BARCĂU RIVER HYDROLOGICAL CHARACTERIZATION DURING THE 1993-2009 PERIOD

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ABSTRACT. Barcau River Hydrological Characterization During the 1993-2009 Period. For hydrological regime characterization of the Barcau river we used hydrometric data resulting from measurements of Crisuri Waters Branch and Environment and Water Directorate over Tisza, Debrecen quantitative monitoring programs. Hydrometric work is done according to quantitative monitoring programs, measured in hydrometric stations located on Romanian and Hungarian territory. Highlighting the main features of the hydrological regime of water was performed for eight hydrometric stations located on the main course.

Keywords: quantitative monitoring, average leakage, minimum discharge flow, maximum discharge flow, hydrometric stations".

1. Introduction

Rivers discharge flow is an accumulation of complex processes which water from a basin or a certain part of its, focus and moves to the lower areas of land, forming a streams network.

The hydrological regime study is particularly important and has the aim to decipher the laws of that lead in time and space variation of the water resources of a territory. This is absolutely mandatory in the present circumstances, when water is considered as a resource and a development factor, the quantity and changes its regime in time and space, depending the local and regional socio-economic development. (Zavoianu, 1999).

The hydrometric monitoring programs in the studied area are carried out according to quantitative measurements of 18 hydrometric sections, of which 13 are located on Romanian territory, and 5 on Hungarian territory. Highlighting the main features of the hydrological regime of Barcau River was analysed the results for eight hydrometric stations located on the main course. The range of years,

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1993-2009, was elected by the following reasons: all stations have hydrometric data during this period; in this range were realised major hydro-technical works; data analysis for the least 15 years permit to have a real conclusions. The table 1 and figure 1 present general morphometric data on the main gauging stations analyzed, and the stream which they are located.

Table 1. The main hydrometric stations on the Barcău/Berettyó river (source: Crisuri Waters Branch and Tikövizig Debrecen)

No.	River	Hydrometric station	Area (km^2)	The average altitude of the upstream basin (m)
1	Barcău	Nuşfalău	269	435
2	Barcău	Marca	404	380
3	Barcău	Marghita	823	292
4	Barcău	Sălard	1686	254
5	Barcău	Kismarja	2364	126
6	Barcău	Pocsaj	3502	98
7	Barcău	Berettyoujfalu	3712	91
8	Barcău	Szeghalom	6095	84

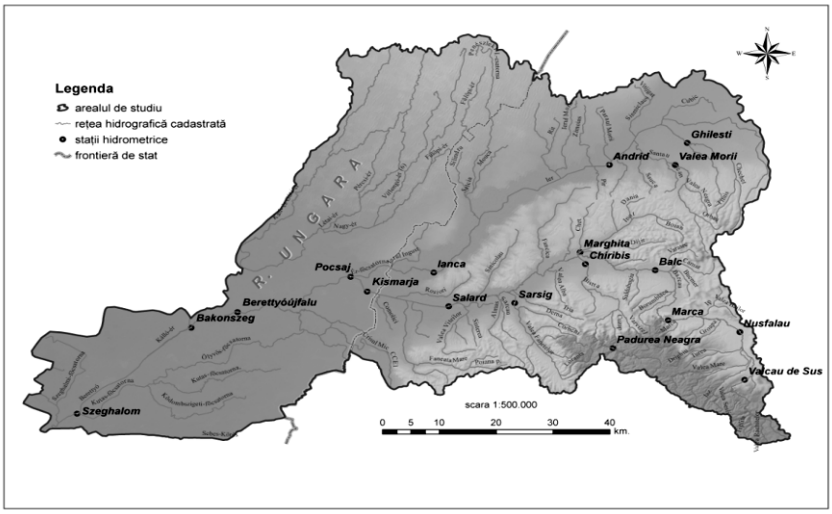

Figure 1. Hydrometric stations in the cross-border basin Barcau. (source: Crisuri Waters Branch and Tikövizig Debrecen)

2. Average leakage

Average annual flow values were the basis for characterizing the variation from year to year of the average leakage. The analysis of spatial and temporal variability of average flow on the river Barcau, was based on hydrological data

recovery (average monthly flows and annual and multi-seasonal monthly average) from hydrometric stations located on the main course: Nusfalau, Marca, Marghita, Salard, Kismarja, Pocsaj, Berettyoujfalu and Szeghalom, characteristic of the upper, middle and lower Barcau.

2. 1. Average monthly leakage

Following the river Barcau water supply, from melting snow and spring rains, the average monthly flow tends towards a maximum in March, throughout the period under review. Thus, the average monthly flow is characteristic of most of March for all sections along the river, which could mean the beginning of periods of high water. The lowest flows are specific interval from August to October. Monthly distribution of flow is characterized by values of mean flow below the annual average in the autumn season (months IX - XI), with values above the annual average in January, February and March, to register then a decrease of May to November.

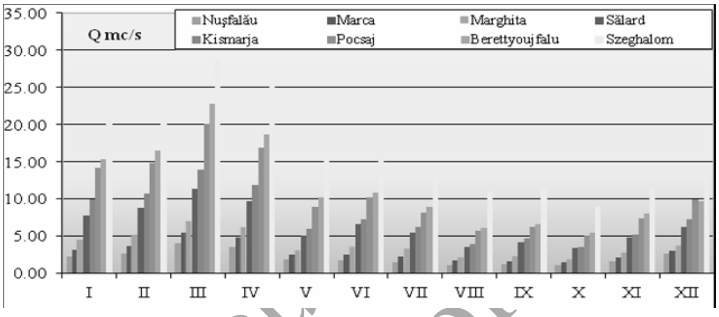

Figure 2. The monthly average liquid flow on the river Barcau during. the 1993-2009 period

Average water leakage under the river remains stable in normal physical and geographical conditions, some approaches in terms of changes in flow at Kismarja and Salard sections, can be explained by storing excess water in the polder from Salard or certain deviations of water leakage the rich network of canals in the low sector. The monthly average liquid flow on the river Barcau is shown in Figure 2.

2. 2. Average annual leakage

The annual flow regime tends to unevenness. These variations, in fairly wide limits, depend on the characteristics of each year rainfall. Maximum values of annual average flow occurred in 1996 at hydrometric station Salard (11.84 m^3/s) in 1999 to Kismarja (12.19 m^3/s) and Szeghalom (29.46 m^3/s), in the year 2006 for gauging stations Nusfalau (2.84 m^3/s), Marca (4.59 m^3/s), Marghita (6.60 m^3/s), Pocsaj (19.25 m^3/s) and Berettyoujfalu (21.16 m^3/s). Average annual flow with the lowest values occurred in 1994, for most stations analyzed, except Szeghalom, where the minimum measured value was recorded in 1995 (8.61 m^3/s).

Characterizing overall Barcau River, in terms of average annual flow, we can say (Figure 3) that 1994 was the driest year, this trend manifested throughout the course. Taking into account the maximum values, we can generalize by saying that 1999 and 2006 were the richest in precipitation.

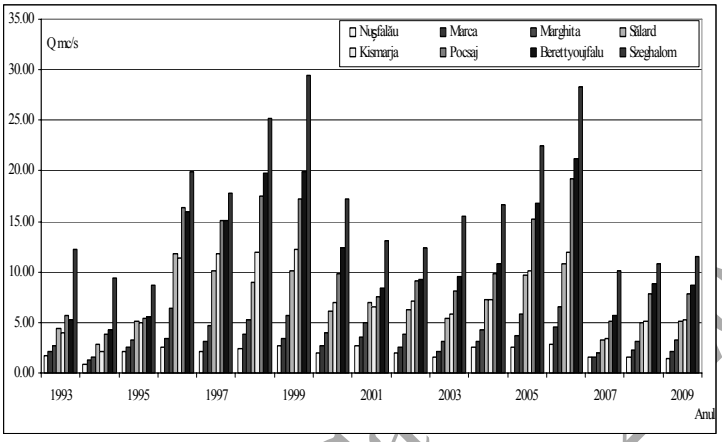

Figure 3. The annual average flow during the 1993-2009 period on Barcau river.
(source: processed data from Crişuri Waters Branch and Tikövizig Debrecen archive)

Expressed in different forms, the Barcau average flow highlights an annual average flow, which shows an increasing trend from 2.08 m^3/s at hydrometric station Nusfalau to 16.53 m^3/s at Szeghalom, in Hungary (Figure 4). Volume flow is directly proportional with the catchment area extending, from the upper to the lower, default number of tributaries and their flow contribution.

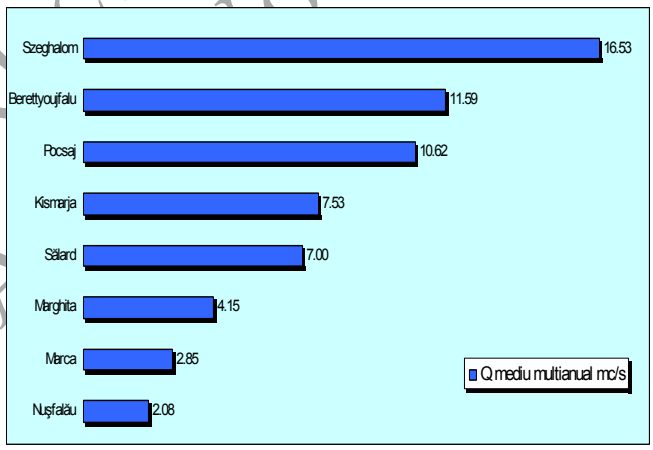

Figure 4. The multiannual average flow during the 1993-2009 period on Barcau .
(source: processed data from Crişuri Waters Branch and Tikövizig Debrecen archive)

2. 4. Seasonal average leakage

The highest values of seasonal leakage on Barcau River (Figure 5 and Table 2) were recorded in spring (11.14 m^3/s). For achieving maximum values contribute the spring rains and snow accumulated during winter, which melts in March, April and sometimes in May, in conditions of reduced evapotranspiration. Draining the land surface is favoured already saturated or nearly saturated soil with water. In summer, the average values recorded (6.09 m3/s) decrease almost half like the spring average flow. This is explained by precipitation reduced amounts and intensified evapotranspiration. Gradual downward trend in rainfall has the effect of reducing leakage in autumn, thus becoming the poorest season in terms of average flow. Recorded flows reach the average of 4.73 m^3/s. With the onset of winter season, but due to rain liquid air masses to western or south-west, under a frozen substrate, adversely infiltration with rapid effects on the river bed, average flow shows an increasing trend values significant, that may even be double compared to the previous season (8.92 m^3/s).

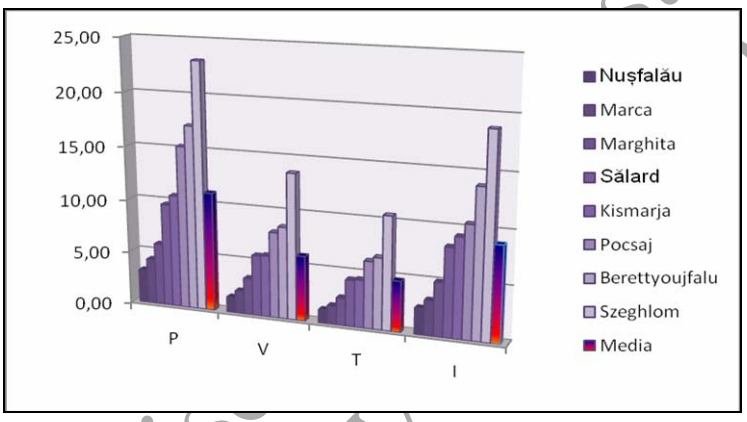

Figure 5. The seasonal average drainage variation on Barcau river. (source: processed data from Crisuri Waters Branch and Tikövizig Debrecen archive)

Table 2. The seasonal average drainage on Barcau river.
(source: processed data from Crisuri Waters Branch and Tikövizig Debrecen archive)

Season/Hydrometric station	Winter	Spring	Summer	Automn
Nușfalău	2,46	3,15	1,44	1,26
Marca	3,26	4,26	2,14	1,72
Marghita	5,01	5,84	3,43	2,57
Sălard	8,28	9,70	5,68	4,35
Kismarja	9,28	10,60	5,78	4,46
Pocsaj	10,47	15,27	8,04	6,26
Berettyoujfalu	13,84	17,22	8,61	6,68
Szeghalom	18,80	23,12	13,63	10,57
Average (m^3/s)	***8,92***	***11,14***	***6,09***	***4,73***
Medium flow. (%)	***28,89***	***36,08***	***19,73***	***15,33***

3. Minimum leakage

Studying the evolution of minimum flow is important for water use in socio-economic activities is especially useful to maintain a constant balance between the needs and hydro-potential of the rivers. The knowledge of minimum flows is essential information, allowing proper management of water resources, so as not to appear imbalances between water requirements by various users and resources. For this purpose, the water authorities are making plans to provide precise conditions of water use by users in restrictive periods.

For the studied area, the minimum leakage is more evident, usually during the drought periods (summer or autumn) and cold winters, as a result of low rainfall, when the rivers in the basin are, mainly, from underground sources.

3. 1. The chronological variation of the minimum flow

Pişota I. (1995), said that in the hydrological regime, minimum flows occur at times when supply is lowest in the rivers throughout the year, when appear the phase called "low water".

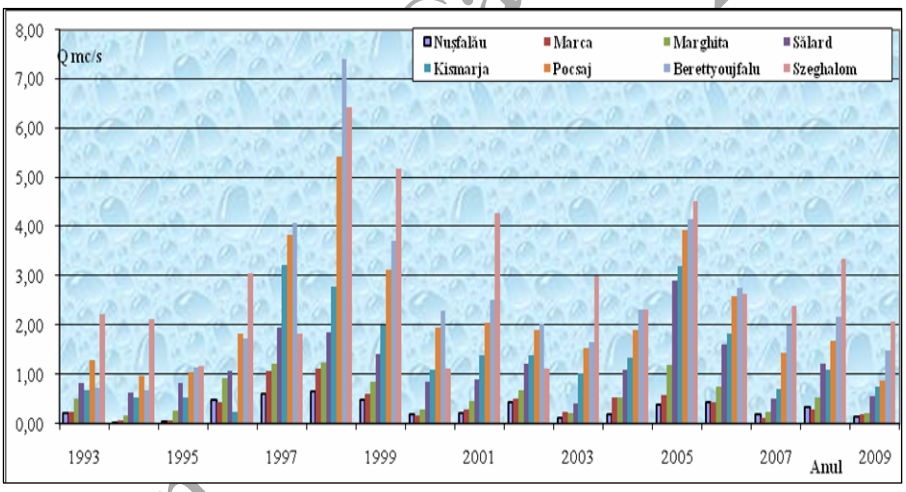

Figure 6. Annual minimmun flow distribution on Barcău/Berettyó river.
(source: processed data from Crisuri Waters Branch and Tikövizig Debrecen archive)

On Barcau River, this had values of 0.03 m^3/s in the upper Nusfalau hydrometric station in 1994, 0.06 m^3/s in 1994 in the middle sector, to Marca and 0.15 m^3/s in Marghita and, in the plains, the minimum flow was 0.5 m^3/s at Salard in 2007. At other stations analyzed, minimum flows were developed as follows: Kismarja 0.25 m^3/s in 1996, Pocsaj 0.88 m^3/s in 2009, Berettyoujfalu 0.68 m^3/s in

1994, and the station located upstream of confluence with Crisul Repede (Szeghalom), minimum of 1.11 m3 / s was recorded in 2000.

Minimum flow distribution between 1993-2009, on the river Barcau / Berettyó is shown in Figure 6.

4. Maximum leakage

The safety and economy degree of a various hydraulic structures is dependent on information as actual maximum flow characteristics. Therefore, to study the maximum flow were considered the same hydrometric stations.

4. 1. The *c*hronological variation of the maximum flow

The string analysis of annual maximum flow at eight hydrometric stations in the studied area shows that the river presented over the years important variations of this type of flow, seen from one year to another. The years that have produced the largest flow are: 1997, 1998, 1999, 2001 and 2002.

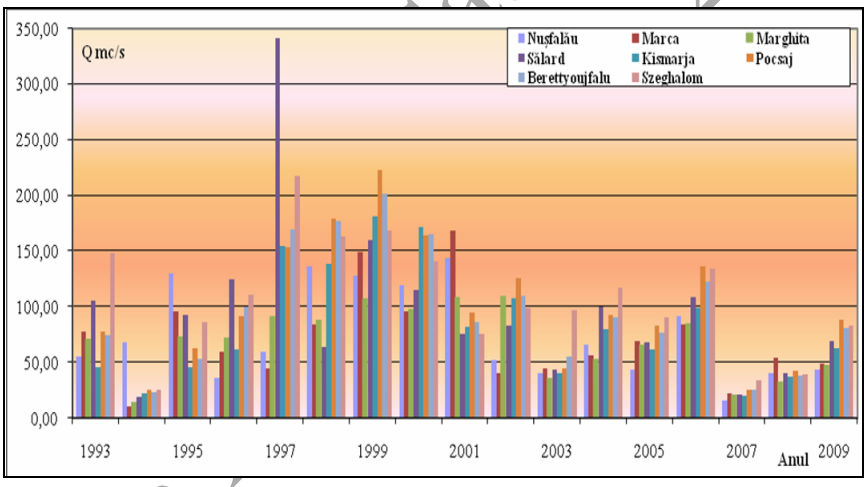

Figure 7. Annual maximum flow distribution on Barcău/Berettyó river
(source: processed data from Crisuri Waters Branch and Tikövizig Debrecen archive)

The highest maximum flow was 341 m^3/s (at Salard) in 1997. On the upper sector (to Nusfalau) maximum flow was 144 m^3/s, reached in 1998 and for the middle (Marca), 168 m^3/s in 2001. Regarding the lower river sector, maximum flow rates were measured in 1997 (Szeghalom 217 m^3/s) and 1999 (Kismarja 181 m^3/s, Pocsaj 223 m^3/s, Berettyoujfalu 201 m^3/s). Chronological variation of the maximum flow recorded during 1993-2009 on Barcau river is shown in Figure 7.

Conclusions

The permanent character of the river in the mountains, is determined by geological conditions, high rainfall regime and slope relief. Semi-permanent and intermittent character in the hilly and plain area is the effect of the geological conditions (permeable rocks), lower rainfall, and marshy landscape favourable to an intense evaporation. The flow regime of the river Barcau is one that caused torrential character, frequently, not only the formation of floods, but there are significant periods of low flow.

The highest values of seasonal drainage basin was registered in spring (due to spring rains and snow accumulated during winter, which melts in March-April), followed by winter, summer and autumn, typical to west Carpathian hills regime – Spring-Winter-Summer-Autumn.

Specific typology, which is the hills and plains river, with low slope and major bed widely developed, and the existence of lands with permeable pedological substrate, favouring the expansion of the flood large areas, water retention and meadow land, without favourable conditions for drainage. In this context, we can say that in plain areas, the lower part of the river and natural drainage of surface practically missing.

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