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AVERAGE FLOW PARTICULARITIES IN RÂUL NEGRU CATCHMENT AREA AND THE CLIMATIC CONDITIONING

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Abstract

Râul Negru catchment area represents a well individualised and relatively homogenous physical-geographical unit inside the Braşov Depression. The two land relief levels – mountainous and depression – are well balanced. The flow is controlled by six hydrometric stations placed on the main collector, and on the two most important confluents. The analysis period contains 25 years (1988-2012) for monthly discharge and 58 years (1955-2012) for annual discharge. There appears a good flow reaction to rainfall quantities modification on the entire observation period. Seasonal flow presents a balance between the six hydrometric stations. During the 25 years maximum period it can be observed that there are certain flow principles concerning mountainous stations input to the seasonal flow. This can be observed also in the variation trends differentiation. In springtime and summer, the flow is higher than in the other two seasons. Monthly average discharges can be analysed over the entire main collector and on the two most important confluents. The month with the maximum discharge is April, belonging to the high flow period March – June. The minimum discharges appear in November because of the lack of precipitations, or in January, due to solid precipitations and to water retention inside ice formations. Percentage repartition of monthly flow indicates differentiations according to local conditions of genetic factors. Seasonal and monthly variation coefficients present differences on the entire river length and according to flow phases.

Keywords: precipitations, average flow, time-space variation, flow principles, variation coefficients.

1. INTRODUCTION

Braşov Depression is a well individualised physical-geographical unit that belongs to the Eastern Carpathians. Because it is situated in the Carpathians' curvature area, it has a remarkable space-time diversity of genetic factors, such as precipitations and flow control (Sorocovschi & Pandi, 2002). Even though it is surrounded by a mountainous ridge, there also appear western and eastern European influences.

Râul Negru catchment area has a surface of 2320 km^2 and is situated in the eastern part of the Braşov Depression, with Bodoc, Nemira, Vrancei and Întorsurii Mountains around it. The basin has an almost a rectangular form, developed on the north – south direction, and is diagonally crossed by the main collector. The two land relief levels - mountainous and depression – present an obvious balance. The mountainous border has relatively steep slopes and well developed piedmonts. The alluvial depression area has an almost plain land relief.

The hydrographic network is nearly equally developed on the entire main collector, with a length of 88 km.

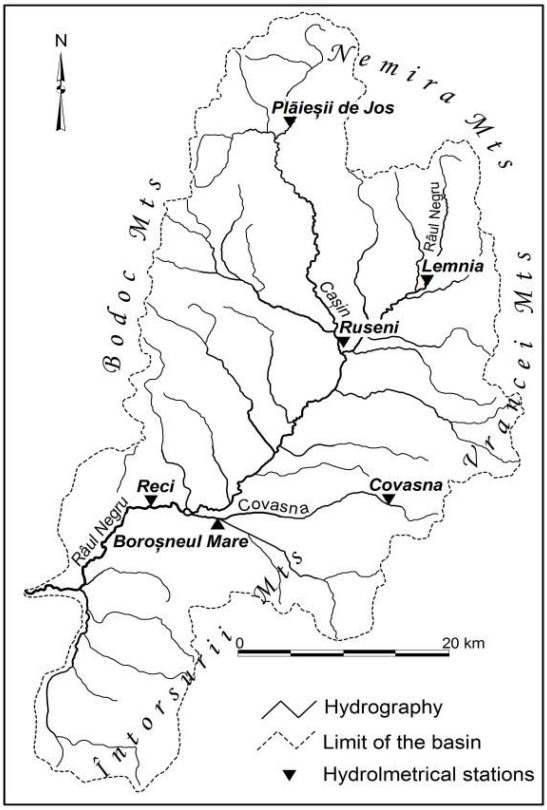

Figure 1. Râul Negru catchment area

The longitudinal slope decreases from 55m/km on the upper sector, to under 1 m/km before the confluence with Olt River. The most important confluents are Caşin River, on the right, and Covasna River, on the left.

The flow particularities are determined by the precipitation regime and by the temperature course that appear on the data from Lăcăuţ (1770 m) and Târgu Secuiesc (568 m) meteorological stations. The precipitation regime presents maximum values in July (173 mm at Lăcăuţ Station, 85 mm at Târgu Secuiesc Station), but the minimum values present differences from a station to the other: October at Lăcăuţ Station (40 mm) and December at Târgu Secuiesc Station (15 mm). The highest monthly average temperatures appear in July (over 17°C at Lăcăuţ Station and 10 °C at Târgu Secuiesc Station). The coldest months are January in the mountain, and February in the depression. The negative temperatures period has five months at high altitudes, and three months at Târgu Secuiesc Station, where also appear frequent temperature inversions.

Another important factor in determining particularities space-time reparation for river flow, beside climatic factors, is basin's morpho-hydrographic conditions: depression's closeness, land relief levels' development, catchment area form, river network characteristics etc. (Ujvari, 1972).

2.DATA BASE AND METHOD

The average flow particularities analysis is based on the discharge data from six hydrometric stations. Lemnia and Reci stations control the Râul Negru River, Plăieşii de Jos and Ruseni stations are on Caşin River, and Covasna and Boroşeul Mare stations are on Covasna River. The analysis period contains the years 1988 – 2012. This period was chosen because some hydrometric stations had been liquidated in the last years. This thing diminishes hydrometric control basin cover. At some station it was needed of data extension for data homogenization.

For the highlighting of flow characteristics and correlations with climatic factors modification, it was taken into consideration a longer time period (1955 - 2012), which corresponds to the precipitation observation period at Târgu Secuiesc meteorological station and to the discharge observation period at Reci closure hydrometric station

Table 1. Data from hydrometric stations (1988-2012)

River	Hydrometric station	Founded	A	H med	Length	L. up.	Q.med	q.med
			km^2	m	km	km	mc/s	l/s.kmp
Râul Negru	Lemnia	1999	101	892	57.2	30.8	0.638	6.32
Râul Negru	Reci	1932	1698	760	80.9	7.1	7.87	4.63
Caşin	Plăieşii de Jos	1983	85,0	954	21.6	32.4	0.679	7.99
Caşin	Ruseni	1949	476	830	51.7	2.3	2.46	5.17
Covasna	Covasna	1987	31,0	1150	10.0	18.0	0.614	19.8
Covasna	Boroşneul Mare	1952	232	739	23.9	4.1	2.31	9.96

The analysis is based on statistical data processing and on discharge variation charts interpretation at the six hydrometric stations, but also on the calculation of variation coefficients. The evaluations refer to time and space evolution.

3.RESULTS AND DISCUTIONS

3.1.Annual flow and genetic factor's modification

The annual average discharge evolution that was analysed at Reci closure hydrometric station presents some characteristic periods. Between 1955 – 1969 and 1986 – 2004, the flow was poor inside the

river basin. In the years 1970 – 1985 the flow was in excess. After 2005, there appeared some important flow oscillations.

For a pertinent analysis of basin's reaction to genetic factors variation, it was taken into calculation the annual precipitation data from the Târgu Secuiesc meteorological Station. We can observe a good correspondence between the two data series. The years with excessive (1955, 1970, 1984, 2005, 2010) or poor precipitations (1963, 1987, 1990, 2012) are well represented by the flow characteristics.

The linear trends of the two data series are slightly increasing and almost parallel. The 6th degree polynomial trends are similar to each other, but the inflections are more pronounced at flow trends. We can say that the flow in the Râul Negru basin presents a "normal" reaction to the modification of main genetic factor – precipitations.

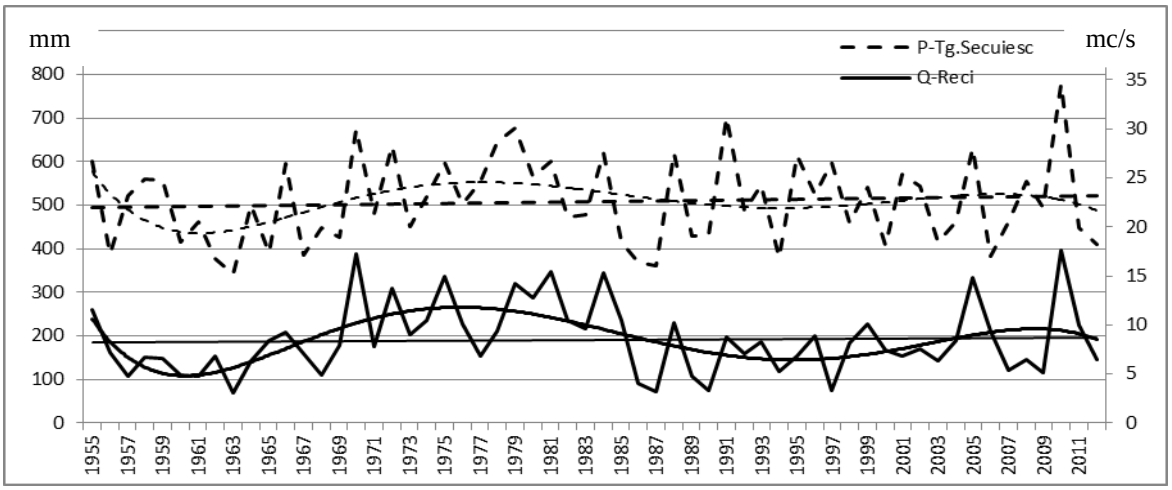

Figure 2. Precipitation and annual discharge evolution

3.2.Seasonal flow

It can be observed a very clear principle in the percentage repartition of seasonal flow. In all seasons, the input from all six sub-basins is very similar. A clear differentiation appears between spring – summer, with high flow (30-45%) and autumn – winter, with obvious low values (10-15%). The most homogenous season is summer, when only at Plăieşii de Jos Station appears higher input. The biggest differences are in springtime, especially at Lemnia Station. But also, this station has the lowest values in the poor seasons.

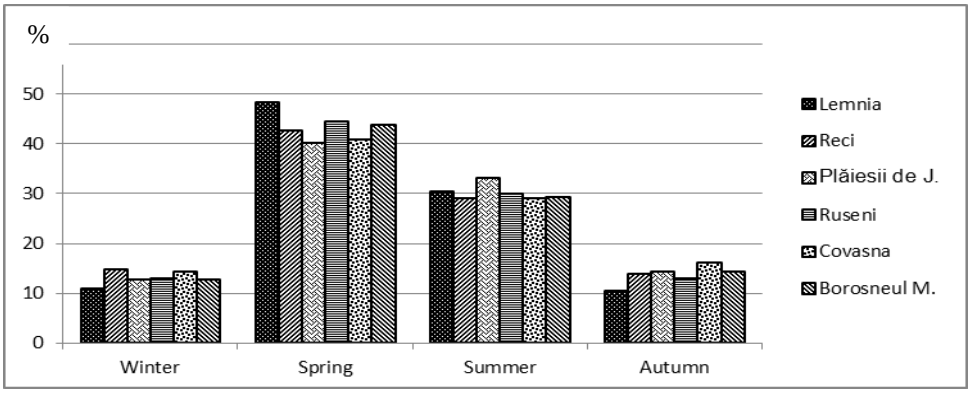

Figure 3. Percentage repartition of seasonal flow

Time evaluation of seasonal flow is based on the average discharges values from the three hydrometric stations situated in the basin's mountainous area (1988 - 2012). It can be observed that evident differences appear between the stations, even though the Râul Negru basin has a relative homogeneity.

At Lemnia Station, in winter time, five years present values above 0,400 mc/s, and nine years with under 0.200 mc/s. The ratio between the maximum (2009) and minimum (2012) value is 9.2. There can be observed six years with discharges lower than 2.0 mc/s at the Plăieşii de Jos Station, of which three

consecutive years (1991 - 1993) with very poor flow (under 0.112 mc/s). In 1996, there was registered an exceptional discharge of more than 1,0 mc/s; the second highest value was registered in 2011 – only 0.706 mc/s. The Covasna Station presents an increasing, rather homogeneous discharge trend. Only three years have higher discharge values than 0.600 mc/s (1998, 2002, 2011) and four years with lower values than 0.200 mc/s (1991, 1992, 1993, 1997). The module coefficient has a high value (16.7) at Plăieşii de Jos Station, and a much smaller value at the othe two stations. The increasing winter flow trend appears at all three stations. A high similarity can be observed for the flow values from Plăieşii de Jos and Covasna stations, even though these stations are situated at a high distance.

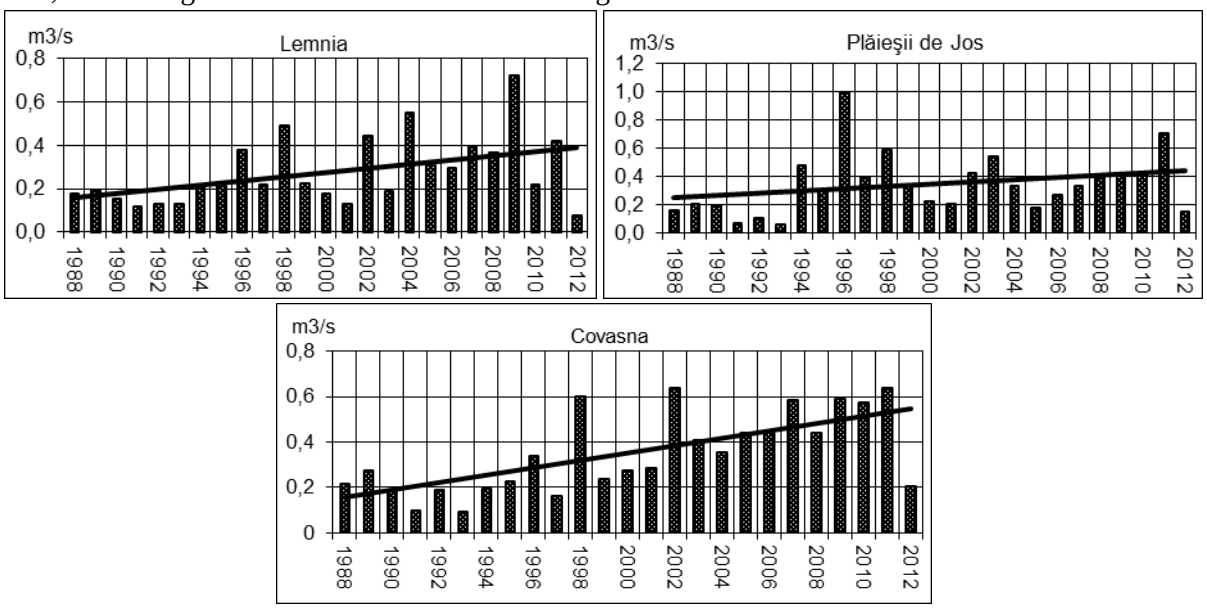

Figure 4. Winter discharges variation and trend

The spring is the season with the highest flow for all stations. The highest discharges are of 2 mc/s, and the smallest do not exceed 0.500 mc/s. Some time differences appear at Lemnia and Plăieşii de Jos stations, where the years 1996 – 1999 present a very rich flow; a similar flow appears at the Covasna Station in the last three years. The Plăieşii de Jos Station presents in the last decade a relatively constant and not very high flow. Because of this the discharge trend presents a slight decrease, when at the other stations the trend is increasing. The module coefficients are relatively constant, with oscillations between 4.3 and 6.1.

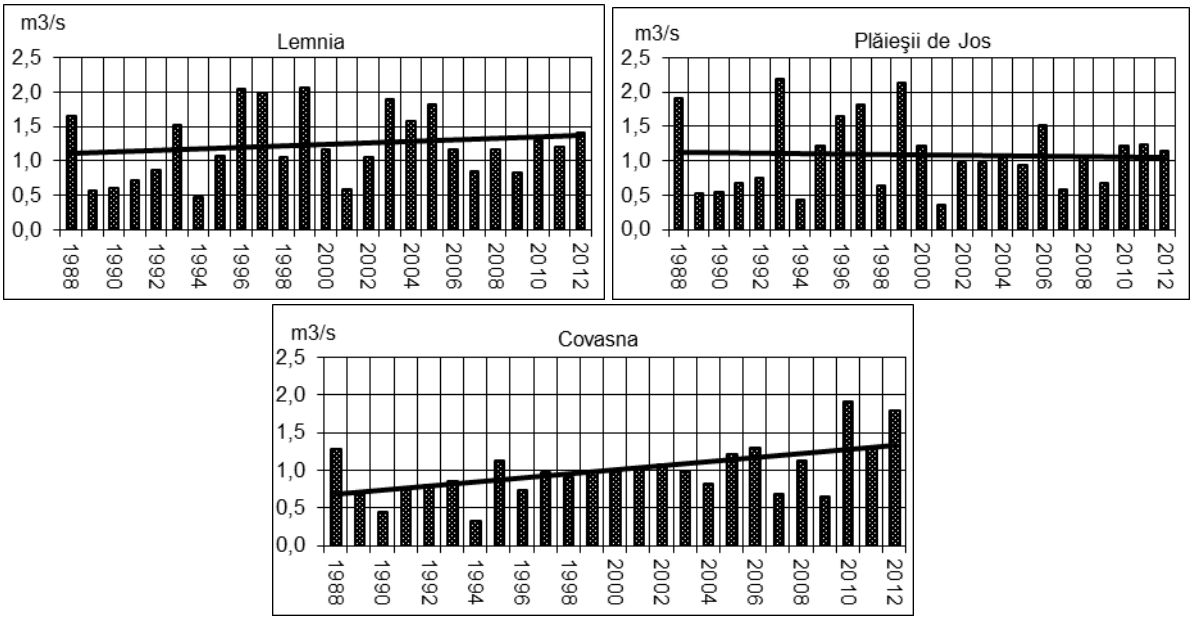

Figure 5. Spring discharges variation and trend

The summer flow presents a better homogeneity between all the stations. Some of the years had rich flow (1997, 2005, 2010), and others had a poor one (1990, 2000, 2007, 2012). In some years, the precipitations repartition was non-uniform, with strong differences of water flow: 1994 (poor water flow at Lemnia and Plăieşii de Jos stations, rich at Covasna Station), 2011 (poor at Lemnia Station, poor at Plăieşii de Jos and Covasna stations). The rate between the highest and the lowest discharge was very big at Lemnia (17.9) and Plăieşii de Jos stations (21.3), comparing with Covasna Station (only 7.0). The variation trends had an ascending curve, a little less visible at Covasna Station.

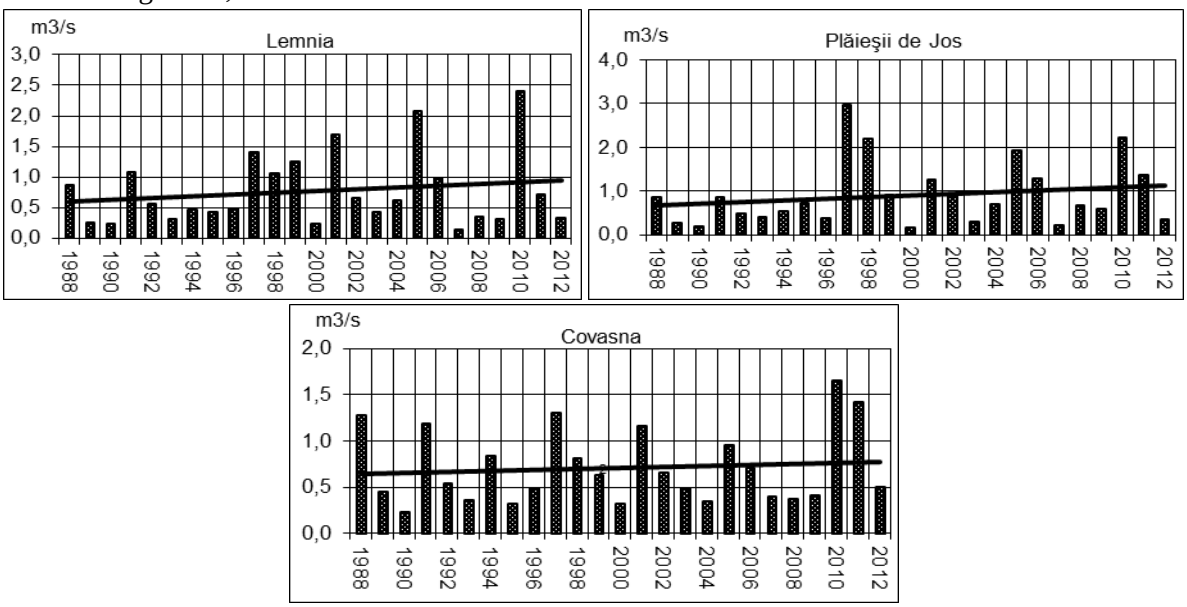

Figure 6. Summer discharges variation and trend

The autumn at Plăieşii de Jos Station presents a span of four years with very high discharges (1995-1998). The maximum discharge was in 1998 – 1.48 mc/s. The autumn at the other two stations has a small discharge, not exceeding 0,700 mc/s. Some years present a very poor flow: Plăieşii de Jos Station – four years (1988, 1990, 1994, 2012), and Lemnia Station – three years (2009, 2011, 2012), when the discharges did not exceed 0.100 mc/s. Instead, at Covasna Station the discharge values did not go under this value, indicating a more constant water supply. The flow trend presents a remarkable stability at all stations, with a slight decrease at Covasna Station. Module coefficients are 15 at Lemnia and Plăieşii de Jos stations, and much smaller at Covasna Station (6.6).

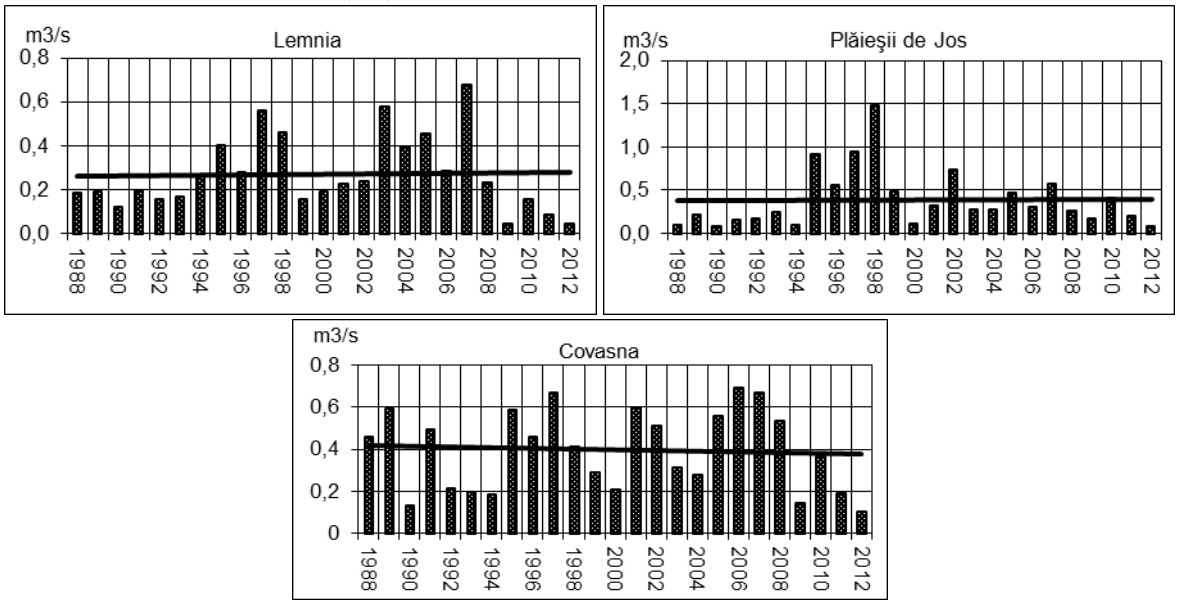

Figure 7. Autumn discharges variation and trend

The seasonal variation coefficients present some big variations at the same hydrometric station. The biggest differences appear at Lemnia, Reci and Ruseni stations between spring and summer, and at Plăieşii de Jos and Boroşneul Mare stations between spring and autumn. All stations present the lowest Cv values in the time of spring flows – a law-like phenomenon.

The season with the highest Cv values varies from a station to another, but it appears in the season with the lowest flow values. It can be noted that in each season, at the upper river stations from the Râul Negru and Caşin rivers, the Cv values are greater or equal to those placed in the lower sector. At Covasna Station the situation is in all seasons reversed – at Boroşneul Mare Station all Cv values exceed those from the upper sector station.

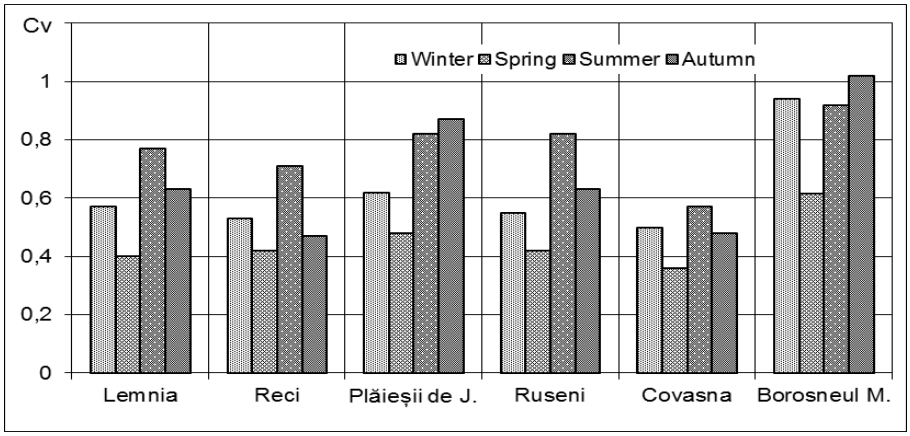

Figure 8. Seasonal variation coefficients

3.3.Monthly flow

The monthly flow is analysed at all stations from the three main rivers that are controlled each by two hydrometric stations. The flow principles are similar, because of the river basin's placement, the relatively homogenous physical – geographical conditions and because catchment area surface (2320 km^2) is not very big.

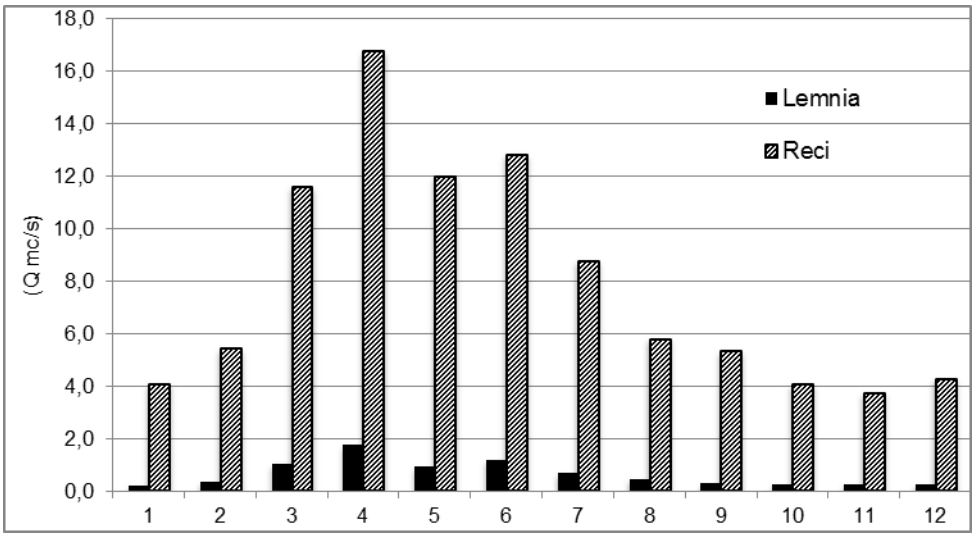

Figure 9. Multiannual monthly average flow on Râul Negru River

The highest discharge values appear in April at all hydrometric stations, due to early snow melting together with spring rains. Similar high flows appear in March, May and June. On the rivers Râul Negru and Covasna, the Discharges from March are equal or smaller than those in May and June. These two months present very close discharge values at all stations, due to April's pronounced warming and high rainfalls.

Monthly average discharges present a continuous decrease from June to November. The exceptions are Lemnia and Plăieşii de Jos stations, situated in mountainous, where the minimum values appear in

November. Sometimes, the depletion curve presents a very homogenous rate – example Covasna and Reuseni stations.

In January, the monthly average discharges at mountainous stations have low values determined by strong water freezing and high water retention in ice formations, and also because of snowfalls in winter time. We must observe that at all stations the flow values from December are a little higher than that from November. This can be explained by the slight increase of rainfalls in this month and because of late snowfall appearance.

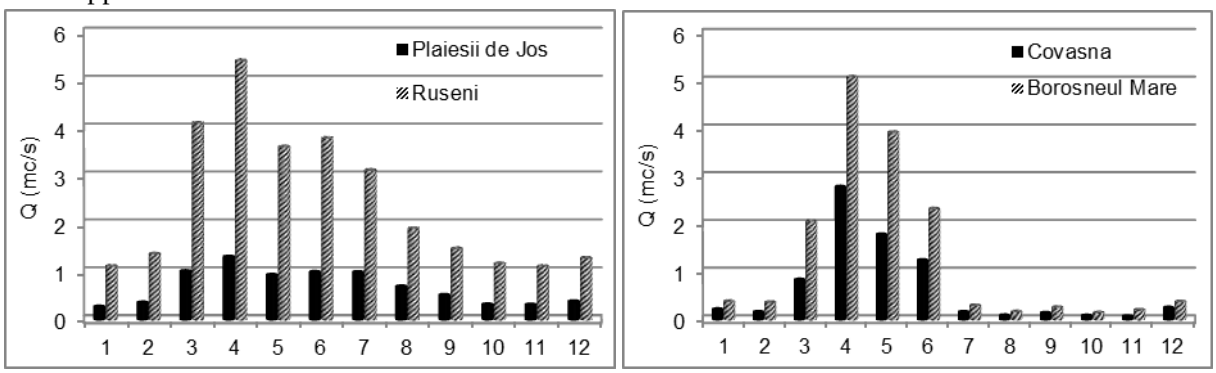

Figure 10. Multiannual monthly average flow on Caşin and Covasna rivers

The monthly discharges on Râul Negru River present a poor relation because of the difference created by high water basin distances between the two hydrometric stations (Vigh, 2014). The rate between monthly discharges from Reci and Lemnia stations varies very much. Very high rate values appear in January and September (around 20). The rates have the smallest values in March, April and June (almost 10). For the other two rivers – Caşin and Covasna – the rates are almost constant. For the stations Ruseni/Plăieşii de Jos and Boroşneul Mare/Covasna, the rates for all months are 3 and 4. The flow on these rivers is very much conditioned by other factors, because of the small water basins around Râul Negru basin.

Percentage repartition of monthly water quantities shows the great homogeneity of the hydrographic basin. IN April, all stations present the highest water flow (16-23 %). Also, the water flow percentage is between 10-15 % in March, May and June. October –February represents a period with poor flow. This thing is determined by the importance of snowfall supplies together with spring rainfalls, a period that can last even till July (Caşin River). The poor water flow from the year's end continues during the winter, because of the snowfalls and water freezing.

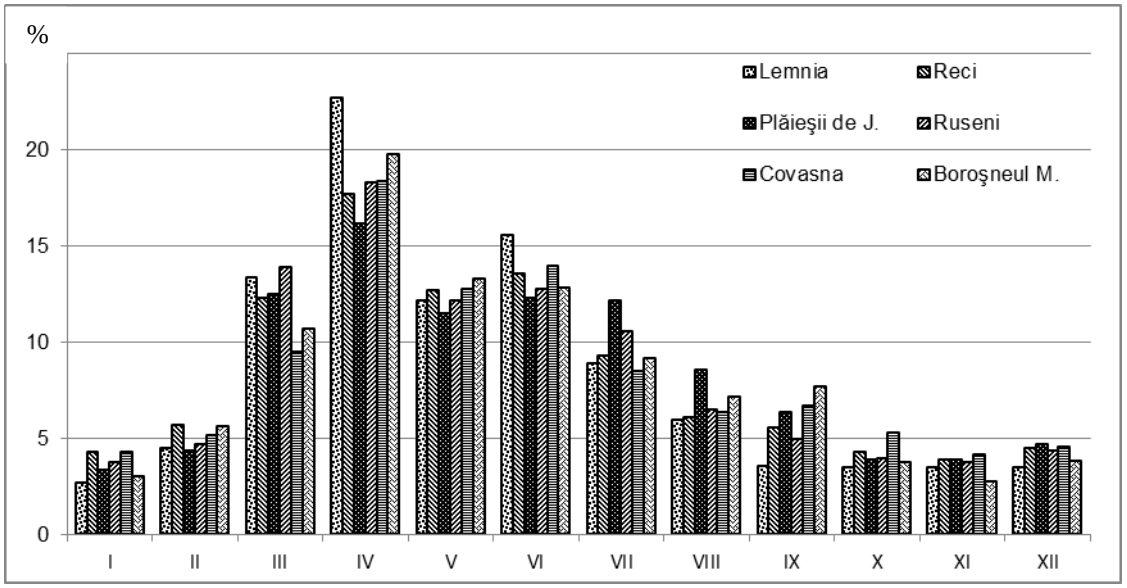

Figure 11. Percentage repartition of monthly flow

It also can be observed some differences for each sub-basin. The flow in April is very rich in Lemnia Basin, but it exceeds the flow from other stations in March and June. In the months with high flow, the values from Plăieşii de Jos Station are smaller than the others. At Plăieşii de Jos and Boroşneul Mare stations, the water flow from July – September has the greatest part. In September – February, the flow at Lemnia Station is the poorest. The minimum flows are more equally distributed than the maximum ones.

The monthly flow values of variation coefficients are of 0.5-1.0. Boroşneul Mare Station presents the highest Cv values each month, but excels in February, August, September and December, all with poor water flow. It can be observed that the months with the highest water flow values have the smallest Cv values. The exceptions are October and November, with very low Cv values at all stations.

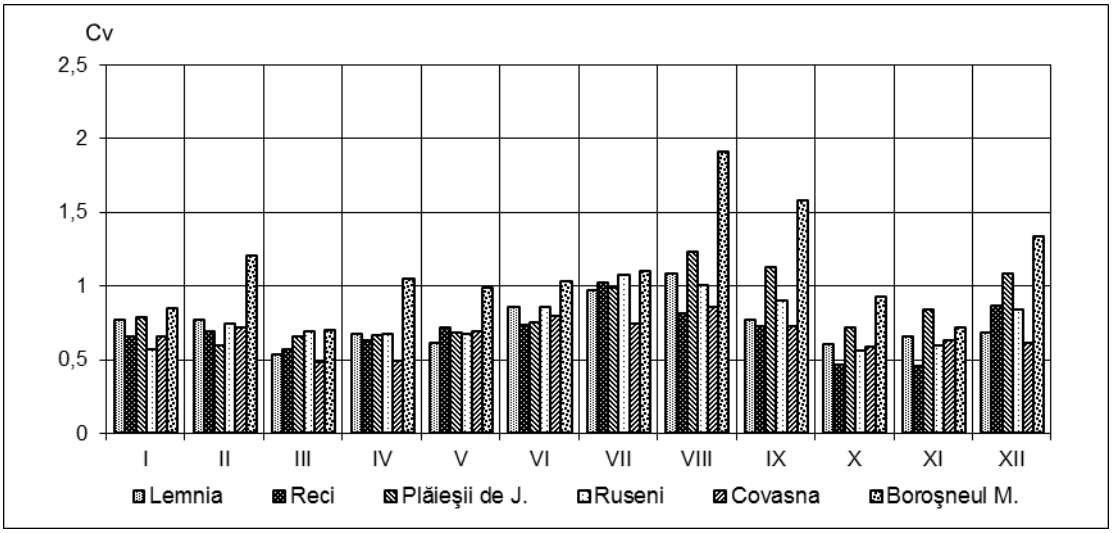

Figure 12. Monthly variation coefficients

4.CONCLUSIONS

The water flow from Râu Negru catchment area presents a rapid reaction to rainfalls variation. The cause for this fact is the sub-basin's relatively small surface and the relative homogeneity of flow formation and propagation. At seasonal and also monthly level, can be observed general flow principles. But also the local factors influence the differences from a station to another.

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