be verified between the years of 1995 to 2015, among: pasture, farming, exposed soil and urban pressure.

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