HIGH WATER FLOW PERIODS FOR THE RIVERS FROM SOMEŞEAN PLATEAU

V. SOROCOVSCHI

Abstract. High water flow periods for the rivers from Someşean Plateau. The period of high water flow from rivers is a complex phenomenon, which manifests itself in the form of large waters and floods. High flow periods are an important phase in the runoff of rivers, both by their extreme nature and by the effects they can produce on the components of the environment. The paper analyses several aspects related to the periods of water runoff from rivers: genetic factors, frequency, and temporal and spatial parameters of large waters and floods, case studies of the most representative floods, environmental, social and economic effects induced by floods.

Key words: genetic factors, high waters, floods, parameters, case studies, effects.

1. INTRODUCTIVE ASPECTS

The studied region covers an area of 2679 km^2, being the largest subunit of the three divisions of the Transylvanian Depression.

The Someşean Plateau is a transitional region between the Apuseni Mountains and the northern part of the Eastern Carpathians. The passage to the Eastern Carpathians is made through a Subcarpathian relief, which includes the Lăpuş Depression and Breaza Peak, and to the Apuseni Mountains through the Căpuş Corridor and the gulf-like penetrations of the Huedin-Călăţele and Iara-Hăşdate submontane depressions.

At the same time, the Someşan Plateau ensures the transition between the Transylvanian Plain and the Western Hills located in the western part of the Intracarpathian yoke formed by the alignment of the crystalline peaks from which it separates through the Almaş-Agij, Guruslău and Fericea depressions.

This settlement, altitude and exposure to the advection of the western air masses facilitated by the lower sectors of the Intracarpathian yoke (Someşan Gate and Chioar Depression) have implications in the spatial distribution of the main climatic elements and the water flow potential of rivers. In the southeast, between Gilău and Apahida, the Someşul Mic Corridor separates the Someşan Plateau from the hilly Feleac Massif. In the east, the Someşul Mic corridor between Apahida and Dej separates the Someşean Plateau from the Transylvanian Plain.

Periods with high runoff are an important phase in the flow of river water, both by their extreme nature and by the effects they can produce on the components of the environment. The phenomena of periods of high runoff usually occur in the form of pulses with various intensities, sizes and durations, which in the hydric regime of rivers are manifested in the form of large waters and floods.

Knowledge of the genesis and mechanisms of production of these phenomena offers the possibility to prevent and combat the economic, social and ecological effects they can cause.

2. METHODS AND DATA

In the elaboration of the paper were used the data from 12 hydrometric stations and four meteorological stations and eight pluviometric stations from the Someşean Plateau and the neighbouring region (Fig. 1).

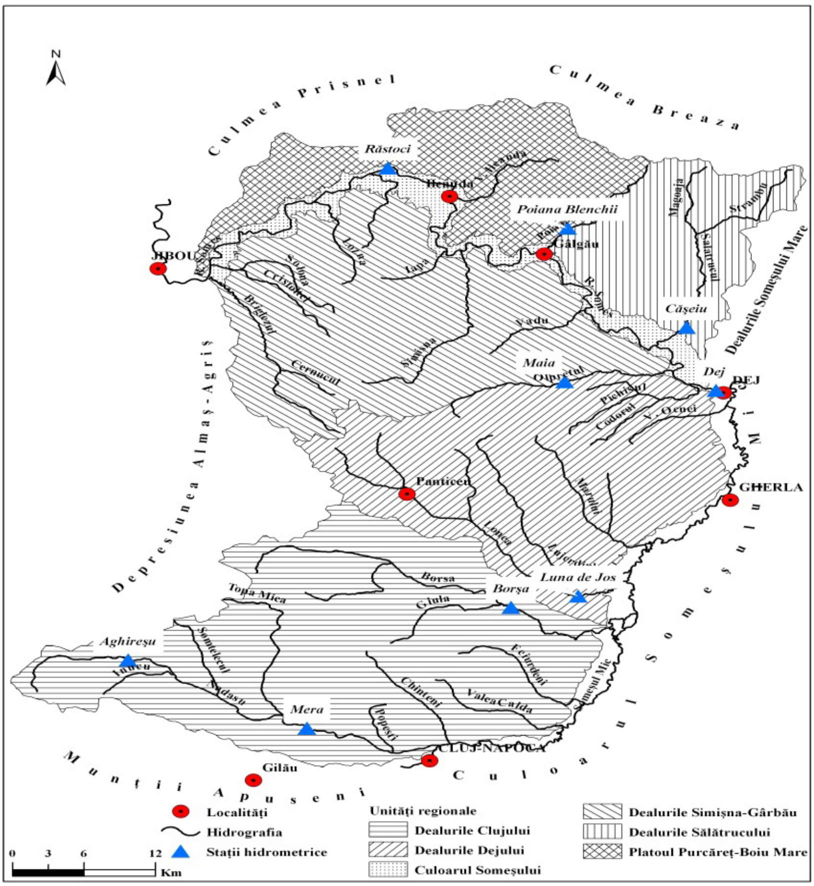


Fig. 1. Repartition of hydrometric stations

The period taken into account was 1961 - 2010, and the methods used were both classical (observation) and modern (statistical analysis).

3. RESULTS AND DISCUTIONS

3.1. Genetic factors of high water flow periods

High waters and floods, as component phases of high flow periods, are generated by rains between May and November, by melting snow in the cold season or by the overlap of the two processes in the winter - spring period.

Excessive rainfall periods have the effect of producing large water flows and floods. Following the chronological variation of the seasonal amounts of precipitation, it can be noticed that the biggest positive deviations are registered in the spring at the meteorological stations from the west of the Purcăreţ – Boiu Mare Plateau (200-250 mm). In the eastern part of the Someşean Plateau, the positive deviations are higher during the summer (160 - 190 mm). In autumn, the positive deviations are lower than in the previous seasons (90 - 110 mm). In winter, the smallest positive deviations are recorded (70 - 130 mm) (Fig. 2).

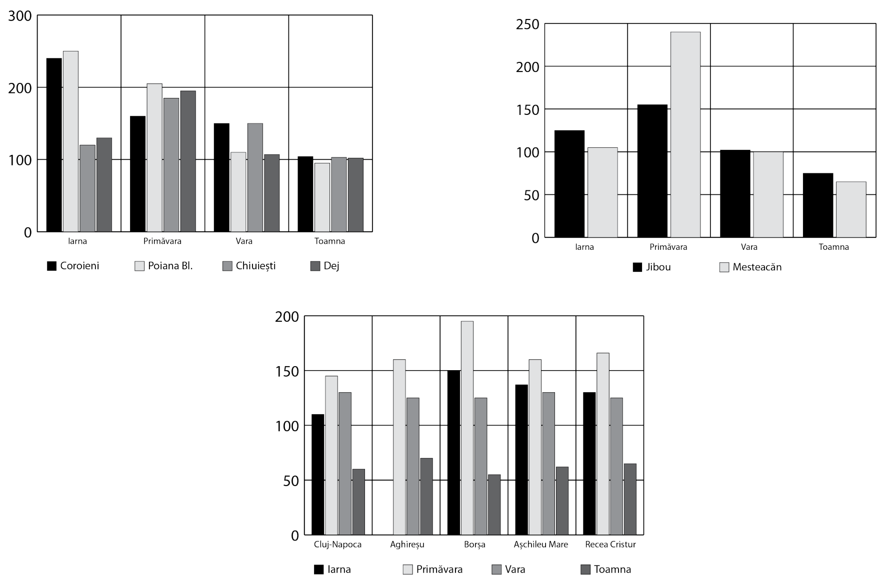


Fig. 2. Maximum positive deviations of the seasonal amounts of precipitation (1950 - 2000)

The amount of precipitations that falls in 24 hours also presents the intensity of rains in a region, which can generate floods, sometimes catastrophic. The maximum diurnal amounts of water resulting from liquid precipitation are generally lower in winter, when the circulation of continental anticyclones is dominant and the thermal convection is very weak. During the hot period of the year, when the absolute humidity is high and the thermal convection processes are added to the frontal processes, the values increase a lot, sometimes generating catastrophic floods. The maximum amount of rainfall in 24 hours has not exceeded 70 mm in the last five decades.

Analyzing the areas with maximum quantities fallen in 24 hours with the probability of exceeding 1%, it appears that the largest quantities (between 80 and 120 mm) occur in the Purcăreţ - Boiu Mare Plateau and in the south part of the Cluj Hills. This shows that floods of pluvial origin have a high frequency in these areas.

Along with liquid precipitation, snow is an important water reserve, which accumulates on the ground in winter, contributing especially in spring and sometimes in winter (consequence of the invasion of hot air masses) to the formation of catastrophic floods, especially when combining melting snow with falling liquid precipitation. Persistence, but especially the thickness of the snow layer, are elements on which the water reserve depends. The average annual number of snow days varies between 40 and 50 days. In some winters, when frost and freezing periods persisted, the snow cover lasted for more than a month (in the winters 1953 - 1954, 1967 - 1968, etc.).

The thickness of the snow layer depends on the nature of the snow, the exposure, the degree of vegetation cover, the nature of the component species, etc. From one year to another, under the influence of traffic conditions and local conditions, the snow layer varies greatly (Fig. 3).

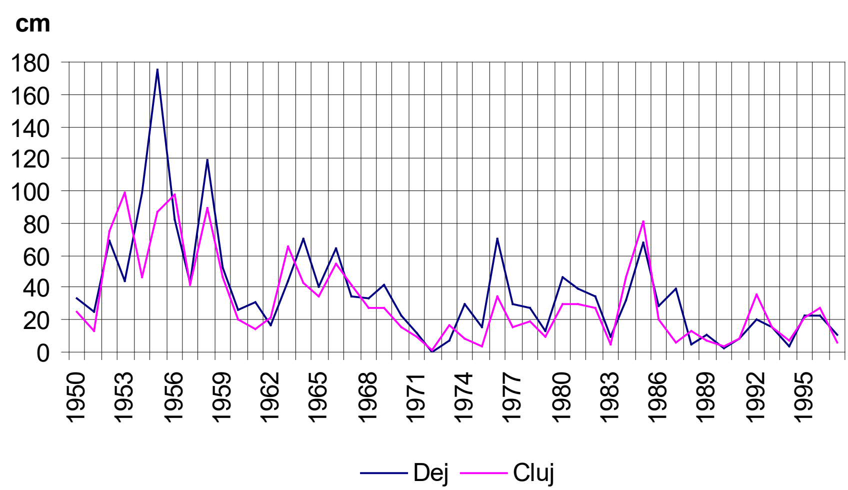


Fig. 3. Chronological variation of snow layer thickness at Dej and Cluj meteorological stations.

Certain morphometric characteristics of the river basin may influence the particularities of the flood. Thus, in the case of elongated and narrow basins, the peak of the floods is lowered and attenuated. In contrast, in a round basin, the peak of the floods is higher and sharper. The duration and size of floods are also affected by the water storage capacity of the soil and in the surface layers and by the possibility of retaining a quantity of fallen precipitation. Thus, in the basins of the streams in the centre and south of the Someşean Plateau, the low degree of afforestation contributes to the formation of fast and high floods.

3.1.2. High waters

The high waters have a high frequency in spring, when the climatic conditions of their formation are the most favourable, imprinting a regularity in their appearance. They represent the faithful mirror of the process of despair, which usually begins in the last decade of February in the south-eastern part of the Someşean Plateau. In the higher part of the north, the process of the formation of large spring waters is delayed, on average, from the third decade of February to the first decade of March.

The average duration of large spring waters is maintained between 15-20 days. The layer of runoff during high spring waters ranges from 20 to 40 mm. The duration of the high waters from March 1980 and March 2005 exceeded 25 days on Someş, and on some local streams it was maintained between 15 and 20 days (Nadăş, Sălătruc, etc.).

In special climatic conditions (long frontal rains), such as those in the spring of 2000, the period of high waters on the streams north of the Someşean Plateau was extended until April. In such situations their duration reached 20-25 days.

Similar climatic conditions determined a long period of high waters on the streams south of the Someşean Plateau. Similar situations occurred in the spring of 1997 and 1985 on the streams between the Purcăreţ - Boiu Mare Plateau and Sălătruc Hills. High spring waters occur more frequently with two waves, less frequently with one. The first wave is lower and usually generated by melting snow, and the second, higher, has snow-rain genesis.

High waters at the beginning of summer have a lower frequency and are generated by frontal rains, which combine with those of a convective nature. Sometimes it continues until July (1997 on Borşa, Maia and Sălătruc),

The high waters during the winter are characteristic for the streams from the north of the Someşean Plateau (1997, 1990). The maximum duration was recorded in the winter of 1990, when the high waters were maintained for about 20 days.In autumn, the high waters appear very rarely, being generated by the frontal precipitations from October - November (1992)

3.1.3. Floods

Regarding the genesis of floods, on most streams the maximum frequency is for those of rainfall origin. Only in the north-eastern part of the Someşean Plateau the floods of mixed origin during the winter have a higher frequency.

Frequency of flood generation. The monthly frequency of flood generation presents on all local streams a maximum in March (between 19% and 28% of the total number of selected floods (Fig. 4). A higher percentage belongs to the streams from Purcăreţ - Boiu Mare Plateau and Sălătruc Hills. On Someş, the highest frequency of floods occurs in May.

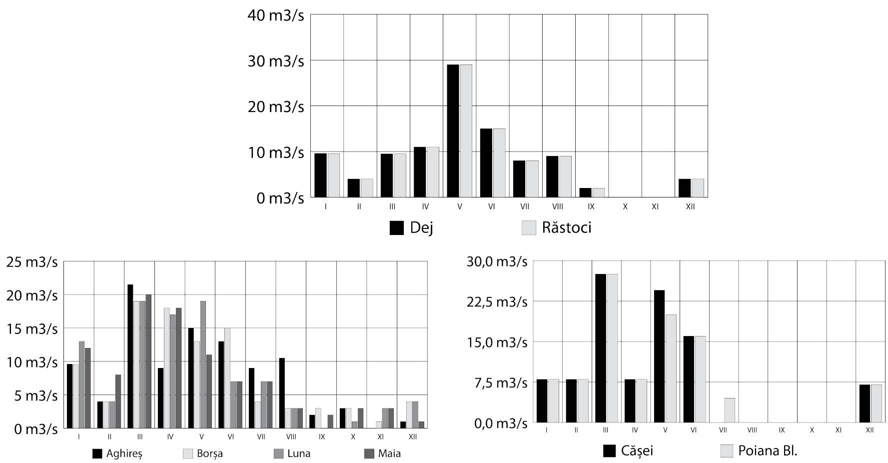


Fig. 4. Monthly flood frequency

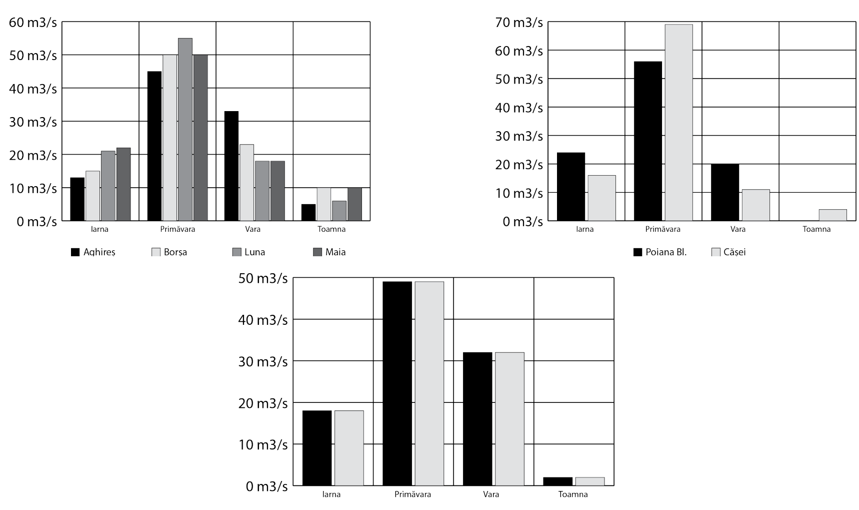


Fig. 5. Seasonal flood frequency

Regarding the frequency of floods during the seasons, there is a maximum in spring (46 - 70%). Higher values were identified on the streams from the Purcăreţ - Boiu Mare Plateau and the Sălătruc Hills (56-68%), followed by floods during summer, winter and autumn, when the most few cases (Fig. 5).

Elements of flood hydrographs. Floods have a number of characteristics that are measured (maximum or peak flow) or calculated (duration, shape).

The duration of the flood is an important element on which the size of the effects it can generate depends. The total duration (T_t) or total time consists of the increase time (T_{inc}) and the decrease time (T_{dcr}).

On most local streams, the highest frequency is for floods whose total duration is between 60 and 120 hours (30-40% of the total number of cases). The exceptions are a series of streams in which floods with a duration of over 75 hours are more frequent (Borsa at Borsa, 29%), respectively between 120 and 180 hours (Sălătruc at Căşei, 40%). Floods with a length of less than 60 hours have the highest frequency in the Nadăş river basin, being conditioned by the torrential character of the precipitations, respectively by the surface of the basin and by the relatively high slope (15 m/km). The duration of floods is different, depending on the nature of precipitation, varying in the analysed streams between 4 hours and 130 hours (respectively from <1 day to>5 days). The territorial differentiations imposed by the character of the precipitations (duration, intensity) are also observed when analyzing the duration of flood growth, another important element on which their manifestation depends. Thus, in streams with close basin areas, the growth time is different, depending primarily on the nature of precipitation (Fig. 6).

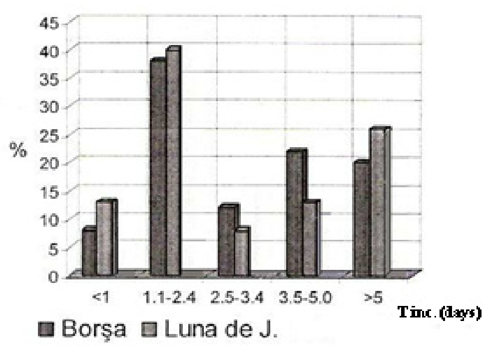
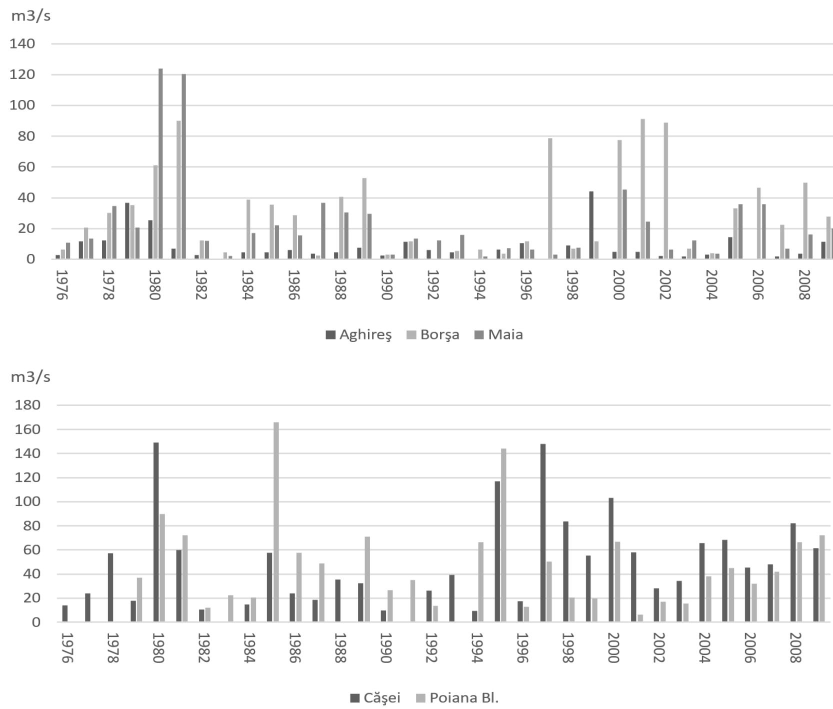


Fig. 6. Flood frequency (%) with different increasing times

The maximum (peak) flow (Qmax m³/s) is the parameter of maximum interest, as it represents the moment of greatest danger of maximum flooding. The maximum flows recorded on the streams in the Someşean Plateau varied within very wide limits, depending on many factors (climatic conditions, the surface of the reception basins, etc.). Values between 44.1 m^3/s (on the Nadăş River at

Aghireş) and 146 m³/s (on the Lower Moon, on the Moon). The maximum flows determined on Someş on the occasion of the floods produced in the period 1981-2009 (1758 m³/s in Dej, respectively 1975 m³/s in Răstoci) were below the value of those determined on the occasion of the flood in May 1970 (2300 m³/s in Dej).

A



B

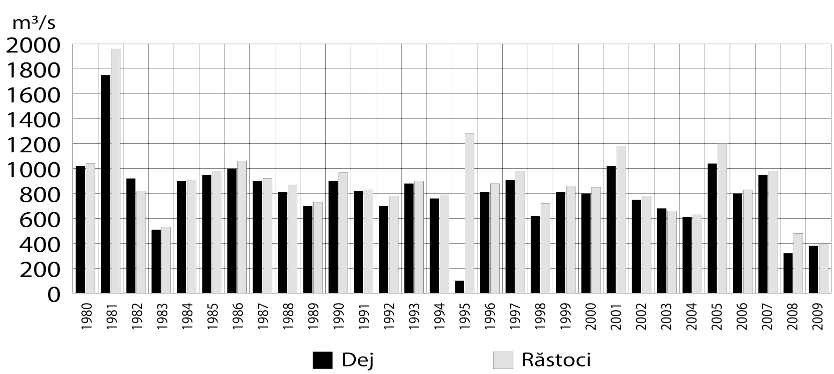


Fig. 7. Chronological variation of the maximum flows on autochthonous streams (A) and Someş (B).

Maximum flows with probability of production between 1 and 5% were recorded in different years (Fig. 7). There are several areas in which the maximum flows were recorded in the same year. Thus, on the streams from the hills of Dej, Şimişna – Gârbou and Sălătruc in 1981 there were floods with very high values of peak flows.

Table 1. Maximum flows (m^3/s) on local streams with years of production

Aghireş	m^3/s	Borşa	m^3/s	Maia	m^3/s	Căşei	m^3/s	Poiana Bl.	m^3/s
1999	44.1	2001	91.2	1981	120.3	1995	117	1980	89.7
1979	36.6	1981	89.9	2000	45.4	1998	83.5	1985	166,0
1980	25.4	2002	88.7	2005	35.9	1981	59.8	1995	144,0
2006	21,6	1997	78.8	2006	35.8	1985	57.6	1994	66.6

On the streams from the Purcăreţ – Boiu Mare Plateau in 1985 and 1995 there were floods with maximum flows whose values were very high (Table 1). On Someş River the maximum flows were recorded on the occasion of the floods produced in 1981, 2005 and 2001.

The maximum flows are registered with a high frequency in March (36-40%) on the streams from Cluj and Dej Hills, while on the streams from the northeast of the Someşean Plateau the maximum frequency returns in April, and on Someş in May.

The shape of the floods. Knowing the shape of the floods is important in assessing the characteristics and effects induced by floods. The values of the shape coefficient ranged between 0.06 and 0.28. Depending on the shape of the hydrographs, the floods were classified into monowave and polywave.

Case studies. For the detailed analysis, the most representative floods manifested in the period 1981-2005 were selected.

The flood produced between March 8 and 15, 2000, was generated by the precipitation that fell on a soil well moistened by the melting of the pre-existing snow. The fallen precipitations had values between 20 and 100 mm, being richer in the Purcăreţ - Boiu Mare Plateau and Sălătruc Hills.

Depending on the particularities of the substrate, the amount of drained water varied between 13 mm (Borsa at Borsa) and 102 mm (Poiana at Poiana Blenchii). The drainage coefficients had high values in the streams basins: Borsa (0.94) and Luna 0.81) from the Cluj and Dej Hills; Sălătruc (0.48) and Poiana (0.46) from the Purcăreţ - Boiu Mare Plateau. The maximum flows had very high values on Lonea (146 m^3/s), Borşa (80 m^3/s) and Sălătruc (103 m^3/s), being corresponding to production probabilities between 2 and 8%.

The flood between April 18 and April 24, 1998 was generated by the amounts of significant precipitation whose values ranged between 30 and 90 mm. It should be noted that in the basins of the streams from the Cluj and Dej Hills, from the Simişna - Gârbou Hills, the quantities of precipitation fell over 45 mm. Although the precipitation generated high values, less than a third of them entered the leakage process. Growth times ranged between 10 and 12 hours on Nadaş to Aghireş). The maximum flows produced ranged between 9.20 m³/s (Nadăş to Aghireş) and 69.5 m³/s (Borşa at Borşa)

The flood between 23 December 1995 and 1 January 1996 was of mixed origin. Precipitation over a pre-existing layer of snow contributed to its melting. humid and warm air from the west. The drained water layer reached high values (25-45 mm). The flood mentioned above manifested itself more intensely on the local rivers, on which quite high flows were registered (35.7 m³/s on the Moon at the Lower Moon, 117 m³/s on Sălătruc at Căşei and 144 m³/s on Poiana at Poiana Blenchii.

Among the floods produced on Someş, three representative floods were taken into account

The flood of March 1981 of mixed origin occurred with two waves, the first increase being lower and determined by the melting of the snow layer over which subsequently overlapped the waters from the fall of precipitation. As a result, the already increased flow acquired a special magnitude reaching 1975 m³/s at the Răstoci hydrometric station.Another mixed flood of polyunda type occurred in 1995 between December 22 and 30, due to rainfall in liquid form. Under these conditions, the total duration of growth obtained was 62 hours. The first wave took place between December 22 and 25 and came from the sudden melting of the snow, which led to increases in maximum flow at high values (1115 m³/s at Dej, respectively 1297 m³/s at Răstoci). This increase was followed by a slow decrease of about two days, followed by a new increase of up to 933 m³/s due to falling precipitation in liquid form, the total calculated growth time was 62 hours.

The flood of 2001 manifested itself in two waves. The first took place between March 2 and 5 when a maximum flow of 531 m³/s is reached at the Răstoci hydrometric station followed by a decrease period of 26 hours after which the flow increases again to a maximum of 1119 m³/s recorded on 6 March at 0.00. The characteristic elements of the analysed floods are shown in tables 2 and 3.

Table 2. The characteristic elements of the main streams manifested at the Dej hydrometric station

Year	Qmed. (m³/s)	Qmax (m³/s)	qmax (l.s.km²)	Tcr. (hrs)	Tsc. (hrs)	Tt (hrs)	Wt (mil m³)	h (mm)	Y
1981	111	1738	811,4	69	121	190	211,8	554,9	0,13
1995	112,3	1115	520,5	58	97	155	133,5	290,4	0,13
2001	92.7	1027	479,4	53	112	165	114,0	289,7	0,11

Table 3. The characteristic elements of the main rivers manifested at the Răstoci hydrometric station

Year	Qmed. (m^3/s)	Qmax (m^3/s)	qmax ($l.s.km^2$)	Tcr. (hrs)	Tsc. (hrs)	Tt (hrs)	Wt (mil m^3)	h (mm)	Y
1981	123	1975	922,3	72	126	198	254,7	657,2	0,14
1995	111,5	1297	605,5	62	105	167	176,5	364	0,15
2001	96	1119	522,4	51	94	145	157,5	272,6	0,15

Flood-induced effects. Floods cause specific phenomena: floods, erosion processes, pollution, etc. Of these, floods are the most frequent and dangerous hydro-meteorological events.

Depending on their nature, the effects of flood-induced phenomena are felt both on the environment and on man and his activities.

The environmental effects are manifested by: surface and torrential erosion; changing the riverbeds in plan and vertically, and modelling the terraces, generated by the processes of erosion and sediment transport, changing the course of rivers or the structure of the river network (regressive erosion catchments).

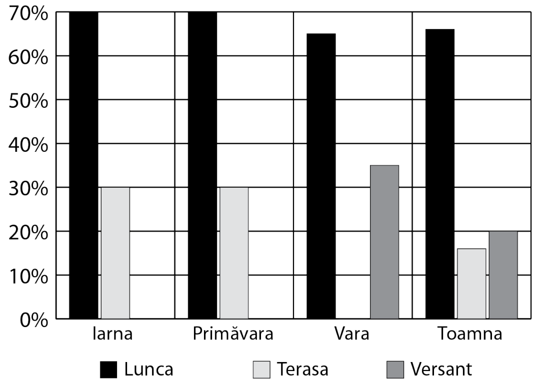
The degradation processes of the riverbed and the banks of the streams intensified as a result of the floods. The length of the watercourses affected by such processes was maintained between 2690 m and 4135 m on Nadăş, respectively 210 and 1440 m on Luna (Table 4).

Table 4. Length of watercourses (m) affected by river and bank degradation processes (data from the Someş-Tisa Basin Administration)

Years	Nadăş	Borşa	Luna	Olpret
1981	2690	6734	210	225
1989	3613	6832	1440	225
1999	4058	5742	710	225

Social and economic effects. Floods are the phenomenon that induces dangerous effects of an environmental, social and economic nature. The effects induced by floods depend on the intensity of the phenomenon and the vulnerability of the population. The fact that most are located in the meadow area (Fig. 8).

Fig. 8. Distribution of households on the main morphological stages in the hydrographic basins developed in the Cluj and Dej Hills



Areas with potential risk of floods have been identified on the streams: Ocna River, downstream of Ocna Dejului locality; Olpret River, downstream of Bobâlna locality; Feiurd River, downstream of Chinteni locality, as well as in some sectors from Someş Valley (Dej – Glod, Rus – Răstoci, Surduc – Var).

In most situations, floods generate negative social, economic and ecological effects. The material and social damages caused by the main floods in the analysed period (1981-2002) are shown in Table 5.

Table 5. Damage caused by the main floods in the Cluj and Dej Hills (Data from the Someş – Tisa Basin Administration)

Years	Cattle (no.)	Houses (no.)	Annexes (no.)	Agric. land (ha)	Road network (km)	Dj.+ Dc. (km)	Ob. ec. (no.)	Ca-nal. (no.)	Total value ($)
1981	20	202	9	437	1,5	-	3	-	220.422
1989	-	7	5	1109	-	-	-	-	88.806
1999	52	55	61	1386	2	55	23	5	441.857
2000	-	1	1	1115	-		-		194.910
Total	**72**	**265**	**76**	**4047**	**3,5**	**55**	**26**	**5**	**945.995**

On Someş River, the biggest damages registered in the period 1981-2005 were caused by the floods from 2001 (62,1 mld. lei), which affected the localities of Dej, Cetan, Vad, Gâlgău, Fodora, Glod, Rus, Ileanda, etc.), from 1995 (54,187 mil. lei) causing damages in several localities (Dej, Căşei, Cetan, Dobrocina, Gâlgău, Rus, Ileanda, Letca, Ciocmani, Surduc, Turbuţa) and 1981 (63021 thousand lei), affecting the largest part of the aforementioned localities.

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