Spatialization of the land use in the watershed Ribeirão Descalvado, Botucatu SP, in the period of 35 years

Sérgio Campos, Ana Paula Barbosa, Leandro Moreira Manzano, Joice Jardim, Natália Sousa Ceragioli, Shahine Paccola Gonçalves

Abstract

The cover vegetation of the soil has undergone constant modifications by humans. In this context, this research was carried out to complete the inventory of land use in the watershed Ribeirão Descalvado, Botucatu, SP, during the period of 35 years in digital satellite image, bands 3, 4 and 5 of the TM sensor of LANDSAT 5, orbit 220, point 76, quadrant A, passing from June 08th 1997 and vertical aerial photographs from 1962, scale 1:25000. The study area lies between the geographical coordinates 22º 50 '05 " to 22º 54' 26" S latitude and the 48º 22 '29 " to 48º 26' 36" W longitude Gr., presenting an area of 2.136, 25ha. The land cover presented the following results in 1962: reforestation - 219.13 ha, agricultural use - 17ha, pastures - 916.51 ha, poultry - 841.36 ha, exposed soil - 36.3 ha and forest - 105.95 ha, and in 1997: reforestation - 24.93 ha agricultural use - 993.33 ha, pastures - 530.64 ha; exposed soil - 2.74 ha, poultry - 281.21 ha and forest - 303.4 ha. The results found that there was a significant increase in the areas of agricultural use at the expense of reducing the areas of forestry, pasture and poultry, mainly. The images of LANDSAT 5 satellite provided an excellent database for the supervised classification, future planning and management of agricultural activities. The Geographical Information System IDRISI was efficient in the discrimination of the use and occupancy of land, showing that the use of tools in geoprocessing facilitates and expedites the linking work of data, allowing the storage of digital data that could be used to further analysis.

Key words: cover vegetation, satellite image, aerial photographs.

Introduction

The vegetation has undergone constant changes over the years because of the action of humans, being more intense this dynamic in better soil fertility and ecological conditions for an agricultural operation.

The poor soils, due to the increase of population density and the improvement of agronomic techniques, have been undergoing changes, being the cerrado, cerradões and the fields replaced by silvicultural activities, as reported Borgonovi e Chiarini (1965).

In the region of Botucatu, SP, areas of forest with favorable climate and topography only present traces of the original vegetation cover, while the closed are gradually reducing with the use of their areas, especially with crops of high economic return, such as sugar cane.

The region has suffered predatory holdings and poor land use, increased mainly due to inadequate methods and lack of land use planning, causing sedimentation process of rivers and reservoirs.

The knowledge of soil occupation in their nature, location, manner of occurrence and changes in certain periods is of great value to the programming of activities to the development of agricultural, economic and social area, according to Politano et al. (1980).

The study of the current land use, necessary for planning purposes, can be obtained from the use of multispectral data, provided by satellite remote sensing and associated to interpretation techniques (PEREIRA et al., 1989). According to Freitas Filho (1993) the advantages of using remote sensing data in surveys of current land use, are reaching areas of difficult access and do the imaging at high altitudes, providing an overview of the land surface, with repeatability and viability of tracking stock.

Santos et al. (1993) comment that the use of satellite imagery, as a base map, is very promising due to its relatively low cost, high frequency and delivery of important information of land use change. Crósta (1992) says that in supervised classification is necessary that the user has prior knowledge of the area to be classified. This area can be used as a standard of comparison, to which all the unknown pixels of the image will be compared to decide which class they belong. The area of the image that the user identifies as a representative of a class is called area of training. To expedite the processing of these data and integrate them with other information such as cartographic, cadastral, etc., it can be use a Geographic

Information System (GIS) that allows even to create a database generated over time, enabling monitoring and analysis time of the study area.

In this context, this research aimed to complete the inventory of land use in the watershed Ribeirão Descalvado, Botucatu, SP, in the period of 35 years.

Material and methods

The watershed of Ribeirão Descalvado, located in the city of Botucatu, SP, is of great importance for the region because it is a genuinely Botucatu's basin which rises and flows into the city, and contain most of the urban area. The watershed is located between the geographic coordinates 48º 22' 29" to 48º 26'36"W longitude GR., 22º 50'05" to 22º 54'26" S latitude, showing a total area of 2,136.25 ha. The prevailing climate in the city, classified according to Köppen system, is Cfa (temperate rainy) and the predominant wind direction is the southeast (SE). The average temperature in the region is 20.2º C, the average temperature at the warmest months of 23.2 ºC, and the coldest months of 16.9 ºC. The average annual precipitation is around 1.447mm, with an average rainfall in the rainy month is 223.4 mm and in the dryer month is 37.8 mm. According to Oliveira et al. (1999), the soils in the watershed are: Nitossolo Vermelho (NV), Latossolo Vermelho Amarelo (LVA) and Argissolo Vermelho Amarelo (PVA). In order to obtain the map of cover crops in 1962, there was, initially, an assembly of the full range of vertical aerial photographs from the São Paulo State, held in 1962, with nominal scale of approximately 1:25000 with longitudinal covering approximately 60% and 30% in lateral, corresponding to the area of the watershed Ribeirão Descalvado to obtain a general view of the area, and then being traced the flight line and the actual demarcation of the area, according to Coelho (1972). Then, with the aid of stereoscopy, pounce on it Terkron D polyester film of 50 microns, the areas of vegetation covers, the objects of this study.

In order to identify the land coverage, it was followed the criteria of general and agricultural photointerpretation described by Ricci e Petri (1965), Marchetti e Garcia (1977) and Piety (1983), and the areas covered with reforestation, agricultural use, grazing, poultry, forest and others, in 1962, assessed through the Software SPLAN, digital planimetry system (SILVA et al., 1993).

In order to obtain the map cover of crops in 1997, it was originally drafted a false color composition with a combination of bands 3, 4 and 5, as this provides a good visual discrimination of the targets, allowing the identification of patterns of land use in a logical way. This composition provides the water bodies in blue tones, forests and other vegetation in green tones, and the soil exposed in red tones. Then there was the geoprocessing of false color composition, using for this the module Reformats/Resample from the GIS - IDRISI, and the control points obtained in the planialtimetric maps. Subsequently, it was cut, extracting only the area of the Ribeirão Descalvado watershed and it drew attention to the areas of training on the image with the cursor and mouse in a number of places, looking up cover all variations of each soil occupation. The signatures were created by the module *Makesig* and supervised classification itself, the method of Maximum Likelihood through the module *Maxlike*. In this, the land use was identified and differentiated according to their pattern of spectral response, and the training areas defined by polygons drawn on each land use in the image. Then, it was stated the names for each class of land use, linked to their identities, and the image was classified based on these data. The digital identification of the targets was based in the key of interpretation for images (Rocha, 1986). The areas were measured with the aid of the software GIS-IDRISI, using the command "area" from the "*Database Query*" menu, belonging to the module "*Analysis*".

Results and discussion

The results (Figures 1 and 2 and Table 1) show that areas with agricultural use have been occupying almost half of the watershed area (46.5%). The vegetation cover has a significant expansion in the period (5.843,12%), at the expense of reducing the areas of pasture, scrub, forest and reforestation.

During this period, the pasture decreased 42.1%, it decreased from 916.51 ha (42.9%) in 1962 to 530.64 ha (24.84%) in 1997. These uses of the land usually occupy the middle relief, probably because

Figure 1. Land use of the Ribeirão Descalvado watershed, Botucatu (SP) obtained from vertical aerial photographs (1962).

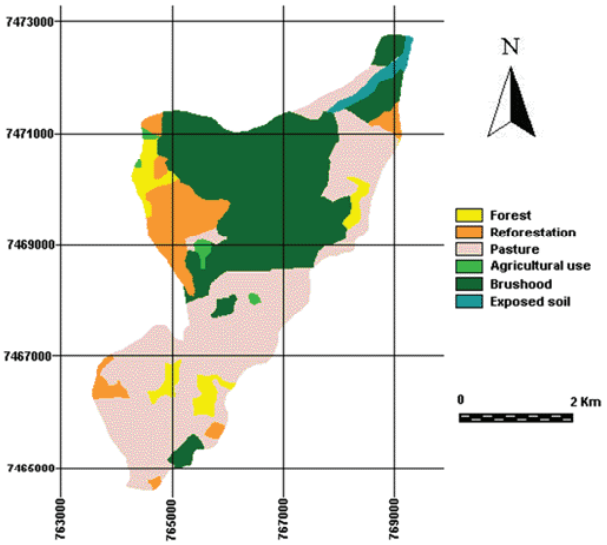

Figure 2. Land use of the Ribeirão Descalvado watershed, Botucatu (SP) obtained by Geographical Information System IDRISI (1997).

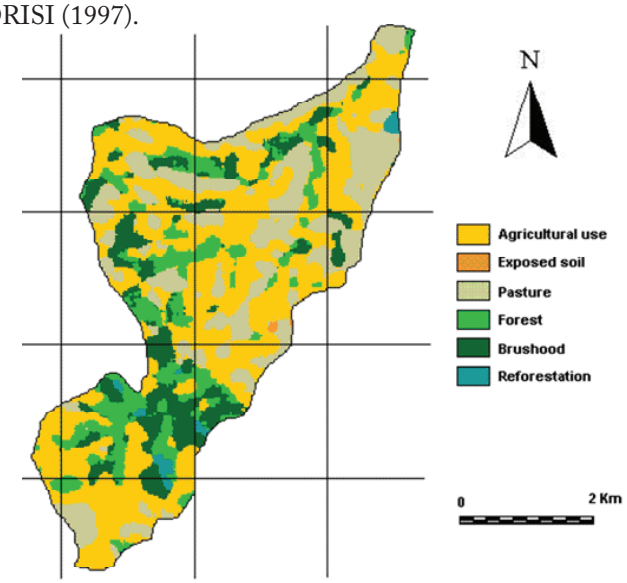

Table 1. Land use of the Ribeirão Descalvado watershed, Botucatu (SP) obtained from vertical aerial photographs (1962) and satellite image (1997).

Classes of the land use	Land use				% of reduction (R) or extension (E)
	1962		1997		
	ha	%	ha	%	
Forestry	219,13	10,26	24,93	1,17	88,63 (R)
Agricultural Use	17,00	0,80	993,33	46,50	5843,12 (E)
Pastures	916,51	42,90	530,64	24,84	42,10 (E)
Poultry	841,36	39,38	281,21	13,16	66,58 (E)
Forest	105,95	4,96	303,40	14,20	286,36 (E)
Exposed soil	36,30	1,70	2,74	0,13	92,45 (E)
Total	2136,25	100	2136,25	100	

the conditions for agricultural activity in these areas are less favorable, reflecting thus the predominance of soils with low fertility.

The forest area had increased in this period about 286.36%, it had increased from 105.95 ha (4.96%) in 1962 to 303.4 ha (14.2%) in 1997. The forests, barns and pastures represent more than 50% of the watershed area, reflecting the predominance of low soil fertility, as Barros et al. (1990) and Campos (1993). The reforestation also has reduced by 88.62% because there are many reforestation companies. The cover vegetation, which represents 1.17% of the watershed is effective in protecting the network of drainage in areas with erosion processes, it also has great influence on the hydrological system, delaying and diverting the runoff and, consequently, the erosive process (Vieira, 1978), attending the economic needs in the replacement of dropping natural forest that are not prevented and whose regeneration is slow. Therefore, the changes in vegetation cover in the watershed occurred dynamically over time and the region suffering sensitive changes in landscapes in these 35 years, characterized by agricultural expansion that has occurred through areas with agricultural use.

Conclusions

The results indicated that the watershed of Ribeirão Descalvado, Botucatu, SP, presented a significant increase in the agricultural use area and forest mainly at reduction the expense of areas of pasture, forestry and poultry. The watershed has been preserved in the environment, as it stands covered with almost 1/3 of forest cover in the type of poultry, and the minimum required by law is 20%. The high rate of land use of settlements with pastures, barns and woods reflect the predominance of sandy soils with low fertility and the presence of more than 70% for agricultural use and pasture, which shows the dominance of regional agriculture. The results presented that the data collected by the TM-Landsat generated valuable information on different targets of use and occupancy of land being very useful for mapping, which was used as the database. The Geographical Information System IDRISI was effective and fast in differentiation, mapping and quantification of land uses.

References

BARROS, Z.X. de, PIEDADE, G.C.R., CURI, P.R. Variáveis de ocupação do solo e análise multivariada. **Revista Geográfica**, São Paulo, n.8/9, 1990.

BORGONOVI, M.; CHIARINI, J.V. Cobertura vegetal do Estado de São Paulo. I - Levantamento por fotointerpretação de áreas cobertas com cerrado, cerradão e campos em 1962. **Bragantia**, Campinas, v.24, n.12, p.159-72, 1965.

CAMPOS, S. **Fotointerpretação da ocupação do solo e suas influências sobre a rede de drenagem da bacia do rio Capivara - Botucatu (SP), no período de 1962 a 1977**. 1993. 164f. Tese (Doutorado em Energia na Agricultura) - Faculdade de Ciências Agronômicas, Universidade Estadual Paulista.

COELHO, A.G. de S. Obtenção de dados quantitativos de fotografias aéreas verticais. **Aerofotogrametria**, São Paulo, v.8, p.1-23, 1972.

CRÓSTA, A.P. **Processamento digital de imagens de sensoriamento remoto**. Campinas: UNICAMP, 1992. 170p.

FREITAS FILHO, M.R.; MEDEIROS, J.S. Análise multitemporal da cobertura vegetal em parte da Chapada do Araripe- CE, utilizando técnicas de Sensoriamento Remoto e Geoprocessamento. In: SIMPÓSIO BRASILEIRO DE SENSORIAMENTO REMOTO, 7, São José dos Campos, 1993. **Anais...** São José dos Campos, INPE, 1993. p.73-80.

MARCHETTI, D. A.B., GARCIA, G.J. **Princípios de fotogrametria e fotointerpretação.** São Paulo: Nobel, 1977. 257p.

OLIVEIRA, J. B. de; CAMARGO, M. N. de; ROSSI, M., CALDERANO FILHO, B. **Mapa Pedológico do Estado de São Paulo**. 1999. 1:500.000. Empresa Brasileira de Pesquisa Agropecuária/Embrapa Solos/ Ministério da Agricultura e do Abastecimento.

PEREIRA, M. N.; KURKDJIAN,M. L. N. O DE; FORESTI, C. **Cobertura e uso da terra através de Sensoriamento Remoto.** São José dos Campos: Instituto Nacional de Pesquisas Espaciais, 1989. 118p.

PIEDADE, G.C.R. **Noções de fotogrametria e fotointerpretação.** Botucatu: Faculdade de Ciências Agronômicas, 1983. 44p.

POLITANO, W.; CORSINI, P.C., VASQUES, J.G. Ocupação do solo no município de Jaboticabal - SP. **Científica**, São Paulo - SP, v.8,n.1/2, p.27-34,1980.

RICCI, M., PETRI, S. **Princípios de aerofotogrametria e interpretação geológica**. São Paulo: Cia Editora Nacional, 1965. 226p.

ROCHA, J.S.M. da. **Manual de interpretação de aerofotogramas.** Fascículo XI, Santa Maria, 1986, 58p.

SANTOS, M.L.M., MATTOS, M.M., PIRES, I.O., BROWN, I.F., ASSIS, W.S. Utilização de imagens de satélite no mapeamento preliminar do uso da terra e na capacitação de agricultores do médio Rio Capim-Paragominas-PA. Brasil. In: SIMPÓSIO BRASILEIRO DE SENSORIAMENTO REMOTO, 7, São José dos Campos, 1993. **Anais...** São José dos Campos, INPE, 1993. 15p.

SILVA, C.M., CATANEO, A., CARDOSO, L.G. Sistema de planimetria digitalizada. In: JORNADA CIENTÍFICA DA ASSOCIAÇÃO DOS DOCENTES, 18, Botucatu, 1993. **Anais**... Botucatu, Jornada Científica, 1993, p.109.

VIEIRA, N.M. **Estudo geomorfológico das voçorocas de Franca, SP**. 1978. 255p. Tese (Doutorado em História) - Instituto de História e Serviço Social, Universidade Estadual Paulista, Franca (SP).