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Morphometric elements of the 7th-order hydrographic sub-basins of the Sărățel Stream

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Abstract: The Sărățel Stream is located in the most geodynamic area of the Romanian territory, the Subcarpathian Curvature. The physical-geographical characteristics, as well as the social-human impact, created a specific landscape system, in which the present morphodynamic processes register accentuated dynamics. Uplift and erosion, together with relief are the fundamental components of geomorpho-dynamic systems of the Sărățel catchment.

On the other hand, for the geomorphologic characterization of any geographical space we take into account the river morphometric parameters, which can be useful in quantitative morphodynamic studies. Then, using the Horton-Strahler classification system, we obtained for each sub-basin the morphometric model of drainage of the stream segments of successively increasing orders; the laws that define them verify well at the scale of the river sub-basin.

Keywords: geodynamic area, morphodynamic processes, morphometric model, drainage

1. INTRODUCTION

The main concerns of our society are high-level progress and sustainable development and presume detailed knowledge of the physical environment as a support of social activities. The similarities of physical and geographical conditions have contributed to the individualization of the geomorphological units and are typically expressed qualitatively.

The morpho-hydrographic catchment of the Sărăţel Stream is located at the exterior of the Carpathian Curvature, in the Buzău Mountains group and in the Buzău Subcarpathians sub-group and it is the tributary of the Buzău River on the left. The confluence is located near the settlement of Berca, Buzău County.

The limit of the Sărățel Stream is represented by the watershed between the river and its tributaries and the adjacent catchments: The Slănicul de Buzău valley in the northeast and the east; the Murătoarea valley in the east (southwards of the Mud volcanoes plateau); the Bălăneasa valley in the west.

The highest altitude is reached in the Ivanețu Ridge, 935 m, and the lowest altitude is located near the confluence with the Buzău River, at only 141.6 m. The total drainage area covers a total surface of 189.54 square kilometres, representing one of the small catchments that are tributary to the Buzău River.

The river stretches along 34.21 kilometres and it is characterized by an average multi-annual flow of around 1 cubic meter/second.

The geological domain in which the hydrographic basin of the Sărățel Stream has developed consists of the Palaeogene flysch and within the Mio-Pliocene molasses, with friable rocks: the sandstones, the limestone, the conglomerates, the gypsum, the salt, the marls, the clays, the sands, included in the folded and faulted structures. The action of the external agents has generated a specific landscape, dominated by landslides and torrential organisms.

Inside of the drainage area, there is a wide range of altitudes, that belongs to the hill landform, such as 900 meters of the Leordețu Hill, 885 meters of the Pietrișului Peak, 802 meters of the Pițigoiului Peak and so on, to altitudes under 150 meters in the lower sector of the Sărățel floodplain. The main interfluvial ridges are developed by the morphotectonic influence, meanwhile, the secondary ones are perpendicular to the former. On the other hand, the structural relief consists of numerous cuesta escarpments and creates a unique note within the landscape. In the saliferous areas, spectacular specific karst relief with an accentuated dynamics has formed.

The groundwater quantity is under-developed, with a scanty flow, and the surface water shows important seasonal and annual variations. For all that, there are to be noticed the sulfurous, chlorinated, salty etc. springs located in the areas of Cănești, Păcuri, Negoșina, Gonțești settlements.

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From the climatic point of view, the main features are influenced by the average temperature, between the 6^0 and 10^0 C isotherm, with an average pluvial value of about 700 millimeters/year.

2. METHODOLOGY

In order to determine the morphometric characteristics of the hydrographic network of the Sărăţel basin, the information has been taken from the topographical maps drawn up at a 1: 25,000 scale, considering that it provides sufficient details for achieving the proposed goal. The morphometric elements for the entire Sărăţel basin and its sub-basins have been obtained by covering the following steps:

- Digitizing the entire hydrographic network
- Grouping it in the Horton-Strahler system
- Exporting the database as an Excel spreadsheet
- Centralizing the data: number of segments, length of segments and their average length, all being performed according to Horton-Strahler system rules
- Drawing up the morphometric models of drainage by building the three exponential regressions: number of segments, the measured length of the segments and their average length
- Using the equation specific to each regression, the calculation of the real order for each river was possible.

3. RESULTS

The analysis has taken into account the three 7^{th}-order basins, of which two: the Sărăţelul Superior Stream and the Grabicina Stream constitute the main basins for the formation of the upper basin of the 8^{th} order. The third basin, the Băligoasa Valley, a tributary located on the left side of the main collector, is a special basin, fact highlighted by the presence of the Mud volcanoes in Pâclele (Mari and Mici) and whose activity influences regionally the evolution of the hydrographic network of the Sărăţel Stream.

By centralizing the data, a series of ascending geometric progressions have been obtained for the number of segments and their measured length (Zăvoianu I., 1985); the Grabicina Stream follows the ascending geometric progression law on the segments length.

The Upper Sărăţelul Stream, due to the elongated shape of the basin, deviates from the rule, the value of the length measured for the upper 7^{th} order far exceeding the value corresponding to the regression line.

In the case of the Băligoasa Stream, the anomaly mentioned above, due to the presence of the Mud volcanoes, is underlined by the deviation from the regression line of the segments' length values for the upper orders, the 6^{th} and the 7^{th}, as seen in figure no. 3.

The development of the hydrographic network has occurred in close connection with the tectonic substratum background, but also in correlation with the geological structure (Cruceru, N., 2005).

This has been deduced from the mathematical analysis of the basins under study, as follows:

Law of the Number of River Segments, of Different Orders

- for the Upper Sărăţel Stream basin, with a total of 7,038 segments of different orders, totalling 1,202,758 m, we reached an estimated order of 6.95 by analysing the regression equations. On the other hand, by estimating the number of river segments by means of the confluence ratio, a value of 7,024 has been obtained, compared to the 7,038 measured; the low degree of error leading us to the idea that the measurements have been relatively correct.

Regarding the assessment of the order of magnitude, we have noticed that the measured values are confirmed by both calculation methods, namely: the methods by which the 1^{st}- and the 2^{nd}-order basins have been considered as fully formed orders; as well as the deviation of points on the regression line has been extremely low. Also, by using the law of the number of segments, an overestimation by 30-40% (1.34-1.39) of the upper basin has been noticed regarding the unit value of the higher order segment, and we have also obtained an order of 7.21 by using the logarithm formula.

The Law of Summed Lengths

Regarding the observance of the law of summed lengths, the situation has differed in the sense that, starting with the 5th order, the values become somewhat independent of the regression line. This is why we have resorted to a graphic representation logistics; Thus, we have drawn up two regression lines, namely: a regression for the 1^{st}-4^{th} orders and a regression for the 4^{th}-7^{th} orders. A first conclusion is that the basin, at some point and in a certain place, has started to function conditioned by a major evolutionary factor. In this case, we can speak of the influence of substratum tectonics, most likely reflecting a tilt movement of regional tectonic blocks. The consequence of this phenomenon is the concentration of the rivers in a certain direction and, implicitly, the asymmetric form of the basin. In addition, the linear continuity of the upper order segment (the 7^{th} order) further strengthens the view that the basin functions closely with regional neotectonic evolution.

The Law of Average Lengths and the Morphometric Drainage Model

By making the progression of the successive order number and that of the total lengths, the law of average lengths and its ratio can be determined. The strains of the two progressions are concurrent at a point where the two equations have common roots. From the ratio of the two rows there results a third string, which represents the average length of the courses with successive orders and is a direct geometric progression. From the three straight lines, determined by the drainage laws of a hydrographic basin, a triangle results in some semi-logarithmic coordinates. The tip prompted by the concurrent lines, which give the law of summed lengths and that of average lengths, represents the point where the two equations have common roots, the abscissa value giving the order of magnitude of the basin in question, in this case obtaining a value of 7.21, i.e. the same value obtained in the case of the law of the number of segments. If we take into account the situation resulting from the analysis of the law of the river segments where we have obtained two successive straight lines, then we would obtain other values, both for lower order (1-4) and for the upper order (4-7) basins. (Figure 1)

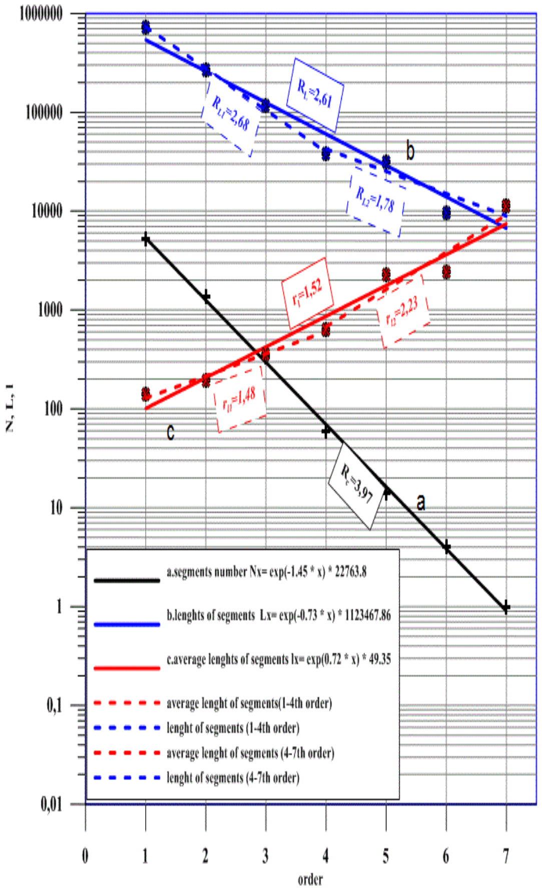

Figure 1. The Upper Saratel Stream- the drainage model: a, the law the number of stream segments; b, law of summed length on orders (km); c, the law of average lengths (in km)

Law of the Number of River Segments, of Different Orders

- for the Grabicina Stream basin, with a total of 3,210 segments of different orders, totalling 464,161.66 m, we have reached an estimated order of 6.7 by analysing the regression equations. On the other hand, by estimating the number of river segments by means of the confluence ratio, a value of 3,209 segments has been obtained, compared to the 3,210 measured; the low degree of error leading us to the idea that the measurements have been relatively correct.

Regarding the assessment of the order of magnitude, we have noticed that the measured values are confirmed by both calculation methods, namely: the methods by which the 1st- and the 2nd-order basins have been considered as fully formed orders; as well as the deviation of points on the regression line has been extremely low. Also, by using the law of the number of segments, an overestimation by 46-47% (0.46-0.47) of the upper basin has been observed regarding the unit value of the higher order segment, and we have also obtained an order of 6.46 by using the logarithm formula.

The Law of Summed Lengths

Regarding the observance of the law of summed lengths, the situation has differed significantly from the first case, but it does not require the representation of two distinct regression lines. We have noticed an overestimation of the measured lengths, starting with the 4^{th} order, following successively the 5^{th}, the 6^{th} and the 7^{th} orders. One conclusion would be that higher order talweg have begun to develop in depth, synchronous with a pseudo-modulation oscillation movement; this has led to a real-time length gain, amid morphodynamic processes at the bottom of the respective basin slopes. The role of tectonic and structural factors in the evolution of these basins should not be neglected.

The Law of Average Lengths and the Morphometric Drainage Model

Considering the algorithm presented in the case of the Upper Sărățel Stream and reminding that the tip prompted by the concurrent lines, which give the law of summed lengths and that of average lengths, represents the point where the two equations have common roots, the abscissa value giving the order of magnitude of the basin in question, in this case obtaining a value of 6.46, i.e. the same value obtained in the case the law of the number of segments. To emphasize that underestimation of the value strings, we can resort to the graphical logistics by making the regression from the 4^{th}- to the 7^{th}-order basins. (Figure 2)

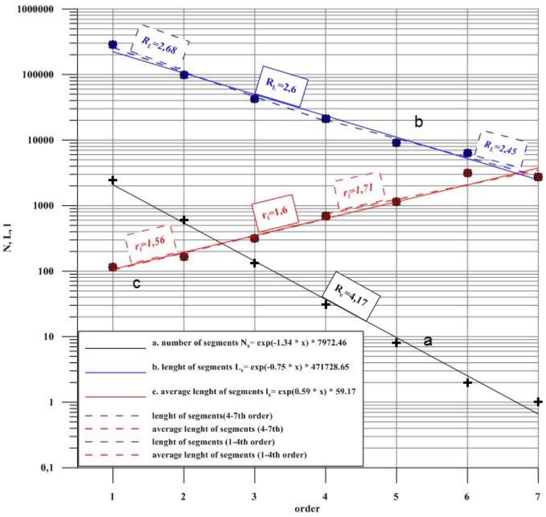

Figure 2. The Grabicina Stream- the drainage model: a, the law the number ofstream segments; b, law of summed length on orders (km); c, the law of average lengths (in km)

Law of the Number of River Segments, of Different Orders

- for the Băligoasa Stream basin, with a total of 3,753 segments of different orders, totalling 579,730.24 m, we have reached an estimated order of 6.65 by analysing the regression equations. On the other hand, by estimating the number of river segments by means of the confluence ratio, a value of 3,751 segments has been obtained, compared to the 3,753 measured; the low degree of error leading us to the idea that the measurements were relatively correct.

Regarding the assessment of the order of magnitude, we have noticed that the measured values are confirmed by both calculation methods, namely: the methods by which the 1st- and 2nd-order basins have been considered as fully formed orders; as well as the deviation of points on the regression line are extremely low starting with the 4th-order basin. Also, by using the law of the number of segments, an overestimation by 47-48% (0.47-0.48) of the upper basin has been noticed regarding the unit value of the higher order segment, and we have also obtained an order of 6.48 by using the logarithm formula.

The Law of Summed Lengths

Regarding the observance of the law of summed lengths, the situation has differed in the sense that, starting with the 5th order, the values become somewhat independent of the regression line. This is why we have resorted to a graphic representation logistics; Thus, we have drawn up two regression lines, namely: a regression for the 1st-4th orders and a regression for the 4th-7th orders. These deviations occur as a result of the complex evolution of the basin, more precisely on the left side, where the mud volcanic plateaus of Pâclele Mari and Pâclele Mici unfold. In fact, the domed shape has led to a reorientation of the hydrographic network, marked in relief by numerous 90° angles, as well as the development of the radial hydrographic network.

The Law of Average Lengths and the Morphometric Drainage Model

Considering the algorithm presented in the case of the Sărățelul Superior Stream and reminding that the tip prompted by the concurrent lines, which give the law of summed lengths and that of average lengths, represents the point where the two equations have common roots, the abscissa value giving the order of magnitude of the basin in question, in this case obtaining a value of 6.65, i.e. the same value obtained in the case the law of the number of segments. To emphasize that underestimation of the value strings, we can resort to the graphical logistics by making the regression from the 4th- to the 7th-order basins. (Figure 3)

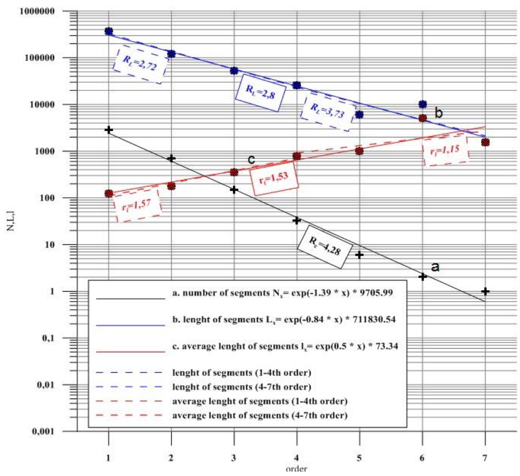

Figure 3. The Băligoasa Stream- the drainage model: a, the law the number of stream segments; b, law of summed length on orders (km); c, the law of average lengths (in km)

4. CONCLUSIONS

The evolution in time of a drainage network, in terms of the number of different rivers, tends to achieve a balance of that system. Due to the fact that the drainage space of the Sărăţel Stream is located in a fragmented area of the Subcarpathian Curvature, with a very active tectonics and a very heterogeneous lithology, the achievement of a drainage balance is very difficult to achieve; this is also evidenced by the presence of basins of different orders that are not sufficiently developed for the order they carry and are subjected to very active erosion and fragmentation processes.

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