DETERMINATION OF MORPHOMETRIC PARAMETERS
OF DRAINAGE BASINS IN GIS/dBASE ENVIRONMENT

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Abstract

This work has investigated the operational tools of SIG, aiming at digitally determining morphometric parameters of drainage basins in order to make out a consistent relational model for non-spatial data basis and to implement manipulations integrated to both bases. 36 absolute and relative parameters were researched in the SGI system and in the data processing dBase III Plus^{TM}, to be used in the determination of the main morphometric parameters of the drainage basins.

1 Introduction

According to [8, pp.6] a "drainage basin is a well-defined topographically area through a stream or a system connected to streams so as that the efluent outflow is discharged all at once into an opening". This opening is represented by a transversal section of a greater stream. A drainage basin is individualized by border lines of contiguous basins.

From a hydrologic viewpoint the hydrographic basins appear as research areas, for their simplicity when they are analysed for the water balance. In terrestrial shaping by Geomorphology, the drainage basins show a systemic relationship among their components [2, pp.1]. According to [1, pp.8] some phenomena occur in the inner side of drainage basins, such as man's role when he builds houses, reservoirs and highways; such effect is related to water. The organization of human activities is processed upon drainage basins such as political organization, for instance. Moreover, man depends upon water for: supply, fishing, recreation, transport, energy mills, everything in the inner part of drainage basins. The nature of this basin also influences man's actions to as to prevent his advance. From Physics viewpoint , several natural interchanges occur in drainage basins specially those induced by gravity such as soil displacement and earth slip, and water acting in slopes and in rivers.

Drainage basins may be descibed qualitative and quantitatively. [6, pp.454] refers to quantification necessity taking into account the close relationship among Geomorphology,Climatology and Hydrology so that the latter work with quantitative values fundamentally. According to the author, such dimensions as length, width, height, area and volume can be used in a unique way or in combination for the dimensional analysis of drainage basins. For [5, pp.38], it is important to take into consideration not only the topographic characteristics but also the interrelationship among these characteristics; named multiform relatioships.

In Brazil, as in every other place, there has been the tendency of interested sectors in information management to migrate to SIG technology. At national grounds, the National Institute of Spacial

Research - INPE has started homemade software development. Its first product, SGI - System of Geographic Information - has been very popular in Brazil.

The present paper has investigated ways of using SGI, so as to obtain and manipulate morphometric information of drainage basins, for the direct determination of quantifications, indirectly by means of the integrated manipulation of spacial and non-spacial data. The core of this study was the drainage basins of Caveiras River, in an area of about 2,400 km^2, located at 27°37' and 27°55' South latitudes, and 50°56'and 49°51' West longitude, in central-south plateau of Santa Catarina State, Brazil. 14 sub-basins were selected out of this basin; their morphometric parameters were also taken.

2 SGI characteristics for morphometric analyses in drainage basins

SGI works with menus which operate a series of data choices. The main menu is activated by software aplicative modules and the following choices are offered: DEFINITION, ENTRANCE, CONVERSION, MANIPULATION, EXIT. Such choices activate the aplicative sub-modules for which there are performable and non-performable functions. The former use the aplicative which was selected by the user and the latter use some other menus.

3 Morphometric parameters of drainage basins and drainage network

At the beginning a systematization of 36 parameters were used physicallly in order to describe shapes, dimension and configuration of drainage basins and drainage network.Taking into account that such parameters are introduced or generated in a SIG integrated environment, we tried to organize them by considering distinct computational environment which were given by SGI and dBase. So, two categories of parameters were classified: the first which referred to absolute parameters, which were obtained directly from digital cartographic basis.in SGI environment; and the second referred to relative parameters which were obtained from the manipulation of absolute parameters in relational data environment.

From dimensional viewpoint, the studied absolute parameters fit into the L dimensions (length, width, height), L^2 (areas), L^3 (volume, samples presented point by point, linear or area in tridimensional space); on the other hand the relative parameters that come from relatioships among two or more absolute parameters, may present different dimension combination.

The developed methods in this research, in SGI environment, are qualified so as to determine parameters at L, L^2, L^3 dimensions. This means that, when it is fit into this dimension, the morphometric parameter may use the same method or a group of methods which were adopted by other absolute paramenters.

4 Methods for determining absolute morphometric parameters

This section presents methods which were developed under SGI environment and they are characterized for the determination of some parameters of dimensions L, L^2 or L^3. In spite of most absolute parameters having taken part in these methods, there are some specific procedures which are imposed by the characteristics of each parameter, which are not dealt with in this chapter.

4.1 The determination of morphometric parameters of L dimension

In this case, we take into consideration the morphometric parameters which were involved in the linear quantification: basin perimeters, basin length, curve length at basin levels and their vetorial equivalents.

There are two main ways for obtaining length and distances in SGI. The first one is available in F9 function in the keyboard, 'calcular distance choice'. This method does not work for sineous lines, once length or vectorial distances between two points are calculated. The second one, available in this situation, does not give out lines length directly, for there is not a specific function for such a situation. In order to deal with this situation the user should develop any Information Plan (PI), so as to copy the line of interest for such PI and list in ASCII file, by means of 'PI line list' aplicative. It is only during the operation of PI line list that length operation is processed in this system, in order to give away the referred file. Aiming at optimizing this file research, a program was diveloped out of the SGI environment, called LINHAS.EXE, whose main functions were:
a) selection of interesting information, such as the identification of the plan of information, project, line length, besides getting other information about reading control;
b) depuration of file information;
c) calculation of the length along the lines;
d) calculation of partial and total vetorial length of the lines.

In the case of vectorial equivalents of lines, another choice is the use of the program LINHAS.EXE, in 2.4 version of SGI in order to incorporate ' analysis of lineation ' aplicative, statistical choice. This choice helps the user to obtain a series of relative values in the group of lines of active PI, as a total number of lineaments and total and average vectorial length.

4.2 Determination of morphometric parameters of L² dimension

This kind of parameter has more choices in SGI. The area determination may be obtained directly from the following aplicatives: a) listing PI polygons; b) obtaining polygon data; c) calculating class area; d) generating crossed tabulation; e) the use of key F9 choice ' calculating the area'. In order to be successful in theses operations a topology of PI, containing the interesting basins, should have been created.

4.3 Determination of morphometric parameters in L³ dimension

In order to determine morphometric parameters of L³ dimension, the user should first define the Numerical Terrain Model (MNT) as it is described in [3]. The model generated in this work was used in the determination of parameters z, Z and Ih, altitude of the mouth of the basin, the highest altitude of the basin over watershed and hyposometric integral. The aplicative 'listing atributes of image' was used as the first method, and the aplicative 'generating regular grid' as used as the second method. The latter was used only when there was a higher point in watershed. For Ih, an adaptation was made for SGI envinronment. So, SGI was determined and the area between two curves of consecutive levels as well, besides the rocky volume of drainage basins, by having used the calculated areas.

4.4 Storage of abasolute morphometric parameters

The absolute morphometric parameters, determined in SGI environment, were stored in related tables, represented by files, .DBF extension, in dBase environment (table 1).

LABEL	S (m²)	P (m)	L (m)	z (m)	Z (m)	Lr (m)
L. BEBE OVO/DOS BONECOS	65574956.0	48277.930	19040.440	746.51	1053.0	24689.200
L. GRANDE/DESPRAIADO	262106768.0	82644.090	22298.420	745.39	1050.9	29014.510
L. DA CRUZ	40287560.0	31551.500	11328.770	894.36	1103.4	13605.150
RIB. CACHOEIRINHA	94115648.0	49961.510	16479.520	900.00	1200.7	21187.170
R. DO GUARA	120042936.0	57196.970	16895.840	891.09	1207.1	26984.950
R. GALAFRE	139362272.0	65859.260	21238.190	947.19	1560.9	28144.420
RIB. DO CONSELHO	12013410.0	17532.850	5306.490	900.00	1159.5	7990.720
RIB. DA PENHA	19998558.0	20897.270	5554.650	897.68	1004.2	6383.650
R. DA PONTE GRANDE	22515648.0	24788.150	9465.710	897.70	1005.9	9866.520
R. CARAHA	30689558.0	23990.600	7164.810	897.80	1056.1	10487.290
L. DOS MOTTAS	33105408.0	29825.030	11505.090	841.98	1050.9	16197.040
R. AMOLA-FACA	114904600.0	52197.110	18803.980	849.89	1050.0	34872.910
R. PASSO FUNDO	80402904.0	40834.800	13149.740	800.00	1054.4	19209.520
L. REFUGA BAIANO	80160104.0	47231.900	13149.740	786.63	1104.6	19009.340

Table 1: Relational data bank of some absolute parameters of sub-basins of Caveiras River's Basin

In order to make the related data generated by this work more consistent, related models were made according to normalization principles [6]. In these models, the key-attributes were used to access a certain register, which corresponds to attribute labels to basins in SGI environment. By using this label there is the connection between the stored spacial data in SGI environment and stored non-spacial data in environment of related data files. If one wants the value of the label to be successful, there must be the same value in both environments. [4] This allows the bases of spacial and non-spacial data to be used in an integrated way.

5 Determination of relative morphometric parameters

The relative morphometric parameters were determined in dBase environment, by using softwares written with available DML (Language of Data Manipulation). By using these softwares it was possible to manipulate the absolute morphometric parameters, which were stored in bases of speficic related data, and to generate the values of relative parameters [6]. The latter was also stored in related bases. Table 2 shows some relative parameters used to describe basin shapes and table 3 shows some relative parameters used to describe network drainage.

LABEL	Kf	Kc	Rc	Re	K
L. BEBE OVO/DOS BONECOS	0.181	1.669	0.354	0.480	1.382
L. GRANDE/DESPRAIADO	0.527	1.429	0.482	0.819	0.474
L. DA CRUZ	0.314	1.392	0.509	0.632	0.796
RIB. CACHOEIRINHA	0.347	1.442	0.474	0.664	0.721
R. DO GUARA	0.421	1.462	0.461	0.732	0.595
R. GALAFRE	0.309	1.562	0.404	0.627	0.809
RIB. DO CONSELHO	0.427	1.416	0.491	0.737	0.586
RIB. DA PENHA	0.648	1.308	0.575	0.908	0.386
R. DA PONTE GRANDE	0.251	1.463	0.460	0.566	0.995
R. CARAHA	0.598	1.213	0.670	0.872	0.418
L. DOS MOTTAS·	0.250	1.451	0.468	0.564	1.000
R. AMOLA-FACA	0.325	1.363	0.530	0.643	0.769
R. PASSO FUNDO	0.465	1.275	0.606	0.769	0.538
L. REFUGA BAIANO	0.464	1.477	0.452	0.768	0.539

Table 2: Relational data bank of some relative parameters of sub-basins of Caveiras River's Basin

LABEL	LT_DRE*	DD	CM	EPS
L. BEBE OVO/DOS BONECOS	77612.16	1.18	0.85	0.42
L. GRANDE/DESPRAIADO	392353.75	1.50	0.67	0.33
L. DA CRUZ	46889.00	1.16	0.86	0.43
RIB. CACHOEIRINHA	94847.07	1.01	0.99	0.50
R. DO GUARA	128873.09	1.07	0.93	0.47
R. GALAFRE	135440.97	0.97	1.03	0.52
RIB. DO CONSELHO	11082.18	0.92	1.09	0.54
RIB. DA PENHA	10616.71	0.53	1.89	0.94
R. DA PONTE GRANDE	9866.52	0.44	2.27	1.14
R. CARAHA	23548.61	0.77	1.30	0.65
L. DOS MOTTAS	38467.37	1.16	0.86	0.43
R. AMOLA-FACA	106113.61	0.92	1.09	0.54
R. PASSO FUNDO	68007.41	0.85	1.18	0.59
L. REFUGA BAIANO	105042.16	1.31	0.76	0.38

Table 3: Related data bank of relative parameters of Caveiras River's Basin's drainage system

6 Conclusions

The analysis of the obtained results in this research and the obtained experience by the use in SGI/dBase environments, in the morpohometric analysis of drainage basins and drainage network led to the following conclusions: a) the choice of SGI/ dBase environment in order to manipulate and obtain morphometric parameters of drainage basins and drainage network is a highly efficient tool. The development and implementation of LINHAS.EXE choice is reliable and it makes the research easier in the files of lines ASCII, generated by SGI, in the determination of morphometric parameters of L dimension. Besides preventing repetitive lines and determining their vectorial equivalents; b) the developed methodology in this paper allowed 1/3 out of 36 morphometric parameters which were studied to be determined in SGI environment; the 2/3 left were determined in dBase environment, where all of them were stored.

7 References

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