SOME CONSIDERATIONS ON AVERAGE, MAXIMUM AND MINIMUM FLOWS IN THE CATCHMENT AREA OF UPPER MUREŞ

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ABSTRACT. – Some considerations on average, maximum and minimum flows in the catchment area of Upper Mureş. Hydrographic network, with all its components is a crucial element in environmental infrastructure planning. Changes in vegetation coverage and in the land use within the mountain area adiacent to Giurgeu basin especially in the last two decades have led to significant modifications in the water balance components, the share of food sources and the drainage system. With the study of hydrological parameters mentioned in the title we can get to explain the current geomorphological processes and phenomena especially in the flood river basins, and we can respond, in some extent, to the needs of local communities regarding rational and efficient use of resources water. The data used, observed and measured, derived from the four gauging stations in the upper Mures basin, namely: Mureş-Suseni, Mureş-Toplița, Toplița-Toplița and Belcina-Gheorgheni.

Keywords: hydrological regime, frequency analysis, hazard

1. DISTRIBUTION AND AVERAGE ANNUAL FLOW AND CHARACTERISTIC PHASES OF HYDROLOGICAL REGIME

The study of the hydrological regime has the aim of deciphering the governing laws of water resources in an area both in time and space. In this sense, the knowledge of flow regime is a practical importance because the socio-economic local or regional development depends on the amount and variation in time and space of water resources.

The analysis of data derived from observations at the four gauging stations of depression during the years, shows that there is quite pronounced periodicity of flow, and the following characteristic phases can be determined in the hydrological regime: the period of spring floods, the period of high waters of spring floods, the period of the summer low waters of summer-autumn floods and the period of autumn-winter and winter low water.

Spring floods period, usually beginning in the second decade of March (when due to rising temperatures during the day the snow in the upper river begins to melt) and take normally up at the second decade of April. The main feature of this period is the high and low levels fast alternation even during the same days. Depending on the intensity and duration of heating, the intensity and duration

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of floods is modifying, which although have a very low frequency in this period. The phenomenon of frost is improving but still not gone, the richer flow have nival root as March is poor in precipitation.

Table 1. ***Multiannual monthly average flow rates of the main rivers of Giurgeu Basin (m3/s)***

Month	Mureş – Suseni	Mureş – Toplița	Toplița – Toplița	Belcina- Gheorgheni
I.	0,344	2,300	0,881	0,334
II.	0,399	2,660	1,000	0,342
III.	2,035	9,700	2,090	0,770
IV.	3,230	16,200	8,180	2,200
V.	1,880	10,950	5,980	1,400
VI.	1,460	8,100	2,980	1,210
VII.	0,860	6,990	2,300	0,740
VIII.	0,510	3,520	1,970	0,477
IX.	0,360	2,840	1,200	0,311
X.	0,400	3,020	1,210	0,390
XI.	0,402	3,200	1,150	0,402
XII.	0,438	3,110	0,885	0,384

Spring high water period usually begin with the second half of April. Flash floods become more frequent, they overlap and maintain high levels and rates with steady growth trends. This period takes normally, until the first decade of June when in the water system begins to appear periods with lower levels and rates. Warming weather, from mid-April, produces widespread melting of snow in all micro-basins in the adjacent mountain area, which cumulated with the liquid precipitation, results therefore a dramatically increased levels and flow rates from March. It almost can not talk about evolution subsistence levels, they mentioning consistently high, increases or decreases from the average period is due to the presence or absence of liquid precipitation. Peak period is in the last decade of April and in the first decade and May when the water resulting from melting snow are added to the increasing amounts of rain, which are already pluviometric maximum in this period, but which does not reach yet the peak.

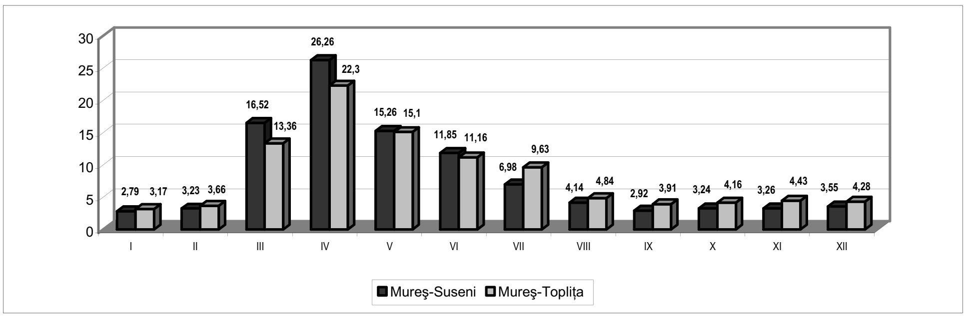

Fig. 1. ***Share of average monthly flow in annual flow (Mureş, %)***

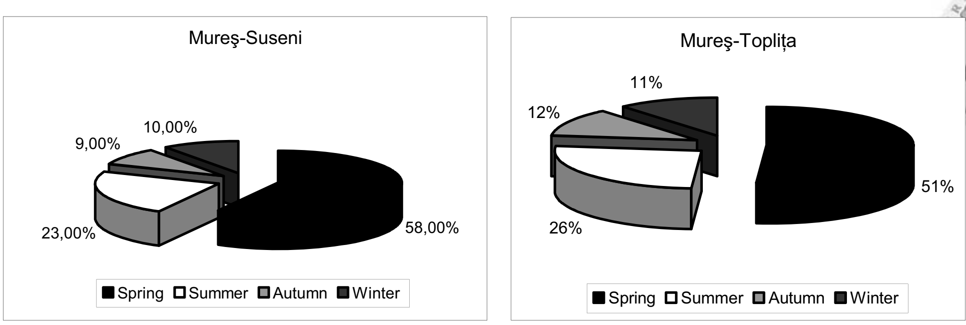

Fig. 2. ***Average seasonal flow share in annual flow for Mureş river (%)***

The period of summer floods can be identified very well in the range immediately after spring high water consumption. Water reserves in snow decreases from the first decade of June, flow levels gets lower, appear more frequently periods – at first short and then longer, with reduced flows against the previous period. Flow alimentation is made from quantitatively significant rains, belonging to pluviometric maximum from May to June, reaching its climax in the very first decade of June. During June, there is no possibility of snow supply, the frequency and intensity of floods depends on the frequency, duration and intensity of rainfall. In the second part of the period, due to decreased precipitation, the frequency and intensity of floods decreases, but due to excess of moisture, which has been created in the previous period in the basin, however the flow rate remains quite high in July.

Table 2. ***Share of monthly and seasonal average flow in multiannual (Toplița, Belcina %)***

Station	Toplița – Toplița		Belcina - Gheorgheni	
Month	Monthly share	Seasonal share	Monthly share	Seasonal share
I.	2,95		3,71	
II.	3,35	10	3,80	12
III.	7,00		8,56	
IV.	27,43		24,47	
V.	20,05	54	15,57	49
VI.	9,99		13,79	
VII.	7,771		8,23	
VIII.	6,60	24	5,30	27
IX.	4,02		3,45	
X.	4,06		4,33	
XI.	3,86	12	4,52	12
XII.	2,99		4,27	

Low water period of summer-autumn begins in August until mid-November. The whole period is characterized by low flows, with a low frequency and intensity of floods, especially in October and November. The first part of the period is characterized by a richer flow through water reserves accumulated during high water and floods across the basin. Because the installing the anticyclone system the contribution of precipitation becomes less, while increasing values of evapo-transpiration causes a continuous decreases in flow values from August until mid-November. Rains, low in quantity in October and November are complementing to some extent, the moisture deficit created during the months of August and September.

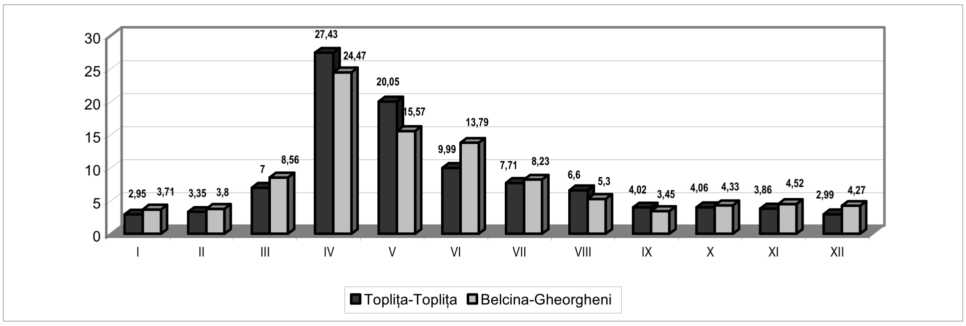

Fig. 3. ***Share of average monthly flow in annual flow (Toplița, Belcina, %)***

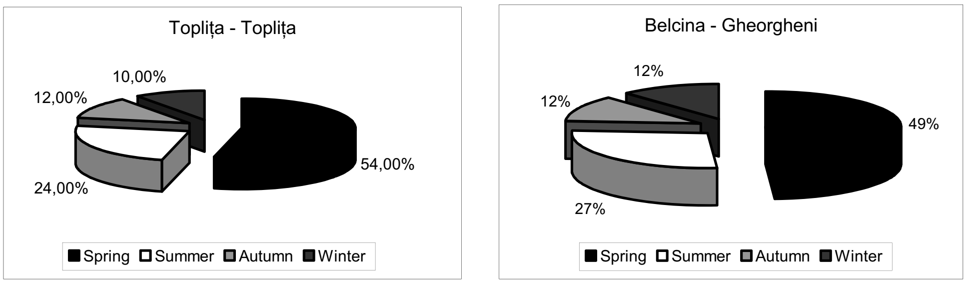

Fig. 4. ***Average seasonal flow share in annual flow for Toplița and Belcina river(%)***

The period of floods in autumn-winter, barely noticeable, and reduced in intensity and duration are remarkably from the previous period. It usually begins in the last decade of November and takes about up-n mid-December. The main causes of the richer flows are not the large amounts of precipitation but a degree of saturation of soil or surface frost that reduces or stops water infiltration from liquid precipitation still present in this period. The frequency and intensity of floods alternating with periods with low flows are lower and their duration is short.

Winter low water period begins with the third decade of December and usually ends with the arrival of the first flash, the first decade of March. The contribution of precipitation to drain is reduced, virtually to zero, the supply being made in more than 70% from the underground. Ice phenomenon is installing permanently, reaching maximum development in the second half of January and first half of February. During this period floods occur very rarely, their intensity and duration are low.

2. FREQUENCY ANALYSIS

To characterize the hazard of important debits on Mures in two locations, Suseni and Toplita a frequency analysis was made. We used monthly debits measured at the mentioned two hydrometrical stations between 1986-2008. From the point of view of the realized maximum debits the most hazardous moths seems to be March, April and July for Toplita and March June, July for Suseni (fig. 1). Through frequency analysis we want to show out the most instable month, where the threat potential is increasing, even if in the studied period no extremely high debits were measured.

As a study methodology first we verified the homogeneity, independence and the stationarity of the data series with R Statistical system, using the Wilcox, Box-Pierce and Mann-Kendall test respectively. All series successfully passed these test. The search for the most suitable frequency distributions was carried out in EasyFit, a software that holds most then 60 frequency distributions for continuous space. For determining the best fit we used the Anderson-Darling test, which takes account the statistical difference between the empirical distribution function and the fitted distribution function, also on distribution tails, which holds a great importance in extreme value calculus.

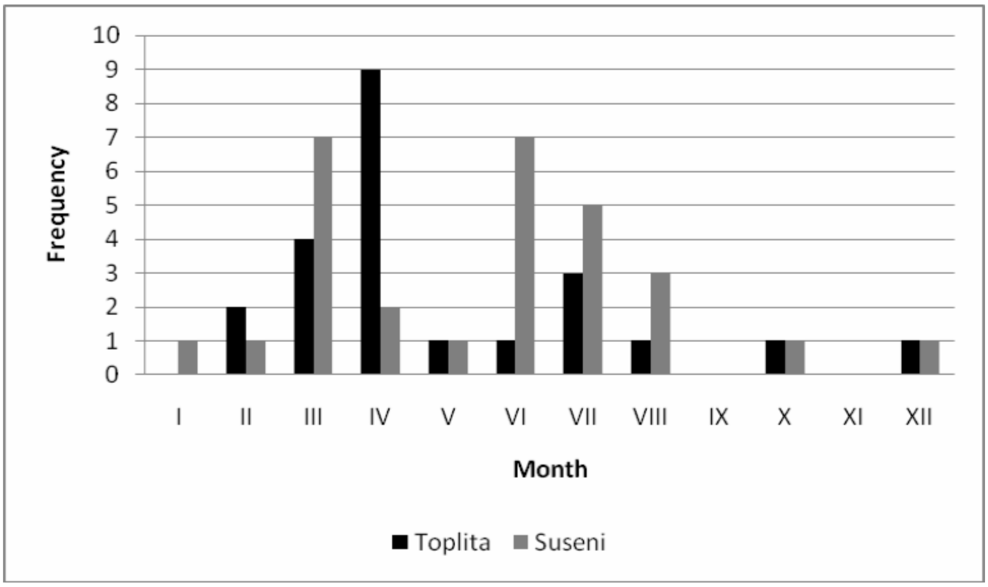

Fig. 5. ***Frequency of maximum annual debits on a month scale***

We also have to mention that some distributions, such as Johnson SB, don’t permit to determine the probability of apparition of a value outside the registered interval, but we don’t encountered such distributions in best fitted ones.

For different months, different distributions proved to be the most suitable. We considered this situation acceptable, based on the changing meteo-climatical ambience for different periods of the year.

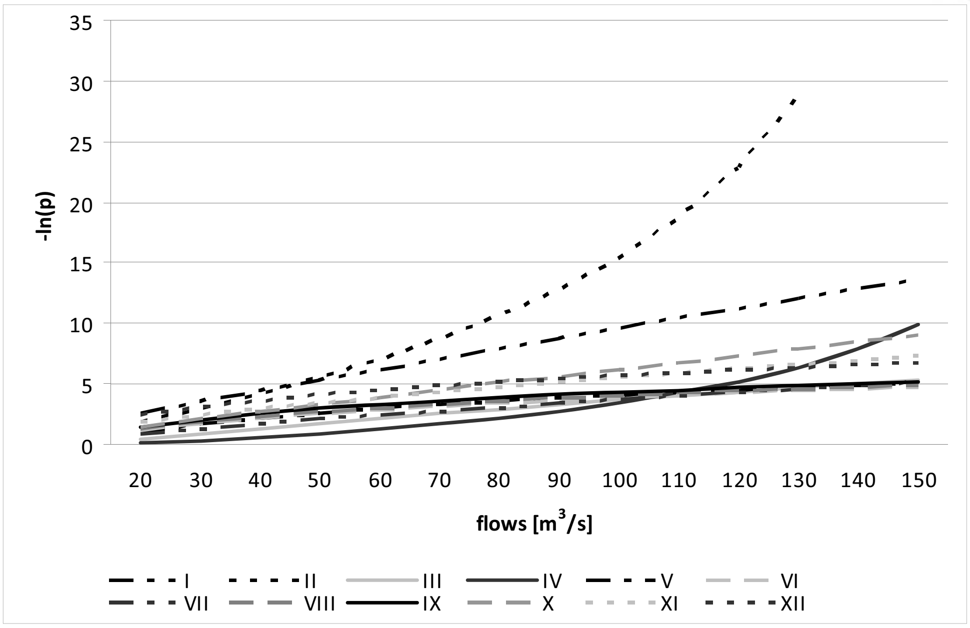

Fig. 6. ***The evolution of high debits hazard at Toplita station for every month***

The main interest of our study was to evaluate the evolution of the hazard for different months. As mentioned before in the study, there are two periods in the year that holds potential threats regarding maximum debit values. In this part of the research we want to characterize the evolution in time of the hazard, even if the corresponding maximum debit values are not so high. For that we represented the –ln(p) against different maximum debit values.

Figure 6 shows the logarithm of the probability of appearing different maximum debits at different months at Toplita station. It should be observed that for different debit values the curves has a changing relative position. The correct appreciation of this graph should take account of the treat represented by different debits according to the transversal profile of the river bed and other characteristics of river flow. For example if we consider dangerous a debit of 100 m^3/s, that could produce flood, than July is much dangerous than March. If we consider dangerous a debit of 50 m^3/s, the realization probability of it is higher in March that in July.

Regarding the maximum annual debit values, we also determined the return periods for different high debit values. For Toplita station the Wakeby distribution proved to be the most suitable, while for Suseni station the Log-Pearson 3 is the best. In this case the return period for the maximum debit measured at Suseni station (45 years) is just 2/3 of the return period measured for the maximum debit at Toplita station (69 year), so the hazard of reappearance of the local maximum is significantly greater at Suseni that in Toplita.

We continued to analyze the hazard curve around the measured maximum value in order to appreciate at the same level the hazard in the two locations. We considered a percentual exprimation based on the maximum measured value. We have taken an interval between 50% and 150% of this value.

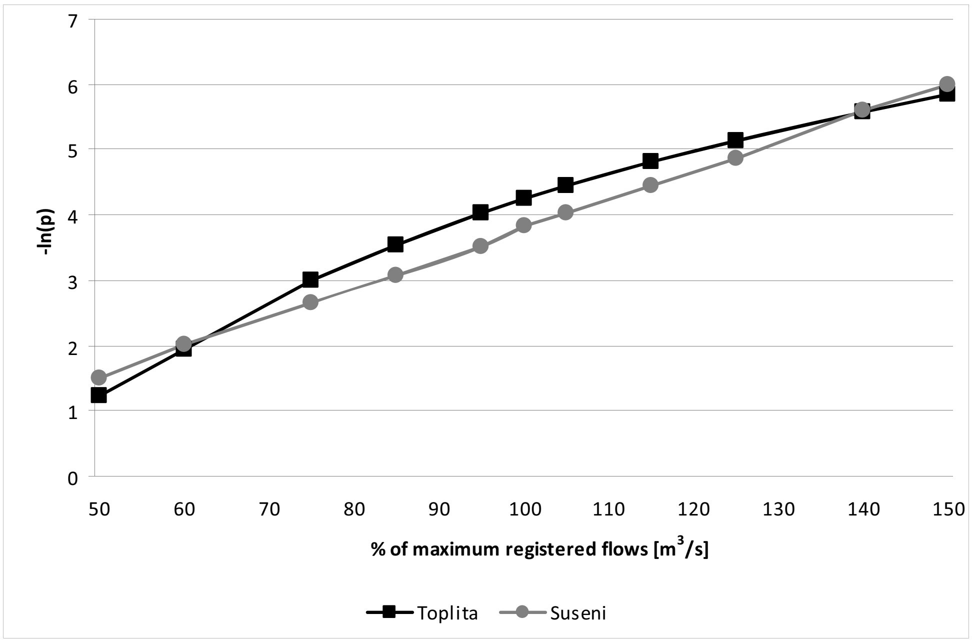

Fig. 7. ***Comparative representation of maximum debit hazard***

From the resulted graph, taking account that higher values on the y axis represents reduced probability, we can conclude that the realization of 60%-140% of the registered annual maximum debit is higher at Suseni against Toplita, while below and over these limits the hazard are increasing for Toplita (fig. 3). These percentual limits correspond to 80-186 m3/s for Toplita and 26-60 m3/s for Suseni.

3. CONCLUSIONS

Frequency analysis is a valuable method appreciating the treat that a given phenomena represents is measured points or areas. But the threat is dependent not only on the realization of a high value, but also on the effect of that value. In our case for every location a river bed analysis should be carried out to can evaluate the concrete hazard of high debits. In case of annual maximum debit analysis we developed a methodology to compare the hazard even if the realized maximum debit values are in different range. The result shows that Suseni is vulnerable in the range of 60%-140% of its registered study period maximum.

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