THE PHENOMENON OF STREAMS DRYING IN THE SOMEŞEAN PLATEAU

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Abstract. The phenomenon of streams drying in the Someşean Plateau. The drying of water flow from rivers is a complex phenomenon, which can manifest itself in different forms. In the Someşean Plateau, an integral part of the Transylvanian Depression, river drying occurs more frequently in the summer and autumn months, and less frequently in the winter months. The paper analyzes several aspects related to the drying phenomenon: the favoring factors, the distribution parameters and the zoning of the drying phenomenon.

Key words: drying, factors, parameters, types, repartition, areas

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. In latitude it extends between the parallels of 46°02 'and 46°43', and in longitude between the meridians of 24°45' and 25°35' (Fig. 1).

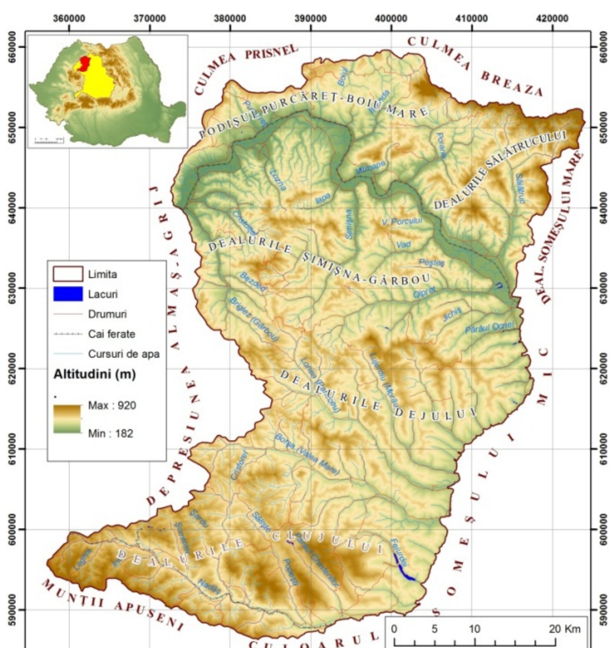

Fig 1. Geographical positions and limits of the Someşan Plateau.

The Someşan Plateau makes the connection between the Apuseni Mountains and the north of the Eastern Carpathians. The connection to the Eastern Carpathians is made by means of a sub-Carpathian relief, which includes the Lăpuşului Depression and Breaza Peak, and towards the Apuseni Mountains through the Aruşu Pass and the golf courses of the Huedin-Călăţele and Iara-Hăşdate sub-mountain 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 to which it separates through the Almaş-Agij, Guruslau and Fericea depressions.

Its settlement, altitude and exposure to the advection of the western air masses facilitated by the lower sectors of the Intracarpathian yoke (Someşană Gate and the Chioar depression) have implications in the spatial distribution of the main climatic elements and the potential for river drainage. The effect is manifested by the more humid and cool climate in this part of the Transylvanian Depression.

In the south-east, between Gilău and Apahida, the Someşul Mic Pass separates the Someşan Plateau from the hilly Feleacul Massif.In the east, the Someșul Mic Corridor between Apahida and Dej separates the Someşan Plateau from the Transylvanian Plain.

River drying is a complex phenomenon with implications in the possibilities of exploiting the water resources of a region, that is, with significant implications in its socio-economic development. Someşan Plateau is a deficient region in terms of water, where the drying phenomenon has a fairly high frequency, duration and intensity. The cessation of river drainage can be supported by three particular cases: *river drying* is the most frequent case and is caused by the prolonged lack of precipitation combined with maintaining high air temperature values; the water puddling in the riverbed represents a transition phenomenon to the drying of the rivers, indicating, as in the previous case, the null value of the flow, that is to say the cessation of the drain; *total frost* also suggests cessation of flow, as the entire water flow has passed from the liquid state to the solid state.It is clear from the observations made that in the Someşan Plateau, as in the whole of the Transylvanian Plateau, the water flow with the lowest value occurs during the summer-autumn and sometimes winter periods, as a result of maintaining an intense evapotranspiration, respectively a prolonged freezing of the brook water. The phenomenon of drying streams in the Someşan Plateau occurs most frequently in the summer or autumn months and less frequently in winter.

The water supply of the streams in the summer or autumn seasons is ensured, for the most part, from the aquifer layers, although even in some very dry summers, they can be completely exhausted, causing the streams to dry. The differences in humidity within the Someşean Plateau are also reflected in the drying of the streams. Thus, the climatic conditions for the regeneration of groundwater are unfavorable in the central and southern part of the Someşean Plateau compared to those in the north of the region.

2. DATA BASE AND METHODS USED IN THE PAPER

The data from 12 hydrometric stations and 4 meteorological stations and 8 rainfall stations from the Căliman Mountains and the neighboring region were used in the elaboration of the paper (Fig. 2).

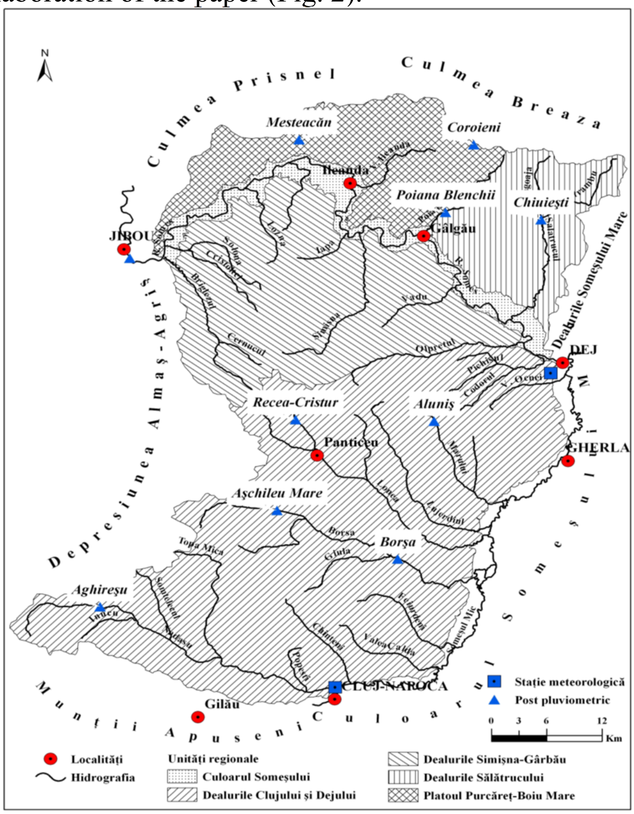

Fig.2. Map with the hydrometric and meteorological stations, and with the pluviometric posts.

The period considered was 1961 - 2010, and the methods used from the classical ones, specific to geography (observation, comparison, synthesis, etc.), to the modern ones (statistics, mapping and geospatial analysis - GIS)

3. RESULTS AND DISCUTIONS

3.1. Factors that favor water flow cease.

The phenomenon of drying streams in the Someşean Plateau is determined by the combined action of several factors, of which the climatic ones play the main role. Thus the flow regime, including its temporary cessation, depends on the main climatic elements (precipitation, temperature, etc.).

The gradual decrease of water availability during the summer and the beginning of autumn depends on certain parameters of the rainfall deficient periods (duration, intensity, etc.) Maintaining for a longer period of time high air temperatures cause high values of evapotranspiration, which leads to at the depletion of the underground reserves and implicitly at the intensification of the drying phenomenon. Such situations occurred in different years: 1983, 1990 and 2003 in the hills of Cluj and Dej, respectively 1986, 2000 and 2003 in the Purcăreţ-Boiu Mare Plateau. In the driest years, the negative deviations of the precipitation quantities represented between 30% and 50% of the multiannual quantity (Table 1).

Table 1. Characteristics of annual precipitation quantities in the Someşean Plateau.

Name of the meteo. and pluvio. station	Annual average (mm)	Minima (mm)	Deviation		Maxima (mm)	Deviation	
			Absolute	Relative (%)		Absolute	Relative (%)
Cluj-Napoca	571.7	341.0	230.7	40.4	819.0	247.3	43.3
Aghireş	572.9	385.1	187.8	32.8	814.9	242.0	42.2
Borşa	582.0	354.8	227.2	39.0	896.8	314.8	54.1
Aşchileu Mare	566.2	349.3	216.9	38.3	806.3	240.1	42.4
Aluniş	640.1	357.4	282.7	44.2	981.2	341.1	53.3
Recea Cristur	577.7	307.4	270.3	46.8	901.3	323.6	56.0
Dej	628.5	411.0	217.5	34.6	876.1	247.6	39.4
Jibou	652.3	420.8	231.5	35.5	1001.6	349.3	53.5
Mesteacăn	616.0	339.4	277.0	44.9	869.o	253.0	41.1
Boiu Mare	755.0	461.1	293.9	38.9	1064.1	309.1	40.9
Poiana B.	700.3	423.3	277.0	39.6	1152.5	452.2	64.6
Coroieni	787.5	529.1	258.0	32.8	1152.5	365.0	46.3
Chiueşti	764.3	496.2	268.1	35.1	1051.1	286,8	37,5

Following the frequency of rainfall deficient periods in consecutive years, we observe a grouping of drought years, which makes their effects worse.

At all stations, the most frequent are the short periods, with two consecutive years of rainfall deficits (Table 2).

Table 2. The frequency of low pluviometric periods with different extensions

Meteorological station	Analyzed period	Period (years)					Total periods	Total years
		2	3	4	5	>5		
Dej	1882-1997	7	4	0	2	2	15	48
Cluj-Napoca	1865-1997	5	4	2	2	2	15	57

From the analysis of the frequency by value classes of the ASPP, it was found that the drought years were missing during the studied period. The very dry years had a very low frequency (2.6%) in the east of the Purcăreţ-Boiu Mare Plateau (Mesteacăn, Poiana Blenchii) and in the southwest of the Dej Hills (Aşchileu Mare). The average frequency of moderately dry years (17%)) exceeds that of the slightly dry years (14%). The values of the frequency of the years moderately drought vary quite a bit within the Someşan Plateau, being higher in the case of sheltered areas (Aghireşu, 23.1%, Coroieni, 20.5%) and lower in the territories with favorable exposure to the advection of the masses. moist air.

Analyzing the frequency on rainfall domains it is found that in the Someşan Plateau the normal domain (38.8%) predominates, the other two domains have close percentage values (Fig. 2).

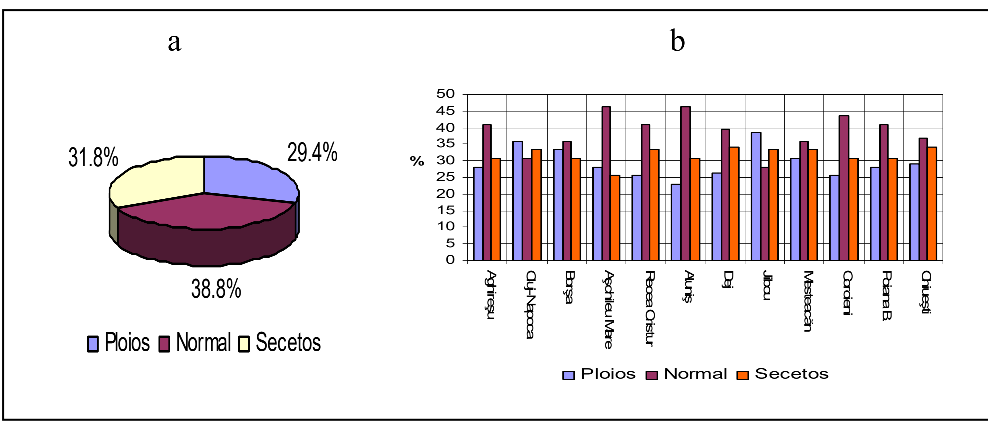

Fig.2. The average frequency of years on rainfall domains at the Someşan Plateau level (a) and at weather stations and rainfall stations (b).

For most rainfall stations the percentage values corresponding to the drought domain are higher than those for the rainy area. The differences are maintained between 2.6% and 7.7%, higher at the Dej meteorological station and the Aluniş rainfall station. A deviation to this rule appears at the Jibou, Borşa and

Aschileu Mare rainfall stations, as well as the Cluj-Napoca meteorological station.

The negative deviations of the average quantities of precipitation from the warm season of the year by their size may reflect the frequency and intensity of the drought. The smallest amounts of precipitation in the warm semester of the year were recorded in different years, varying between 146.6 and 254.0 mm (table 3).

The calculation of the ASPP for the warm semesters (April-September) was also done for practical reasons, considering the need for water for agricultural crops during the hot period of the year and the knowledge of the water reserve accumulated in the soil.

Table 3. The deviations of the precipitation quantities from the warm semester of the year.

Meteo. station and pluvio. post.	Average (mm)	Maxima (mm)/an	Deviation		Minima (mm)/an	Deviation	
			Abs.	%		Abs.	%
Cluj-Napoca	401.6	630.7 1970	229.1	57.1	205.9 2007	195.7	48.7
Aghireş	396.4	647.9 1974	251.5	63.5	273.3 1994	123.1	31.1
Borşa	383.3	643.9 1970	260.6	68.0	226.1 1990	157.2	41.0
Aşchileu Mare	365.8	566.9 1974	201.1	55	209.5 1990	156.3	42.7
Aluniş	406.4	699.9 2001	293.5	72.2	152.4 2003	254.0	62.5
Recea Cristur	360.3	627.9 2005	267.6	74.3	146.4 2003	213.9	59.4
Dej	390.4	623.8 1970	233.4	59.8	189.8 2007	200.6	51.4
Jibou	410.5	674 1980	263.5	64.2	181.5 2003	229.0	55.8
Mesteacăn	421.0	698.1 1972	277.1	65.8	182.7 2008	238.3	56.6
Poiana B.	414.6	676.9 1970	262.3	63.2	179 2003	235.6	56.8
Coroieni	448.6	676.9 1970	228.3	50.9	223.8 2003	224.8	50.1
Chiueşti	443.9	667.7 1978	223.8	50.4	211.3 2003	232.6	52.4

*Frequency by ASPP value classes in the warm semester h*ighlights the lack of drought and excess drought classes. The class of normal values has the highest frequencies (41 -47.4%) in Dejului Hills, in the east of Şimişna-Gârbou Hills and in Sălătrucului Hills, and the lowest ones in the east of Cluj Hills (33.3-35.9%).

For the most part of the Someşan Plateau, the slightly dry warm semesters had a high frequency (15.8% -30, 8%) compared to the moderately dry ones (5.1% -15.4%). The only exception is east of Cluj Hills, where the class of moderate drought values has higher frequencies (20.5%), than that of the slightly drought values (12.8% -17.9%). The class of very dry values has low frequencies (2.6% - 5.1%), missing in the Cluj Hills and the west of the Dejului Hills (Table 4).

Table 4. Frequency per ASPP value classes for quantities of rainfall during the warm semester (%)

Class / Pluvio. station, post	P4	P3	P2	P1	N	S1	S2	S3	S4
Aghireşu	0,0	5,1	15,4	7,7	33,3	17,9	20,5	0,0	0,0
Cluj-Napoca	0,0	2,6	17,9	7,7	35,9	20,5	15,4	0,0	0,0
Borşa	0,0	5,1	15,4	5,1	33,3	30,8	10,3	0,0	0,0
Aşchileu Mare	0,0	2,6	15,4	10,3	38,5	12,8	20,5	0,0	0,0
Recea Cristur	0,0	5,1	12,8	5,1	41,0	28,2	7,7	0,0	0,0
Aluniş	0,0	2,6	12,8	12,8	38,5	20,5	10,3	2,6	0,0
Dej	0,0	5,3	13,2	2,6	47,4	18,4	10,5	2,6	0,0
Jibou	0,0	2,6	12,8	20,5	28,2	17,9	12,8	5,1	0,0
Mesteacan	0,0	2,6	15,4	7,7	38,5	17,9	17,9	0,0	0,0
Coroieni	0,0	2,6	15,4	7,7	43,6	17,9	10,3	2,6	0,0
Poiana Blenchii	0,0	5,1	15,4	5,1	43,6	23,1	5,1	2,6	0,0
Chiueşti	0,0	2,6	15,8	5,3	47,4	15,8	10,5	2,6	0,0
Average by region	**0,0**	**3,6**	**14,8**	**8,1**	**39,1**	**20,2**	**12,7**	**1,5**	**0,0**

The water deficit increases if two or more seasons with precipitation deficit occur. Most frequently, two rainy seasons have followed one another. The maximum frequency returned for the winter-spring coupling, and the minimum for the autumn-winter coupling. Intermediate situations are characteristic for the summer-autumn and spring-summer couplings, respectively. summer - autumn, followed by winter - spring - summer, autumn - winter - spring and summer - autumn - winter. The situations with four consecutive seasons with rainfall deficiency were rare, with a case being registered in Cluj-Napoca (Moldovan, Sorocovschi, Holobâcă, 2002).

In winter, prolonged maintenance of negative air temperatures can lead to cessation of leakage through total freezing of stream water. This phenomenon occurs during extremely cold periods, when the air temperature drops below -100 and is usually maintained throughout the period with negative air temperatures.

It is worth noting that in the Someşan Plateau, the total of winter days (maximum temperature ≤ 0°C), on average, annually, is below 20 in the south plateau, 20-25 in the central part and 25-30 in the northern part. There are cases where 50-60 winter days can be recorded in a single year, as they were in 1963, 1964. The maximum number of winter days is recorded in January and February (Table 5).

Table 5. Number of days with maximum temperature ≤ $0,0^0$C (winter days)

Meteorological station	Average monthly number					Annual
	I	II	III	XI	XII	
1953-1997						
Cluj-Napoca	8,8	5,8	1,3	1,4	6,2	23,5
Dej	10,5	7,0	1,6	1,9	6,1	27,1
1970-1997						
Cluj-Napoca	7,5	5,0	1,2	1,3	4,6	19,6
Dej	9,0	6,2	1,4	2,0	5,5	24,1
1987-1997						
Cluj-Napoca	5,9	5,0	2,0	2,1	4,5	19,5
Dej	6,7	5,8	1,5	2,0	4,9	20,0

Frost days (minimum temperature ≤ 0°C) occur from September to April and even more. Annually, it occurs, on average, between 105 and 110 days with frost in the southern part of the Someşan Plateau and 110-120 days in the northern one. The maximum annual number of frost days is 154 and was reported in 1953. However, there were situations when in a single year there were 24-28 frost days (1978 and 1987). in winter, during the year, the highest frequency of frost days occurs in January (26-30 days) and February (21-25 days), when polar or arctic cold air forecasts are also more frequent (table 6).

Table 6. Number of days with minimum temperature ≤ $0,0^0$C (frost days)

Meteorological station	Average monthly number									Annual
	I	II	III	IV	V	IX	X	XI	XII	
1953-1997										
Cluj-Napoca	29,2	24,0	17,9	4,3	0,3	0,2	5,2	13,5	23,1	117,7
Dej	28,5	24,2	18,6	4,7	0,1	0,3	6,8	15,0	24,1	122,3
1970-1997										
Cluj-Napoca	28,1	23,2	16,8	4,2	0,2	0,2	4,6	13,3	23,1	113,7
Dej	27,9	24,3	18,3	4,7	0,1	0,3	6,9	15,4	23,6	121,4
1987-1997										
Cluj-Napoca	27,7	22,4	16,5	4,5	0,3	0,0	5,1	13,3	20,5	110,3
Dej	26,6	23,9	18,3	5,1	0,0	0,1	6,9	14,9	22,3	118,1

A multitude of other factors favor the cessation of leakage on the streams in the Someşan Plateau. Of these we mention the nature of the substrate and the lithological composition of the (predominantly impermeable) riverbeds, the depth of fragmentation and the slope of the relief, the morphometric particularities of the differentiated rivers on three sectors (especially in the main collectors), the degree of vegetation cover and its nature.

From the observations and measurements made, it was found that the duration of the drying phenomenon is greatly influenced by the surface of the reception basins.

Besides the natural factors, the drying phenomenon of the streams in the Somşan Plateau is also influenced by the anthropic factor. In this sense we mention that the presence of ponds on some streams (Lujerdiu) greatly diminishes the occurrence of the drying phenomenon. Also, the works to regulate the riverbed of some watercourses have influenced the phenomenon of stream drying, which appears less frequently and in shorter sectors (Nades).

3.2. Parameters of the drying phenomenon.

The main parameters of the drying phenomenon are: the frequency of the period and the duration of manifestation. They indicate the possibilities of exploiting the water resources of the rivers.

Frequency is the number of cases in which the phenomenon has been recorded relative to the total number of years with observations or for each individual month.

The frequency of the check can be expressed in absolute values in percentages. Depending on the annual frequency of drying, several categories of streams have been separated:

- streams or stream sectors that have never stopped their flow;
- streams that stop their flow once more than 5 years;
- streams that stop their flow every 2-5 years;
- streams that stop their flow annually for longer periods of time.

A particular category is the streams that flow and which can dry or remain at this stage.

Analyzing the monthly frequency of cessation of leakage, we find a main maximum at the end of summer and a secondary one in winter-January, generated by diametrically opposite causes. Thus, the month in which the stream drying phenomenon most frequently occurred was August, followed by July and September, determined by the high values of evapranspiration and the depletion of groundwater reserves.

In January and February, there is a quite high frequency of the drying phenomenon, determined by the negative temperatures that lead to the total freezing of the water.

The lowest frequency of the drying phenomenon corresponds to May and November. The drying phenomenon was not reported in March and April, when the values of evapotranspiration are low, and the liquid rainfall and water reserves from the melting of the snow are significant. In November, the phenomenon of cessation of flow was not reported due to increased precipitation quantities, reduced values of evapotranspiration and restoration of groundwater reserves.

The period represents the time interval during the year in which the phenomenon of drying occurs. The periods of occurrence the phenomenon of drying can be analyzed seasonally.

The duration is the number of days in which the phenomenon of drying manifests.

From the analysis carried out for the period 1950-2005 it was found that the phenomenon occurred more frequently in summer, followed by autumn and very rarely spring and winter. The maximum frequency of the drying phenomenon comes back to July and August followed by September. The maximum duration of the drying phenomenon was recorded during the summer-autumn periods when the precipitation amounts are reduced or missing, and the underground supply is also reduced or missing.

The frequency and duration of drying in the winter are low, except for very later years

3.3. Territorial distribution of stream drying phenomenon

Based on the data resulting from the hydrometric observations from a number of eight hydrological stations, from the questionnaires and from the analysis of the determinants of the leakage, the map of the stream drying was drawn up. Someşan (69) are affected by the phenomenon of drying (58%).

A detailed analysis of the distribution of the streams that stops the leak highlights the important role of the surface of the receiving basin. From the observations and measurements made it was found that the drying period varies inversely proportional to their surface.

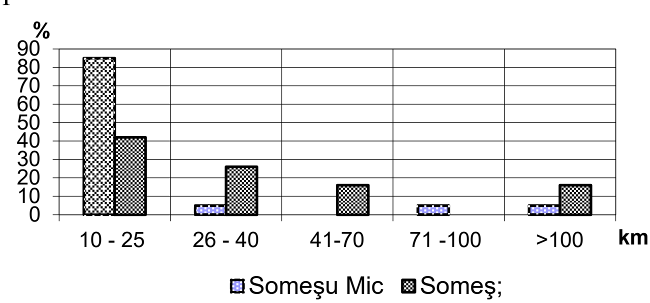

Fig.3. The percentage of the streams affected by the drying phenomenon in the Someşan Plateau, depending on the surface of the receiving basin

The spatial distribution of the drying phenomenon on the streams related to the Someşul Mic and Someş river basins, depending on the surface of the reception basins, presents some quite significant differentiations, but the above mentioned legacies are highlighted (Fig.3).

In the Someşului Mic basin of 21 rivers in which the flow ceases, the stream is held by streams with basin areas between 10 and 2 km2. The flow cessation was reported on a single river with a basin area over 100 km^2 (Valea Mare - 104 km^2).

In the Someş basin the rivers that stop their flow have a lower percentage (33%) of the total rivers included in this basin of (29). The share also has streams with basin areas between 10 and 20 km^2.

Depending on the frequency and duration of drying on the territory of Somşan Plateau, three categories of watercourses have been delimited.

The streams with permanent drainage never dry, having water flow all year (Nadaşu, Borşa, Lonea, Sălătruc). This category includes rivers with basin area over 100 km^2.

The streams with semi-permanent drainage dry every 2-5 years or several years and have more than half of the total rivers (51%). The streams with intermittent flow have basin areas between 20 and 40 km2. Most streams included in this type belong to the Someşul Mic basin (85%)

The streams with temporary drainage are those that dry each year for different periods. In this type, 35% of the total number of rivers to which the runoff ends (table 7).

Table 7. Types of drainage on river basins

Hydrographic basin	**Number of streams**	**Number of streams with ceased flow**	**Frequency of water flow cessation in multiannual profile**		
			Each year	**2-5 years**	**5-10 years**
Someşu Mic	40	21	12	7	2
Someş	29	19	2	13	4
Total	69	40	14	20	6

Zoning the drying phenomenon is quite difficult due to the relatively uniform natural conditions in the Someşan Plateau. However, depending on the cessation of the flow, within the Someşan Plateau there were delimited three areas with different types of water flow.

The first area with the predominance of semi-permanent leakage includes the streams within the Purcăreţ-Boiu Mare Plateau.

The second area with the predominance of the temporary flow includes the streams with the basins developed in the southeast of the Dej Hills (Nima, Buneşti, Orman, Mărului and Lujerdului tributaries) and northeast of Cluj Hills (tributaries from the lower course of the Lonea and Borşa rivers)

The third area extends to the west of the Dej Hills, to the west and south of the Cluj Hills, including the Nadis River basin, the upper basins of the rivers Borşa and Lonea, as well as the tributaries of Someş downstream of the Vad stream.

In this area, besides the streams with temporary drainage, the streams with semi-permanent drainage are included.

4. CONCLUSIONS

The phenomenon of the water flow cessation on the streams from the Someşan Plateau, regardless of the form under which it is manifested (drying, bathing, total frost), is favored by the specific natural conditions in this part of the Transylvanian Depression.

Climatic factors have a decisive role in the occurrence, duration and intensity of the drying phenomenon, the stream feeding being predominantly pluvial and to a very small extent underground. The depth of the groundwater level also plays an important role in the stream feeding possibilities.

The character of the leak is also determined by the surface of the reception basins. Thus, streams with basin areas between 20 and 40 km2 are intermittent, and those with surfaces between 41 and 100 km2 are semi-permanent, drying only during the drought years.

The particularities of the substrate, the morphometric characteristics of the relief and the vegetal cover have a secondary role. Azonal intervenes the anthropic factor through the arrangement of ponds and works to regulate the riverbed.

The phenomenon of drying of streams affects more than half (58%) of the number of streams included in the cadastral of the waters.

The maximum frequency of the drying phenomenon was reported in summer (July and August) and in early autumn (September). Total frost has a high frequency in January and February.

From the zoning of the drying phenomenon, quite difficult, resulted in three areas. Depending on the duration and intensity, the drying phenomenon brings essential changes, at the micro-scale on the components of the natural environment, and at the macro-scale on the components of the socio-economic environment.

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