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EVALUATION OF THE MORPHOMETRIC PARAMETERS OF THE CUBOLTA RIVER BASIN WITH THE GIS SUPPORT

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Abstract

The morphometric parameters of a territory are an important part in the research carried out in order to have a complete picture of its relief. Morphometry represents the main elements through which it is possible to achieve a complete description of geomorphological conditions within a given territory. This article presents aspects regarding the morphometric parameters that are achieved with the help of GIS technology. With the help of the digital terrain model, a series of morphometric parameters were generated: altitude, slope inclination, relief fragmentation. Subsequently, these data can be used in the complex and detailed geomorphological and pedological analysis of the basin territory.

Key words*: morphometric parameters, GIS technology, geomorphological conditions.*

INTRODUCTION

The morphometric parameters of the relief represent an important potential in the development of geomorphological processes. For example slope declivity, through the value of the slope angle, together with other parameters of the relief, can condition the triggering of torrential and gravitational processes on the slope.

The morphometric parameters (length, slope, shape of the slope, etc.), act as determining factors in combination with other factors, type and intensity of the process. The morphometric characteristics can be evaluated as a result of the dynamics of the factors in question as well as a consequence of subsequent changes in the landscape. This method gives a complex characteristic of the relief of the researched territory based on the topographical material: the characteristic of the altitudes (hypsometry), the angle of the slope, the depth and the density of the fragmentation of the relief, etc.

The relief of the basin, sculpted by the numerous flowing waters, forms alluvial beds, slopes, interfluvial ridges, etc., characteristic of the fluvial relief type (Donisă et al., 1994). The slopes of the valleys of the Cubolta tributaries that are part of the basin have altitudes between 50-100 m, and the length of the slopes often does not exceed the length of 1000 meters.

MATERIALS AND METHODS

Due to the possibility of applying informatics in geography and by use of the Geographical Information Systems (GIS) it was possible to map the morphometric parameters of the researched basin and make their graphic representation through maps and graphs. Topographic maps at a scale 1: 25,000 represented the cartographic support of the Geographical Information System. For the morphological and morphographic analysis of the studied region, a specialized software was used that allows the development of high-precision maps within the limits of the topographic base taken as a starting point. All developed maps were made with the help of MapInfo 9 and ArcGIS 9.3 programs. Thus, basing on the interpolation of the obtained level curves the main thematic maps (altitude, slope, exposure, etc.) were automatically created.

RESULTS AND DISCUSSIONS

The digital terrain model was created for the evaluation of the morphometric indicators (Juc et al., 1995; Rudraiah et al., 2008; Gustavsson et al., 2006). Thus, from the morphometric point of view, the relief within the boundaries of the Cubolta basin is relatively fragmented (Figure 8). It is characterized by

altitudes between 85-280 m, with an average altitude of 221 m. The maximum altitude values are 280 m, and the minimum 85 m.
The hypsometric map highlights 6 altitudinal steps (Figure 1) present on the studied territory. The histogram of surfaces by hypsometric classes (Figure 2) represents their share from the total area of the territory.

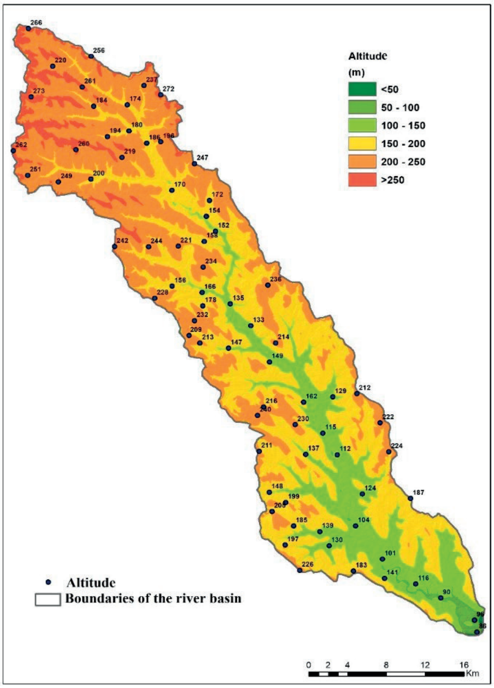

Figure 1. Hypsometric map of the Cubolta basin

As a whole, altitudes between 150-200 meters (41.19% of the area) occupy the highest share in the area of the basin. The altitude range of 200-250 m makes up 35.27% and the range of 100-150 m is represented by 17.27% of the area. The lowest values, which do not even reach 2% of the total area of the basin, are represented by the altitudinal ranges up to 50 m and 50-100 m, reaching a share of 0.33% and 1.51%, respectively. Surfaces that exceed the altitude of more than 250 m, occupy 4.43% of territory and are located in the upper course of the basin.
Slope is a very important feature in relief analysis. It is one of the essential factors in the development of some geomorphological processes, especially the processes related to the movements on the slope.

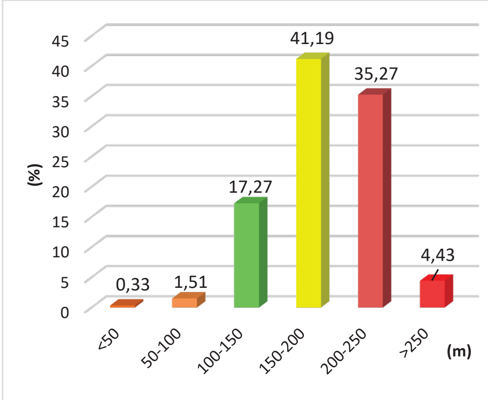

Figure 2. Histogram of surfaces by hypsometric classes (m)

The slope map was generated from Digital Terrain Model (DTM). Within the investigated territory, the slope values were classified into 5 classes (Figure 3).

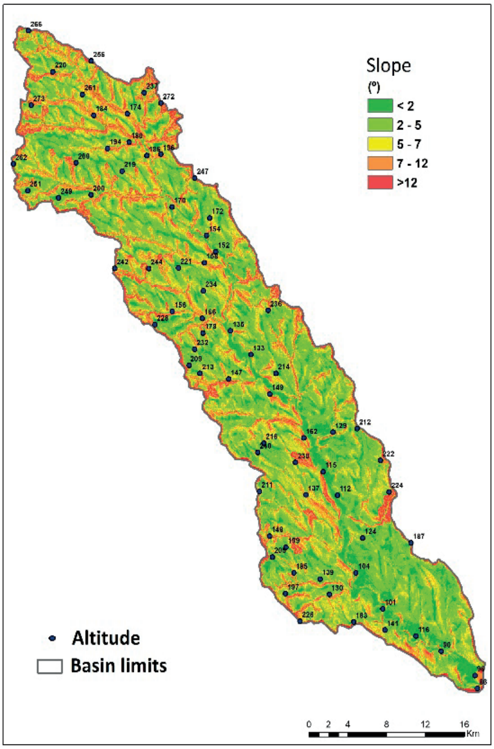

Figure 3. Slope map in the Cubolta basin

Analysing the histogram of the slopes (Figure 4), it can be noticed that slopes below 2° makes 13.19% of the territory and are spread in the river meadows and on interfluvial peaks.

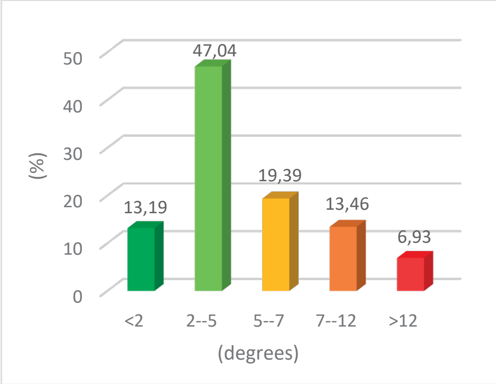

Figure 4. Histogram of slope classes in the Cubolta Basin

The class of slopes between 2-5º recorded the largest share, which constitutes 47.04% of the total area of the territory. That makes practically half of the studied area.

The next category of slopes is the class of slopes between 5-7º, which is almost two times inferior to the previous class, occupying 19.39% of the basin surface and is spread on the slopes of small rivers (tributaries of the Cubolta).

Slopes between 7-12º occupy roughly the same area as slopes lower than 2º and makes 13.46% of the total area of the basin. The lowest share have the slopes higher than 12º and in most cases they are spread at the bottom of the slopes.

A no less important characteristic is site orientation or the exposure of the slopes (Condorachi, 2000; Haidu, 1998). The analysis of the site orientation map (Figure 5) made possible to quantify the share of slopes with different exposure which determine variations in the thermal regime. The thermal regime of slopes have significant influences on the triggering of some slope processes. Slopes with northern orientation are shaded, and, as a result, they are wetter and colder. In conditions of a substrate represented by clay-sand rocks, they are more prone to trigger negative exogenic processes such as landslides, torrential erosion and solifluction.

Thus, according to Figure 6, the north-east and south-west oriented sites dominate in the studied area in comparison with north-west, north and south-east slopes, exceeding the values of the latter practically twice, in places triple.

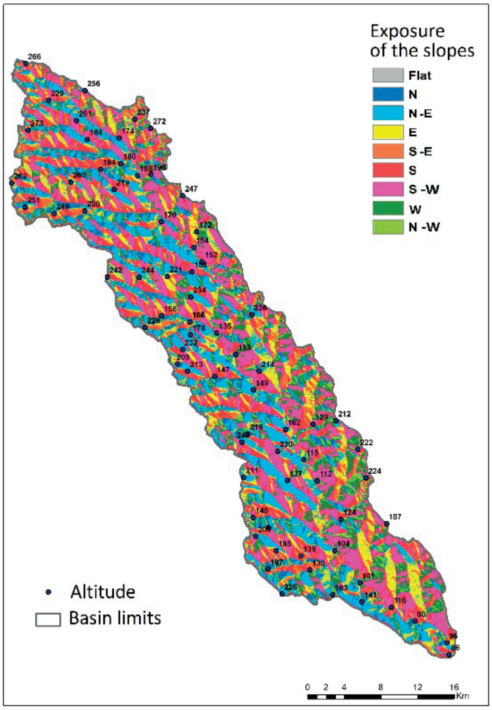

Figure 5. Exposure of the slopes in the Cubolta basin

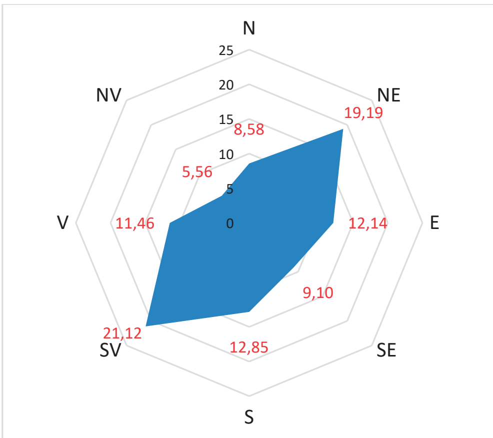

Figure 6. Exposure of the slopes in the Cubolta Basin

The north-east and south-west oriented lands have the largest share and occupy 19.19% and 21.12% respectively of the total area of the territory. The lands with eastern exposure occupy surfaces of the relatively gentle slopes with lengths of over 1000 m, and the lands with southwest orientation occupy the short and steep surfaces of the slopes.

The western, eastern and southern slopes are represented with relatively equal values. They have a share of 11.46%; 12.14% and 12.85% respectively. The western ones are predominantly located on the left side of the Cubolta river, and the southern ones on its right. The lowest values are presented by the northwestern and northern slopes, which constitute 5.56% and 8.58%, respectively. The slopes with north-west exposure are represented by short slopes and in most cases with a slope higher than 5º, and the northern ones occupy surfaces of relatively gentle slopes with slopes between 5-7º.

Two other morphometric parameters with appreciable potential in triggering external geomorphological processes are vertical fragmentation or relief energy (Figure 7) and relief fragmentation density (Figure 8) or horizontal fragmentation (Popuşoi et al., 2012; Canţîr, 2012).

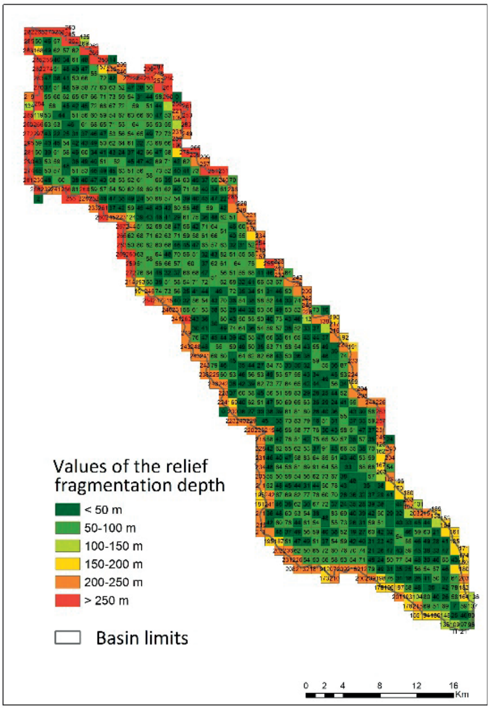

Figure 7. Relief fragmentation depth

The vertical fragmentation or relief energy represents the difference of level between the maximum and minimum elevation within a square with a side of 1 km. The values thus calculated for each individual square were later interpolated, being then divided into 6 classes (Figure 9).

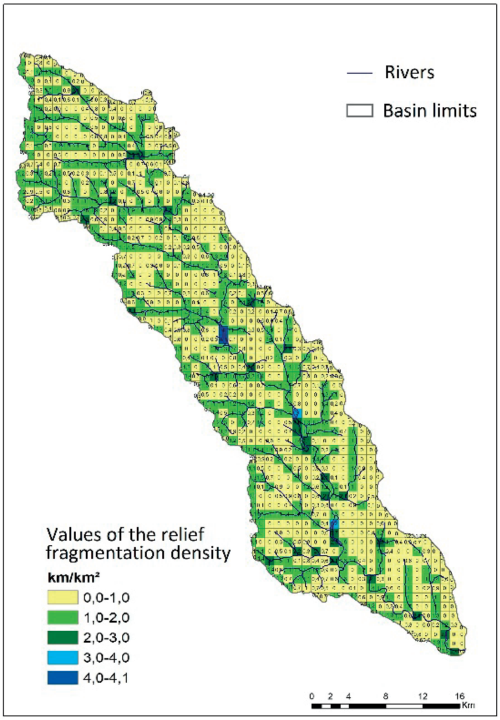

Figure 8. The density of relief fragmentation

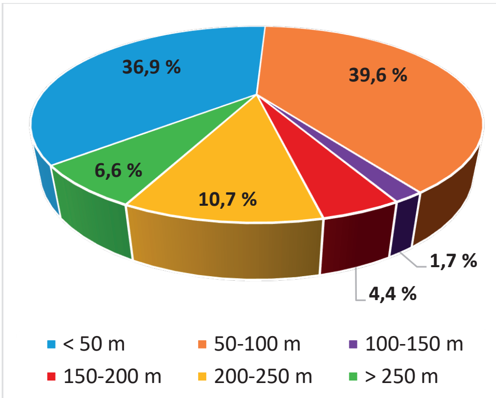

Figure 9. The share of surfaces by classes of vertical fragmentation of the relief

The average value of the vertical fragmentation of the relief is 151.0 m. About 36.9% of the territory's surface is fragmented (<50 m), and the surfaces with relief fragmentation between

50-100 m occupy roughly the same area as the previous class and constitutes 39.6% of the total area of the basin. The average values (150-200 m) occupy only 4.4%. The higher values (200-250 m and >250 m) have the share of 10.7% and 6.6% of the total basin.

The density of relief fragmentation map (Figure 8) was made by the cartogram method, using the ArcGis program. The fragmentation density or the horizontal fragmentation of the relief is defined as the total length of the hydrographic network in relation to the total surface of the territory, hence the unit of measure was km/km². To create this map, it was necessary to create the hydrographic network on the base of information from the topographical map. It was created a grid in kilometres and the grid was cut according to the limit of the study area. The lengths of all the rivers in each square within the grid were determined and finally the layout part was made (Crăciun & Bejan, 2019).

It was found that the territories that have the largest share of the total surface of the basin (62.9%) are the surfaces with a relief fragmentation density that does not exceed 1 km/km² (Figure 10).

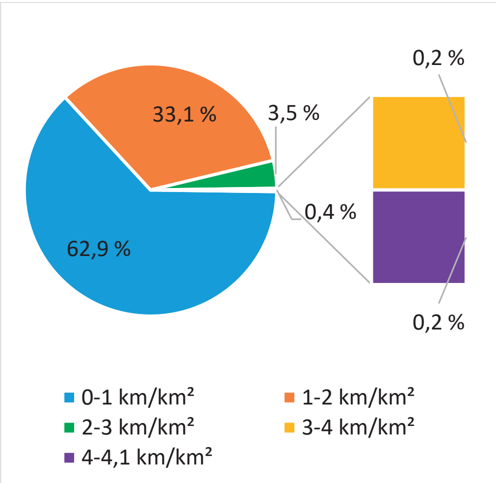

Figure 10. Relief fragmentation density histogram

These are followed by lands with a density of fragmentation between 1.0-2.0 km/km² with a share of 33.1%. The density between 2.0-3.0 km/km² occupies 3.5% of the entire territory, and the surfaces with a density exceeding 3.0 km/km² and 4.0 km/km² barely reach 0.2% of total area.

CONCLUSIONS

Digital terrain modelling is the initial stage in performing relief analysis of a territory. These modelings are impossible to accomplish without the help of the Geographical Information System. The use of GIS techniques presents numerous advantages, by monitoring, verifying and permanently supplementing a field monitoring database. With the help of these systems it is possible to process a large amount of information with the possibility of supplementing this database with new data. In the present case, the analysis of the database resulted in the cartographic visualization of the morphometric parameters of the relief (hypsometry, orientation, slope, etc.) within the limits of the Cubolta basin.

The morphometric parameters provide information with reference to the territories likely to be affected by geomorphological processes. The relief of the Cubolta basin is characterized by altitudes between 85-280 m, with an average altitude of 221 m. The maximum values of the altitude are 280 m, and the minimum of 85 m with a less pronounced slope, the surfaces between 2-5° occupying a weight of 47.04% of the total area of the territory. On the territory of the basin, the southwest-oriented slopes predominate, and the most extensive depth interval of relief fragmentation is 50-100 m (39.6%) of the total area of the basin.

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