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The Geography of the Mures River

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Summary

The Mures river, one of the most important tributary on the catchment area of Tisza river, has significant influence on the formation of flood on the southern part of the Tisza valley. The author evaluates the effects of the hydrogeographic, geologic and climatic factors appeared on the floodplain of the river. These factors are playing a very important role in the change in discharge and water regime.

Introduction

The Mures carries the inner waters of the Transylvanian basin in Western direction and it meets the Tisza at Szeged. The full length of the river is 749 km, the length of its valley is 651 km, the distance between its spring and its orifice is 425 air km. Its length and 30,000 km^2 large drainage basin make the Mures one of the significant rivers of the Carpathian basin. Most of its drainage area is covered with mountains and hills, and only a smaller proportion is plains. 25% of this territory is highlands, 55% is plateau and hill-country, 15% is river valley and 5% is lowlands (VITUKI 1975)(Fig.1).

Geohistory of the Mures drainage area

The beginnings of the hydrogeological aspects of the Mures coincide with the formation of the Transylvanian basin and its spur mountain regions in the Tertiary period. The presence of the Poiana Rusca Mountains and the Bihar Mountains was especially important in the Miocene, since these stood erect in the Mediterranean Sea as island mountains. Later the rise of the ranges of the Eastern Carpathians (Carpatii Orientali) and the Transylvanian Mountains finalized the formation of the Transylvanian basin (Depressione Transilvaniei).

The inner region of the Transylvanian basin was further formed by the slow rotation of the volcanic ranges and the inside blocks accompanying the movements in the mountain structure. Traces of the most intensive volcanic activity can be found in the Bihar Mountains and around the Mures river head, in the Calimeni Mountains, in the Giurghenhi Mountains, Gurghinhi Mountains, Cincului Mountains and in the Harghitei Mountains. The center of the basin had subsided in a relatively quick pace compared to the rise of the

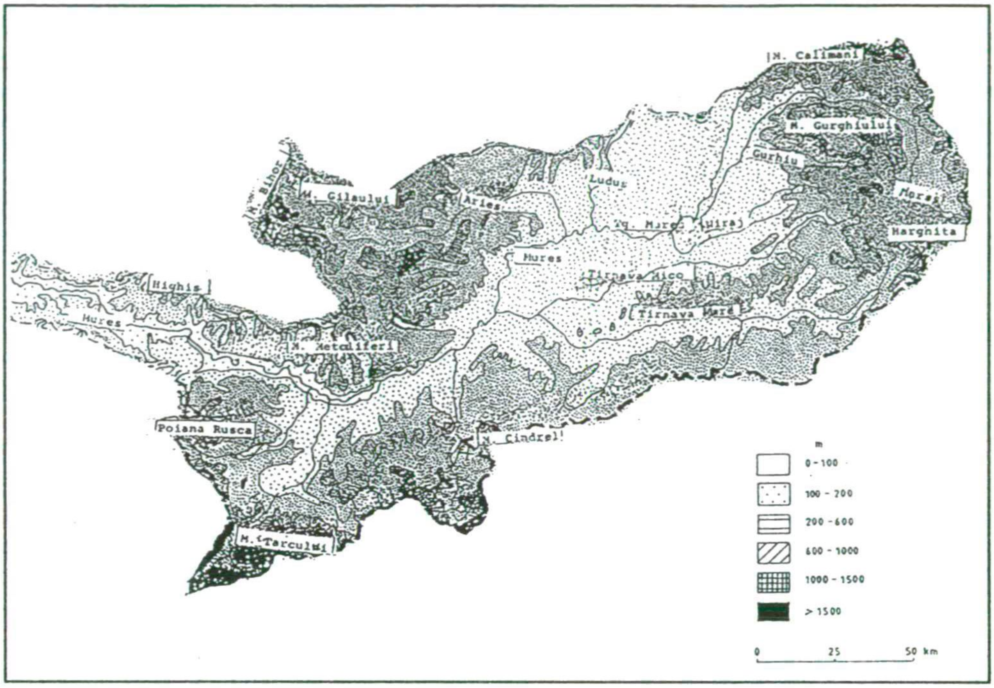

Figure 1 Surface of the Transylvanian drainage basin of the Mures (m above sea level)

mountain frame. The forceful rise of the mountain frame and the relative elevation of the basin resulted in the gradual and substantial recession of the shores of the Miocene (Pliocene) inner sea (Bulla B. 1943; Pávai Vajna F. 1914; Tulokdi J. 1925).

The present Mures valley, between the Bihar Mountains and the Poiana Rusca Mountains, however, did not rise and thus the Pannon sea of the Alföld and the Transylvanian inner sea were connected for a long time. This narrowing was the Zám-pass (Strimtoarea de la Zum), the oldest element of the Mures valley and of the Transylvanian river system as well.

In the beginning of the Pliocene the lowland section of the Mures was still covered by the Miocene lake. In the central Transylvanian basin significant bay-like depressions formed. Even in the beginning of the Pliocene, it was characteristic that shorter streams started off from the surfaces of the surrounding higher mountains. Some of these streams were later taken up and further deepened by the Pleistocene Old Mures.

The Transylvanian bay formation developed into an independent closed lake and was filled up significantly only by the middle Pliocene. The alluvial fan, which determined the lowland section of the later Old Mures, started to build up from the coarse alluvium of the waters rushing down from the Highis-Drocea and Magura areas also around this time. The torrential streams also deposited a significant quantity of alluvium at the meeting of the Alföld and the foreland of the surrounding moutains (Gaál I. 1912; Oancea, D. et al. 1987).

An important rise in the drainage area of the Mures at the end of the Pliocene caused a recession in the inner lakes. By the end of the tertiary period (by the beginning of the Pleistocene,) the Mures had become a quick river, carrying the water of the Transylvanian inner lake to the significantly lowerlying Alföld.

The Old Mures left the mountains and appeared in the Alföld in the Pliocene and left a large alluvial deposit in the tectonic valley. This deposit gren as a Levantean talus, first only at the feet of the mountains and then slowly, with the further development of the talus system, it reached the talus systems of the Bega and the Crisul (Márton Gy. 1914).

The Alföld had been subsiding at the end of the Pliocene, and this process continued in the Pleistocene and even in the Early Holocene. The significant subsidence can be traced back in the structure of the regional debris of the talus sytem beginning at Lipova and spreading out fan-wise in the South-Eastern plain region (Andó M. 1976). There was no permanent surface river bed on the Mures Pliocene alluvium surface; the alluvium was spread in several branches. In the Early Pleistocene the Mures took on a definite direction that coincides with the seismotectonic lines of the rim of the Alföld. One of these directions is the "Paulis-Lipova" tectonic line, the other follows the foot of the Highis-Drocea Mountains in Northwest-Southeast direction.

During the "Günz" and "Mindel" glaciations the river formed a terrace system on its previous valley plain, influenced by the climatic change and the rise of the area, too. In the "Mindel" the Old Mures left the Lipova gorge and, producing several meanders, turned to Northwest on the talus system of the Alföld. First the river ran on the Southern rim of the talus, then, turning North, its main branch met the Old Tisza together with the Riul Crisul (Fig.2).

In the "Riss" period the talus developed mostly in the central area of the present talus. Significant surface changes occured mostly in the glacial and interglacial periods of the "Würm", when dominantly coarse and medium sand deposit levelled up the earlier deepenings of the river bed. At the same time in the Transylvanian area the usually wide but not too high terrace systems of the Mures developed; these can be traced from Reghin to Lipova (VITUKI 1975).

In the Holocene period the Mures settled in the Transylvanian basin and its horizontal bed changes became insignificant compared to the previous stages. The Holocene terrace follows the river all along with a 5-10 m height. At the same time, however, the Alföld section underwent a serious transformation that was especially due to the subsiding of the region of the Crisul river (Andó M. 1976). The oldest Holocene Mures reached the Tisza, the base of erosion (Gazdag L. 1964), at Kürtös and Kevermes. However, the Tisza moved to Northwest in a forceful process; the Mures beds followed it on fan-like taluses.
The river first followed the Békés-Kondoros, then the Kürtös-Nagykamarás-Orosháza, then the the Dombegyháza-Mezőhegyes-Makó and then the Szárazér line (Fig.3). The present bed was basically formed by the regulation of the river, since before this, in the Holocene, it also supplied the Aranka stream system.

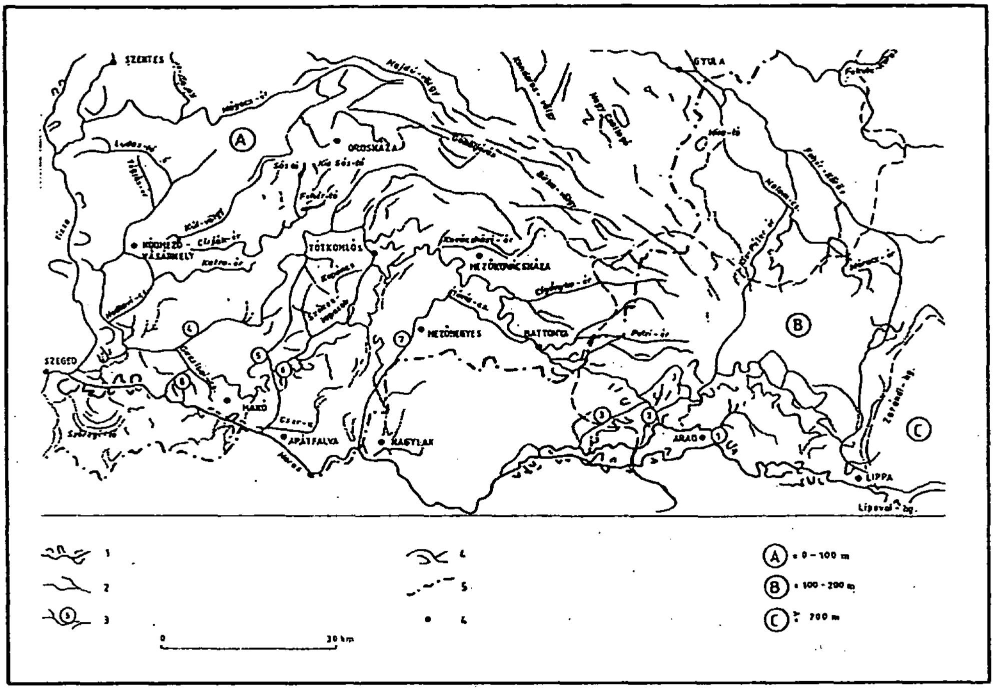

Figure 2 The river system of the Alföld section of the Mures
1. The present bed and meanders of the Mures; 2. Brooks; 3. Artificial canals; 4. Lines of Old Holocene beds; 5. Borders; 6. Town or village; A, B, C= m above sea level

Main climatic and hydrographic characteristics of the Mures drainage basin

The temperature and precipitation of the Mures drainage basin is influenced by masses of air from the Atlantic Ocean and the Mediterranean and as well as from Eastern Europe. Besides these, features of the ground also account for the regional differences; for example, compared to the precipitation on the plains, in the mountainous areas the precipitation doubles (Andó M.-Vágás I. 1973). Similarly to the Alföld, the annual quantity drops in the Transylvanian basin as well. In the case of the latter, the lack of precipitation is the result of the climate modifying influence of the Southern and Eastern Carpathians, especially in the winter semester.

Since the drainage area of the Mures is supplied with water by the Western winds, there are significant differences between the quantity of the precipitation in the "luv" and "lee" sides of the surface. This is especially characteristic on the Western expositions of

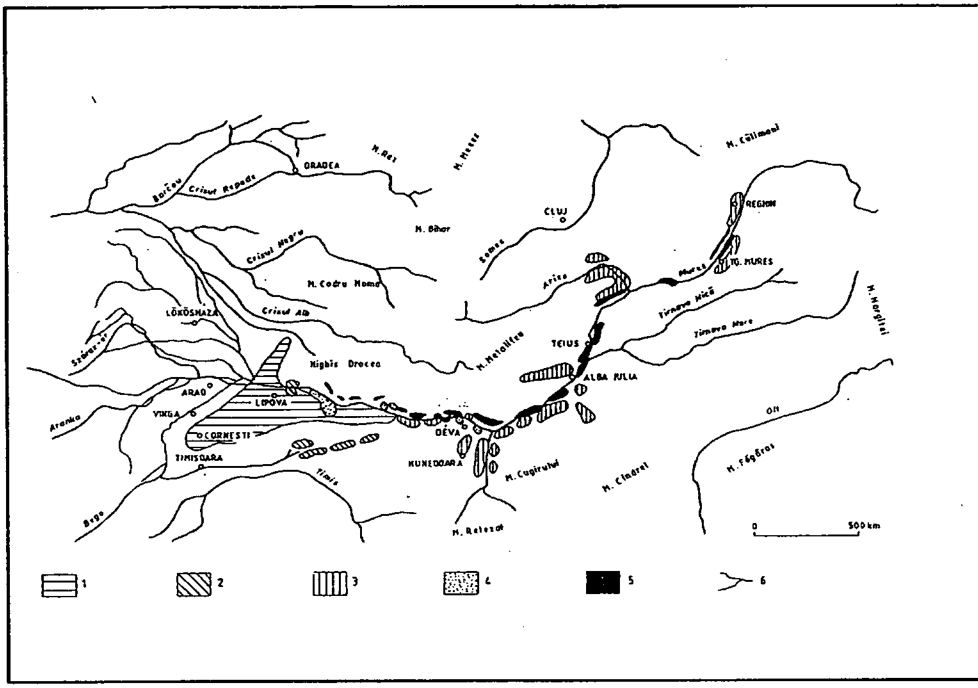

Figure 3 Terraces of the Mures in Transylvania and the traces of its old bed in the Alföld (source: OHV map)
1. Levante pebble deposit; 2. Günz terrace traces; 3. Mindel terrace remnants; 4. Riss terrace remnants; 5. Würm terrace remnants; 6. Old Holocene Mures bed lines

the Calimeni Mountains and the Gurghinhi Mountains where the annual precipitation is over 1,500 mm while in the Transylvanian basin it is only 500-600 mm and on the "luv" sides of the lower mountain areas it is 700-1,000 mm. The distribution of the temperature is similar; the annual mean temperatures are distributed according to the height above sea level. The whole drainage area of the Mures can be characterized by a 4-11 °C annual mean temperature. The coldest area is the Aranyos river region, the Mures river head and the Giurghenhi Mountains with 3-6 °C mean temperature. Most of the Transylvanian basin and in the Mures valley that is open to the West the annual mean temperature is 8-10 °C and in Szeged it is 11 °C.

Influencing the water level of the affluents, the regional water absorption is of great importance. This leads to significant regional contrasts in the different parts of the drainage area because of the great seasonal differences. For example, in the winter months the surface precipitation is mostly snow, therefore the monthly averages of the water absorption distribution can be characterized by the snow accumulation that increases with elevation. In the drainage areas especially in the mountain regions above 1,000-1,500 m the winter precipitation is not more than 15 mm. This also means that the water absorption in the drainage basins is the lowest in the winter, which is due to the accumulation of snow.

In the spring, as the snow melts from March till April, the surface water absorption highly increases. This time even 50-60 mm water quantities can occur in areas 500-1,500 m above sea level. At the same time on the Alföld and in the Transylvanian basin only 15 mm water quantity can be measured. On the surfaces of the higher mountains the water absorption begins to increase only in April, and in this period values between 100-200 mm are often observed in the mountains.

In April in the plains and hills comprising a large proportion of the drainage basin the total of the water supply comes from the rains; in the summer this is characteristic of the whole basin. In the fall the surface water absorption significantly drops and in areas 1,500 m above sea level the accumulation of snow begins, while in the Alföld and in the Transylvanian basin less than 30 mm precipitation occurs. This latter is mainly due to the Mediterranean climate connected to the Adriatic cyclones.

The data presented here suggest that the annual distribution of the precipitation is connected to periods and not certain seasons. Two characteristic periods can be distinguished: a "wet" period and a long "dry" one. The wet period sets in between April and August and the dry from September to March. The floods on rivers do not exactly correspond to this temporal distribution, since the early spring flood and the high waters in the spring are not caused directly by rains, but rather these are the consequences of the snow accumulated in the winter and now melting.

In the drainage area of the Mures the melting of the snow is a quick process which significantly raises the stock of water. When the melting lasts longer, the slow and gradual water supply does not lead to floods. The Mures has two important floods in a year (spring and summer green flood), and both are equally dangerous (Andó M.-Vágás I. 1973). In the first case the snow melts in the mountains because of the strong insolation at the end of February. The river swells very quickly, but equally fast is the retreat of flooding (8-12 days). The spring flood of the Mures preceeds that of the Tisza, sometimes reaching its peak at Szeged when the flood ware of the Tisza has not even culminated at Szolnok.

Since 80% of the Mures drainage basin is made up of impermeable layers and because of the significant differences in level and the significant slopes the Mures becomes a quickflowing river (Andó M.-Vágás I. 1973). Considering the distribution of the precipitation of the drainage basin, we can approximate the dates of the floods. In the mountains and in the Transylvanian basin the quantity of precipitation increases from January to June and decreases from July to January. Therefore there are only spring and summer green floods on the Mures, and regularly it does not have a flood in the fall, as there are nolarger and significant rains in Transylvania then.

The precipitation of the drainage area is carried away by the dense water system of the Mures, therefore the water level of the river is influenced by the precipitation and the specific runoff and the circumstances of the accumulation as well. The specific runoff greatly varies, depending on the surface features, development and edaphic conditions of the given area.

In the high mountain areas of the drainage basin the specific runoff is 30-50 l/s/km², in most the Transylvanian basin it is 1-3 l/s/km², and on the plain it is below 1.0 l/s/km². Extremism characterizes the specific runoff of the individual drainage basins of the tributaries. For example, in the riverheads of the Aries, Ampoi and Geoagin, the average runoff is between 5-30 l/s/km², but the value corresponding to the highest water discharge is 350-1,000 l/s/km², and the lowest discharge is 0.8-1.1 l/s/km². The highest runoff values are observed in the riverheads of the Sebes, Strei and Riul Mare. Here the average runoff is over 40 l/s/km², the highest discharge can be over 1,000 l/s/km², but the lowest discharge is 2.0-6.0 l/s/km² (Tulogdi J. 1925; Újvári J. 1972). The affluents are characterized by the virulent changes of water level, the quick rise and the quick recession.

Hydrographically the drainage basin can be divided into two characteristic areas, a plain section and a basin surrounded by mountains. The varied drainage basin narrows down on the plain while it broadens in Transylvania. The drainage basin is expanded with asymmetrical hydrographical characterictics especially East of Deva. The highest point of the drainage area is 2,509 m in the Retezat Mountains, the lowest point is 78 m above sea level where the Mures meets the Tisza.

The Mures is a highgradient river, running on elevated surfaces to its mouth and keeping its gradient all along. The gradient is evenly distributed. For example it falls 46 cm/km from Ludus to Alba Julia, 40-43 cm/km to Branisca, to Savirsin, to Rodna and 38 cm/km from Rodna to Lipova. In the Alföld, its gradient decreases somewhat, but the number of the bends significantly increases. The development of meanders is especially important along the sections where bed gradient is small (Periam, Perjámos; Egres, Csanád, Kiszombor, Szőreg.)

In the Alföld the width of the bed also varies, for example its average width is 150 m between Rodna and Pecica, 180 m between Pecica and Csanád, and 100 m between Csanád and Tápé. The river bed stretches out in the plains so that its water depth reduces, while at other sections it narrows down and deepens.

There can be distinguished four sections of the river bed with uneven gradients: 1. Lipova - Zsigmondháza, 39.8 km, 0.28 m/km gradient; 2. Zsigmondháza-Pécska, 23.6 km, 0.44 m/km gradient; 3. Pécska-Csanád, 52.6 km, 0,28 m/km gradient; 4. Csanád-Tápé, 37.5 km, 0.13 m/km gradient.

The environment of the riverbed is varied by different age terrace formations. Of these, the Old Holocene terrace can be found occassionally 10 meters above mean water level. These terraces are not covered even by the highest flood. The Holocene terrace is made up of mainly alluvium piled up in the Pleistocene, rinsed through and resturctured by the floods of the river. Several upper Pleistocene terraces can be observed which do not form a continual terrace system (Fig.3). These are 20 m above the river flats: A coarse pebble layer containing loess and red clay covers the Pleistocene terraces.

In the mountain valley there are several Pleistocene terrace remnants 40-60 m above the river flats. In the mountain section frequently different cliffs stand out of the river sediment. Occassionally there are no terraces and the river had deepened into the bedrock (between Deva and Lipova).

On the Alföld section of the Mures a different development of the valley has taken place from the Pliocene till now. Leaving the mountains, the river built a talus which is spreading out fan-wise. Only in the Holocene did the river took on a definite direction on the alluvial system and this riverbed usually coincides with the seismotectonic lines of the Alföld (Márton Gy. 1914).

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