SPATIAL DIFFERENTIATION OF FLOW IN APUSENI MOUNTAINS

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ABSTRACT. Spatial differentiation of flow in Apuseni Mountains. Apuseni Mountains – through the Vlădeasa-Bihor-Metaliferi alignment – represents a barrier against the western air masses circulation. This determines strong differentiations in river flow. This phenomenon is recorded by 48 hydrometric stations, with 19 on the western slopes and 28 on the eastern slopes for the period 1950 – 1994. The basins correlations between discharge and altitude are logarithmic. They express the spatial flow differentiations between the two slopes or between different hydrographic basins.

Keywords. Flow, altitude, western circulation, logarithmic function, deviation

1. FLOW'S GENETIC FACTORS

Apuseni Mountains are characterized by a pronounced fragmentation, with frequent alternation of peaks, valleys, depressions and plateaus. The mountainous peaks have different orientations. The Vlădeasa – Bihor alignment and the eastern extremity of Metaliferi Mountains represent a strong north – south axis. This is a determinant factor in flow genesis, because it constitutes a barrier against the dominant western air masses circulation. Even though the altitudes are not very high, they influence the air movement towards the Transylvanian Depression, the nebulosity variation, and in consequence, the rainfalls quantity and repartition.

The other peaks, most of the appendix of the main alignment, have west – east as the main direction. Towards east there is present an almost parallel alternation of mountains and valleys, where there had developed elongated depressions. This way, the western circulation is oriented towards the north – south barrier. The wet air masses have an ascending movement.

In the eastern part of the group, the relief is more complicated, with a high variety of peaks, valleys and depressions. The mountains Gilău, Muntele Mare și Trascău end relatively sudden with the Someșul Mic and Mureș corridors. Of course, these characteristics influence flow genesis in this part of Apuseni Mountains, because the air masses crossing this mountains receive a descending movement (Mihăilescu, 1969).

Within this main legit can be identified other spatial differences, determined by local conditions that determine rainfalls and flow formation (Ujvari, 1972).

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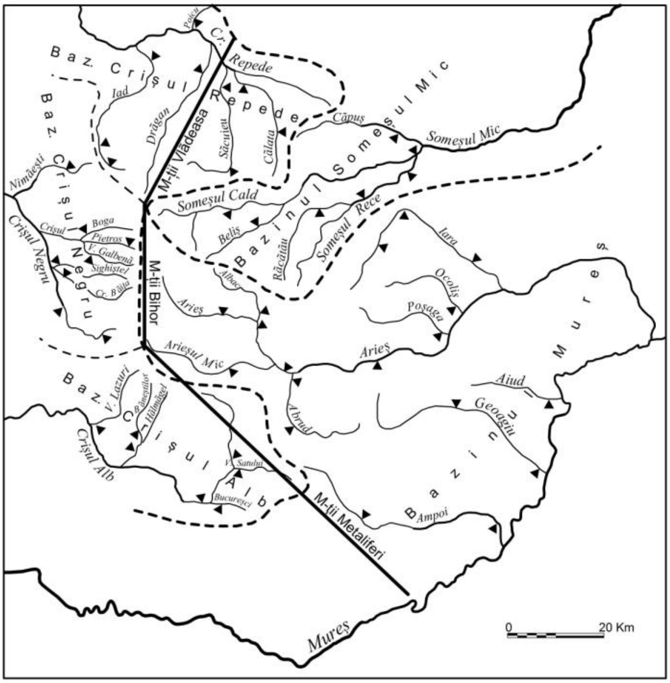

Fig. 1. ***Hydrographic network and hydrometric stations from Apuseni Mountains***

2. DATA BASE AND METHOD

The flow monitoring on the rivers from Apuseni Mountains is well organized. There are a total of 49 hydrometric stations, properly distributed, both spatially and depending on the altitude. From these stations, 20 control the flow from the western part of the Vlădeasa-Bihor-Metalifer alignment, and 29 the eastern part.

On each major slope there have been identified some groups of stations with different relations between hydrographic basins' average altitude. Hence, the stations from the western slopes have been divided into three groups: Crișul Repede River Basin at west of Vlădeasa Mountains (5), Crișul Negru River Basin (8) and Crișul Alb River Basin (7). The stations from the eastern slopes are divided into five groups: Upper Crișul Repede River Basin at east of Vlădeasa Mountain (4), Someșul Mic River Basin (7), Upper Arieș River Basin (8), Lower Arieș River Basin (5) and the river basins from eastern Trascău (5).

For each hydrometric station there has been calculated the multiannual average flow value for the period 1950-1994. There was not select a more recent period because many hydrometric stations from the mountainous area were dissolved in 1995, which would greatly diminish correlations value. Using these values, there were calculated the functions q=f(Hm) for two areas separated by the Vlădeasa-Bihor-Metaliferi alignment, and also for the hydrographic basins mentioned.

Grouped this way, the correlations with the average altitudes present well defined trends. For all groups, the trends' relations are logarithmic, and the calculation formulas are:

$$x = e^{(y-a)/b} \quad \text{or} \quad x = e^{(y+a)/b}$$

Using these functions, there were calculated the average specific flow values by altitude steps of 200 m, between 600-1200 m. These values were used to express flow's space differentiations in Apuseni Mountains.

3. RESULTS

3.1. Flow differentiations between the western and eastern slopes

The repartition of hydrometric stations on the two slopes assures a good flow control. The stations cover hydrometric basins with average altitudes of 553-1210 m in west and 632-1295 m in east. To make correlations there were used data from 17 stations in the western region, and respectively 18 stations in the eastern region. In these charts there were eliminated some stations to make the correlations.

The allure of these two correlations is similar. In both cases, the rising flow slope increases at high altitudes. The rising rates differentiate on both slopes. In west, for 200 m level difference the rising rates are of 8, 14 and 23 l/s km^2, and in east of 3, 5 and 10 l/s km^2. The specific flow values are different from a slope to the other, but also for each altitude step.

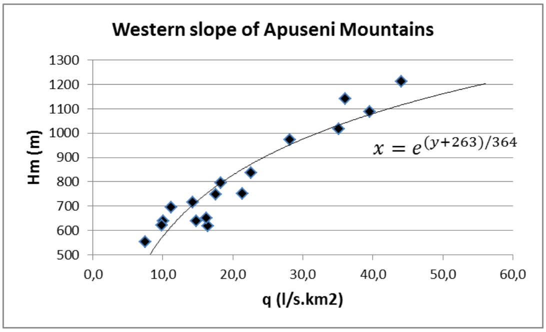

Fig. 2. ***Flow-altitude variation on the western slopes of Apuseni Mountains***

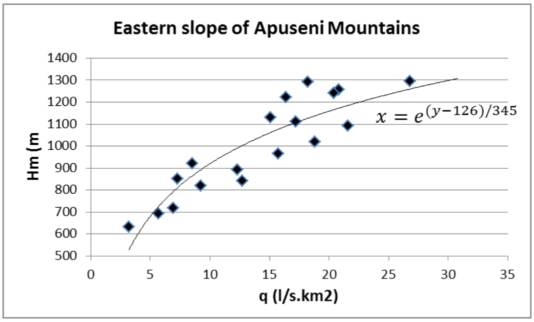

Fig. 3 ***Flow-altitude variation on the eastern slopes of Apuseni Mountains***

After analyzing flow deviations at mountains foot, the flow is with 63 % lower in east than in west. The percentage of deviations slowly decreases towards higher altitudes, with 60 % at 1200 m. So it follows a very big average difference between the rich runoff from the west and east of the main slope alignment. This shows that, although the peaks are not very high, they constitute an important barrier for the wet air masses movement towards east.

Table 1. ***Flow deviations between west and east***

	West	East	
Hm (m)	q (l/s.km2)	q (l/s.km2)	ε (%)
600	10.7	4.0	63
800	18.5	7.1	62
1000	32.1	12.6	61
1200	55.7	22.5	60

3.2. Regional flow differentiations

The regional differentiations refer to the variation of specific average flow in different river network basins and subbasins. Because the main control factor is represented by the ridge of Vlădeasa and Bihor Mountains, reaching in east the Metaliferi Mountains, the situation will be analyzed on both slopes of this alignment.

In Crișul Repede basin, a very asymmetric basin, the Vlădeasa Mountains divide a group of eastern tributaries (Călata, Săcuieu etc.) from the ones situated further in west (Iad, Poicu etc.). this factor significantly differentiate the flow in the two basins. In west, the flow is richer than in the shadowed eastern mountainous basins. The exponential correlations are well defined by four hydrometric stations.

Drăgan River presents a special situation (Horváth, 2008). The upper river basin is situated at west of Vlădeasa Mountain, but the lower basin presents a smaller rainfall quantity due to the shadowing effect of Pădurea Craiului Mountains. At the station from Drăgan Valley that is situated near the confluence with Crișul Repede River can be felt this shadowing effect, situating this station at the same level with the stations from the upper basin on the eastern slopes of Vlădeasa.

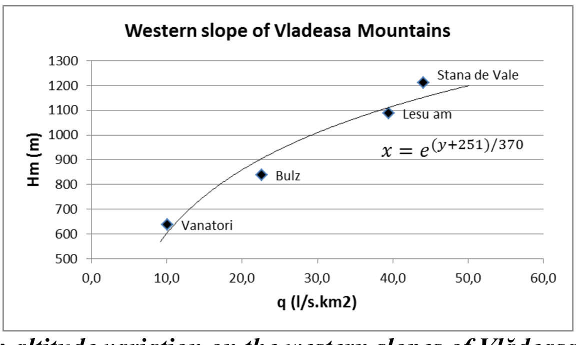

Fig. 4. ***Flow-altitude variation on the western slopes of Vlădeasa Mountains***

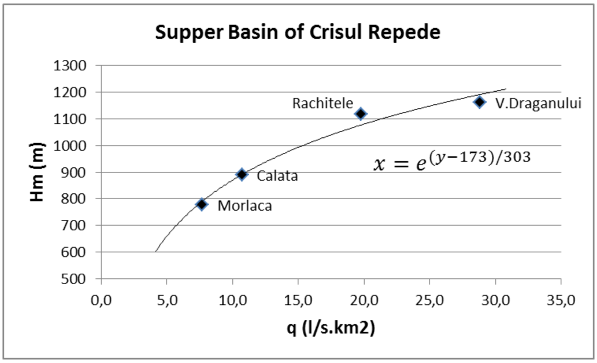

Fig. 5. ***Flow-altitude variation in Upper Crișul Repede Basin***

At east of Vlădeasa Mountains, the average flow represents only half of the flow values from the western slopes. There can be observed a altitude differentiation. At lower altitudes the deviations are greater than near the peaks. The phenomenon is a normal one in terms of flow genesis according to altitude.

Table 2. ***Flow deviations between the basins situated west of Vlădeasa Mountain and Upper Crișul Repede River***

	W. Vlădeasa	Cr. Repede sup.	
Hm (m)	q (l/s.km2)	q (l/s.km2)	ε (%)
600	10.0	4.1	59
800	17.1	4.9	54
1000	29.4	15.3	48
1200	50.5	29.6	41

The Bihor Mountains divide the hydrographic basins of Crișul Negru River, in west, and of Someșul Mic and Arieș rivers in east. The flow in the three basins is controlled by stations with a well-balanced repartition. The number is sufficiently and balanced assigned: 8 stations in Crișul Negru River Basin, 7 stations in Someșul Mic River Basin and 8 stations in upper Arieș River Basin. The correlation is more closed in Someșul Mic River Basin; in the other two basins, the points are more scattered.

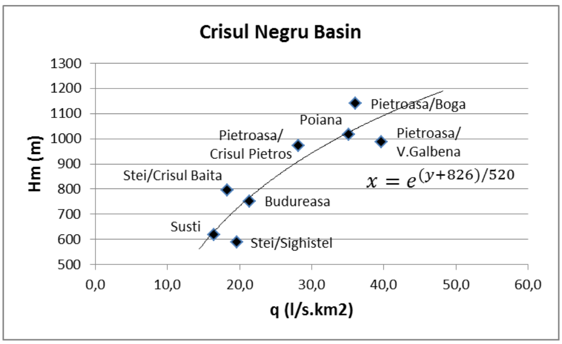

Fig. 6. ***Flow-altitude variation in Crișul Negru River Basin***

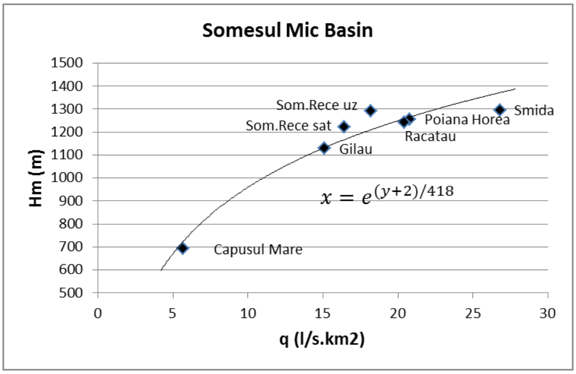

Fig. 7. ***Flow-altitude variation in Someșul Mic River Basin***

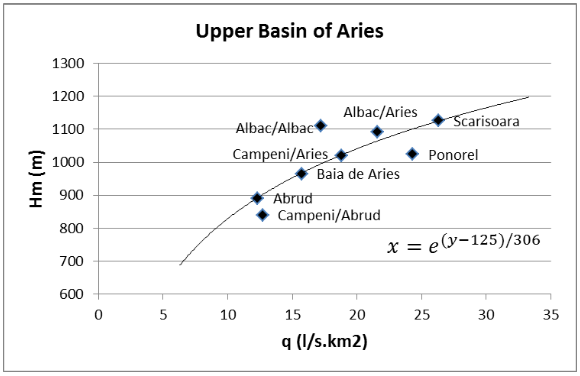

Fig. 8. ***Flow-altitude variation in Upper Arieș River Basin***

The decrease of flow values determined by the presence of Bihor Mountains is more strongly felt in Someșul Mic River Basin. Here the flown water quantities at 600 m altitudes are of barely 4 l/s.km^2, compared with 15 l/s.km^2 in Crișul Negru River Basin, determining an abatement of 73 %. On both basins, the deviations decrease with the altitude, but with different rates, reaching 64 % at 1200 m altitude.

After comparing the flow in the basins of Crișul Negru and upper Arieș rivers, there can be observed some small abatement, more enhanced at higher altitudes. In this way at 800 m there is an abatement of 60 %, reaching almost half (32 %) at 1200 m altitude. It can be observed that between the basins of Someșul Mic and upper Arieș Rivers appears a difference of 2 % at 800 m, reaching 16 % at 1200 m.

Table 3. ***Flow deviations between the river basins of Crișul Negru and Someșul Mic – Upper Arieș***

	Cr.Negru	Som. Mic	Arieșul sup	Cr.N./S.M	Cr.N./A. sup
Hm (m)	q (l/s.km2)	q (l/s.km2)	q (l/s.km2)	ε (%)	ε (%)
600	15.5	4.2	-	73	-
800	22.8	6.8	9.1	70	60
1000	33.5	11.0	17.5	67	48
1200	49.2	17.7	33.6	64	32

Crișul Alb River is oriented only partially towards Arieș River Basin. The air masses crossing the lower watershed move towards the Trascău Mountains. Because of this it must be done a comparison with the stations from the eastern slopes of Trascău Mountains. The points controlling the logarithmic correlations are pretty scattered. The average basin altitudes cover a much smaller vertical deviation: 550-750 m in Crișul Alb River Basin and 650-950 m on the slopes of Trascău Mountains. This is way the comparison of flow abatement can be made only between 600-800 m.

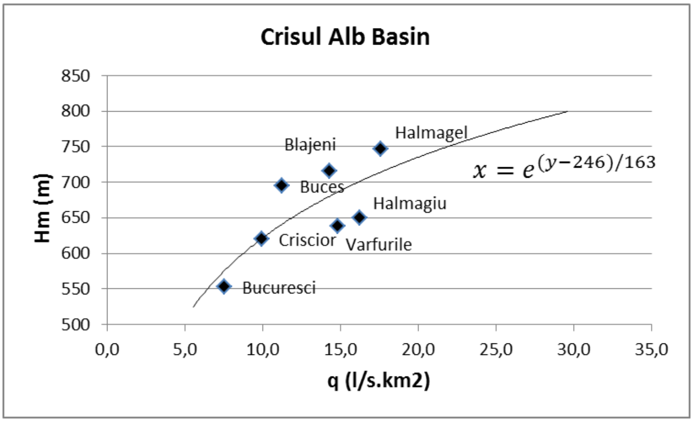

Fig. 9. ***Flow-altitude variation in Crișul Alb River Basin***

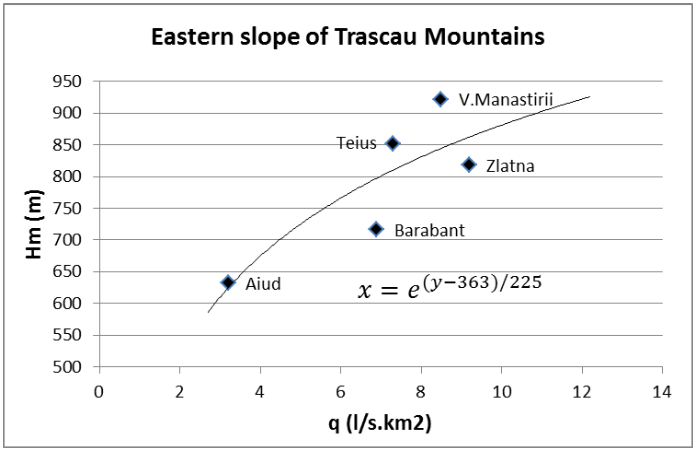

Fig. 10. ***Flow-altitude variation in the basins from eastern Trascău Mountain***

In this region it can be observed the weakest flow. The values don not exceed, at 800 m, 30 l/s.km^2 in west, respectively 7 l/s.km^2 in east. The deviations' variation trend is reversed to the one on the northern slopes: a slight increase at higher altitudes. There can be observed a vertical deviation of only 10% at the analyzed altitudes (67-77 %). These distinct characteristics are determined by the relatively small altitudes of this region.

Table 4. ***Flow deviations between the river basins Crișul Alb and those from eastern Trascău Mountains***

	Crișul Alb	East Trascău	
Hm (m)	q (l/s.km2)	q (l/s.km2)	ε (%)
600	8.8	2.9	67
700	16.2	4.5	72
800	29.9	7.0	77

4. CONCLUSIONS

The position and the relief characteristics of Apuseni Mountains have a strong influence over the diversification of river flow. The alignment of Vlădeasa-Bihor-Metaliferi Mountains, orientated north-south, perpendicular to the movement direction of western air masses, represents the main influencing factor. In such conditions, the water flow on the eastern slopes of the mountainous alignment is much weaker than the one on the western slopes.

Besides the aforesaid, other comparisons can be made between the specific flow from different basins. The local factors can cause other flow differentiations.

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