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Technical note

Geoprocessing applied in morphometric of the Ribeirão do Veado watershed - Piratininga (SP), seeking the conservation of the water resources

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Abstract

The planning of the soil use has been turned out to be a very important activity in the agricultural and socioeconomic development, because the inadequate use and without planning of the lands it causes low yield of the crops. This work aimed the morphometric characterizatiwon of the Ribeirão do Veado watershed - Piratininga (SP), tributary of the Rio Batalha, seeking the planning of conservation practices of the soil in the area, through geoprocessing. The watershed with 1776 ha, is located in the geographical coordinates 22º 23' 32" to 22º 26' 17" of latitude S and 49º 06' 34" and 49º 09' 45" of longitude W Gr. It was used as cartographic base the Map of Brazil (IBGE, 1973), in scale 1:50000. The dimension variables analyzed were: larger length (C), area (A) and perimeter (P) of the watershed and the for the relief were: medium altitude (Hm), altimetric width (Ha), medium steepness (H), form factor (Ff), relief reason (Rr) and drainage density (Dd), measured through the System of Geographical Information - Idrisi Java. The results showed that the medium steepness allowed classifying the relief as wavy, probably, due to the substratum that has high permeability with larger rain water infiltration and superficial drainage of the water, conserving the soil. The form factor (0.38) and the drainage density (1.66 km km^{-2}) allowed to conclude that probably the watershed is not subject the flood, once the relief presents high influence on the hydrological factors. Therefore, the knowledge of the area hydrology and relief is of fundamental importance in the decision taking of planning actions and administration in the future preservation.

Key words: morphometric; dimensional variables; relief variables.

Geoprocessamento aplicado na morfometria da microbacia do Ribeirão do Veado - Piratininga (SP), visando a conservação dos recursos hídricos

Resumo

O planejamento do uso do solo vem se tornando uma atividade muito importante no desenvolvimento agrícola e sócio-econômico, pois o uso inadequado e sem planejamento das terras provoca a baixa produtividade das culturas. Este trabalho objetivou a caracterização morfométrica da microbacia do Ribeirão do Veado – Piratininga (SP), afluente do Rio Batalha, visando o planejamento de práticas de conservação do solo na área, através de geoprocessamento. A microbacia com 1776 ha, situa-se entre as coordenadas geográficas 22º 23' 32" a 22º 26' 17" de latitude S e 49º 06' 34" a 49º 09' 45" de longitude W Gr. Foi utilizado como base cartográfica a Carta do Brasil (IBGE, 1973), em escala 1:50000. As variáveis dimensionais analisadas foram: maior comprimento (C), área (A) e perímetro (P) da microbacia e as do relevo: altitude média (Hm), amplitude altimétrica (Ha), declividade média (H), fator de forma (Ff), razão de relevo (Rr) e densidade de drenagem (Dd), medidas através de do Sistema de Informações Geográficas – Idrisi Java. Os resultados mostraram que a declividade média permitiu classificar o relevo como ondulado, provavelmente, devido ao substrato que tem alta permeabilidade com maior infiltração da água das chuvas e escoamento superficial da água, conservando o solo. O fator de forma (0,38) e a densidade de drenagem (1,66 km km^{-2}) permitiu concluir que provavelmente a microbacia não é sujeita a inundação, uma vez que o relevo apresenta grande influencia sobre os fatores hidrológicos. Portanto, o conhecimento da hidrografia e do relevo da área é de fundamental importancia na tomada de ações de planejamento e gestão na preservação futura.

Palavras chaves: morfometria; variáveis dimensionais; variáveis de relevo.

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Geoprocesamiento aplicado en la morfometria de la cuenca del Ribeirão do Veado - Piratininga (SP), buscando la conservación de los recursos hídricos

Resumen

La planificación del uso de la tierra se está convirtiendo en una actividad muy importante en los sectores agrícola y socio- económico, ya que el uso inadecuado de la tierra ocasiona bajos rendimientos de los cultivos. Este estudio tuve como objetivo la caracterización morfometrica de la cuenca del Ribeirão do Veado - Piratininga (SP), un tributario del río Batalha, visando planificación de las prácticas de para la conservación de suelos en el área, a través de Geoprocesamiento. La cuenca con 1776 ha, está situada entre las coordenadas geográficas 22° 23' 32" y 22° 26' 17" de latitud S y 49° 06' 34" y 49º 09' 45" de longitud W Gr. Fue utilizado como base geográfica el Carta del Brasil (IBGE, 1973) en escala 1:50000. Las variables dimensionales evaluadas fueron: mayor longitud (C), área (A) y el perímetro (P) de la cuenca y as de lo relieve: altitud media (Hm), amplitud altimétrica (Ha), la pendiente media (H), el factor de forma (Ff), relación de relieve (RR) y densidad de drenaje (Dd), medidos mediante el sistema de Información Geográfica - Idrisi Java. Los resultados mostraron que la declividad media de pendiente permite clasificar el relieve como ondulado, probablemente debido al sustrato que tiene una alta permeabilidad con una mayor infiltración de agua de la lluvia y el escurrimiento superficial del agua, manteniendo el suelo. El factor de forma (0,38) y la densidad de drenaje (1,66 km km²) permitieron la conclusión de que, probablemente, la cuenca no está sujeto a las inundaciones, ya que el relieve muestra una gran influencia sobre los factores hidrológicos. Por lo tanto, el conocimiento de la hidrografía y relieve de la zona es de importancia fundamental en la toma de acciones de planificación y gestión en la conservación futura.

Palabras clave: morfometria; variables dimensionales; variables de alivio.

Introduction

To the extent that the humanity uses more the nature to satisfy its necessities, greater is the risk of compromising in a violent way the environment. Drastic changes and environmental imbalances reverberate worldwide and impair the quality of life of people. Considering this, the environmental, social and cultural studies are necessary to a better planning and management of the areas (NARDIN, 2005).

The watershed is an ideal unit for the integrated planning of natural resources management of the environment, allowing a better harnessing, both in water terms as well as social-economic, seeking specially the environmental sustainability with yield and quality of life to its users (TUNDISI, et al., 2008). This is nominated as an area of natural catchment of rain water by many topographic and groundwater dividers, drained by a drainage system that flows into the ocean (LIMA, 2006; RODRIGUES, 2008).

The physical, socio-economic and environmental deterioration is today a constant reality in the watersheds and, as consequence, the nature answers with erosions, droughts, floods, disease and misery. Therefore, it is advisable to study the watersheds to recover or at least ease the environmental problems, besides of being perfect for the production, conservation, management and more detailed studies of several factors involving water, soil, vegetation, animals, biodiversity and the sustainable forestry production (RODRIGUES, 2003).

There is the necessity of thinking in terms of sustainable development, which is recommended by the Legislation on Water Resources and by the scientific community, using an integrated approach, involving the drainage basin and the concept of ecosystem, for the planning and management of these unities of work (PEIXOTO, 2002).

The law nº 9.433 of the National system of Water Resources, of January 8th of 1997, instituted the National Policy of Water Resources (PNRH) and created the National System of Water Resources Management (SINGRH) in Brazil, the same establishes the watersheds as physical-territorial units for the planning of water resources and that the administration of these must account with the participation of the Public Power, of the users and of the communities (BRASIL, 1997).

Besides this, the morphometry of the watershed and the characterization of the riparian zone are other important tools of diagnosis of the susceptibility to environmental degradation. Its morphometry analysis, is in the fact of enabling

through graphic representations the main characteristics of determined areas from a series of quantitative parameters, such as slope, topographic gradient and altimetry, besides the hydrographical parameters, such as fluvial magnitude, canals length, pattern and drainage density (RODRIGUES, 2000).

The same author associates the morphometric analysis with the relief of the watershed, obtaining the result of a geomorphological formation process throughout time and space. The landscape formation, types of vegetation and hydrological behavior of the watershed have direct relation with the different land slopes, features, shapes and types of relief. Thus, this must be understood as an indispensable natural resource for an adequate environmental administration (SUERTEGARAY, 2002 apud NARDIN, 2005).

The aim of this study was to analyze the hydrography and the relief of the Ribeirão do Veado watershed – Piratininga (SP), seeking the conservation of natural resources.

Material and Methods

Localization of the watershed

The Ribeirão do Veado microbasin belongs to the Tietê/Batalha hydrographic basin, located in the municipality of Piratininga-SP, whose area is of 17.76 km^2, and its streams flow into Rio Batalha.

Based on the Map of Brazil of the municipality of Bauru, edited by IBGE (1970), in a scale of 1:50000 (Folha – SF-22-Z-B-I-4), it was identified the microbasin (Figure 1), through its watersheds, reproducing in polyester film Terkron D – 50u the 20 in 20 meters curves of equidistant levels, corresponding to the studied microbasin, for determination of the dimensional variables and the drainage pattern to the analysis. To HORTON (1945), the junction of two tributaries of first order (w1) originates a segment of second order (w2), and the union of these a segment of third order (w3), it is concluded that the Córrego do Veado is of fourth order of ramification (w4).

The dimensional parameters studied were (HORTON, 1945): area (A) and perimeter (P) and larger length (LL), and the for the relief were (LIMA, 1986): medium altitude (Hm), altimetric width (Ha), medium steepness (H), form factor (Ff), relief reason (Rr) and drainage density (Dd), determined through the System of Geographical Information - Idrisi Java.

The medium altitude of the microbasin (Hm) was obtained through the arithmetic average between the values of higher altitude (AM) observed in the headwaters and of the lower altitude (Am) in the mouth (MOREIRA, 2007).

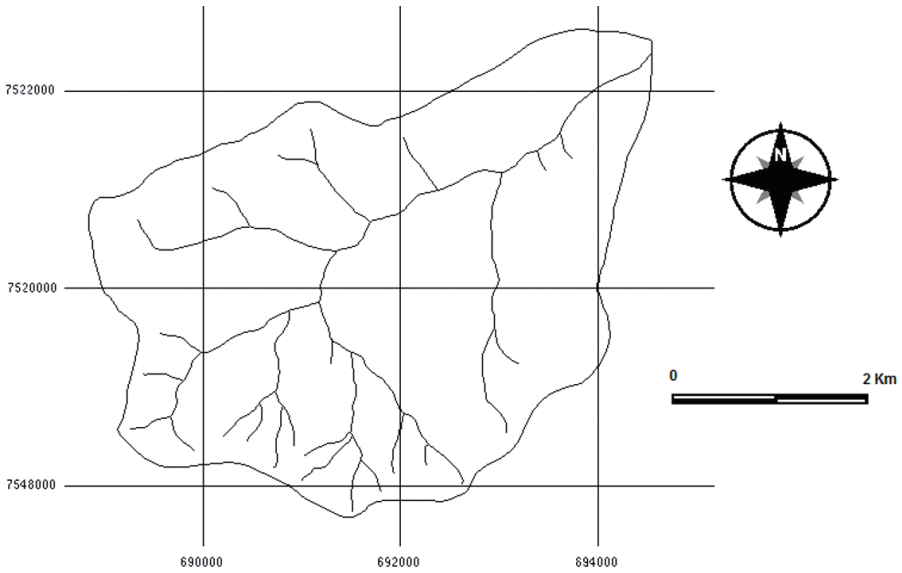

Figure 1. Hydrographic net of the Ribeirão do Veado microbasin – Piratininga (SP).

$$Amd = \frac{(AM + Am)}{2}$$

Where:
Hm = medium altitude in m;
AM = higher altitude in m;
Am = lower altitude in m.

The altimetric amplitude (H) is the difference between the higher and lower altitude of the microbasin and is expressed in meters, according to the expression:

$$H = AM - Am$$

Where:
H = altimetric amplitude in m;
AM = higher altitude in m;
Am = lower altitude in m.

The slope of a hydrographic microbasin has relation with several processes, such as the hydrological, the surface runoff, infiltration, soil moisture and time of concentration of water in the drainage canals. The average slope was calculated by the equation (MOREIRA, 2007):

$$D\% = \frac{\sum Ca.\Delta h)}{A} * 100$$

Where:
D% = average slope in %;
Σ Cn = sum of the length of curves of level in km;
ΔH = equidistance between the elevations in km;
A = area of the microbasin in km².

The form factor of the microbasin (Ff) was used through the equation: = A / C², where A is the area in km² and C the length in km. Generally the microbasins are pear shaped, but can have other shapes, which depends of the interaction between eather, geology and others. The surface of the microbasin is always concave, which determined the direction of the flux of water.

$$Ff = \frac{A}{C^2}$$

Where:
Ff = form factor;
A = area of the microbasin in km²;
C = Length in km.

Therefore as closer of a (1.0) is the form factor, closer to the circular shape, and consequently there are greater chances of a flood in the microbasin (LIMA, 2006).

The ratio of the relief indicated the general slope or total slope of the microbasin surface (Table 1).

$$Rr = \frac{H}{C.100}$$

Where:
Rr = ratio of the relief
H = altimetric amplitude in m;
C = wider length of the microbasin in m.

Corresponds to the relation between the total length of the rivers in the microbasin limits, and its area, thus providing an indication of the efficiency of the microbasin drainage (CARDOSO, 2006).

$$Dd = \frac{Cr}{A}$$

Where:
Cr = Length of all rivers in Km
A = microbasin area in km²

As for the drainage density, the microbasins can be classified according to Table 2.

Table 1. Classes of slopes and types of relief of the Ribeirão do Veado watershed – Piratininga (SP), according to EMBRAPA (1991).

Sloe (%)	Type of relief
0 – 3	Plain
3 – 8	Smooth wavy
8 – 20	Wavy
20 – 45	Strongly wavy
45 – 75	Mountainous
> 75	Steep

Table 2. Classification of drainage density (Dd) of the Ribeirão do Veado watershed – Piratininga (SP), according to STRAHLER (1957).

Dd (km km^{-2})	Classification
< 5.0	Low
5.0 – 13.5	Medium
13.5 – 15.5	High
> 15.5	Very High

Results and Discussion

Morfometric analysis

The measurement of the microbasin area is a very important parameter, because this variable has correlations with several other morphometric parameters of the microbasin, besides of its importance for the calculation of the water balance. The perimeter was determined after the delimitation of the contour of the microbasin in the cartographic base, resulting in 17.34 km.

The characteristics of the microbasin relief (Table 3) show that the higher and the lower altitude of the microbasin, are 620 m and 480 m, respectively, with an average altitude of 550 m and the altimetric amplitude is 140 m.

This amplitude related with the higher length of the microbasin, which corresponds in the direction to the main valley, at 6.750.00 m, results in a relief ratio of 0.0207. According to STRAHLER (1957), the relief ratio indicates a total slope of 2.0% or general slope in direction of the main valley of the microbasin.

As stated by RODRIGUES (2003), as higher is the altimetric amplitude, greater will be the relief ratio and consequently greater is going to be the erosive process. Therefore, the microbasin in study does not present erosive process,

According to RODRIGUES (2008), the value of the form factor (Ff) varies from 0 to 1 and the studied microbasin presented an Ff of 0.38, considered low, this demonstrates that it possess a less elongated shaped, consequently, less chances of floods.

The density of the drainage was 1.66 km km^{-2}, according to STHRALER (1957), can be classified as low, this signifies a microbasin with greater capacity of infiltration, resistant rocks, permeable soil, smooth relief, being less susceptible to degradation (HORTON, 1945).

The average slope is one of the main factors which regulates the time of duration and speed of surface runoff, and the time of rain water concentration in the main canal. Starting from the value found in each level curve, it was elaborated a table which served as base for the generation of slope classes, according to the Brazilian System of Soils Classification (EMBRAPA, 1999), (Table 4).

The average slope (D%) of the microbasin was calculated in 10.13%, therefore, considered medium, being among the slope class of (8-20%) with a type of wavy relief, with an area of 54.62% which corresponds to 9.7 km^2 (Figure 2).

Table 3. Morphometry of the Ribeirão do Veado watershed – Piratininga (SP).

A km^2	P km	D (%)	Dd km/km^{-2}	H m	Ff	Rr	W	Hm
17.76	17.34	10.13	1.66	140	0.38	0.0207	4^a	3.08

Obs: A - area, P - perimeter, D – medium slopea, Dd – drainage density, H - altimetric amplitude, Ff – form factor, Rr – Relief ratio, W – order and Hm – average altitude.

Table 4. Classes of slope and type of relief of the Riberião do Veado watershed – Piratininga (SP).

Slope Classes	Area (km^2)	%Area	Type of relief
0-3%	0.96	5.40	Plain
3-8%	1.90	10.70	Smooth wavy
8-20%	9.70	54.62	Wavy
20-45%	5.20	29.28	Strongly wavy
Total	17.76	100	

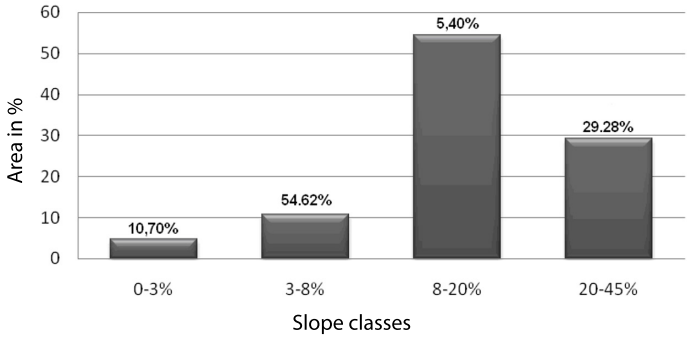

Figure 2. Slope Classes (%) of the Riberião do Veado watershed – Piratininga (SP).

Conclusions

The average slope of 10.13% according to the classes of slope and types of relief of the microbasin was classified was wavy. This slope allows inferring that the substrate has high permeability with greater rain water infiltration and surface runoff of the water, conserving the soil, being it susceptible for agriculture. The form factor of 0.38% and the drainage density of 1.66 km km^{-2}, both considered medium, allowed concluding that the microbasin probably will not flood, once the relief of a hydrographical microbasin has great influence on the hydrological factors. The Ribeirão do Veado watershed is of fourth order of ramification according to the classification system of rivers and present a drainage system with 26 segments of rivers of 1ª order; 08 of 2ª; 02 of 3ª and 01 segment of 4ª order.

In this way, it is concluded to be fundamental the knowledge of the microbasin as conservation management practice, implanting a preservation action, since the activities developed in its interior have influence on the quantity and quality of the water, also taking in consideration the preservation of the APP, around the springs which serve as auxiliary to the planning and management of the area.

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