THE PECULIARITIES OF THE SEASONAL AND MONTHLY FLOW REGIME OF THE RIVERS IN THE UPPER RIVER BASIN OF MUREŞ

NICOLETA DANIELA GORON[1]

ABSTRACT. – The peculiarities of the seasonal and monthly flow regime of the rivers in the upper river basin of Mureş. The study is based upon the processing and the interpretation of data from eight gauging stations. In order to emphasize the peculiarities of the flow regime year-round there has been taken into account the common period, namely 1986-2010. The features of the geographic cover characterizing the central eastern part of Eastern Carpathians, especially those regarding the slopes and the climatic elements are reflected accurately in the river water flow regime. Thus, the dominant flow of all rivers occurs during the spring season and the lowest share of the total annual average season is winter. The month with the richest flow is April, and the low flow occurs during the months of January and February. The seasonal and monthly flow variation in multi profile was highlighted by the coefficients of variation.
Keywords: seasonal flow regime, monthly flow regime, upper river basin of Mureş

1. GENERAL CONSIDERATIONS

The process of defining the flow regime of a river implies a statement of all the factors that influence it under a series of aspects (Pop, Horvath, 2010).

The factors that influence the seasonal and monthly flow regime peculiarities in the upper river basin of Mures are rather of a physical nature regarding the relief features, the climatic conditions, highly influenced by the first category, and the vegetation coverage influenced by both of the above.

The upper river basin of Mureş is grafted over the mountain territory covering major areas such as the Gurghiu Mountains, the Călimani Mountains the Depression of Giurgeu and the gorge sculpted by the river Mures.

The climatic elements that influence the flow regime in the upper river basin of Mures are a lower temperature compared to the downstream regions, heavier precipitation which represent water suppliers that provide water directly as well as indirectly to the river bed (Pandi, 2011), a higher humidity and a lower evaporation than the hill-plateau region.

The thermal inversion phenomenon that occurs mainly in the Toplita-Deda gorge also determines a vegetation inversion delineated by beech in the valley and spruce on the slopes which also makes an impact upon the river flow regime in this region.

[1] Facultatea de Geografie a Universităţii "Dimitrie Cantemir" din Târgu .Mureş. email: dana_goron@yahoo.com

In hydrologic terms the studied area represents mainly the upper river basin of Mures and the analysis requires an emphasis on two sides called upon data collected from the hydrographical stations of Suseni, Topliţa, Stânceni and Gălăoaia situated on the Mureş river and data collected from hydrographical stations located on its tributaries: the Belcina, the Topliţa, the Răstoliţa and the Bistra. (Table 1).

The period of 1986-2010 has been chosen for analysis due to the fact that it is the period all the eight representative hydrometrical stations have in common.

As one can depict from table 1, nothing is set in stone in what concerns the hydrometrical stations that register the river dynamics within the upper river basin of Mureş. As such, during a period of 40 years due to some territorial adjustments, mainly the shutdown of some of the hydrometrical stations or the emerging of new hydrometrical stations such as Gălăoaia upon Mureş or Bistra upon the river Bistra, the area that corresponds to some hydrometrical stations has changed (see the stations of Suseni, Stânceni, upon the river Mureş or Răstoliţa upon the river Răstoliţa) generating a slight influence upon the data.

River	Hydrometric station	Altitude m	Area in 1972 km^2	Area in 2012 km^2	River length km
Mures	Suseni	987	152	160	19
Mures	Topliţa	935	-	1071	77
Mures	Stânceni	967	1492	1532	98
Mures	Gălăoaia	988	-	2135	127
Belcina	Gheorgheni	1.115	-	94	31
Topliţa	Topliţa	1.149	211	215	28
Rastolita	Rastoliţa	1174	158	163	20
Bistra	Bistra	1.104	-	92	25

Table 1. ***The hydrometric stations in the upper river basin of Mureş***
Source: The Water Resource Association in Mure, Ujvari, 1972

2. SEASONAL RIVER RUN-OFF REPARTITION

The river run-off year-round repartition determines the economical value of the rivers, since a homogenous flow describes a river that can be used more efficiently (Sorocovschi, 2002, 2005).

On an annual basis, within the period of 1986-2010, the greatest amount of river flow concentrates during the spring while on the other hand during the winter season the river run-off is at its lowest.

Winter is, in terms of precipitation, the driest season of the year, being characterized by a discharge of 15.2-15.7% of the total annual run-off on the main course and ranges from 13 to 18% on its tributaries in the upper river basin.

Spring is the season of the richest conditional discharge which is due to the melting of the snow, the relatively high amounts of precipitation, the low evaporation, and an early stage in the annual evolution of plants.

The largest water volume flowing on the main course of the upper river basin of Mureş is registered at the Stânceni and Topliţa hydrometric stations while among the tributaries one can notice Topliţa which registers a rate of 44% of the total annual run-off during this season. At the same time, it is during this season that potentially dangerous phenomena with a rapid deployment occur.

High water periods extending over a longer period of time compared to the flash-floods are caused by rain fall over an extended period of time overlapped by snow melt. The "saw tooth" floods are typical during the spring especially in the smaller river basins within the area, where given the lower dimension of the basin, the response to the natural factors is immediate (fig 1).

Of the eight stations that monitor the water dynamics in the upper river basin of Mures, one can observe by analyzing Figures 2 and 3 that all the rivers are characterized by a peak spring season, and that seven of them record during this season a percentage volume of 40% or more of the annual total while the Belcina river records go below this line with a percentage of 36% of annual volume during the spring.

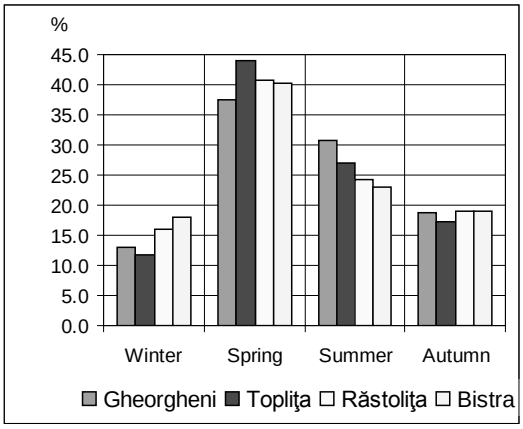


Figure 1

Fig. 1. ***Seasonal river run-off repartition upon the Mureş river tributaries in the upper river***

During the summer there is a slight decrease from the previous season due to air temperature increase and thus the intensifying the evaporation process. The Mureş river percentage values at the 4 hydrometrical stations varies between 20-25%, and one could spot a slight difference between stations Gălăoaia, Stânceni and Topliţa which are rather more exposed to hot air in comparison to the first hydrometrical station upon the Mureş river: Suseni located in the central depression of Gheorgheni thus being less influenced by the hot air circulation during the summer (Figure 2).

Among the tributaries, whose value varies between 20-30% seasonal percentage, Belcina stands out with a value of over 30% of annual flow, which can be explained by the same climatic factors that influence the river run-off measured at the hydrographic station Suseni, the two localities being at a distance of 10km from each other, within the same depression of Gheorgheni (fig 1).

By analyzing figures 1 and 2 one can distinguish a difference between the run-off rate recorded on the Mureş River and on its tributaries. If for the main river among the 4 stations Mures the hydrometric data appear homogeneous, compact, with no significant differences in the percentage ratio even if the stations are spread out over a distance of 85 km.

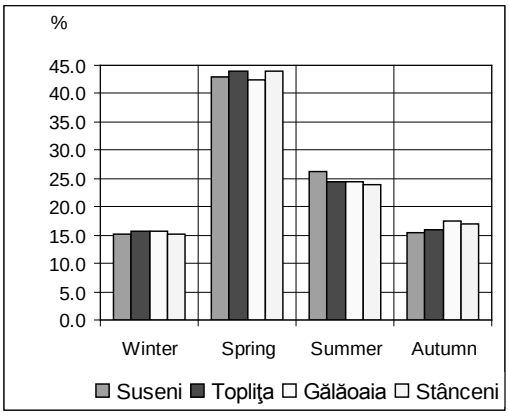


Fig. 2. ***Seasonal river run-off repartition upon the Mureş River***

Comparing the data referring to the seasonal fluctuations of the regime of the rivers Topliţa and Belcina one can observe that although the related hydrometric stations are less than 40 km apart there are striking differences with regard to the warm season: the spring flow volume amounts to 37.6 % for the Belcina river and 44.1% for the Topliţa river while during the summer the Belcina boasts a 30.8% when compared to 26.9% Topliţa (fig 1).

By comparing the average seasonal flow evolution in the eight hydrometrical stations it may be concluded that the most dramatic changes occurs on the river Topliţa where the winter contribution to the annual average flow is 11.8%, the spring contribution reaches 44.1%, summer represents 26.9% and fall 17.2% of the total.

3. MONTHLY RIVER RUN-OFF REPARTITION

The period analized for the monthly river regime repartition in the upper sector of the river basin of Mureş consists of 25 years mainly 1986-2010 representing the conjoint period to all the eight hydrometrical stations taken into account.

The distribution of the average monthly flow during the year in the upper basin of the Mures River reveals a peak in April and minimum reached during January. The lowest percentage value recorded for the period from January to February characterized the Topliţa River and the highest characterized the Bistra River (fig. 3).

Compared to the months of January and February when the Mureş river and its tributaries record a minimum flow that amounts to 3-6%of the annual total, due primarily to the lack of rainfall and evaporation during the month of March one can observe a significant increase in percentage (8 -13%) caused by snow melt and liquid precipitation.

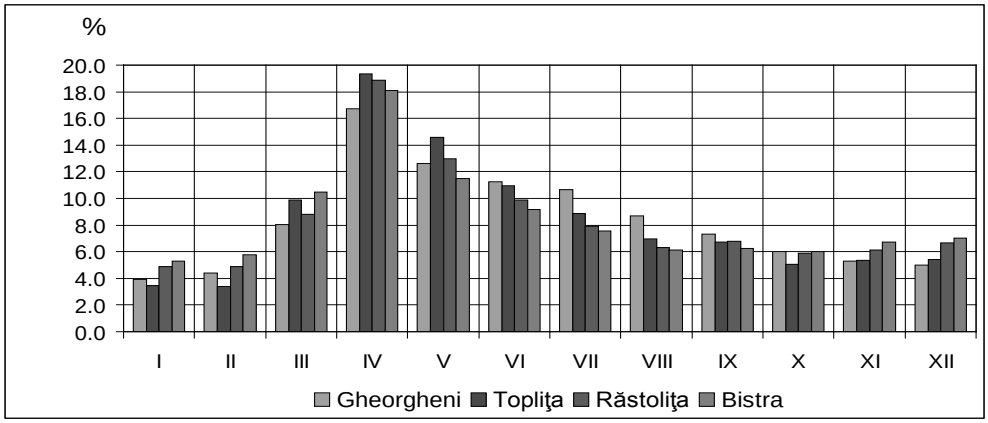


Fig. 3 ***Monthly river run-off repartition within the upper river sector of Mureş (tributaries)***

The richest flow within the upper river basin of Mureş is achieved during the month of April, upon the Topliţa River (of the tributaries) and on the main course at the hydrometrical stations of Stânceni and Topliţa that attain almost 20% of the average annual volume. The lower peak values in this period are recorded at the hydrometrical stations of Gălăoaia upon the Mureş River and Gheorgheni on the Belcina River (16-17%) (Figures 3 and Figure 4).

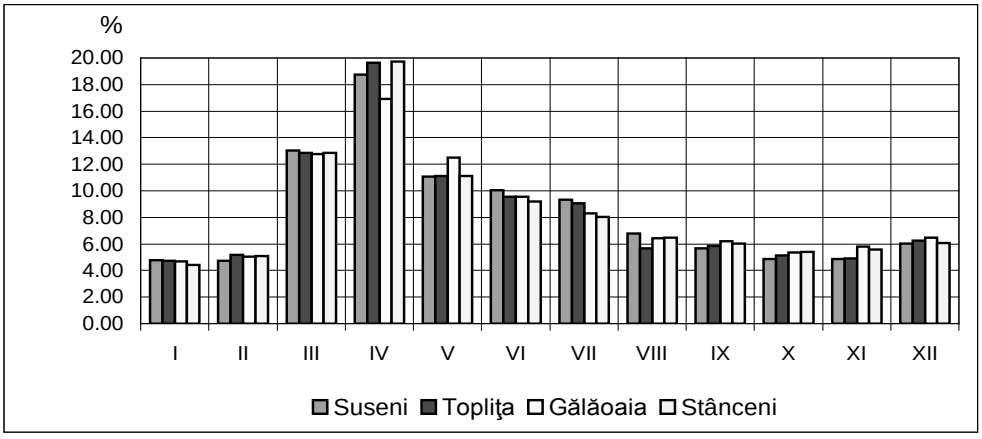


Fig. 4 ***Monthly river run-off repartition upon the upper river sector of Mureş at four hydrometrical stations***

By comparing the period analyzed by Ujvari in 1972 to the period analyzed here for the hydrometrical station of Topliţa upon Topliţa (established in 1952) one can conclude that the higher percentage represented the months of April and May both with a 20% of the year run-off., a peak that is not attained only by the month of April solely. (fig 5)

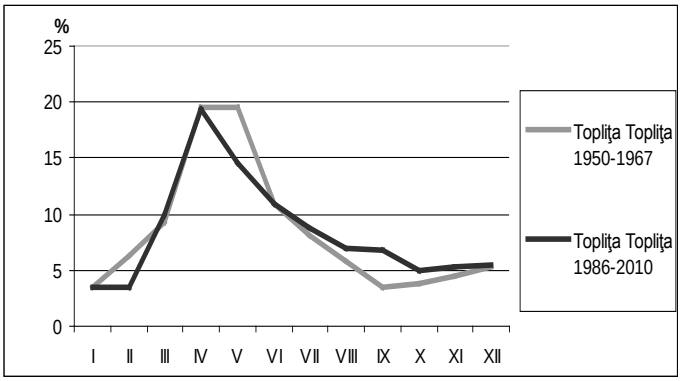


Fig 5 A comparison of the monthly river run-off repartition at Topliţa station

Following this, one can depict, due to the said adjustment, higher percentages characterizing the river mainly during the months of January and September (fig 5).

4. THE SEASONAL AND MONTHLY VARIATION ON A MULTIANNUAL SCALE

Within the seasonal flow variation one can distinguish a remarkable synchronicity rendered by the fact that seven out of the eight hydrometric stations have registered their greatest flow during the winter of 1996, the hydrometric station of Gheorgheni upon Belcina being the exception.

During the spring season one can remark a second synchronicity between several hydrometrical stations: it is the case of the rivers Răstoliţa and Topliţa on one hand and Suseni, Topliţa and Gălăoaia upon the Mureş river on the other hand that register the greatest spring flow during the year of 2006.

For five of the eight hydrometric stations taken into account namely: Topliţa upon the Topliţa river, Răstoliţa upon the Răstoliţa river, Bistra upon the Bistra river, Topliţa and Gălăoaia upon the Mureş river the year with the greatest summer flow was 2006.The fall of 2002 represents for half the hydrometrical stations taken into account namely: Gheorgheni upon the Belcina river, and Topliţa, Stânceni and Gălăoaia upon the Mureş river, a period that favours the concentration of high river flow.

Thus a period of high flow cumulating both spring and summer of 2006 is delineated for the hydrometrical stations of Topliţa upon the river of Topliţa, Răstoliţa upon the river of Răstoliţa from what the main tributaries of the river

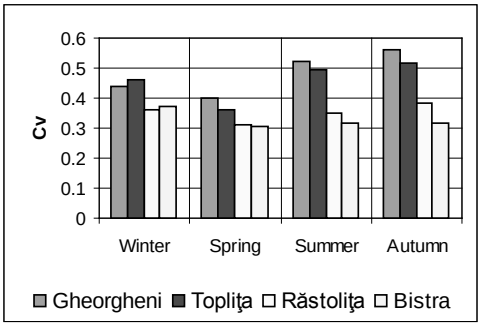
Mureş in the upper sector are concerned and the hydrometrical station of Topliţa upon the river Mureş.

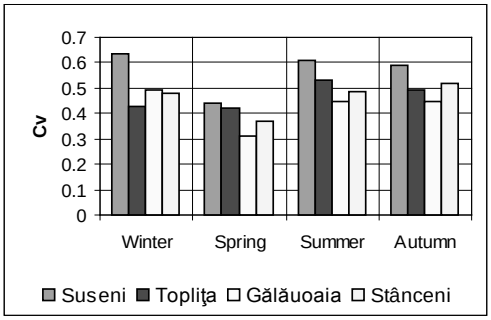
At the opposite pole there are the years of 1986-1987, 1991, 2000, 2001 and 2003 which are characterized by rather a minimum run-off.

One can detect a minimum flow period that cumulates both the seasons of spring and summer of 2003 upon the rivers of Topliţa and Răstoliţa (fig 5.1).

The summer of 2003 is a period with a low contribution to the average annual flow, fact proven by six of the eight total hydrometric stations that had registered the lowest flow from a representative period analyzed here (1986-2010), with the exception represented by the stations of Gheorgheni upon Belcina river and Gălăoaia upon the Mures river that have registered a minimum summer flow in 1986.

A prolonged period of minimum flow characteristic to the cold season is represented by the one cumulating both the seasons of autumn and winter of the years 1986-1987 and registered by three hydrometric stations within the studied are out of which there are two of the main stream studied: Stânceni and Gălăoaia.





1 **2**

Fig. 6 ***The evolution of seasonal variation coefficients upon the tributaries (1) and the Mureş river (2) within the upper river basin***

A comparative analysis of the direction of the seasonal flow evolution during the period of 1986-2010 reveals an increasing trend especially within the summer-autumn period especially for the small river basins (Figure 6.1). Overall, the basins can be thus grouped in Belcina and Topliţa on the one hand and Răstoliţa and Bistra river basins and on the other hand based on similar developments during the winter, spring and summer seasons (Figure 6.1).

If in the case of the Bistra river basin one can observe a uniform flow characterized by coefficients of variation ranging from 0.305 and 0.315 in the spring-summer-autumn and not much higher value of 0,371 during the winter season, not the same can be said about the evolution of seasonal flow for watershed of Belcina and Topliţa. The coefficients of variation for the Belcina river basin

have recorded striking differences from one season to another, their values are ranging from 0.559 to 0.400 (Figure 6.1).

The hydrometric stations upon the river Mureş record several regional differences. At the hydrometric station of Topliţa upon the Mureş river the variation coefficients recorded differences between winter-spring period when coefficients lie in around 0.420 and the summer-autumn period when the coefficients lie around 0.520 (Figure 6.2).

The year-round evolution pattern upon the upper river basin of Mureş can be seen by analyzing the first and last hydrometric station of this sector. Thus, the range of coefficient values at Suseni is situated around 0.44 during spring and varies from 0.600 to 0.640 during the rest of the year. Similarly, the coefficients of variation calculated for the spring period at Gălăoaia equal 0.31 which differs from the representative values for the rest of the year whose values range from 0.447 to 0.492 (Fig. 6.2).

By analyzing a series of 25 years ranging data one can observe a crescent trend that characterizes mainly the winter, summer and autumn seasons, while the fall is represented by a stationery trend at the last hydrometrical station upon the Mureş River in this sector: Gălăoaia.

5. CONCLUSIONS

Following this analysis one can conclude that the river flow concentrates mainly during the spring as opposed to winter.

In terms of average monthly flow distribution during the year in the upper river basin of Mures there is a peak in April and a minimum in January. The lowest percentage value recorded for the period from January to February characterized the Topliţa River and the highest characterized the Bistra River.

Regarding the maximum flow variation on a multiannual seasonal scale during the period of 1986-2010 one can identify years characterised by a rich discharge such as 1996, 2002 and 2006 seasonally distributed as follows: the winter of 1996, the fall during the year of 2002 and the warm season representing both spring and summer within the year of 2006.

REFERENCES

1. Sorocovschi, V. (2002, 2004) *Hidrologia uscatului*, Casa Cărţii de Stiinţă, Cluj-Napoca.
2. Sorocovschi, V. (2005), *Câmpia Transilvaniei. Studiu hidrogeografic*, Edit. Casa Cărţii de Ştiinţă, Cluj-Napoca
3. Ujvari, I, (1972), *Geografia apelor României*, Edit. Ştiinţifică, Bucureşti
4. * * (1987), *Geografia României, III, Carpaţii şi Depresiunea Transilvaniei*, Edit. Academiei, Bucureşti.
5. * * Data from The Water Resource Association in Mureş
6. http://aerapa.conference.ubbcluj.ro/2010/pdf/OAPop_Horvath.pdf
7. http://aerapa.conference.ubbcluj.ro/2011/PDF/pandi_gavril.pdf