

The Use of the Geomorphometric Method for the Assessment of the Giumalău Massif Drainage Development Stage

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Cuvinte cheie: rețea de drenaj, bazine hidrografice, nivel de bază, parametrii morfometrici

Rezumat: În Masivul Giumalău în condițiile unui substrat geologic, constituit în cea mai mare parte din roci metamorfice și al unor circumstanțe climatice care nu prezentau diferențieri spațiale importante, evoluția rețelei de drenaj a ținut seama, în primul rând, de nivelul de bază local dat de râurile Moldova și Bistrița. Demersul științific de față încearcă, prin metode morfometrice, să pună în evidență diferențierile existente între bazinele hidrografice de diferite ordine de mărime dar și nivelul până la care se resimt acestea, având în vedere faptul că există ipoteze care consideră că bazinul hidrografic al Moldovei s-a organizat mai repede decât bazinul Bistriței. Se constată o anumită diferențiere în ceea ce privește gradul de dezvoltare al rețelei de drenaj. Analiza parametrilor statistici indică un grad mai avansat de organizare la nivelul rețelei aferente bazinului Moldovei, nivelul de bază local fiind extrem de important pentru bazinele hidrografice de ordinele V și IV (sistem Strahler) și mai puțin semnificativ pentru bazinele hidrografice de ordinul III și mai mici.

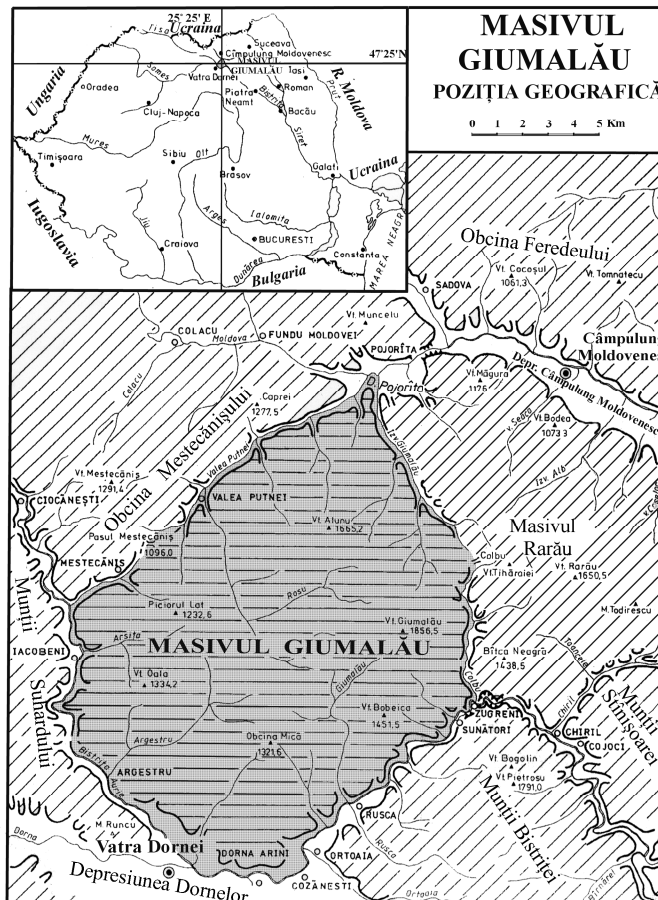


Fig. 1 Geographical location of Giumalău Massif

Drainage constitutes the main way through which eroded materials may be transported outside the Giumalău Massif perimeter. According to the geological time scale, material evacuation was tightly related to climatic manifestations, petrographic associations, vegetal composition and, last but not least, the development of the two important hydrographic basins: Moldova and Bistrița (Fig. 1).

The Giumalău Massif is part of the mezozoic crystalline area in the Oriental Carpathians, the present relief being the result of the interactions among multiple morfogenetic factors. The geological substratum is constituted mostly of metamorphic rocks (Balintoni, 1996), the morphotectonical and morphosculptural relief being differentiated into two tectonical compartments (eastern and western). The eastern one may be considered a horst raised by 500m above the western compartment. The second one, on the other hand, corresponding to the peak line Poiana Runcului-Mestecăniș, constitutes the watershed between Bistrița and Moldova rivers.

Considering the context, a great part of the morphosculptural and fluvial relief of the massif has to be related to the local base levels of Moldova's and Bistrița's thalwegs.

Thus, by means of morphometric methods, the present study attempts to emphasize the differences found among multiple size order basins and also the level up to which these are to be felt, considering the fact that Moldova's hydrographic basin was organized faster than Bistrița's one (Donisă, 1968, 1972, 1973).

The research started with the establishment of a hierarchical system for the considered territory drainage, with the use of the A.N.Strahler system (1952), which offers a logical support for the comparative geomorphological study of drainage basins in relation to different factors determining their evolution (Ohmori et al. 1993, Ichim et al., 1981, 1983, 1986, 1989, Bravard, 1998,). The Vth, IVth and IIIrd order basins were those used as a basis for the morphometric analysis (Zăvoianu, 1978, Grecu Florina, 1992, 2008).

The following have been identified: 49 IIIrd order hydrographic basins, totalizing an area of about 136.44 sqkm, which represent, within the massif limits, around 55% of the total area (Fig. 2.a.), 14 IVth order hydrographic basins and 3 Vth order hydrographic basins (Lesenciuc, 2000, 2004, 2006).

For the comparative analysis of the two drainage basins of Moldova and Bistrița, a series of variables associated to hierarchical orders, lengths, areas and frequencies have been determined: the number of Ist order rivers (magnitude), the drainage basin area (S_b, sqkm) and the minimum altitude in the basin (H_{min}, M). To these, there may be added the concavity quotient of the longitudinal profiles of different sized order thalwegs.

From the total number of IIIrd order basins, 23 belong to Bistrița's hydrographic basin and 26 to Moldova's. As they have an approximately equal population in number, the statistical processing of these data was conducted according to the two greater hydrographic basins, in order to detect possible differences.

The analysis of the statistical parameters corresponding to IVth order hydrographic basins, grouped according to their affiliation to the two greater basins, was favoured by the equal number of 7 IVth order hydrographic basins belonging both to Moldova and Bistrița. The average basin area is of 11.11 sqkm for Bistrița and 7.50 sqkm for Moldova (Fig. 2.b.).

The comparative analysis of the average areas of differently ordered hydrographic basins emphasizes the following aspects:

- the Vth order basins of Moldova have an approximately fourth time larger average area than that of the Vth order basin belonging to Bistrița;
- a reversal occurs in the case of the IVth order basins: those belonging to Bistrița have a larger average area than those of Moldova;
- in the case of the IIIrd order basins, average areas corresponding both to Moldova and Bistrița are considerably similar (Fig. 3).

With respect to the areas of drainage basins, conclusions may be drawn on a general level. Differences in the average areas of the basins corresponding to Moldova and Bistrița are progressively diminishing from Vth to IIIrd order, which points to the idea that it is only in the case of hydrographic basins superior to the IIIrd order that the two local base levels influence Giumalău Massif from a morphosculptural point of view.

Thus, we may admit the fact that Moldova's IVth and Vth order hydrographic basins proved to have a more advanced drainage organization degree.

The comparative analysis of the two basins' minimum altitudes indicates a greater influence of

Moldova's and Bistrița's local base levels on Vth and IVth order basins and a decreasing one, to the point of disappearance, at the level of IIIrd order basins (Fig. 4).

The analysis of the local base average levels points to the fact that Moldova's Vth order drainage basins have their local base level by approximately 50m lower than the ones of Bistrița. Considering the base levels, Moldova's IVth order basins are

90m higher than the Bistrița's ones. In the case of IIIrd order basins, local base levels are situated at similar altitudes, with a plus of only 14m for Bistrița's basins. In conclusion, this variable also indicates that differences between the base levels of the drainage basins within the two main hydrographic basins have the tendency to decrease considerably from the Vth to the IIIrd degree.

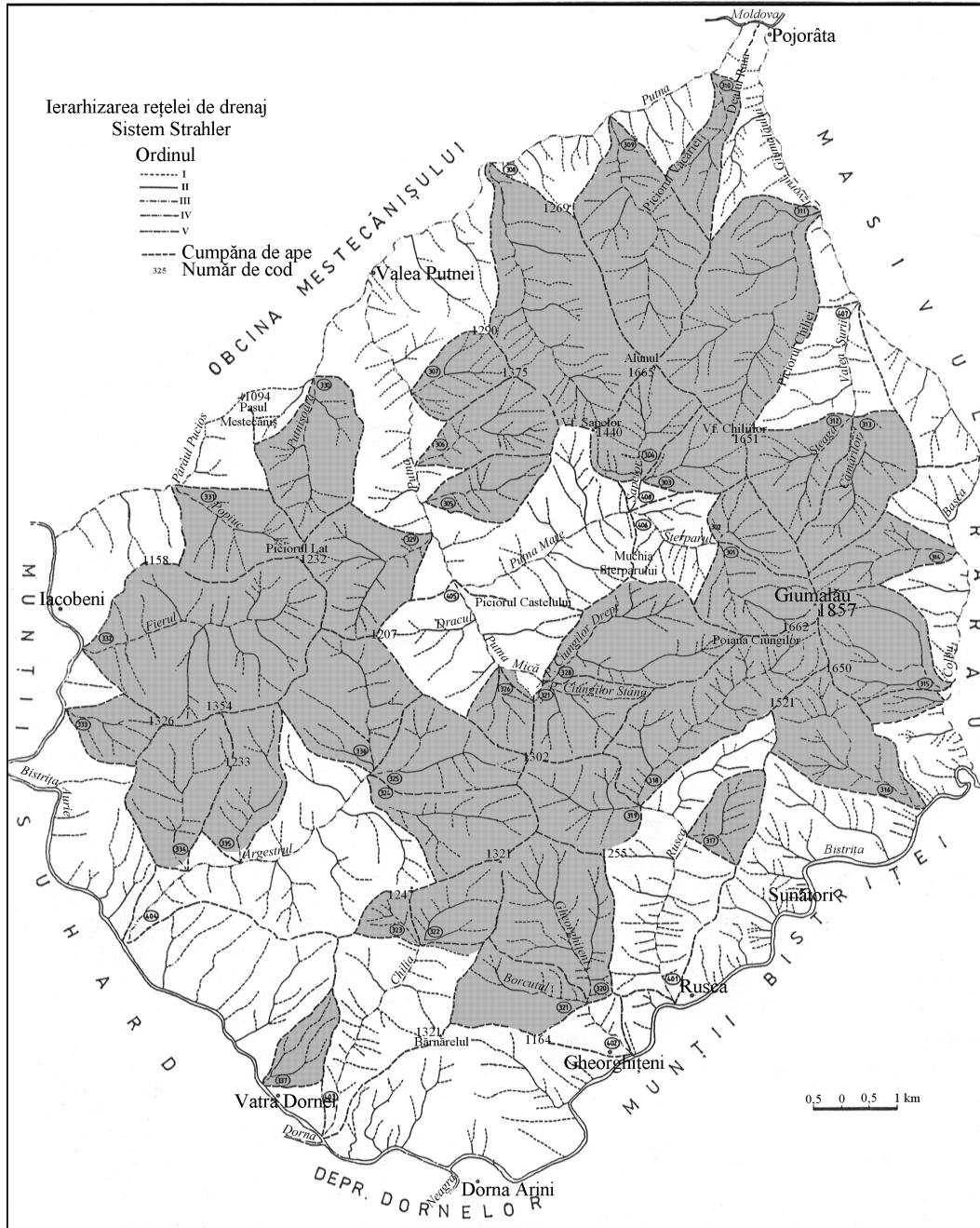


Fig. 2. a. Third order drainage basins distribution in the Giumalău Massif

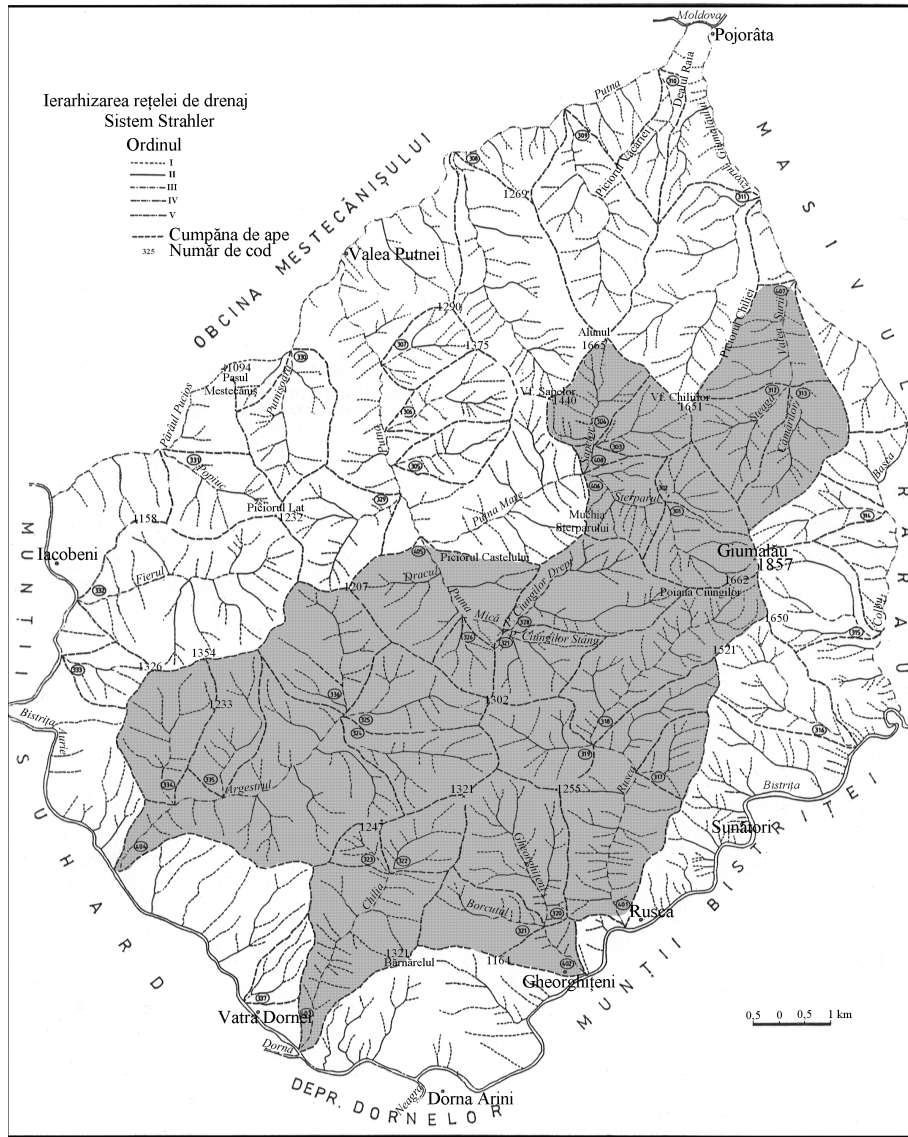


Fig. 2.b. Fourth order drainage basins distribution in the Giumalău Massif

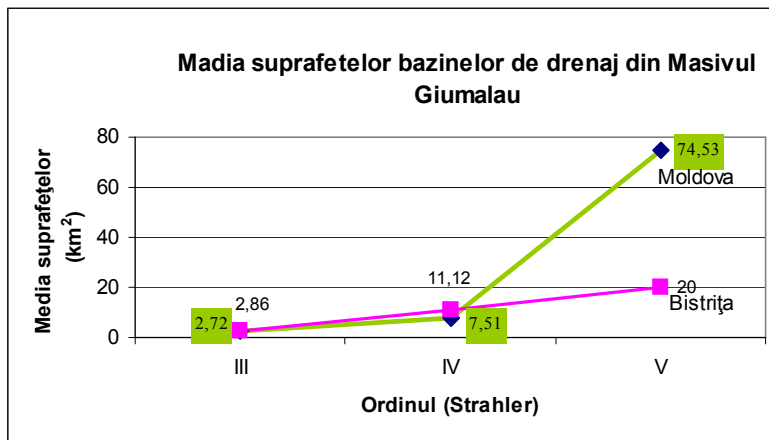


Fig. 3 Average areas of Moldova and Bistrița drainage basins

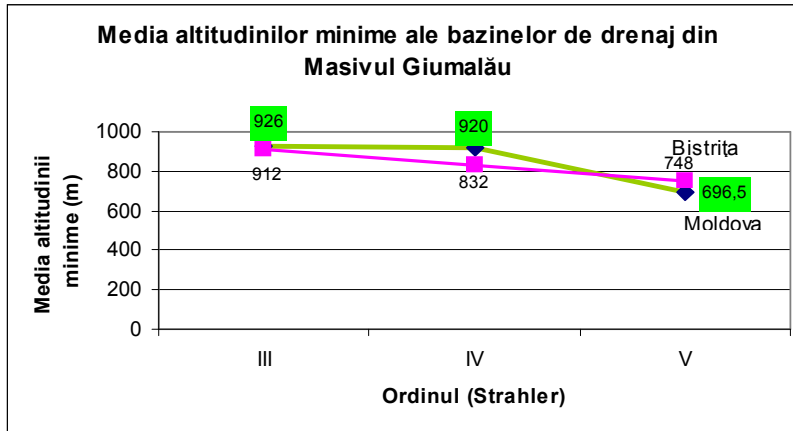


Fig. 4 Average minimum altitudes of Moldova and Bistrița drainage basins

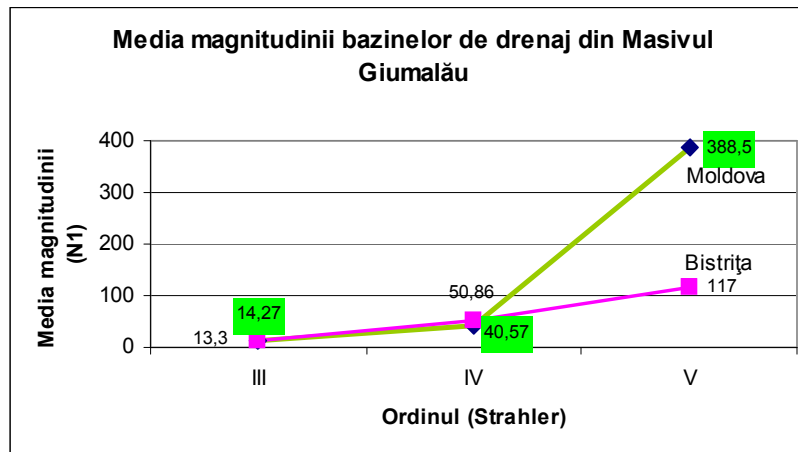


Fig. 5 Average magnitude Moldova and Bistrița drainage basins

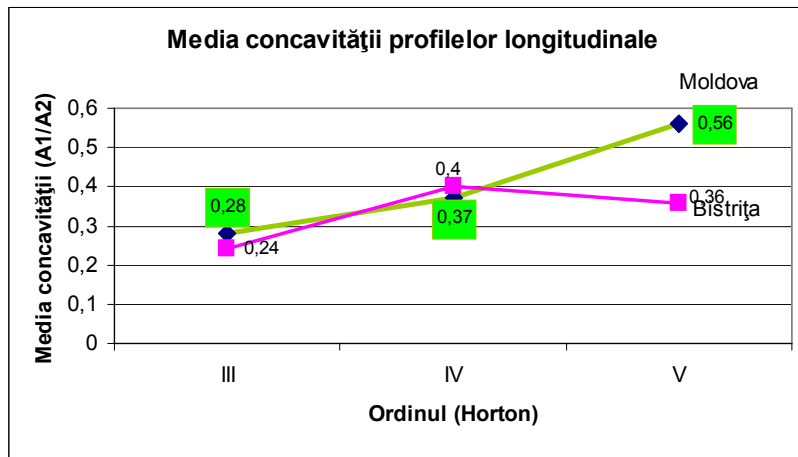


Fig. 6 Average concavity of longitudinal profiles in the Giumalău Massif

Regarding the magnitude (N1), significant differences between the two main hydrographic basins appear on the level of IVth and Vth order basins. Average values corresponding to IVth order basins are considerably greater for Moldova's basins, which may be explained by a much stronger

relief fragmentation in the area of Giumalău-Alunu peak line, to which may be added a local base level altitude situated approximately 50m lower than Bistrița's. Putna's Vth order drainage basin has a more advanced organization, covering more than half of the massif's total area. Bistrița's IVth order

drainage basins have average magnitude values superior to Moldova's, while on the level of the IIIrd order drainage basins, the magnitude is higher for those belonging to Moldova, although extremely similar to Bistrița's. The conclusion to be drawn once again is that magnitude differences diminish while the order decreases (Fig. 5).

The longitudinal profiles average concavity analysis demonstrates that the relationship between concavity and the local base level is obvious for all of the hydrographic basins categories (Vth, IVth and IIIrd orders), with a more advanced development for Bistrița's IVth order basins. The explanation lies in the fact that most of them are Bistrița's direct tributaries, while, on the level of Moldova's drainage basin, better developed IVth order tributaries (Putna and Izvorul Giumalăului) have at their turn local base levels situated at higher altitudes than Bistrița (Fig. 6).

We may thus conclude that Moldova's and Bistrița's local base levels represent two extremely important elements for the Vth and IVth order drainage basins evolution, this influence diminishing to the point of disappearance in the case of inferior order drainage basins.

At the level of IIIrd order drainage basins, distributed within multiple morphotectonical conditions, we may observe a significant reduction of the differences occurring between the two main drainage basins to which they belong.

In the context of a mostly metamorphic geological substratum and scarcely different climatic circumstances, drainage evolution was especially controlled by the two collectors local base levels.

A certain differentiation appears in the drainage development degree. The statistical parameters analysis indicates a higher degree of organization for Moldova's drainage basin. In these circumstances, we would be tempted to give the time factor an essential role, in accordance to some researchers opinion that Moldova drainage basin is older. But, taking into account a drainage network which does not go beyond the Vth order, we believe that its evolution degree is especially a result of the local base level established by these two main collectors – Moldova and Bistrița –, as well as a consequence of an adaptation to the area's tectonical and structural situation.

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