PARTICULARITIES OF THE SEASONAL WATER FLOW REGIME OF THE RIVERS FROM TRANSYLVANIAN PLATEAU

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Abstract. Particularities of the seasonal water flow regime of the rivers from Transylvanian Plateau. The researched region overlaps the vast depression area inside the Carpathian arch, from which the waters transported by the autochthonous rivers are drained by three main collectors oriented in different directions: north (Someş), west (Mureş) and south (Olt). The study is based on the data processing and interpretation from 28 hydrometric stations, of which 17 are located on autochthonous rivers and 11 on allochthous rivers. Depending on the available data, two periods were used: a long one (1950-2015) and a short one (1980-2015), using all available observation data, and the period taken into account is sufficient to identify the particularities of the seasonal water flow on the rivers in the Transylvanian Plateau. From the analyses carried out, it is remarked that on all the rivers the dominant flow is the one in springtime, when the climatic conditions are favourable for a rich and sustained nivo-pluvial supplying. The lowest contribution to the multiannual water volume is in the autumn. The particularities of the types of seasonal regime were highlighted and the respective deployment areas were delimited. The variation of the seasonal flow was evidenced by using simple and synthetic indicators.

Key-words: regime, season, variability, indicators, Transylvanian Plateau

1. INTRODUCTION

The Transylvanian Plateau, an integral part of the vast negative morphological area inside the Carpathian Arch, has been individualized into three distinct units, which follow from north to south: the Someș Plateau, the Transylvanian Plain and the Târnavelor Plateau. The central position in the Carpatho-Danubian-Pontic space gives it the function of convergence area for a number of geographical components, with particular reference to rivers and human potential.

The mountain-depression connection is expressed in the differentiation of the drainage system on the two categories of rivers: allochthonous and autochthonous rivers, among which there are remarkable differences in both the

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volume of water transported and the water drainage regime. The river network is drained through three main collectors with different orientation: Someş to the north, Mureş to the west and Olt to the south.

The individuality of the studied geographic space is underlined by several characteristic aspects: orientation of the water flu in three directions through several main collectors; the frequency of the foehn process experienced in the western part of the plateau, which results in the diminution of nebulosity and precipitation values and the slight increase of the thermal values compared to the locations at similar altitudes in the eastern plateau; the general decrease of the relief altitude from the east to the west, more obvious in the Târnavelor Plateau than in the Transylvanian Plain; identifying of two spaces with distinct morphological features: valley corridors and main and secondary interfluves; the different exposure of the territory to the advection of wet air masses in the west through the lower sectors on the Mureș Valley in the south-west and the "Meseş Gate" in the northern part of Transylvanian Depression.

2. DATA AND METHODS

For the elaboration of the study, two periods were taken into account: one long (1950-2015) and another one short (1980-2015), which allowed full capitalization of the data from all the hydrometric stations located on the autochthnous rivers (22), more accurately reflecting the particularities of the water flow regime in the Transylvanian Plateau. Also, data from 11 hydrometric stations on alltochthonous rivers (Table 1) were processed for the same period.

Table 1. Data on the hydrometric stations under study.

No. crt.	Rivers	Hydrometric station	F (km)	$H_{med.}$ (m)	Direct period
	AUTOHTON RIVERS				
	Someş hydrographic basin				
1.	Gădălin	Bonțida	290	590	1968-2015
2.	Fizeş	Fizeşu Gh. (Mintiu Gh.)	436	403	1952-2015
3	Meleş	Rusu de Jos (Beclean)	279	416	1964-2015
4	Dipșa	Chiraleş	441	425	1953-2015
5.	Nadăş	Aghireş	46	519	1964-2015
6.	Borşa	Borşa	182	452	1952-2015
7.	Lonea	Luna de Jos	180	418	1961+2015
8.	olpret	Maia	101	394	1961-2015
9.	Sălătruc	Căşei	149	463	1961-2015
10,	Poiana	Poiana Blenchii	96	423	1959-2015

1	2	3	4	5	6
Mureş hydrographic basin					
11.	Luţ	Breaza	268	479	1967-2015
12.	Comlod	Band	325	403	1976-2015
13.	Comlod	Crăeşti	117	432	1973-2015
14.	Pârâu de Cîmpie	Miheşu de Câmpie	130	378	1979-2015
15.	Valea Largă	Viişoara	200	395	1978-2015
16	Laslea	Laslea	109	503	1964-2015
17..	Visa	Şeica Mare	447	470	1957,60-61, 70-2015
18.	Domald	Zagăr	51	440	1968-2015
19	Şecaşu Mic	Colibi	312	376	1975-2015
20	Pârâul Nou	Noul Român	249	511	1974-2015
21	Hârtibaciu	Agnita	278	548	1959-2015
22..	Hârtibaciu	Cornăţel	961	512	1952-2015
1.	Someşul MIc	Cluj-Napoca	1210	923	1950-2015
2.	Someşul MIc	Apahida	1863	863	1950-2015
3	Someşul MIc	Salatiu	3595	604	1975-2015
4.	Someşul Mare	Beclean	4328	711	1950-2015
5	Someş	Dej	8845	645	1950-2015
6.	Someş	Răstoci	9704	623	1970=2015
7.	Someşu Mare	Beclean	4323	711	1950’2015
8	Mureş	Glodeni (Tg. Mureş)	3781	849	1950-2015
9.	Mureş	Luduş	6640	670	1987-2015
10	Târnava Mică	Sărăţeni	461	913	1950-2015
11.	Târnava Mică	Târnăveni	1499	585	1954-1957; 1959-20]5
12	Târnava Mică	Blaj	2067	533	1979-2015
13.	Târnava Mare	Vânători (Topa)	1600	695	1954-2015
14	Târnava Mare	Blaj	3653	558	1949-2015
15.	Târnava	Mihalţ	6247	532	1968-2015

For data processing there were used statistical methods and special programs for assessing the percentages values of seasonal water flow.

The variability of seasonal water flow over the multiannual average was highlighted using simple (amplitude and linear deviation) and synthetic indicators (mean square deviation, dispersion and variation coefficient).

The percentages of the seasonal water in the two analysed periods remained relatively close, especially at the hydrometric stations on the alltochthonous rivers, but also at the hydrometric stations on the autochthonous rivers (Fig. 1).

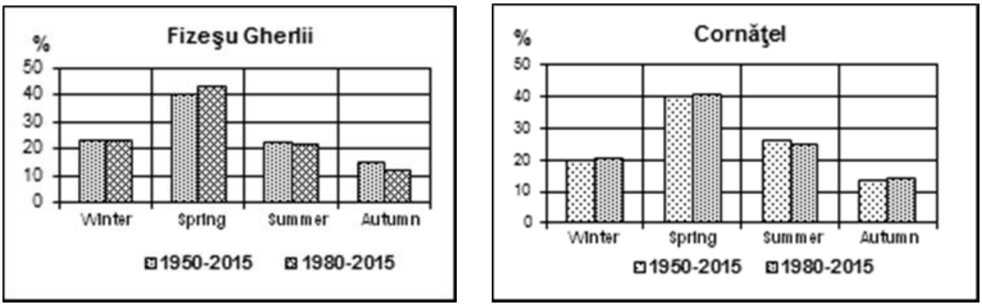

Fig. 1. Percentage leakage values from the two study periods.

3. RESULTS AND DISCUTIONS

From the analysis of the processed data for the two periods and the correlation between the percentages values of the seasonal discharge and the average altitude of the relief in the river basins controlled by the hydrometric stations under study, it can be observed that the territorial distribution of the seasonal discharge is closely dependent on the climatic conditions, and under the influence of other physical-geographic factors some local differences appear.

The territorial distribution of the seasonal discharge from the Transylvanian Plateau is determined by the relief altitude of the water basins and their exposure to the advection of western air masses.

3.1. Space-time variation of seasonal water flow.

Depending on the determinants and the influence of the leakage there is an uneven distribution of the leak during the year. The analysis shows that all the dominant rivers are the spring runoff, when the climatic conditions are favourable for a rich and sustained nive-pluvial supply. The lowest contribution to achieving the multi-annual average volume is in the autumn season. The way in which the main sources of energy are combined is reflected in the distribution of water flow in the year, with significant differences from one season to another and between the so-called leakage regime on the native and allochthonous rivers.

In winter, with the exception of a few alohtone rivers (Someșșul Mic, Mureş in Glodeni, Târnava Mare at Vânători), the volumes of water transported by the rivers participate with over 20% in achieving the multi-annual average volume. The percentages of the winter spill exceed those corresponding to autumn leakage.

In the winter, the highest percentages (29-31%) were reported on rivers in the northeast of the plateau, where the possibilities of feeding the snow melt rivers are much higher due to the relatively high frequency of the intervals of the periods with positive temperatures. On the rivers in this part of the plateau the percentages of the winter run are similar or even exceed those in the summertime (Table 2).

Table 2. Percentage values of the seasonal spill.

Hydrom. station	% from the multiannual average water flow							
	1950-2015				1980-2015			
	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn
	AUTOCHTHONOUS RIVERS							
Bonțida	-	-	-	-	21.5	42.6	23.8	12.1
Fizeşu Gh.	23.1	40.6	22.2	14.5	23.1	43.0	21.9	12.0
Rusu de Jos	-	-	-	-	26.1	47.4	16.5	10.0
Chiraleş	-	-	-	-	21.7	46.0	21.6	10.7
Aghireş	-	-	-	-	22.9	35.3	28.2	13.6
Borşa	-	-	-	-	25.2	45.1	19.8	9.9
Luna de Jos	-	-	-	-	27.0	45.1	18.3	9.2
Maia	-	-	-	-	29.7	35.3	28.2	13.6
Sălătruc	-	-	-	-	29.3	44.0	16.6	10.1
Poiana Blenchii	-	-	-	-	31.6	42.6	15.7	10.3
Breaza	-	-	-	-	29.0	43.6	17.3	10.1
Band	25.0	40.3	23.5	11.2	22.6	42.4	23.4	11.6
Crăeşti	-	-	-	-	24.2	43.2	20.6	12.0
Miheşu de Câmpie	-	-	-	-	27.1	38.1	17.9	16.9
Viişoara	-	-	-	-	25.9	35.9	24.9	13.4
Laslea	22.9	37.5	25.1	14.5	22.3	36.3	26.7	14.7
Şeica Mare	21.3	37.1	21.0	15.6	22.6	36.4	24.6	16.4
Zagăr	23.5	37.4	26.1	13.0	23.8	37.7	25.0	13.5
Colibi	17.9	45.0	24.9	12.2	23.5	43.6	21.1	11.8
Agnita	-	-	-	-	20.5	40.6	22.2	16.7
Cornățel	20.1	40.3	25.9	13.7	20.5	40.7	24.6	14.2
	ALLOCHTHONOUS RIVERS							
Cluj-Napoca	13.9	42.5	28.1	15.5	13.5	42.8	26.6	17-3
Apahida	15.0	41.5	27.9	15.6	14.8	42.0	26.4	16.8
Salatiu	16.6	41.6	26.8	15.0	15.7	42.2	25.9	16.3
Beclean	21.6	44.0	20.4	14.0	21.0	43.9	19.9	15.2
Dej	20.7	42.8	22.0	14.5	19.0	44.2	20.7	16.1
Răstoci	21.8	41.5	22.7	14.0	21.2	41.9	21.6	15.3
Glodeni	17.4	44.5	23.6	14.5	17.1	44.5	22.9	15.5
Sărățeni	20.6	41.7	23.0	14.7	20.2	42.5	22.4	14.9
Târnăveni	21.1	41.0	23.9	14.0	21.1	41.5	22.9	14.5
Blaj	-	-	-	-	21.2	41.1	23.7	14.0
Vânători	19.1	45.5	23.7	11.7	18.6	45.3	24.2	11.9
Blaj	19.4	42.8	24.8	13.0	19.4	42.7	24.8	13.1
Mihalț	-	-	-	-	20.2	41.3	25.2	13.3

In contrast, in the southeast of the plateau, where the winters are more stable, the smallest percentages of the winter runoff were reported (20-21%).

Following the chronological variation of the seasonal discharges, there is a rather obvious synchronicity. Thus, in the winters with favourable conditions for a rich supply of liquid precipitations and the successive melting of the snow layer (1978/1979, 1969/1970, 1981/1982, etc.), the highest values of leakage were recorded. Alltochthonous rivers in the Someș basin, the largest volumes of water were transported in 1982 and 1996, and those in the Mureș basin in 1982, 1996 and 1998.

In the case of the indigenous rivers in the northern Transylvanian Plateau, related to the Someș Basin and most of the autochthonous rivers in the Mureş Basin, the most mature volumes of water were transported in the 1980/1981 and 1981/1982 winters.

The smallest volumes of water were transported in the winters characterized by a persistent anticyclone regime (1953/1954, 1963/1964, 1971/1972, etc.), when discharge values were 20 to 25 times lower than normal winter values. In the chronological variation of the winter discharge, a 11-year cycle was observed. The lowest values of the winter water flow occurred in the 1983/1984 winter on the autochthonous rivers in the Someș river basin, and in 2012 and 2013 on those in the Mureş basin.

Spring is the season with the richest flow caused by snow melt, the relatively high rainfall rates and low evapotranspiration values.

On the allochthtonous rivers, the percentage values of spring flow represent between 40 and 45% of the average annual volume, and the autochthnous ones between 35.9% (Viişoara) and 46% (Chiraleş), being higher on the eastern and southern rivers (over 40%) and lower in the central and western part of the Transylvania Plateau (36-40%) (Table 3).

The richest spring flow occurred, on most allochthonous rivers, in 1970 and 1999, and on autochthonous rivers in different years: 1981, 1982 and 1999 for those in the Olt and Mureş basins; 1980 and 1998 on those in the Someș basin (Table 3).

In **summer**, the increase in air temperature and the development of vegetal carpet lead to the intensification of evapotranspiration, a phenomenon reflected in a noticeable decrease in water flow compared to the previous season. Although the intake of rainfall this season is maximum, only between 15% (Poiana Blenchii) and 26.7% (Laslea) of the average annual water flow volume is produced. The percentages of the summer flow are lower on the rivers in the central and eastern Transylvanian Plain and Someșan Plateau (15-20% of the average annual volume) and higher (20-27%) on the rivers in the Târnavelor Plateau (Table 2).

Regarding the average situation presented, extreme cases were reported. Thus, the highest summer flow occurred in 1980 and 1998 on the allochthonous rivers and in 1998 on the autochthonous ones (Figure 2).

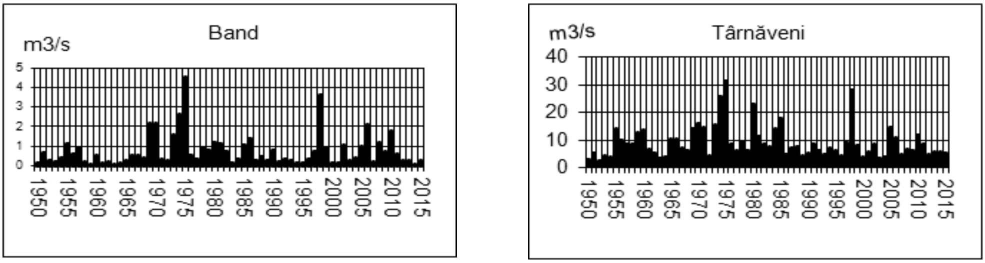

Fig. 2. Multiannual variation of summer water flow.

The highest values of the summer flow occurred on most of the allochthonous rivers in 2003, and on the autochthonous ones in different years (1990, 2003, 2014, etc.).

In **autumn,** evaporation decreases, and underground reserves are depleted and not regenerated. As a result, at the beginning of this season, the period low water is set, and by the end of the season increases may arise from the eventual persistent rainfall.

Autumn is the season with the lowest contribution to the average annual volume (10-17%). Generally, percentage values are higher on allochthonous rivers (14-17%) than on autochthonous ones (10-12%).

A special characteristic of the autochthonous rivers on which there are ponds (Fizeş, Pârâul de Câmpie, Visa) are the high percentage values of the autumn flow caused by the emptying of the ponds of this season (Miheşu de Câmpie, 16,9%, Şeica Mare, 16,4%).

The richest autumn flow occurred in 1980, 1998 and 2000 on the allochthonous rivers, and in 1998 on the autochthonous ones. The high autumn discharge values of the mentioned years and those recorded in the eighth decade of the last century (1972, 1974 and 1978) occurred in climatic conditions characterized by high rainfalls that had fallen over a long period of time, thus having a substantial hydrological effect.

Years with the lowest autumn flow were 1961, 1971 1983 and 2011, when long periods of no precipitation were recorded, which led to the depletion of underground reserves.

3.2. Seasonal water flow repartition types

These have been identified according to the succession of seasons in descending order of contribution to annual water flow, with the exception of spring, which predominates in all rivers in the studied region.

Two types of territorial distribution of seasonal flow have been identified. The dominant type is I.V.T. (winter, summer, autumn), specific to the autochthonous rivers from the Someș Plateau and the Transylvanian Plain (except the Band Stream) and the western part of Târnavelor Plateau (Secaş).

Type V.I.T. is specific to the allochthonous rivers in the northern and central part of the Transylvanian Plateau (Someşul Mic, Someş, Mureş, Târnava Mică and Târnava Mare), as well as the autochthonous rivers in the east and the center of the Târnavelor Plateau (Hârtibaciu, Visa, Laslea and Domald).

On some allochthonous rivers, there is a metamorphosis of the seasonal type. Thus, Someş River in Dej presents the type I.V.T, and in Răstoci V.I.T. The identification of this type is explained by the different affluent regime, which although small influences collector water flow.

3.3. Oscilația scurgerii anotimpuale

The variation in time of the annual flow was highlighted by simple and synthetic indicators.

Among the simple indicators were the linear deviation, the standard deviation and the amplitude, and the synthetic ones, the coefficient of variation.

After analysing the maximum relative deviations, it was revealed that on most rivers the lowest percentages appear in spring and winter seasons, and the smallest in summer and autumn (Fig. 3).

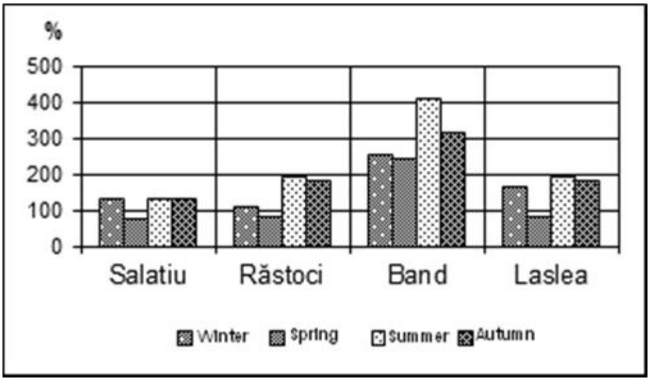

Fig. 3. Percentage values of positive relative deviations

It has also been observed that there are obvious differences between the percentage values of the maximum deviations determined for the two categories of rivers. The percentages of the maximum relative deviations are lower on the autochthonous rivers and much higher on the allochthonous ones, which respond faster to the changes occurring in the conditions of water flow formation (Fig. 4).

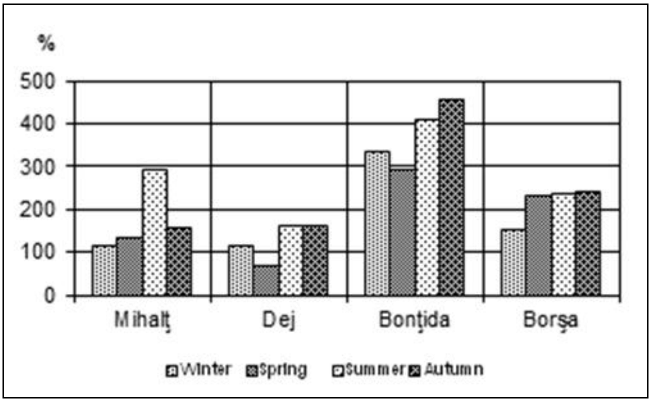

Fig. 4. Percentage values of positive relative deviations
from the allochthonous and the autochthonous rivers.

Significant contrasts arise between autochtonous rivers with reception basins developed in the eastern and western parts of the Transylvanian Plateau (Figure 5). The explanation is the different degree of humidity between the two parts of the Transylvanian Plateau, determined by the way of exposure to the advection of western wet air masses.

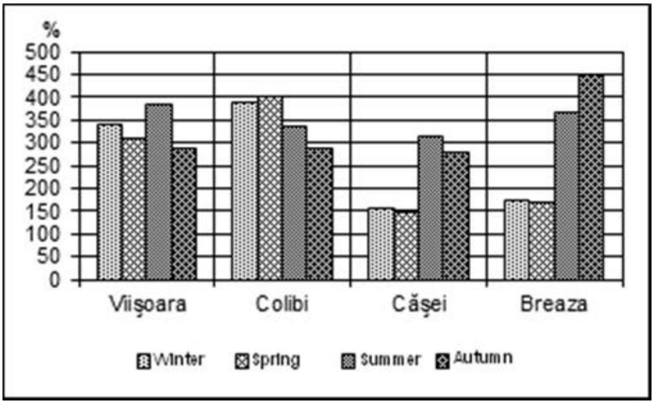

Fig. 5. Percentage values of .positive relative deviations
for the autochtonous rivers

The values of negative relative deviations do not exceed 100%, being more reduced than those for positive relative deviations. The smallest percentage values belong to the spring and summer seasons (Fig. 6).

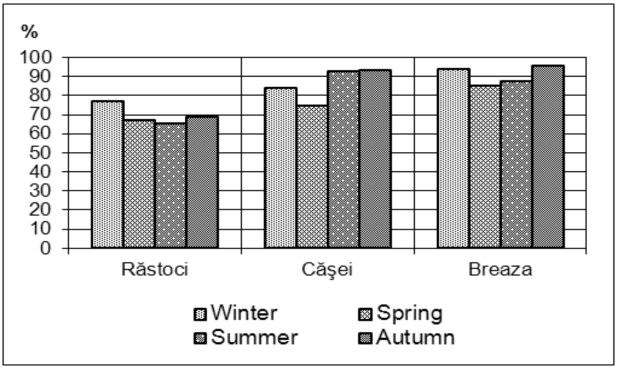

Fig. 6. Percentage values of negative deviations

At some hydrometric stations, they have been observed low percentages in the autumn (Someşul Mic at Salatiu, Târnava at Mihalț) and winter (Gădălin at Bonțida and Borşa at Borșa).

The amplitude is another simple indicator used to characterize variation of river water flow. The smallest percentages of relative amplitude are in spring. On Someşul Mic at Salatiu and on the rivers in the western part of the Transylvanian Plateau (Valea Largă and Secaş), the lowest values appear in autumn.

The variable humidity, specific to the studied territory, is reflected in the high values of the variation coefficients, conditioned also by the size of the basin surfaces.

On all rivers in the Transylvanian Plateau, the values of the variation coefficients are lower in spring and winter, reflecting the more uniform character of the water flow distribution in the two seasons. In contrast, in summer and autumn, when the variation coefficients have the highest values, the territorial differences are more pronounced (Fig. 7).

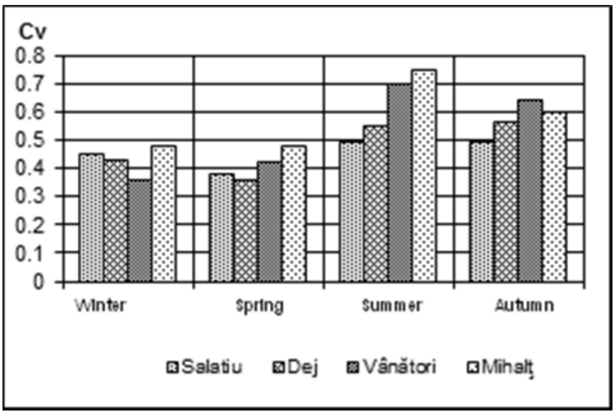

Fig. 7. Values of seasonal variation coefficients.

In the summer the highest values of variation coefficients are noted, while in autumn, river water flow is more constant, which is reflected in the lower values of the variation coefficients (Table 3).

Table 3. Values of seasonal variation coefficients.

Hydrom. station	Winter	Spring	Summer	Autumn
1	2	3	4	5
Cluj-Napoca	0.41	0.33	0.42	0.50
Apahida	0.39	0.32	0.45	0.46
Salatiu	0.45	0.38	0.49	0.49
Beclean	0.49	0.34	0.54	
Dej	0.43	0.36	0.55	0.56
Răstoci	0.46	0.39	0.58	0.58
Glodeni	0.48	0.39	0.44	0.57
Sărățeni	0.42	0.37	0.49	0.48
Târnăveni	0.43	0.39	0.61	0.55
Blaj	0.43	0.44	0.72	0.56
Vânători	0.36	0.42	0.70	0.64
Blaj	0.53	0.49	0.71	0.62
Mihalț	0.48	0.48	0.75	0.60
Bonțida	0.93	0.93	1.26	1.23
Fizeşu Gherlii	1.06	0.82	1.41	1.22
Rusu de Jos	0.99	0.77	1.60	1.58
Chiraleş	0.83	0.52	1.12	1.38
Poiana Blenchii	0.52	0.52	1.27	1.25
Căşei	0.53	0.59	1.08	0.95
Aghireş	0.64	0.57	0.93	0.68
Borşa	0.67	0.64	0.98	0.90
Luna de Jos	0.68	0.70	1.72	0.99
Maia	0.62	0.74	1.42	1.36
Agnita	1.10	0.91	1.09	0.91
Cornățel	0.83	0.71	1.10	1.20
1	2	3	4	5
Șeica Mare	0.64	0.66	0..95	0.74
Colibi	0.95	1.00	1.00	0.90
Laslea	0.63	0.60	0.80	0.73
Zagăr	0.58	0.63	1.05	0.84
Breaza	0.66	0.61	1.02	1.15
Crăești	1.00	0.74	1.39	1.81
Band	0.83	0.72	0.96	0.97
Miheşu de Câmpie	1.07	1.19	1.50	1.60
Vişoara	1.10	1.00	1.02	1.02

Exceptions are the rivers where there are ponds, and in autumn there are frequent depletions for harvesting fish fauna (Crăeşti, Miheşu de Câmpie, Cornățel).

4. CONCLUSIONS

The particularities of the seasonal water flow regime are manifested differently in space, several areas with specific traits, which are determined by natural factors and, to a lesser degree, by the anthropic ones, can be delimited. The analysis of these conditions in correlation with the particularities of the flow allowed the identification of several areas where the flow regime is manifested differently. Thus, according to the regime of the seasonal flow, the rivers in the Someș basin differ from those in the Mureş and Olt basins.

Significant differences were found between the regime of the allochthonous rivers with the origin in the mountainous area and the autochthonous ones, which faithfully reflect the conditions of water flow formation in the researched region.

There are obvious contrasts in the case of autochthonous rivers with reception basins developed in the north-eastern and eastern part of the Transylvanian Plateau, compared to those located at the shelter of the Apuseni Mountains.

REFERENCES

1. Croitoru, Adina Eliza (2006*), Excesul de precipitații din Depresiunea Transilvaniei*, Edit. Casa Cărții de Știință, Cluj-Napoca,
2. Diaconu, C, Vârcol, A.,Vârcol, L. (1962),*Unele rezultate ale studiului reparrtiției scurgerii în timpul anului la râurile din România*,Studii de hidrol., vol.2, Bucureşti.
3. Diaconu, C., Şerban, P.(1994), *Sinteze şi regionalizări hidrologice*. Edit.Tenică, Bucureşti.
4. Dumitrescu, S.(11958), *Repartiția scurgerii pe sezoane la râurile din România*,Met.Hidrol., Gosp. Apelor, Vol3, nr.1., Bucureşti.
5. Gâştescu, P. Ujvari, I. (1986,*Rolul spațiului carpatic în formarea şi repartiția în timp a resurselor de apă,* Terra, , XXXVIII, Bucureşti
6. Konecsny, C. (1997), *Bilanțul hidric din Depresiunea Transilvaniei şi regiunile montane aferente*, Teza de doctorat, Cluj-Napoca.
7. Lăzărescu, D., Panait, I. (1957), *Tipurile de regim ale râurilor din Romțnia*, Metorol. And hydrology, vol.6, nr.2, Bucureşti.
8. Lăzărescu, D., Panait, I. (1958), *Sursele de alimentare ale râurilor din R.S.România*.Met., Hidrol., Gosp. Apelor, vol.3, nr.2-3, Bucureşti.
9. Mociorniță, C., Dincă, A., Nițulescu, M.(1963), *Repartiția scurgerii pe sezoane şi luni în cadrul anuui mediu pe râurile din România*, Studii de hidrol., vol.5, Bucureşti.
10. Platagea Gh., Ujvari, I. (1960), *Les principals caracteristiques du regime hdrologique du territoire de la Romaine*.Recueil d'etudes geographiques, Edit. Academiei R.P.R., Bucureşti

11. Sorocovschi, V., Konecsny, C. (1991), *Variația scurgerii râurilor de pe versantul vestic al munților Gurghiu şi Harghita*, Studia univ. Babeş-Bolyai, Series geogr.t. XXXVI, Clluj-Napoca.
12. Sorocovschi, V. (1996), *Podişul Târnavelor. Studiu hidogeografic,* Edit. CETIB Cluj-Napoca.
13. Sorocovschi, V. (1999), *Rolul componentelor hidrice în organizarea spațiului din Depresiunea Transilvaniei,* în Vol. "Geografia în Contextul Dezvoltării Contemporane", Cluj-Napoca, p. 200-206.
14. Sorocovschi, V., Pandi, G.(2002), *Characteristics of river flow in the Transylvanian Basin,* Development and Application of Computer Techniques to Environmental Studies IX, Editors C. A. Brebbia, P. Zannetti, WIT Press, Southampton, Boston, p. 489-498
15. Sorocovschi, V. (2005), *Câmpia Transilvaniei - studiu hidrogrogrfic*. Edit. Casa Cărții de Ştiință, Cluj-Napoca, 212 p.
16. Sorocovschi, V. (2008), *Particularitățile scurgerii râurilor din Depresiunea Transilvaniei*, Geographia Napocensis, An II, 2 Casa Cărții de Ştiință, Cluj-Napoca, ISSN 1843-5920, p. 29-36.
17. Ujvari, I. (1972), *Geografia apelor României*, Edit. Ştiințifică, Bucureşti,
18. Sorocovschi, V. (2008), *Resursele de apă ale râurilor din Câmpia Transilvaniei*, Geographia Napocensis, An II, 1, Casa Cărții de Ştiință, Cluj-Napoca, ISSN 1843-5920, p. 28-37.
19. Sorocovschi, V., Pandi, G.(2002), *Characteristics of river flow in the Transylvanian Basin,* Development and Application of Computer Techniques to Environmental Studies IX, Editors C. A. Brebbia, P. Zannetti, WIT Press, Southampton, Boston, p. 489-498
20. Sorocovschi, V., Pandi, G. (2012), *Particularities of seasonal and monthly flowing regime on the small rivers of MaraMureș Mountains*, în "Water resources and wetlands", Conference Proccedings 14-16 September 2012, Tulcea, Romania, p. 39-47
21. Sorocovschi, V., Pandi, G., Horvath Cs., Bătinaş, R. (2014), *Seasonal and monthly flow regime particularities for the eastern Apuseni Mountains small rivers*. In vol. "Water resources and wetlands", Conference procedings, 11-13 September 2014, Edit. Ştiințifică, Bucureşti.Tulcea Romania, Edit. Transversal, Târgovişte
22. Tilinca, Z., Fărcaş, I., Mihăilescu, M. (1976), *Contribuții la sstudiul sinoptic al fönului în Munții Apuseni*, Studii cercet. Meteoreşti.logir I/2.IMH, Bucureşti.
23. Ujvari, I. (1972), Geografia apelor României.Edit.Ştiințifică, Bu
24. Ujvari, I. (1980), *Les types de regime hydrique des rivieres de la Roumanie,* Rev. Roum. Geol., Goph.,, Geogr., Geeogr, t.24, Bucureşti.
25. *** (1971), *RâurileRomâniei,* Monografie hidrologică. Inst.de Mt. şi Hidrol., Bucureşti.
26. *** (1983), *Geografia României*, vol.I, Geografie fizică, Edit. Academiei, Bucureşti.