(DOI): 10.5777/PAeT.V4.N1.02

This article is presented in Portuguese and English with “resumen“ in Spanish.

Brazilian Journal of Applied Technology for Agricultural Science, v. 4, n.1, p. 31-44, 2011.

Scientific paper

Geoprocessing in the generation of thematic maps aiming at environmental planning

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Abstract

The rising of the soil use in a certain area is fundamental for the understanding of the organization patterns of that determined space. The present work had as objective to evaluate the applied geoprocessing in the generation of thematic maps aiming at environmental planning, through the Geographical Information System Idrisi Andes 15.0. The Stream Comur watershed is placed in the municipality of Botucatu (SP) and among the geographical coordinates: latitude 22º 44’ 42” to 22º 48’ 12” S and longitudes 48º 23’ 04” to 48º 25’ 54” W Gr, with an area of 1458.4 ha. The results enabled to infer that the slope classes from 0 to 3% and from 3 to 6% which exist in the watershed represent more than 67% of the area and the one from 0 to 20% prevailed in more than 80% of the watershed. The areas with relief smoothly wavy (3 to 6%) they were the most representative (36.92%). the unit of soil Latossolo Vermelho Distroférrico happened in more than 45% of the area. The GIS was an excellent and indispensable tool, because it facilitates and it activates the obtaining of the data, besides enabling its storage, which can be used for other analyses in future geoenvironmental planning.

Key words: slope classes; watershed; geoprocessing.

Introduction

The analysis of soil use and cover, trough Remote Sensing information, is a technique of great utility to the planning and administration of the ordered and rational occupation of the physical mean, besides enabling the evaluation and monitoring the preservation of areas with natural vegetation (RODRÍGUEZ, 2000).

The study of the land use in a certain region covers the physical characteristics, fundamental for the comprehension of the organization patterns of that determined space. Thus, there is a necessity of promoting the constant update of the registers of land use, in order to avoid the disordered growth without technique and the appropriate rational management (DELMANTO Jr., 2003).

The monitoring of the soil use dynamics in the municipalities have great importance in the aim at reflecting on the changes of socioeconomical aspects of certain regions and even to enable their environmental monitoring.

The land use inappropriate and without planning impoverishes it in an irreversible way, providing low crop productivity and even bringing in some regions as consequence the low socio, economical and technological level of the rural population. The implantation of an appropriate agricultural policy needs reliable and updated information of the land use and occupation to structure and enable the local or regional agricultural planning. Thus, the ideal use of soil in order to protect it from erosion and develop gradually its productive capacity requires a preliminary planning. The intensity of the erosion increases with the reduction of the vegetal cover in soil, connected to each type of plant community, according to POLITANO (1988), mainly in very sandy soils.

The inappropriate use of soil by man is an aggravating factor of environmental degradation and ecological unbalance. It is necessary that the action of man in the environment is planned and appropriated so that the effects to the physical environment are the lowest possible (MOTA, 1981).

This work aimed to analyze the classes of use capacity of the watershed of the Comur Stream, Botucatu-SP, aiming to contribute for the improvement of the place and increase of the basic knowledge about the better use of its resources.

Material and Methods

The watershed of the Comur Stream is located in the municipality of Botucatu (SP). Its geographic

Received in: 10/12/2010 Aceito para publicação em: 02/03/2011

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situation is defined by the coordinates: latitude 22º 44′ 42″ to 22º 48′ 12″ S and longitudes 48º 23′ 04″ to 48º 25′ 54″ W Gr, with an area of 1458.4 ha.

The predominant climate of the municipality, classified according to the Köppen system, is of the type Cwa – Humid subtropical climate with dry winters and hot summers and the annual average rainfall is around 1.447 mm.

In order to determine the water basin, it was considered the water diving lines which delimitate its contour. These lines were identified since they were defined by the conformance of the curves of level existent in the planialtimetric maps and they connect the most elevated points of the region around the drainage, as it was described by ARGENTO and CRUZ (1996).

For the work with computerized it was used the Softwares Arcgis 9.2, and the SIG Idrisi Andes, version 15.0. The contour of the watershed was performed manually in the Planialtimetric Map. Later, it was scanned and imported to the Geographic Information System – IDRISI, in the format .BMP, generated in the process of scanning, to the format .IMG trough the module File/Import, to be georeferenced.

The control points (coordinates) for the georeference and the points with maximum altitude for the digitalization of the limit of the watershed had as cartographic base the Planialtimetric Map edited by the Brazilian Institute of Geography and Statistics – IBGE in 1969, sheet of Botucatu (SF-22-R-IV-3), in scale 1:50000, with vertical distance between curves of 20 m.

In the georeference, it was used two files of control points, and the first one was the digital image and the other, the referred Planialtimetric map. It was determined the coordinates of each point and with this data, it was edited a correspondence file, trough the command Edit from the menu Database Query, present in the module Analysis.

After the georeferencing, the digitalization of the limit was performed trough the computer scream trough the module of digitalization (Digitalize).

The map of soils of the watershed was obtained through the map of soils of the municipality of Botucatu (PIROLI, 2002). From this map, it was performed a scanning of the area referent to the watershed and imported to the software Idrisi Andes 15.0 trough the module File/Import, and it was next georeferenced. The different soil classes were digitalized and, next, it was indicated the names of each areas, associated to their respective identifiers.

The areas and the percentages of each soil class were determined trough the command Area of the menu Database Query, which belong to the module Analysis.

The hydrography of the watershed was vectorized trough the satellite image Landsat 7, passage from 2009 and from the Carta Digital edited by IBGE (1969) (Figures 1 and 2). From the maps, it

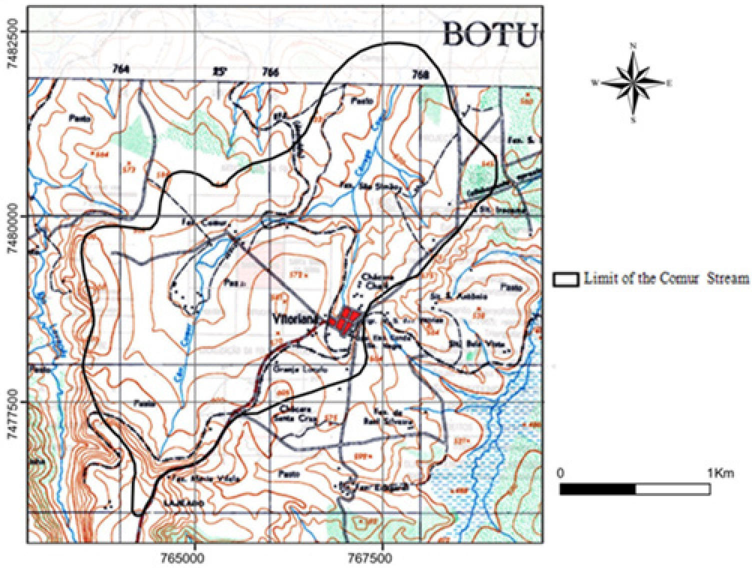

Figure 1. Limit of the watershed of the Comur Stream in the Carta Digital IBGE (1969).

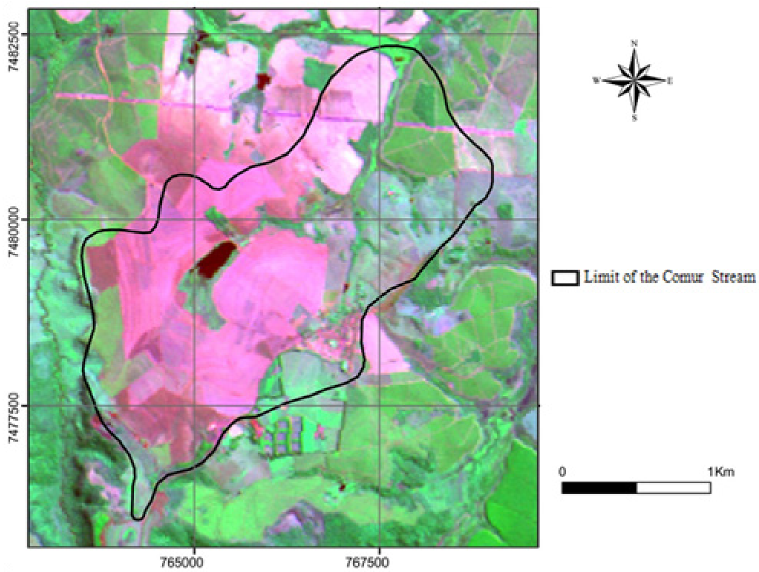

Figura 2. Limit of the watershed of the Comur Stream in the Satellite Image from 2009.

was calculated the value of the length of the main watercourse from the spring to the mouth of the watershed for each map, trough the tool measure, using the function length of the software ArcGis for Windows, version 9.2, aiming to determine the decrease of the length of the main watercourse of the drainage net in this period.

The curves of level with vertical equidistance from 20 to 20 meters were obtained from the topographic maps of 1:50000.

It was performed the conversion of the topographic maps from the analogical format to the digital, trough scanner. The map in the digital format was converted to the format .img from Idrisi and, next, georeferenced in the UTM projection system, band 22 S.

The slope classes were obtained through the digitalization in the screen and interpolation of the curves of level of the watershed. Next, the curves of level were exported to the software Arcgis 9.2, and were later digitalized and identified according to the values of their altitudes. Next, they were exported to the SIG Idrisi to perform an interpolation of the level curves.

The interpolation of the curves of level was executed trough the SIG Idrisi, using the methodology TIN (Triangular Irregular Network). This process consisted in the use of the vector file containing the level curves in the module TIN interpolation, which effected the interpolation. Late, it was calculated the slopes in the module surface and finally it was used the module of reclassification of values, reclass, the values which were interpolated were grouped in the interval of slope classes of 0-3, 3-6, 6-12, 12-20, 20-40 and >40%.

The slope map was created from the digital model of elevation, according to the slope classes used to soil conservation (Table 1) recommended by the SOIL SURVEY STAFF (1975).

In order to finish the slope map, it was applied a filter with mode 7 x 7 and with median 5 x 5 with the aim at excluding very small areas and to soften

Table 1. Intervals of slope classes for the soil conservation. Adapted from SOIL SURVEY STAFF (1975).

Interval	Relief	Characteristic Color
0 a 3%	Plain	Light Green
3 a 6%	Gently undulating	Yellow
6 a 12%	Undulating	Red
12 a 20%	Strongly undulating	Blue
20 a 40%	Montaneous	Dark Green
> 40%	Steep	Purple

the borders of each slope class. To apply this filter, it was used the module context operators/filter.

Results and Discussion

The hydrography of the watershed of the Comur Stream (Figures 3 and 4) showed a decrease of 2.26 km in the length of the main watercourse during the period from 1969 to 2009, i.e., 7.45 km of length in 1969 and 5.28 km in 2009. This fact is probably due to the occupation by sugarcane in permanent preservation areas of the watercourse (MOREIRA et al., 2010), causing the silting of the stream spring, because of an inappropriate soil management during the cultivation.

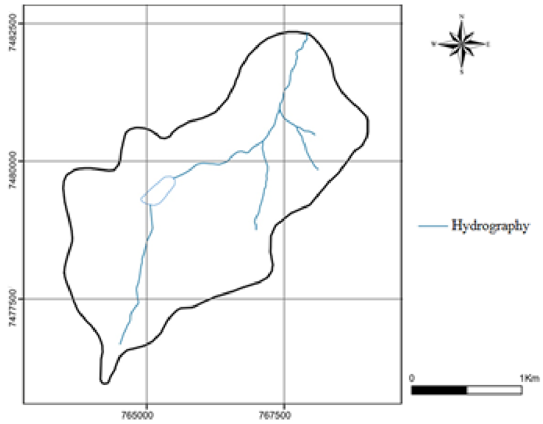

Figure 3. Original hydrography of the Comur Stream – Botucatu (SP).

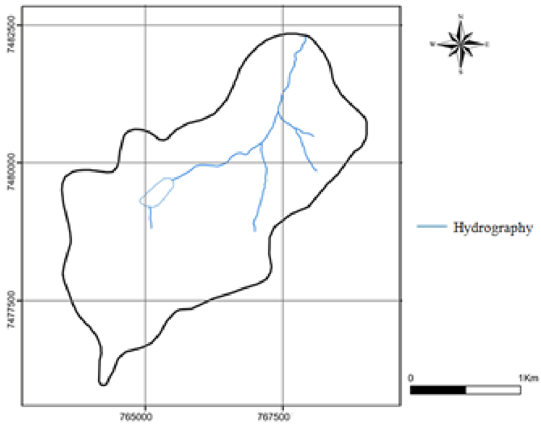

Figure 4. Current hydrography of the Comur Stream – Botucatu (SP).

The level curves of the watershed (Figure 5) show that there was a range of altitude from 480 to 760 m, considering that the highest altitudes prevailed in the springs of the water courses.

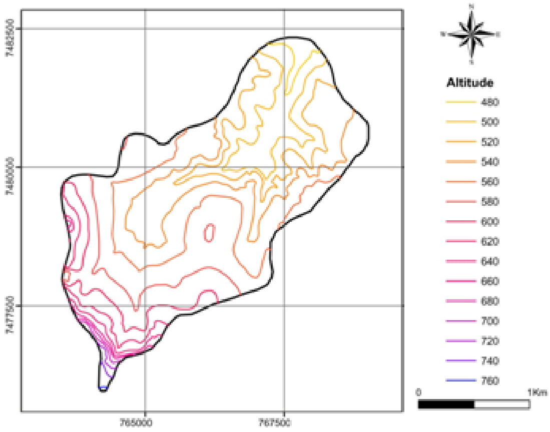

Figure 5. Planialtimetry of the watershed of Comur Stream – Botucatu (SP).

The digital elevation model (DEM) obtained from the planialtimetry of the terrain confirms the presence of the highest altitudes in the stream springs in the watershed (Figure 6).

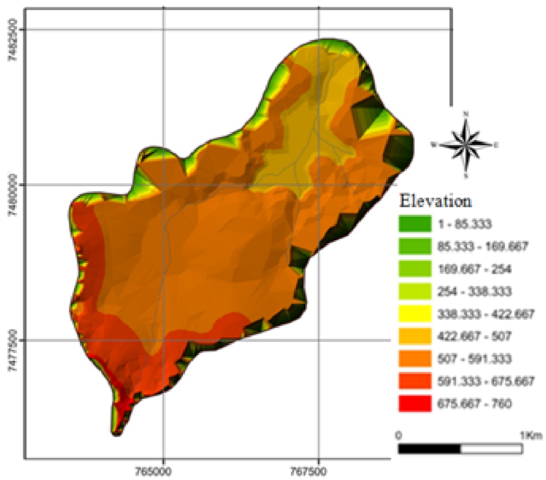

Figure 6. Digital elevation model – DEM of the watershed of the Comur Stream – Botucatu (SP).

The analysis of the Figure 7 and of the Table 2 enabled to infer that the slope classes from 0 to 3% (plain areas) and from 3 to 6% (gently undulating), which occurred in the watershed of the Comur Stream represent more than 65% of the area. According to LEPSCH et al. (1991), lands as these are indicated for the cultivation of annual crops with the use of simple practices of soil conservation, as, for example, the planting in levels which may control the erosive process of the soil (FILADELFO Jr., 1999).

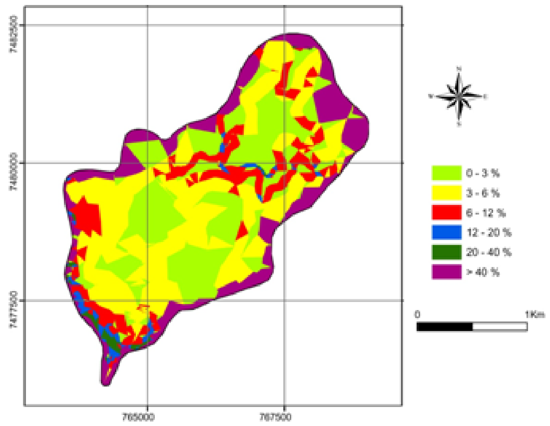

Figure 7. Clinographic map of the watershed of the Cumur Stream – Botucatu (SP).

The areas with undulating relief (slope from 6 to 12%), which represent 13.21 of the total area of the watershed (227.24 ha), are indicated for the sowing of annual crops with the use of soil conservation practices, according to LEPSCH et al (1991).

The strongly undulating relief (slope from 12 to 20%), indicated for the exploitation of permanent crops, which provide soil protection, represents 1.94% (33.40ha) of the watershed area, while the mountainous relief (from 20 to 40%), indicated for the development of cattle breeding and forestry, prevailed in only 0.91% (15.75 ha).

Table 2. Slope classes of the watershed of the Comur Stream – Botucatu (SP).

Slope classes	Area in relation to the watershed	
(%)	ha	%
0 – 3	524.11	30.48
3 – 6	634.87	36.92
6 – 12	227.24	13.21
12 – 20	33.40	1.94
20 – 40	15.72	0.91
> 40	284.25	16.53
Total	1719.60	100

Areas with more than 40% of slope represented 16.53% (284.25 ha) of the watershed area. These areas, classified as steep relief by CHIARINI and DONZELI (1973) and by LEPSCH et al. (1991) are lands favorable for the cultivation with forestry and pastures, with limitations.

It can be said that the watershed presents a high agricultural potential, since it presents almost 82.55% favorable for the cultivation with annual and perennial crops, i.e., with slopes ranging from 0 to 20%.

When analyzing the soils which occur in the studied area (Figure 8 and Table 3) it is verified that

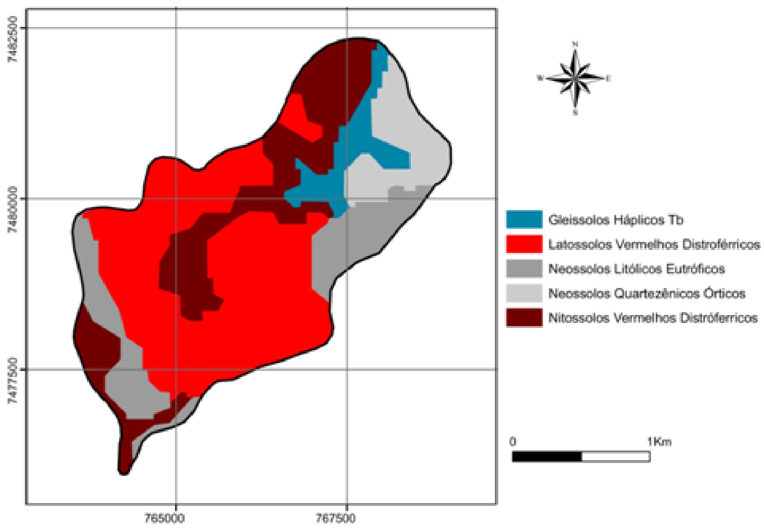

Figure 8. Soil Classes of the watershed of the Comur Stream – Botucatu (SP).

Table 3. Soil units which occur in the watershed of the Comur Stream – Botucatu (SP).

Soils	Area in relation to the watershed	
	Ha	%
Gleissolo Háplico Tb	113.26	6.59
Latossolos Vermelhos Distroférricos	784.78	45.64
Neossolos Litólicos Eutróficos	262.50	15.27
Neossolos Quartzarênicos Órticos	157.57	9.16
Nitossolos Vermelhos Distroférricos	401.49	23.35
TOTAL	1719.60	100

the most significant soil unit is Latossolo Vermelho Distroférrico[1] with 784.78 ha (45.64%). The other soil units found were: Nitossolo Vermelho Distroférrico with 401.49 ha (23.35%), Neossolo Litólicos Eutrófico with 262.55 ha (15.27%), Neossolo Quartzarênico Órtico with 157.57 ha (9.16%) and the one with lower intensity was Gleissolo Háplico Tb with 113.26ha (6.59%).

With these results, it is verified that the satellite image and the geographic information systems are an excellent tool to determine the slope and the soil unit areas, in function of the facility and rapidity to the mapping and, thus, enabled to support in the elaboration of digital maps, providing reliable results in a small interval of time, which may be used for other analysis in future area planning.

1 Brazilian soil classification

Conclusions

The results enabled to conclude that there was a decrease of 2.26 km in the length of the main watercourse of the watershed of Comur Stream, during the period from 1969 to 2009, possibly due to the occupation by sugarcane in permanent preservation area, which cause the stream spring silting, due to the inappropriate management of soil during the cultivation.

The methodology enabled to conclude that the slope classes which occur in the area, in decreasing order, were 3 – 6%, 0 – 3%, more than 40%, 6 – 12%; 12 –20% and 20 – 40%. The slope class from 3 to 6% (gently undulating) was the most significant in the watershed of Comur Stream – Botucatu (SP), with 634.87 ha (36.92%).

The soil unit Latossolo Vermelho Distroférrico occurred in more than 45% of the watershed with 784.78 ha (45.64%). The slope classes from 0 to 20% occurred in more than 82% of the watershed, and the areas with gently undulating relief (3 to 6 % of slope) were the most representative.

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