

# THE ROLE OF HYDROLOGICAL CONDITIONS IN SPACE ORGANIZATION IN TRANSYLVANIA DEPRESSION

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**Abstract. The role of hydrological conditions in space organization in Transylvania Depression.** The Transylvanian Depression, the most extensive inter-Carpathian area in Romania, presents numerous features in the space organization induced by natural and anthropogenic factors, of which the hydrological ones have an important role. The analysis of the water-induced particularities was based on the data obtained from the discharge data processing from 61 hydrometric stations and on the elaboration of the specific average flow map, as well as the knowledge of the quantitative and qualitative particularities of the main lacustrine units. By analyzing the processes of water flow and water storage, the role of the water factor in distinguishing the organization of the space both horizontally and vertically was emphasized. Thus there are obvious contrasts between both the marginal depressions and the plateau, as well as between the valley corridors and the interfluvial spaces within the plateau.

**Key words:** space, organization, hydric factor, Transylvania Depression.

## 1. INTRODUCTION

Hydro-atmospheric processes involve the transformation, flow and storage of matter and energy on a planetary and regional level. The duration, intensity and rhythm of 72.8% of the processes produce the space in which certain qualitative and quantitative features are established, which determine favorable or unfavorable climatic structures for the organization of the respective territory.

In the water processes that take place the water circuit in nature, a special place is the water flow. This terrestrial phase of the water circle is complex because at the same time as the water displaces, a certain amount of solids, dissolved chemicals, living or dead matter and energy are conveyed simultaneously. Thus, from the peripheral mountainous space, a flow of matter and energy is circulated towards the marginal and plateau region of the Transylvanian Depression, a part of which is stored for a longer or short period of time, and the difference is transferred through the three main collectors (Someș, Mureș and Olt) to the peripheral regions of the west and south of the Carpathian arch.

From the Transylvanian Basin, on average, a volume of water of 8110 billion m<sup>3</sup> is evacuated, of which 72.8% is formed in the mountainous area and

only 27.2% in the depression (Ujvari et al., 1982). At the same time, 5.37 billion tons of alluviums are evacuated on average from the Transylvanian Basin, of which more than half comes from the Transylvanian Depression, representing an eroded layer of 0.128 mm/year.

The amount of material and energy transported and stored is higher on the allochthonous rivers, which are the main concentration axes for the population and the socio-economic activities, compared to the autochthonous ones. The interfluvial surfaces are formed of agricultural and, in some cases, forest areas.

The water storage processes are more intense along the main arteries, in the piedmont steps from the peripheral regions of the Transylvanian Depression and in the lower third of the interfluvial spaces and very rarely near the watershed. In addition to the mentioned water processes (transport and storage), water acts on the space components and other processes such as dissolving and hydrating. These processes contribute to substrate modeling, to the formation of different soil categories, and to the provision of material to be transported by various external agents and then stored.

## 2. DATA AND METHOD

For the elaboration of this paper were used the data from 118 hydrometric stations, of which more than half (57.6%) were located on the rivers in the Transylvanian Depression (Figure 1).



**Fig. 1.** Distribution of the network of rivers and hydrometric stations on hydrographic basins.

The period used to characterize river water flow was 1950-2000, which maximized the existing hydrometric data and provided the possibility of calculating the lowest error rule because it includes three flow cycles compensated in the rainy and dry years.

The methods used to calculate the average water flow and the spatial and temporal variation parameters were statistical and personal programs or developed by specialized institutions.

### 3. RESULTS AND DISCUSSIONS

In order to highlight the role played by the water conditions in the organization of the Transylvanian Depression area, the richness and the space-time variation of \water resources offered by the rivers and the particularities of the distribution of the lacustrine units within the Transylvanian Depression and the neighboring mountainous area were analyzed.

The liquid discharge process is one of the terrestrial phases of the water circuit in nature, including several components, such as the hypodermic flow represented by the amount of water flowing into the superficial soil layer. Another occurs on the slope (slope flow) or in the riverbed (concentrated flow). Each of these flows has a role, but the most important one is the one in the riverbed. An overall indicator of water resources in rivers, which influences and sometimes even determines how space is being erected is the river discharge. For example, the water quantities transported by the rivers have greatly contributed to the differentiation of the urbanization and industrialization degree between the spaces corresponding to the corridors and the marginal depressions and those in the plateau.

In the valley corridors one can see a type of organization of the low, intermediate and the hilly areas. Of the steps mentioned, the first ones have large amounts of water supplied by rivers. Thus, the submontane collectors in the marginal corridors and depressions in the west and south-east of the Transylvanian Depression present significant water discharges. For example, in the Alba Iulia-Turda Depression, Arieş and Mureş rivers transport large quantities of water (25.6 m<sup>3</sup>/s, Turda - Arieş, 105 m<sup>3</sup>/s, Alba Iulia - Mureş). A similar situation occurs in Făgăraş Depression (61.4 m<sup>3</sup>/s on Olt at Făgăraş) and Cibin Depression (15.3 m<sup>3</sup>/s on Cibin at Tâlmăciu). Much lower water quantities carry the collectors under the Meseş Mountains (1.09 m<sup>3</sup>/s on Agrij at Românaş) and from the northwest of the Cindrel Mountains (2.43 m<sup>3</sup>/s Southern Secaş at Cunţa).

In the area of the hills and marginal depressions from the eastern side of the Transylvania Depression, most of the rivers coming from the Oriental Carpathians have an east-west orientation. They transport important quantities of water below 10 m<sup>3</sup>/s (7.76 m<sup>3</sup>/s on Bistriţa at Bistriţa, 8.14 m<sup>3</sup>/s on Gurghiu at

Solovăstru, 9.65 m<sup>3</sup>/s on Târnava Mare at Vânători, 6.37 m<sup>3</sup>/s on Târnava Mică at Sărăteni). Exception is the Mureș River, which at the entrance to the plateau region has a multiannual average flow rate of 37.4 m<sup>3</sup>/s. Submontane collector rivers carry quantities less than 5.4 m<sup>3</sup>/s (3.90 m<sup>3</sup>/s at Rupea Station on Homorod and 1.55 m<sup>3</sup>/s on Șieu at Domnești).

Within the Transylvanian Plateau, the contrasts between the quantities of water transported by the allochthonous and the autochthonous rivers contributed to a great extent to the different way of organizing and using the spaces in the valleys compared to the interfluvial ones. The significant quantities of water transported by Mureș and Târnava Mare rivers (15.1 m<sup>3</sup>/s in Blaj) contributed, compared to other favorable natural factors, to the urbanization and industrialization of this color. The same situation is found in the Someșul Mare corridor, although the water quantity transported is significant (47.7 m<sup>3</sup>/s at Beclean). In the space organization of this area, other natural factors were limiting (position, accessibility, relief, etc.). Although Someșul Mic river transports a smaller quantity of water (22.4 m<sup>3</sup>/s at Salatiu), in the Someșul Mic Corridor the concentration of the human settlements was favored by the access ways from the neighboring areas (plateau, mountain).

The hydrographic convergence in Dej favored the apparition and development of the settlement and of water-consuming industries.

Of the allochthonous rivers, the smaller water quantities are transported by the Târnava Mică river (9,97 m<sup>3</sup>/s at Târnăveni, 11,0 m<sup>3</sup>/s at Blaj), which made this corridor less populated and industrialized. Of course, a series of limiting factors (position, evolution of relief, accessibility, etc.) contributed to this situation.

The water flows transported by the local rivers are reduced, generally between 0.200 and 1.00 m<sup>3</sup>/s in the ones from the Someșan Plateau. On the rivers in the Transylvanian Plain, with larger hydrographic basins, the average annual discharge reaches up to 1.50 m<sup>3</sup>/s in the sections near the river mouth in the marginal collectors (Table 1).

**Table 1.** Characteristic data on the average drainage of the local rivers in the Transylvanian Depression

River	Hydrom. Station	Q <sub>i</sub> (m <sup>3</sup> /s)	Q (l/s·km <sup>1</sup> )	Y (mm)	W (mil. m <sup>3</sup> )	C <sub>v</sub>
Dipșa	Chiraleș	1.48	3.36	106	46.7	0.57
Meleș	Rusu de Jos	1.04	3.73	117	32.8	0.65
Nadăș	Aghireșu	0.220	4.78	150	6.91	0.46
Nadăș	Mera	0.938	3.44	109	29.6	0.40
Borșa	Borșa	0.615	3.31	104	19.4	0.54
Gădălin	Bontida	0.572	1.97	62	18.0	0.64
Luna	Luna de Jos	0.620	3.44	106	19.6	0.58
Fizeș	Fizeșu Gh.	1.25	2.87	91	39.4	0.67
Olpret	Maia	0.42	4.38	136	13.9	0.60

River	Hydrom. Station	Q <sub>i</sub> (m <sup>3</sup> /s)	Q (l/s·km <sup>1</sup> )	Y (mm)	W (mil. m <sup>3</sup> )	C <sub>v</sub>
Căței	Sălătruc	1.04	6.98	219	32.8	0.44
Valea Poienii	Poiana Blenchii	0.730	7.60	240	23.0	0.41
Luț	Breaza	1.09	4.07	128	34.4	0.57
Comlod	Band	0.832	2.56	81	26.2	0.63
Laslea	Laslea	0.360	3.30	104	11.04	0.32
Visa	Șeica Mare	1.44	3.22	102	45.4	0.42
Domald	Zagăr	0.168	3.29	104	5.3	0.53
Secaș	Colibi	0.451	1.44	46.0	14.2	0.60
Cohalm	Homord—Rupea	0.694	2.47	78.0	21.9	0.42
Pârâul Nou	Noul Român	0.903	3.63	114	28.5	0.67
Hărtibaciu	Agnita	0.965	3.47	109	30.4	0.68
Hirtibaciu	Cornățel	3.12	3.25	102	98.4	0.62

The dominant agricultural function of the Transylvanian Plain and the regional specificity of this area is largely conditioned by the water shortage and the poor water quality in the area. The brooks that originate in this region have discharges that can be taken into account for industrial purposes only near the river mouth.

An even worse water situation occurs in the Secaș Plateau, where the main collector (Secașul Mic River) disposes of a multiannual average flow of 0.451 m<sup>3</sup>/s at Colibi near the river mouth.

In the Târnava Mică Hills, restricted interfluvial areas allowed only the development of small streams with discharges below 0.20 m<sup>3</sup>/s (Domald at Zagăr).

In Hărtibaci Plateau there are rivers with higher flows that exceed the flow rate of 3 m<sup>3</sup>/s. The other streams have low discharges below 1.00 m<sup>3</sup>/s (Table 1). In organizing this space, the hydrological factor has a more limited but differentiated role,

For the characterization of the slope discharge, the average specific discharge and water layer values were calculated to compare the water potential of different territories. The correlation between the average specific discharge and the average altitude of the spaces controlled by the hydrometric stations under study allowed the territorial generalization of discharge and the elaboration of the specific average discharge map (Figure 2).



**Fig.2.** Average specific discharge map of Transylvania Depression (after Konecsny, 1997)

The analysis of the map shows that the lowest values, between 1 and 2  $l/s \cdot km^2$ , occur in the western part of the Transylvanian Depression, where the effects of the descending air mass movements as foehn are felt. This area includes Alba Iulia-Turda Corridor, the south-west of the Transylvania Plain, and the west of the Lopadia and Secașelor plateaus. From this area, the average discharge values rise eastwards and northeast. The izoree of 4  $l/s \cdot km^2$  generally defines the plateau region from the subcarpathian one in the east. Also, there is an increase in the average discharge values from the southern depressions to the Southern Carpathians. Thus, the specific average discharge reaches 6  $l/s \cdot km^2$  at the contact between the piedmont step which makes the passage from Făgăraș Depression to Făgăraș Mountains (Figure 2). The vertical gradients of the specific flow are reduced in the transition zone between the Sibiu Depression and the Secaș Corridor towards the montane area.

In Someșan Plateau the specific average discharge values generally increase from the Cluj Hills (2-4  $l/s \cdot km^2$ ) to the Ciceu and Năsăud Hills, which are exposed to the advection of massive wet air masses from the west (Figure 2). These spatial differentiations require a certain way of land capitalization and, implicitly, the organization of agricultural space.

Compared to the general situation presented here, there are deviations caused by local conditions that influence the spatial distribution of the discharge. In this regard it can be mentioned that pliocene sands provide a continuous and rich underground water supplying for streams.

The variation in time of the annual water flow was analyzed using the variation coefficient. Discharge variations are more pronounced on the allochthonous rivers in the high peripheric mountain region characterized by abundant humidity. On autochthonous rivers the flow variation is much higher ( $C_v$  over 6.0), which reflects the degree of continentalism that is accentuated from the east to the west of the plateau, respectively from the north to the south of this hilly area (Table 1).

Because a large part of the Transylvanian Plateau does not have water resources sufficient for the development of different socio-economic activities, it has gradually passed to different ways of water storage (natural, artificial, superficial or underground). Regardless of how it is done, water storage offers additional opportunities for land recovery and socio-economic development. In the first stage, for the retention of excess water from the humidification periods, artificial terraces were created, which had been documented for more than four centuries. Subsequently, natural and anthropic ponds appeared, having as main function the fish growing and, to a lesser extent, the discharge regulation.

The ponds are specific to the Transylvanian Plain, where it forms a chain along the Fizeş River (Sântioana, Țaga Mică, Țaga Mare, Sucutard I, II, Geaca I II, III, Tăul Popii, Cătina), Pârâul de Câmpie River from Miheşu de Câmpie to Sânger, 20 km away, occupying 659 ha (Miheşu de Câmpie, Zau de Câmpie, Tăureni etc.), Şarului River (Glodeni, Păingeni), as well as some tributaries.

The spatial distribution of ponds in the Transylvanian Plains is unequal, more than half belonging to the Mureş basin (55.5%), one third to Someşul Mic basin (35.1%) and only 9.4% to the Someşul Mare basin. The number of ponds from the Transylvanian Plains has decreased from 250 to about 20 from the beginning of the last century.

In the Târnavelor Plateau there are several ponds in the upper course of Hârtibaci (Brădeni, Netuş I, II) and Visi rivers (Loamneş), as well on Moşna Stream (Moşna), tributary of the Târnavă Mare River.

The presence of the ponds influences the way space is organized in the river meadows by reducing the cultivated or grazing area. At the same time they generate in their immediate vicinity a specific environment, characterized by increased humidity, lower thermal amplitudes, high level of underground waters, extension of hygrophilic vegetation, etc.

In the salt lakes located at the edge of the Transylvanian Plateau (Ocna Sibiu, Ocna Mures, Cojocna, Ocna Dejului and Sovata), the water storage is made over a longer period of time. There are situations in which there is a rapid evolution of the lacustrine cuvette with negative effects in the organization of the space in the

boundary region (Ocna Mures). In other cases, the bathing qualities of the water accumulated in the lake and / or the disappearance of the phenomena associated with salt lakes, which lead to a reduction of the spa and touristic activities (Ocna Sibiului, Ocna Dej etc.)

Recently, to supplement the water demand required by the water use in the Transylvanian Depression and to prevent the negative effects caused by the floods, the permanent and non-permanent accumulations on the river bed were improved. Permanent accumulations with complex functions were improved on allochthonous rivers and their tributaries in both the mountain (Zetea on Târnava Mare; Colibița on Bistrita; Gilău, Someșu Cald, Tarnița and Beliș on Someșul Cald; Petrești. Nedeiu, Tău and Oașa on Sebes, a tributary of Mureș River), and in the southern marginal region (Viștea, Scoreiu, Avrig, etc. on Olt River). Lakes of larger dimensions with special functions were made on smaller rivers in the plateau region (Ighiș on Ighiș, for water supply) or in the Transylvanian Subcarpathians (Bezid on Bezid for the mitigation of floods).

The non-permanent accumulations designed for flood control (Bălăușeri, Vânători on Târnava Mare) does not change the lands way of use in those areas, but can generate in the side areas excess humidity due to water flow from slopes, which do not reach the river collector.

The processes of water deposition in the meadows and terraces are done in the corridors generated by the allochthonous rafts. Significant quantities of water are stored for a longer period in the piedmont steps from the south and west of the Transylvanian Depression and those developed at the foot of the Călimani Mountains. They provide very good quality water used to supply human settlements.

In the colluvial and elluvial deposits from the floodplain areas in the plateau region, small amounts of water accumulate over a relatively short period of time.

#### **4. CONCLUSIONS**

In the space organization there are several factors that can be grouped into natural and anthropic ones. From the category of natural factors, the hydrological ones that often cause spatial differentiation are an important part.

In order to identify the particularities regarding the space organization it is necessary to know the space-temporal features of the quantitative and qualitative parameters of the factor taken in the studio.

Knowing in detail the space-temporal features of water flow and storage processes and the correlation with other natural and anthropic factors allowed the identification of hydrological induced by particularities in space organizing in this vast area from central Romania.



In the organization of the Transylvanian Depression space there is contrast between the marginal depressions that make the transition to the mountainous area adjacent to the prismatic plateau. The contrasts between the valley corridors crossed by allochthonous rivers and the interfluvial spaces appear in the plateau.

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