

# **Geo-processing in identifying and locating potential conflicts of land use in areas of permanent preservation of the Monte Belo watershed, Botucatu (SP, Brazil)**

## **Geoprocessamento aplicado na identificação e localização potencial de conflitos de uso em áreas de preservação permanente na microbacia do córrego Monte Belo, Botucatu (SP, Brasil)**

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### **Abstract**

This work aimed to evaluate the potential of geo-processing in the identification and localization of potential conflicts of use over 1592 ha in permanent preservation areas (APPs) of the Monte Belo watershed - Botucatu (SP, Brazil) (22° 45' to 22° 48' S and 48° 15' to 48° 21' W), through the use of Geographical Information Systems (GIS) and digital satellite images, bands 3, 4 and 5 of Sensor TM of LANDSAT 5, of the orbit 220, point 76, quadrant A, passage of 23/10/2006. The results allowed verification that 62.78% of the area is occupied with reforestation and 37.22% is forest, and that only 2.65% of the area has been used inadequately with reforestation.

**Key words:** landscape evolution; watershed; remote sensing

### **Resumo**

Este trabalho teve como objetivo avaliar o geoprocessamento aplicado na identificação e localização potencial de conflitos de uso de 1592 ha em áreas de preservação permanentes (APPs) da microbacia do Córrego Monte Belo - Botucatu (SP, Brasil) (22° 45' a 22° 48' de latitude S e de 48° 15' a 48° 21' de longitude WGr.) através do uso de Sistema de Informações Geográficas e de imagem de satélite digital, bandas 3, 4 e 5 do Sensor TM, do Landsat 5, da órbita

220, ponto 76, quadrante A, passagem de 23.10.2006. Os resultados permitiram constatar que 62.78% da área é ocupada com reflorestamento e 37.22% é mata, e que somente 2.65% da área vem sendo usado inadequadamente com reflorestamento.

**Palabras clave:** Paisaje, aspectos fisiográficos, evolução paisagística; microbacia; sensoriamento remoto.

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## Introduction

The Permanent Preservation Areas (PPAs) have a key role to play within a watershed, as they are responsible for the maintenance, preservation and conservation of existing ecosystems (Magalhães & Ferreira, 2000). The PPAs must be permanently covered with the original vegetation, as vegetation cover attenuates the effects of erosion and leaching of the soil. The PPAs also contribute to the regulation of water flow, reducing the siltation of streams and reservoirs, bringing direct benefits to wildlife (Costa et al., 1996).

The monitoring of the PPAs has been a great technical and economical challenge, as the delimitation criteria based on the topography require the involvement of people with experience and detailed information regarding the spatial unit under consideration.

The characterization of land use and land cover yields a vast quantity of information regarding the area, which needs to be evaluated, integrated and stored. The geoprocessing is a technology used for the integration of various tools, data and programs (Rocha, 2000).

The present study aimed to use geotechnologies to map the land use and land cover, and conflicts between these in the PPAs in the watershed Monte Belo - Botucatu (SP, Brasil).

## Materials and methods

The watershed of Monte Belo (1592 ha), located in the Municipality of Botucatu São Paulo (48° 21' W, 48° 15' W, 22° 48' S & 22° 45' S, 18°C a 22°C, 440 - 620 m.a.s.l., humid subtropical climate).

The interpretation of the types of land use and cover was conducted based on the digital satellite images, bands 3, 4 & 5 of Sensor TM, of Landsat 5, of the orbit 220,

point 76, quadrant A, passage of 23.10.2006, using the method of screen classification.

The images were georeferenced in ENVI 4.2, and the control points used were obtained from planimetric maps. Subsequently, they were exported to IDRISI where RGB compositions were made for each one of the datasets. These compositions were converted to BMP using CartaLinx, to subsequently interpret them.

Having identified the different classes of land use and cover, the vectorized polygons were exported to ArcView 3.2 for the preparation of the final map, and area quantification. Initially, using the software Arc View 3.2, geo-referencing was performed, using the topographic map of Botucatu, scale 1:50000 and a GPS (Global Positioning System) for data collection in the field.

The delimitation of the area of the digital image was performed according to the geographical boundaries of the area using the software Arcview. Mapping was then performed on screen according to the analysis standards, based on the principles such as color, tonality, texture, shape, grouping, size (elements used in photo interpretation), and shade.

The PPAs were defined along the water courses of the stream Monte Belo, using the operation *Buffer Selected Features* of the software ArcView 3.2, which provided a buffer area of 50m radius of the springs, and a buffer of 30 m along each side of the drainage along the stream bed (Art.3º resolution Conama no. 303/2002, Forest Law, Law 4771-1965).

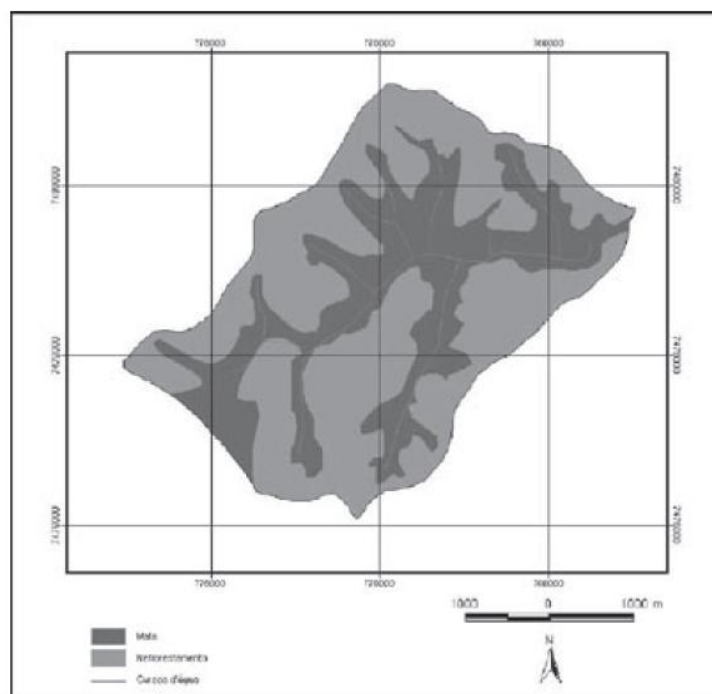
The mapping and quantification of land use conflicts in PPA areas were performed using map algebra. The procedures were performed in the environment of *Raster Calculator* of the *Spatial Analyst* module of ArcGIS.

## **Results and discussion**

The land use in the watershed of the stream Monte Belo - Botucatu (SP) shows that planted forests prevailed in more than 60% of the area in 2006 (Figure 1 and Table 1). This class of land use is occurring because of the predominance of fertile soils and the easy mechanization in these areas (Barros et al., 1987).

The forests, important elements in environmental preservation, represented over 35% of the area. These classes were mainly comprised of riparian forests, and the forests themselves. The riparian, or gallery forests consist of forest located along the drainage network, comprising closed corridors. According to the forest law, the

minimum forest area must be 20%. These data allow us to infer that the watershed has been environmentally preserved, due to the high percentage of riparian vegetation present (37.22%). The riparian forest protects the soil against the direct impact of raindrops, reducing the velocity of runoff, and promoting water infiltration into the soil (Silveira et al., 2005).



**Figura 1.** Uso e cobertura do solo da microbacia do córrego Monte Belo – Botucatu (SP), em 2006.

Figure 1. Land use and cover in the watershed of Monte Belo – Botucatu (SP), in 2006

**Tabela 1.** Classes de uso do solo e conflito de uso em áreas de preservação permanentes (APP's) da microbacia do córrego Monte Belo – Botucatu (SP), em 2006.

Classes de uso da terra	Área			
	Microbacia		Conflito	
	ha	%	ha	%
Mata	592.23	37.22	98.50	97.35%
Reflorestamento	998.92	62.78	2.68	2.65%
Total	1591.15	100	101.18	100%

Table 1. Classes of land use and conflict of use in the permanent preservation areas (PPAs) in the watershed of the stream Monte Belo – Botucatu (SP), in 2006.

The map of land use conflict in the PPAs shows that in the buffer zone conflicted use occupies 7065 m<sup>2</sup>, representing approximately 0.05% of the surface of the watershed, while along the drainage network, it occupies 6.74% (100.48 ha) of the total area of the watershed.

Over time, the change in vegetation cover has been occurring dynamically in the watershed, with the region experiencing sensitive changes in landscapes in recent years, mainly characterized by the expansion of forestry plantations.

The PPAs represent 6.78% of the area of the watershed. The area of the PPA identified along the length of the drainage network was 101.18 ha, with only 2.65% of the area of the PPA occupied by inadequate reforestation (conflict). Thus, 97.35% of the PPA area had been adequately used, demonstrating that the watershed is environmentally conserved according to current Brazilian Forest Law (1965).

This study analyzed the conflict in land use in the PPAs only along the drainage network of the watershed, not considering the other areas of the PPA as the watershed has been environmentally conserved, as shown in the distribution of land use types in Figure 1.

## **Conclusions**

This study, that was carried out in the watershed of the stream of Monte Belo - Botucatu (SP) showed that the inadequate land use in Permanent Preservation Areas was considerably low, as inadequate anthropogenic use reached only 2.65% of the PPA area. Land use maps can serve as a tool for law enforcement by public bodies, to identify and locate the areas of conflict in land use. The use of remote sensing technologies employing products from the Landsat orbital, proved to be efficient; the definition of land use, the integration of geo-referenced data within a database, proved to be a fundamental tool for planning land use in a small watershed, and in compliance with environmental legislation, especially in the PPA areas. The geographical information system ArcView 3.2 was efficient in the discrimination of classes of land use, showing that 62.78% of the area was occupied with reforestation and that 37.22% was covered with forest and that the area of the PPA of the watershed was 101.18 ha, where only 2.65% was being used inadequately (in conflict) by reforestation.

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## **References**

Barros, Z. X. de; Cardoso, L. G.; & Targa, L. A. 1987. Utilização de fotografias aéreas em ocupação do solo por cobertura vegetal.. En: Congresso Brasileiro de Engenharia Agrícola. 16, Jundiaí, Brasil, SBEA, 1987. p. 598 – 603.

Conama (Brasília, DF). 2002. Resolução No. 303, de 20 de março. Diário Oficial [da República Federativa do Brasil], Brasília, 13th May.

Costa, T. C. C.; Souza, M.G.; & Brites, R.S. 1996. Delimitação e caracterização de áreas de preservação permanente, por meio de um sistema de informações geográficas. En: Simpósio Brasileiro de Sensoriamento Remoto, 7, Salvador, Brasil, INPE, 1996. Anais... p. 121 – 127.

Law 4771 of 15<sup>th</sup> September, establishing the new Forest Law Brazil.

Magalhães, C.S.& Ferreira, R.M. 2000. áreas de preservação permanente em uma microbacia. Informe Agropecuário, Belo Horizonte. 21(207):33-39.

Rocha, C. H. B. 2000. Geoprocessamento: tecnologia transdisciplinar. Juiz de Fora, MG: Ed. do Autor. 220 p.

Silveira, E. M. O.; Carvalho, L. M. T.; & Silva, A. M. 2005. Uso conflitivo do solo nas áreas de preservação permanente no município de Bocaina de Minas/MG. En: Simpósio Brasileiro de Sensoriamento Remoto, Goiânia - GO. Anais... São José dos Campos: INPE.

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