*This article is presented in Portuguese and English with "resumen" in Spanish.*
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***Scientific paper***

# Soil cover and determination of conflicts in the drainage network of the Lageado and Edgardia farms in Botucatu – SP, obtained from aerial photography

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## Abstract

This study aimed to discriminate, map and quantify areas of land occupation, as well as identify possible areas of conflicting land use in Permanent Preservation Areas (PPA) which occur in the Edgardia and Lageado Farms - Botucatu (SP). We used color aerial photos of 2005, taking as a tool for assessing the Geographical Information System - IDRISI Andes 15.0. A total of 140.91 ha which should be the permanent preservation area, 24.94% is occupied by pastures, agriculture and other uses. The permanent preservation area (140.91 ha) is occupied by pastures, agriculture and other uses (24.94% h) and the remainder by riparian woods and wetlands with fragmented occupation. The Lageado and Edgardia Farms, in 2005, were prevalently occupied by riparian woods, showing recovery in relation to 1962, followed by agriculture, and other occupations, grasslands and wetlands, respectively. The aerial photographs linked to the GIS-Idrisi proved to be powerful tools in mapping the area and monitoring of environmental impacts.

**Keywords:** permanent preservation area, geoprocessing, remote sensing.

## Introduction

The compromise of the water sources and springs, in quantity and quality, is associated to the human actions which almost always does not respect the capacity of support of the nature. MARTINS (2008) emphasizes that the presence of APPs implies in the legal impediment of human actions which compromise the sustainable exploitation of the natural resources.

According to the Brazilian Forestry Code, areas close to rivers, lagoons, sources and hilltops, whose function is to preserve the water resources, the landscape, the ecological stability, the biodiversity, the gene flow of the fauna and flora, to protect the soil and ensure the well-being of the human populations are considered Permanent Preservation Areas (APP).

The Brazilian Forestry Code (Law 4.771/65), which instituted the APPs, is already 45 years old from the moment of its enactment, and the population is still unaware of it, or interprets it without the proper knowledge. The APPs were created to protect the natural environment, and it is not allowed in them any change of land use. By the law, they must be covered with the original vegetation. According to COSTA et al. (1996) the vegetal cover in these areas will mitigate the erosive effects and the soil leaching, contributing also for the regularization of the water flow, reduction of

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the silting up of the water courses and reservoirs, bringing benefit directly to the fauna.

POLITANO et al. (1989) remember that the activities of soil use and management, protection of the sources, control of the rainfall water, stabilization of the ramps or slopes, infra-structure and road systems must be elaborated in accordance with the characteristics of the basin in which it will be implanted. This characterization involves its delimitation, identification and the map of the compounds, as: relief, hydrography, geology, soil, vegetation, erosion, slope class, among others.

The sustainable management of the agroecosystems needs the planning of their use, with use of concepts introduced for the approach of the environmental complexity, with evaluation of the problems considering all their interdependent aspects: geology, soils, vegetation, climate, current use, hydrology and anthropic aspects (SANTOS, 1996).

For NASCIMENTO et al. (2005), the monitoring of the permanent preservation areas has been a great challenge under the technical and economical aspect, since the criteria of delimitation based on the topography demand the involvement of specialized people and of detailed information in the spatial unit which is being analyzed. However, with the development of sophisticated algorithms and their incorporation to the set of functions of the Geographic Information Systems (GIS), it has been possible the fast and efficient processing of the data needed to the characterization of the morphometric variables of the land, essential to the analysis of the anthropic interventions in basins (OLIVEIRA, 2002).

For RODRIGUES (2000), the analysis of soil use and cover, through the information obtained by remote sensing, it of great use to the planning and administration of the ordered and rational occupation of the physical mean, besides it enables to evaluate and monitor the preservation of areas of natural vegetation. According to the author, the remote sensing is a tool of great value to aid man in the characterization of the physical, biotic mean and of areas submitted to the process of anthropism.

The present study has as objective to discriminate, map, quantify areas of soil occupation and also to verify possible areas of conflict of use of soil in APP which occur in Lageado and Edgardia Farms – Municipality of Botucatu (SP), in 2005, obtained of color aerial photographs and evaluated trough the applicative Carta Linx and the SIG-Idrisi.

## Material and methods

The area of study covers the Lageado and Edgardia Farms, which are property of UNESP located in the Municipality of Botucatu, Mid West region of the State of São Paulo, according to Figure 1. This area is locate between the geographic coordinates 22o 47′ 10″ to 22o 52′ 38″ of S latitude and 48o 22′ 07″ to 48o 26′ 38″ of W longitude.

The municipality of Botucatu is located in the center region of the State of São Paulo, and occupies an area of 1522 km2, with distance in a straight line from the state capital of 200 km and from the federal capital, 898 km. Botucatu is the 4th municipality of the state in territory area.

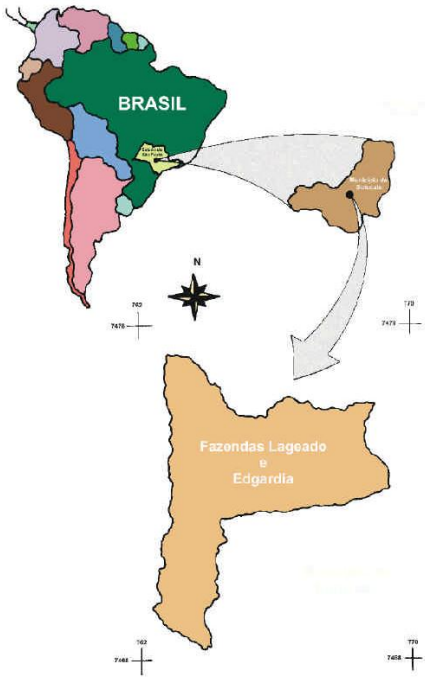


**Figure 1.** Localization of the studied area in the state of São Paulo.

For the determination of the limit of the study area, it was used planialtimetric maps in the scale 1:50000, with vertical equidistance between level curves of 20 m, edited by the Instituto Brasileiro de Geografia e Estatística (IBGE - Brazilian Institute for Geography and Statistics), in 1969, sheet of Botucatu (SF-22-R-IV-3).

In the map of soil use and cover, it was used color aerial photographs of the municipality of Botucatu referent to the year 2005, with approximated nominal scale of 1:30000 and longitudinal recover of approximately 60% and 30% of lateral.

The stereoscopic observation of the pairs of aerial photography was performed with aid of the stereoscope of mirror bland Wild, model ST-4 and the transference of the elements of interest detached from the photos for the base map was effected with aid of the Aerosketchmaster Carl Zeiss, Yena. For the input of the information referent to the limit, the drainage net and the springs, it was used the scanner of the printer HP Photosmart C4480.

For the obtaining of the map of the studied drainage net, it was made, initially, a montage of all the set of aerial photographs correspondent to the study area, and it was traced flight lines and the delimitation of the useful area, according to COELHO (1972); and with aid of stereoscopy it was detached, in polyester film Terkron D-50 mícrons, the elements of interest.

In the development of the work, it was used a notebook HP with processor AMD Turion TM X2 Ultra Dual Core; 3.0 GB of RAM memory; winchester of 250 GB; with operation system Windows Vista © 2005 Microsoft Corporation.

Later, it was performed the georeference in the SIG-Idrisi, and the control points were obtained from the planialtimetric map. Next, the georeferenced file was exported for the applicative CartaLinx for the vectorization of the areas, which was send to SIG-Idrisi, Andes, in which the vector file was converted in raster and the map of the APPs was obtained, in which it was performed an "overlay" on the map of use and soil cover with the map of the APPs for the determination of the areas of conflict, in SIG-Idrisi, from a buffer of 50 m of ratio in the source settlings and ponds and 30 m along the water courses (Resolution CONAMA 303/2002, article n.3 - Constituição de Áreas de Preservação Permanentes[1]). Later, it was quantified the conflict area with the concerned use (Table 2 and Figure 3).

## Results and discussion

When analyzing Table 2 and Figure 2, which are result of the photointerpretation and restitution of the color aerial photographs referent to the year 2005, it was possible to determine five features in the soil surface: riparian area, varzeas, pasture, crops and other.

**Table 1.** Distribution of the absolute area in ha and in % of the soil occupation mapped in Lageado and Edgardia Farms, 2005.

| Soil occupation | Área | |
|---|---|---|
| | ha | % |
| **Riparian area** | 1219.39 | 57.00 |
| **Varzea** | 125.57 | 5.87 |
| **Agricultural crops** | 342.92 | 16.03 |
| **Pasture** | 215.21 | 10.06 |
| **Other uses** | 236.17 | 11.04 |
| **Total** | 2139.26 | 100 |

[1] *Constitution of Permanent Preservation Area*

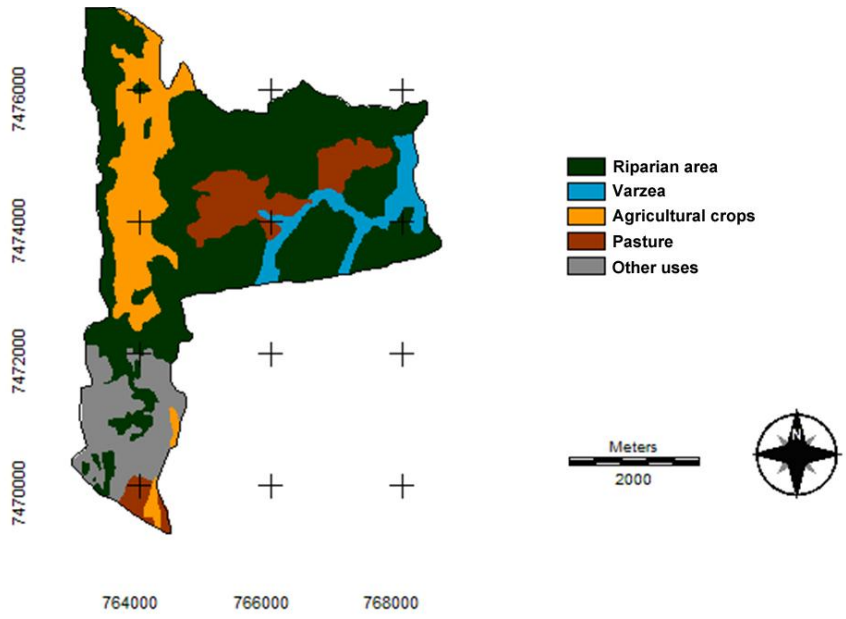


**Figure 2.** Map of soil use and cover of Lageado and Edgardia Farms, Botucatu – SP, 2005**.**

The soil occupation defined as pasture located predominantly in the center portion of Lageado and Edgardia Farms represents 215.21 ha, corresponding to 10.06% of the total area. This area presented a reduction when compared to the year 1962, which represented 345.25 ha of the total area of the farms (DEGANUTTI, 2000).

Still, it can be verified also that the area destined to the crops represents 342.92 ha (16,03%). This fact is justified since the study area is an Experimental Farm (Table 1). This area presented a small reduction when compared to the year 1962, when it represented 380.83 of the total area (DEGANUTTI, 2000); considering that in this period, most part of the agricultural cultures were referent to the coffee crop, today these areas were substituted by corn and soybean crops, predominantly.

The south portion of the area, occupied by other uses, with less expression, grouped for being hard to separate, represent 236.17 ha (11,04%), according to what can be verified in Table 1. According to data by DEGANUTTI (2000), in the year 1962, this region of Lageado and Edgardia Farms were occupied predominantly by clean field, coffee and eucalyptus.

Riparian forests represent important emphasis in the occupation of the soil of the study area (Figure 2), representing 1219.39 ha, which mean 57% of the area of the Experimental Farms (Table 1), being the main occupation of the referred area. It is important to emphasize that in 1962, the area occupied by riparian areas represented 607.58 ha (DEGANUTTI, 2000), which represents an improvement of approximately 50% of this use, showing recovery of the natural vegetation, in function of the awareness about the importance of the riparian areas, increase of the supervision and appearance of new technologies.

It may be seen that the feature named varzea (Figure 2) is noteworthy in the environmental view point and in the case of Egardia Farm it is particularly important due to the cultivation of rice by controlled flooding, cultivation method of high technology, obtaining high productivity. This feature occupies an area of 125.57 ha, representing 5.87% of the total area studied (Table 1). In 1962, the vegetation of varzea in Lageado and

Edgardia Farms represented a total of 119.49 ha (DEGANUTTI, 2000), with small change in this occupation.

The color aerial photographs provide the map of the riparian areas, varzeas, pasture, agricultural areas and other uses which exist with the studied nets of drainage studied. The quantification of these occupations in hectares and percentage as well as the areas of conflict of use in APP can be seen in Table 2.

Riparian areas, as well as varzeas, present great importance in the balance and maintenance of the environmental quality, occupations that are regulated as areas of permanent preservation, by the Law CONAMA no 303 de 20/03/2002, representing 75.36 ha (53.48%) and 30.41 ha (21.58%), respectively in the area considered APP, according to Table 2. Values important in relation to the total area of APP (140.91 ha), since the riparian areas have important role in the protection of the sources against the sediments carried from the harvests and the varzeas function as filter for the waters which supply the rivers and dams which provide water for the different kinds of consumption.

These totals analyzed both in the riparian area and varzeas present in a fragmented way according to the Figure 3, providing with this areas along the river have no vegetal cover that is
so important for the balance of the biodiversity and regulation of the flow of water mainly in the period of lack of rainfall.

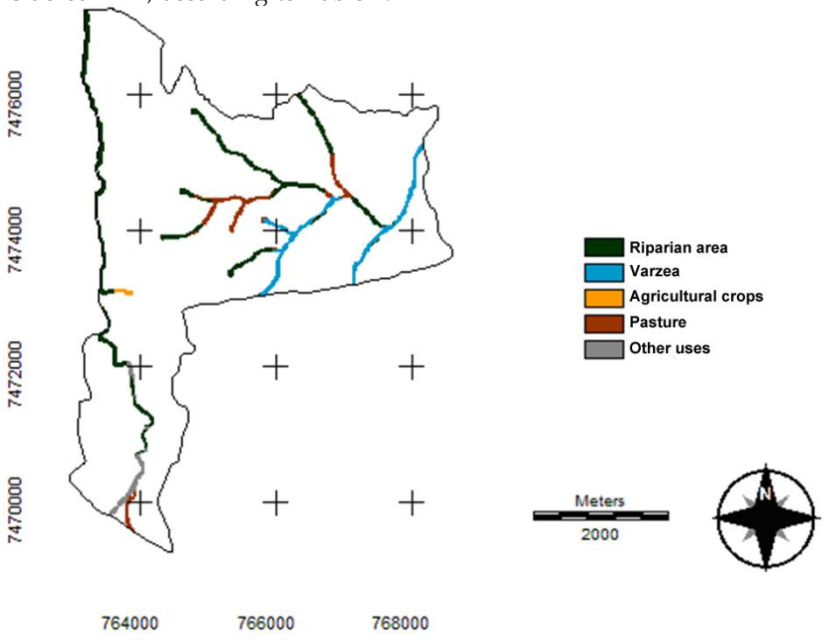


**Figure 3.** Map of conflict of the use of soil in the APP of Lageado and Edgardia, Botucatu – SP, 2005.

The area of APP studied present 75.06 % of occupation coherent with the values demanded by law, despite this kind of occupation is very fragmented along the drainage net studied.

The areas of permanent preservation bounded along the drainage net be a total of 140.91 ha and the area of conflict in use in APP, presented 35.14 ha, representing 24.94% of a total of APP, being this conflict represented almost in their total by pasture 22.64 ha (16.07%), other uses 10.69 ha (7.59%) and one small area represented by agricultural area (crops), 1.81 ha (1.28%) according to what was observed in the aerial photographs used for the determination of the drainage net (Table 2).

The south and center part of the studied area, more degraded, presents wide areas of

permanent preservation being used by pasture, agricultural areas and other uses, as buildings, parking lots, lakes, etc., which denounces a situation of alert concerning the law and the environment, while the west part of the Lageado and Edgardia, more well preserved, presents areas occupied by riparian areas.

**Table 2.** Total area in hectares and percentage relative of the soil occupations and areas of conflict in APP, in the studied drainage net.

| Class of land use | APP area | | Conflict area in APP | |
|---|---|---|---|---|
| | ha | % | ha | % |
| **Riparian area** | 75.36 | 53.48 | - | - |
| **Varzea** | 30.41 | 21.58 | - | - |
| **Agricultural crops** | - | - | 1.81 | 1.28 |
| **Pasture** | - | - | 22.64 | 16.07 |
| **Other uses** | - | - | 10.69 | 7.59 |
| **Total** | 105.77 | 75.06 | 35.14 | 24.94 |

## Conclusions

In a total of 140.91 ha that should be the area of permanent preservation, 24.94% is being occupied by pastures, agricultural areas and other uses; the areas occupied by riparian areas and varzeas represent 75.06% of the APP, being this occupation fragmented.

Lageado and Edgardia Farms, in the year 2005, were occupied in a predominant way by riparian Forest, showing their recovery in relation to the year 1962, followed by agricultural crops, other occupations, pastures and varzeas, respectively.

The aerial photographs associated to the SIG-Idrisi were efficient tools in the mapping of the area and the future studies of the area.

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