THE ROLE OF CLIMATE AND HYDROLOGICAL ELEMENTS IN THE PRODUCTION AND PERSISTENCE OF EXCESS WATER IN THE PLAIN OF SOMEȘ

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ABSTRACT. – The role of climate and hydrological elements in the production and persistence of excess water in the Plain of Someş. In determining water excess in the Plain of Somes, we analysed the triggering factors which are directly involved in the formation of the risk phenomenon and which are considered to be the dynamic factors. Of major importance in deciphering the causality of the water surplus are the *triggering elements*, especially *the climatic ones* (the rainfall regime), and depending on them to a great extent - *the hydrological ones* (water resources, drainage). It can be argued that in the last decade, the biggest problems were created especially by small basins and small watercourses, which due to the changes in the precipitation regime (large intensities on small surfaces) had caused many floods, destruction of human settlements, roads and bridges, and had favored the triggering of landslides and implicitly the excess of soil water. The analysis of the natural hazards, implicitly of the *water excess*, was primarily aimed at meeting the requirements of the elaboration of the landscaping and urbanization plans of the Plain of Someş, according to the legislation and norms in force.

Key words: meteorological stations, precipitation, hydrometric stations, hydrographic network, drainage.

1. INTRODUCTION

Of major importance in deciphering the causality of the water surplus are the ***triggering elements***, especially ***the climatic ones*** (the rainfall regime), and depending on them to a great extent - ***the hydrological ones*** (water resources, drainage).

The analysis of the factors, mainly the rainwater and thermal regime should be viewed globally, in the context of global climate changes, and in particular in local conditions specific to the plain under study.

The climatic conditions and the rainfall regime of the Plain of Somes are determined by its geographic position in the northwest of the country, subject to more humid air advection and the particularities of the active surface, amongst which the landform, through exhibition, slope and hypsometry, play a dominant role.

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Depending on the geological formation, the paleogeographic conditions dictated by the sedimentation of the Pannonian Basin and the formation of the volcanic landforms, *the hydrographic network* and *groundwater* have specific characteristics.

The surface of the Plain of Somes is crossed by a network of natural and anthropogenic courses, resulting from the paleohidrographic evolution, plus spontaneous or systematic human intervention through land improvements (canals, gullies, land drainage, polders, etc.).

2. SPATIO-TEMPORAL ANALYSIS

2.1. The climate of the plain is generated by three main categories of factors: radiative, dynamic and physico-geographic ones. All of these have a direct influence on the spatio-temporal variation of climate elements on this plain.

For the climatological analysis carried out in order to establish the main climatic parameters which directly influence the formation of the water surplus, more precisely the *rainfall*, we used observation data from 24 sampling and processing points of the meteorological data across the Plain of Somes (Fig. 1). However, only eleven of them underwent a more complex analysis, taking into consideration the 26-year common operating period, with complete data strings from 1979 to 2004, so that it would be much more relevant.

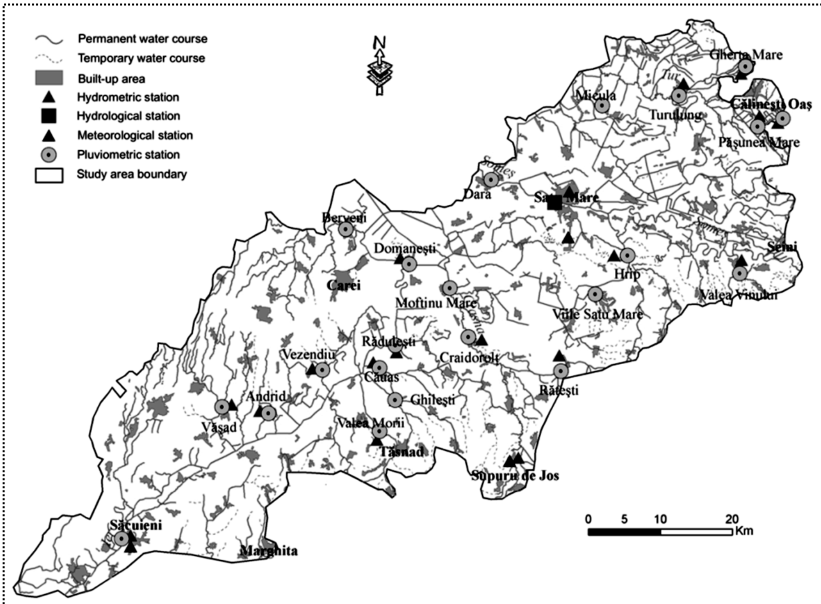

Fig. 1. ***Locating the sampling points of hydrological and meteorological data from the Plain of Somes***

Regarding the rainfall regime of the Plain of Somes, it is worth mentioning that the precipitation can oscillate between *400 mm* in the dry years and over *1000 mm* in the rainy ones, and monthly, a maximum precipitation occurred in 10-13 May 1970 when the amount of precipitations reached *100 l/m²* in a single day, which normally corresponds to 2-3 months of Carpathian spring.

The genesis of atmospheric precipitation is determined by the frontal activity; frontal rain is the most frequent precipitation type in the region, however, convectional rainfall can also occur at the bottom of the Oaş Basin. A basic feature of precipitations is the large amount of water that falls, even on the lowest slope of the plain, of course, with some regional differentiation due to its position in the North and North-East of the Oas and Ignis Mountains.

The maximum annual precipitation amounts sometimes exceed *800 mm / year* in the eastern part of the Plain of Somes, at its contact with the highest landform units in its vicinity (Table 1).

Table 1. ***The maximum annual and daily rainfall amount in the Plain of Someş***

Gauging station	Annual amount pp. (Mm / year)					Annual daily maximum pp. (mm)				
	Registration Year					Registration date and year				
Păşunea Mare	1151.5	1102.5	1034.3	988.8	951.4	70	58.1	57.9	54.3	52.3
	2001	1998	1995	1980	1999	19.10 1996	28.06 1982	30.09 1992	09.06 1990	14.07 1989
Gherţa Mare	991.9	974.8	956.1	942.9	931.7	77.8	69.2	59.2	56.2	54.4
	1998	1980	2001	1979	1981	30.09 1992	29.06 1989	02.08 1991	19.06 1998	22.07 1980
Turulung	920.5	879.4	853.1	809.4	801.1	69.8	56.3	48.7	46.3	44.6
	1980	2001	1979	1998	1995	01.08 1991	3.07 2001	23.08 1988	17.05 1986	25.03 2004
Valea Vinului	1058.0	1009.4	910.1	869.2	853.1	88.0	71.5	56.1	54.8	54.2
	2001	1998	1980	1979	2004	04.10 2003	03.07 2001	01.07 1998	31.07 1980	25.03 2004
Hrip	876.5	788.5	786.0	767.3	759.5	72.1	66.0	65.9	65.2	62.8
	2001	1980	1984	2002	1999	12.08 1984	04.10 2003	19.11 1993	10.09 1995	17.04 1998
Satu Mare	808.7	807.5	779.6	687.8	645.7	59.5	57.9	48.5	44.6	44.3
	1980	1998	2002	1999	1996	22.07 1993	13.07 1989	12.05 2001	17.10 2004	19.10 1996
Berveni	673.5	642.4	588.5	545.5	503.4	68.7	58.0	50.8	46.8	43.1
	2001	2002	2004	1999	2003	04.07 2001	31.07 2003	11.08 2002	10.05 1997	24.05 1996
Domăneşti	775.7	733.3	704.4	639.1	633.6	69.0	62.1	58.2	54.7	52.3
	1980	2001	1998	1979	1984	24.06 1989	29.06 2001	10.06 1992	30.07 2003	12.09 1995
Supuru de Jos	841.0	625.7	612.8	606.7	591.5	62.7	62.3	62.1	60.7	58.9
	1980	1989	1991	1984	1979	30.07 2003	28.07 1991	19.06 1993	16.04 1998	23.06 1996
Valea Morii	838.3	787.1	785.3	727.6	715.8	67.4	57.1	56.7	55.7	55.0
	2001	1995	1980	1989	1996	13.07 2003	30.07 1980	17.05 1985	20.06 1995	12.07 1981
Săcuieni	776.1	737.2	711.9	689.0	686.3	88.9	54.9	53.1	52.2	51.1
	1980	2001	1998	1979	2004	12.09 2001	28.07 1998	08.08 1979	17.06 1983	13.07 1981

Thus, at Păşunea Mare and Gherţa Mare rainfall stations, from the hydrographic sub-basin of Tur, at the foot of the Oaş and Igniş Mountains, where the air masses are forced to escalate the higher landforms, the upward movement contributes to the intensification of the nebulosity on the slopes exposed to the air masses, so that rainfall is generated. The annual precipitation amounts exceed *800 mm*, with a maximum annual sum of *1151 mm* in 2001 for the former rainfall station and *991.9 mm* in 1998 for the latter. Also in the sub-basin of Tur, at the Turulung rainfall station, the annual maximum amount of *920.5 mm* was registered in 1980.

The same situation is also found in the North-Western part of the Codru Peak, at Valea Vinului rainfall station, where the maximum annual amount was also registered in 2001 reaching the value of *1058 mm*.

The maximum monthly quantities recorded during the respective period were *88.9 mm* in Săcuieni on 12/09/2001, *88.0 mm* in Valea Vinului on 04/10/2003, *77.8 mm* in Gherţa Mare on 30/09/1992 and *72.1 mm* at the Hrip rainfall station on 12/08/1984 (Table 1).

Analyzing the dynamics of the annual rainfall amounts at the meteorological stations and rainfall stations mentioned above, for the common period of 26 years, from 1979 to 2004, it is noticed that **the most rainy years** in the Plain of Somes were the following: 1979, 1980 , 1998, 1999 and 2001, when cyclonic activity persisted, many years registering values above 800 mm, at most of the rainfall stations, when the air temperature increased, amplifying the thermal convection of the air.

2.2. The hydrographic network and groundwater accumulation and circulation conditions

As mentioned above, as regards the water resource as a triggering factor in the determination of the water surplus, the following aspects were considered: surface water through (*multiannual average drainage, maximum recorded flows*), groundwater and deep confined waterbed.

2.2.1 Organization and morphometric features of the hydrographic network

The surface of the Plain of Somes is crossed by a network of natural and anthropogenic courses, resulting from the paleohidrographic evolution, plus spontaneous or systematic human intervention through land improvements (canals, gullies, land drainage, polders, etc.).

In the analysis of the morphometric parameters were used the observations data from **9 hydrometric stations**, on complete datasets (26 years), from 1979 to 2004, controlling hydrographical basins whose altitude oscillates between 251 m and 534 m, and the area between 69 km² and 15,600 km² (Table 2).

2.2.2. Rivers and lakes systems

The river network of the studied region attracted by one of the maximum sinking areas of the Plain of Tisa comprises a total of 107 coded water courses with a total length of 1487.5 km belonging to two large water catchment areas: ***Someş-Tisa*** (Tur, Homorod and Crasna) and ***Crişuri*** (Ier) (Fig. 2).

Table 2. ***The hydrometric stations in the Plain of Somes***

River	Hydrometric Station	H (m)	F (km^2)
Tur	Turulung	366	1 144
Turț	Gherța Mare	315	74
Talna	Pășunea Mare	402	186
Someș	Satu Mare	534	15 600
Valea Vinului	Valea Vinului	251	69
Crasna	Domănești	261	1 705
Crasna	Supuru de Jos	310	1 170
Santău/Cehal	Valea Morii	294	169
Ier	Săcuieni	287	1 392

The rivers from the Plain of Somes now occupy much-diminished areas compared to the past, the current aspect of the hydrographic network being the result of hydrotechnical works. Thus, the course of the rivers was largely regularized, many of the Somes meanders were directed and the smaller rivers were fully channelled.

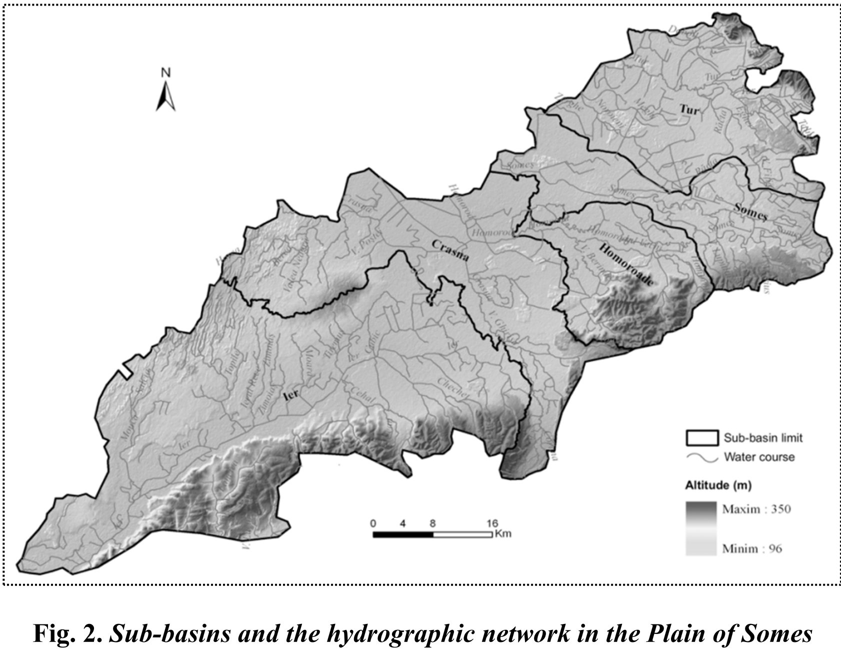

Fig. 2. ***Sub-basins and the hydrographic network in the Plain of Somes***

Impoundment and draining have also resulted in the emergence of many channels by digging drainage channels.

Stagnant waters in the studied area occupy reduced surfaces following hydroameliorative interventions that required important mutations. Long time ago the lakes, and especially the numerous ponds, related to the extensive marshlands, were one of the dominant elements of the landscape in this part of the country, the most representative being the Ecedea swamp.

At present, in addition to the protected *marshland*, there are only *anthropic lakes*, such as *ponds and millponds*, with small surfaces and few in number. Most of them are retentions on the valleys that come from Carei Plain to Ier (the lakes Andrid-Dindeşti, Văşad, Galoşpetru, Şimian), rarely the ones on the left side, or the valleys of Sălacea-Roşiori Plain (the lakes Sălacea, Vaida, Ianca, Făncica).

For the Tur River sub-basin, we can mention the accumulations of Bercu Nou (Micula), Adrian (Livada), on the left side of Tur and the Dabolţ pond (Halmeu) on its right side. can be mentioned.

On the site of the old meanders and the deserted courses of the Tur and Somes rivers there are dozens of small-scale lacustral units formed in natural conditions.

2.2.3. The maximum rivers runoff

By the weight of the destructive effects and its characteristics (levels, flows, volume, duration, etc.), the maximum drainage is the most important phase of the regime, all the more so since it is directly responsible for determining the water excess.

Following the chronological variation of the maximum annual flows over the 26 years between 1979 and 2004, at all 9 hydrometric stations in the Plain of Somes, it is noted that in the basins of Tur, Gherţa Mare, Păşunea Mare and Turulung, the maximum flow rates were recorded in 1996, 1997 and 2001; in the Somes river basin at Valea Vinului and Satu Mare stations, the maximum flows were recorded in 1980 and 1981; at the Domăneşti and Supuru de Jos hydropower stations from the catchment area of Crasna, the maximum flows were recorded in 1979 for the former case, and 1989 for the latter; the Ier river basin had the maximum flow values in 1980 at the Săcuieni hydrometric station on the Ier river and in 1989 on the Santău River at Valea Morii.

2.2.4. Groundwater accumulation and movement conditions

A major role in the water movement is represented by the underground water deposits. The study of groundwater, especially the study of dynamics and their relations with the surface hydrographic network and the local climatic conditions, is necessary for all hydroamelioration works, especially in drainage works. According to the genesis and hydrogeological storage conditions, groundwater is divided into deep water and subsoil water. The geology of the sedimentary deposits in the Plain of Somes subbasement has determined a diverse range of hydrogeological conditions.

In the Subsoil of the Plain of Somes there have accumulated a thick stack of different structures with a whole range of hydrogeological conditions. Depending on these conditions, two environments can be distinguished: *a deep one* and another one *closer to the surface*. Of greater interest is the layer close to the surface comprised during new formations, especially the Pleistocene and Holocene, which are represented by an alternation of pebbles, clays, loamy sands, sandy clays, loess, slimes etc., which contribute directly to the determination of the excess water..

In exceptional cases of extremely high precipitation, such as those in 1970, 1975, 1980 and 2001, the blue sand layer could not capture all the precipitation water, thus the surplus water passed into the covering layers. In such situations, water appears on the surface, defending the processes of pouring and even engraving.

Depending on the *hydrogeological factors* that generated them, the groundwaters of the Somes Plain are divided into two main categories: *surface waters* (with no hydrostatic pressure), located in the active area in terms of hydrological balance, and *depth waters*.

Surface groundwaters may be: *surface groundwaters*, which occur in the aeration area during periods of high moisture, especially in the spring, and are of a temporary nature; groundwater and descendant captives, formed in the upper loose layers, are of a permanent nature and are influenced by lithological and climatic conditions; *stratification or lenticular waters* with no hydrostatic pressure, found in places with alternating structure of permeable (sands) and impermeable layers (clays). These waters can be found in the lower parts of subsidence of the Plain (Lower Somes Plain), with a slow or no leakage at depths varying between 0.5 and 3.0 m, causing saltiness of the area (Moftin and Sânmiclăuş), and in the foothill fields (5-15 m deep), where they manifest themselves as springs, locusts and even shrubs (Ierului Plain). Groundwaters and downstream captive waters (15-20 m) in fluvial-lake formations (sands) are used to supply drinking water for Satu Mare and Carei municipalities and their surrounding areas, but which can suffer certain infiltrations likely to cause groundwater contamination.

3. CONCLUSIONS AND FINDINGS

Following the spatio-temporal analysis of the triggering factors involved in the formation of the water surplus, it is worth mentioning that as far as the Plain of Somes is concerned, under natural conditions, the general character of the natural landscape was due to the presence of wetlands with hydrophilic vegetation and extended oak forests. However, following the anthropogenic interventions carried out over time, these occur only in the form of clusters, and the eutrophic marshes and the meadow vegetation have almost disappeared, yet there are clear traces of hydrophilic adaptability among them as a result of the water excess in the soil where it is retained.

Nowadays, the landscape of the Plain of Somes is given by agricultural crops, the arable lands representing the dominant form of land use, pastures and natural grasslands, covering only the fields with lower fertility, and the ones with humidity excess being a potential factor in determining the water surplus, and hence - agricultural damage.

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