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Articole/Papers

Călmăţui (Teleorman) Hydrographic Basin
– Morphometric Analysis Elements –

Maria ALBU DINU

Abstract. Teleorman Călmăţui Basin is an important local basin located in Olt - Argeş Sector of the Romanian Plain. It springs from an altitude of only 160 m and pours into Suhaia lake, an old oxbow of Danube river, about 20 m altitude.

From the analysis of morphometry features of the basin we can draw a series of particularities of the relief evolution of this region. Although it started its evolution relatively recently, after the finalization of Boianu Plain, in the inferior Pleistocene, this river has already reached the maturity stage. Its fast evolution was favored especially by the accentuated descent of the basic level, the friability of the rocks in which it is carved but also the climatic variations. The acute depth of Călmăţui and Urlui in the middle and inferior sectors led to the intersection of ground-water table and to the apparition of numerous springs and spring lines, preventing the total drainage of rivers during summer.

Key words: hydrographic basin, morphometry, paleogeomorphologic evolution, balance profile.

1. Introduction

Teleorman Călmăţui Basin is a hydrographic basin autochthonous to the Romanian Plain, completely situated in Boianu Plain (fig 1). It springs from an altitude of only 160 m and pours into Suhaia lake, an old oxbow of Danube river. Regarding the major genetic type of relief, Boianului Plain is situated in the fluvial-lacustrine plain type, characteristic for the entire Romanian Plains, and as sub-types, within this basin, we can distinguish: a) *IminogPlain* (Nord of Boianu Plain), occupying the northern part of the basin – *a Getic piedmont plain*, representing an extension of Getic Piedmont, and b) *Urlui Plain – a pre-Balkan piedmont plain (piedmont plain with Frăteşti Strata),* coming from an old pre-Balkan piedmont, that was covered with lacustrine and loess deposits and spreading to the south of the towns Radomireşti-Mihăeşti, occupying the middle and inferior sectors of the basin (Gr. Posea, 1987).

Călmăţui River is carved in loess deposits of Pleistocene age, having as basis the "Frăteşti Strata" of St. Prestian age (P. Enciu, 2007). The discordance between Romania deposits and Frăteşti Strata is based on the erosion bed of Paleo-Danube in front of the delta-cons, after exiting the defile (E.Liteanu, 1961). Due to the fast descent of the basic level, as well as the positive neotectonic movements, the river deepened in the inferior sector, in the leoss deposits as well as in Frăteşti Strata.

Fig.1 **Localization of Călmăţui hydrographic basin within Teleorman Plain**

2. Morphometric aspects

The fluvial geomorphology must highlight the way the climatic changes and tectonic activity influence the aspect of the valley on long term and of the longitudinal profile of the river (V. R. Thorndycraft, G. Benito, K. J. Gregory, 2008).

The morphometric researches are especially useful for the unstudied regions, in which the geomorphologic proofs miss for explaining the evolution of the relief. Through the faithful and correct play of the current aspect of Earth's surface, the morphometric analysis leads us to paleoevolutive or genetic intuitions (F. Grecu, 1986).

2.1. Watershed

Watershed of Călmăţui morphohydrographic basin has a length of 184.93 km, being symmetrically distributed on the two banks, the right bank 94.19 km (50.93%), and the left bank 90.74 km (49,07%). The watershed is almost rectilinear, the sinuosity coefficient of the watershed calculated using the formula (Zăvoianu, 1978, quoted by F. Grecu, 1992):

$Ks = Lc/Lp$, being of only 1.08.

In this formula:

- Lc – length of the watershed,
- Lp – the distance on the watershed between the spring and the flow.

The difference between the two parts of the insignificant basin:

($Ks\ left = 1.07$ $Ks\ right = 1.09$)

The average height of the watershed is of 116.05 m, presenting higher altitudes on the right side of the basin (120.4 m) regarding the left one (111.7 m).

2.2. The shape of the basin

We can consider that the shape of the basin is a result of the action of drainage network under the conditions given by lithology, tectonics, climate and vegetation and it is modified during time. The geomorphologists came to the conclusion that hydrographic basins developing under homogenous morphotectonic conditions, tend to come to a balance of the watersheds and have a shape close to a pear, in the same time being discussed the shape of circle (A. Posea, 1977, quoted by Comănescu, 2004). Călmăţui Basin broadens step by step from the springs to the flow area, reaching the maximum width of in the middle sector 32.6 km, and then there is a contraction in the inferior sector. We can say that the mechanic action of Clămăţui river tends to performing a balance shape not only regarding the longitudinal profile, but also regarding the contour of the watershed.

For Călmăţui basin, the ***shape index***, set by Gravelius as a report between the perimeter of the (P=184.9 km) and the perimeter of a circle with the same surface (S =1375 km²)

$K = P/2\pi r$ is of *1.4*.

This value gives the ovoid aspect of Călmăţui basin of Teleorman. The current aspect of the basin is determined by repeated modifications of the basic level represented by the Danube, who generated several stages in the forming of the basin.

We must observe the flowing direction of the 4th order segments, who are mostly parallel to Călmăţui. Due to this fact, within 4th order basins, we register values further from the unit of shape index it is of: 1.6 for the superior basin of Călmăţui, 1.89 for Călmăţuiul Sec, 1.43 for Totiţa basin and 1.92 for Urlui basin, which proves their high degree of elongation.

In order to have a real image of the basin's shape, we calculated ***the shape report***, having as reference figure the square (Zăvoianu, 1978).

$$Rf = S/(P/4)^2 = 0,6.$$

We can observe that using as reference shapes the circle as well as the square, the difference between the shape and unity indexes remained the same (0.4).

The elongation report, calculated as report between the diameter of the equal area circle and the length of the basin

$$RA = \Phi CS/L = 0.53$$

(Schumm, 1956, Zăvioanu, 1978).

This shows that the basin is elongated, but the elongation degree is medium.

The roundness report can be calculated as report between the basin's surface S (S=1375.07 km²) and Scp – surface of a circle of equal perimeter (P = 184.93 km) using the formula (Miller, 1953, quoted by Comănescu 2004).

$$Rc = S / Scp$$

For Călmăţui basin we obtain the value of 0.50 which indicates an elongated basin.

Analyzing the obtained results we notice that Călmăţui basin is an elongated environment while the 4th order sub-basins have a much higher elongation degree.

Basin's asymmetry reported to the main course offer information regarding its evolution in time. The surface of Călmăţui hydrographic basin of 1375 km², is asymmetrically distributed on one side and the other of the valley ax (fig. 2a). The surface of the right bank is of 623.84 km² (45.37%), and of the left side of 751.23 km² (54.63%). The asymmetry coefficient, calculated using the formula (Pişota, Zaharia, Diaconu, 2005):

$$kas = 2(Fdr - Fst)/ F = 0.18$$

show that the basin is an asymmetric environment. This situation is due to the two important confluents Călmăţui receives on the left side: Călmăţuiul Sec and Urluiul.

If we consider the main ax of the basin (fig. 2b), then the situation is reversed. The surface on the right side of the main ax is of 949.14 km² (69.02%), and on the left side of the main ax is only of 425.93 km² (30.98%), the asymmetry degree in this case being much greater. This asymmetry is due to the change of flowing direction of Călmăţui river. In the superior course, the flowing direction is NNW – SSE, in the middle course the flowing direction is NW-SE, while in the inferior sector the flowing direction modifies again, becoming almost N-S.

2.3 Length dimensions

The shape of reception surface influences a series of important parameters: surface, perimeter, length and width. For the morphohydrographic basin of Călmăţui and for the main sub-basins we calculated *the maximum length* – considered as the distance in straight line between the furthest points of the basin, *the maximum width* – is the longest segment, perpendicular on the length of the river and *the medium width* – determined as report between the surface of the basins and their length (Grecu, 1980).

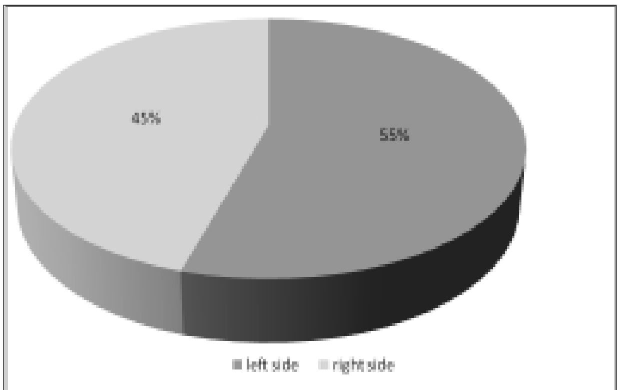
The length of Călmăţui basin is of 78.32 km, and the ones of 4th order basins vary between 19.42 km (Totiţa) and 41.23 km (Urlui).

Analyzing the dimensions of length of Călmăţui basin (table nr.1), we note that its shape tends to balance, while the 4th order sub-basins have more elongated shapes.

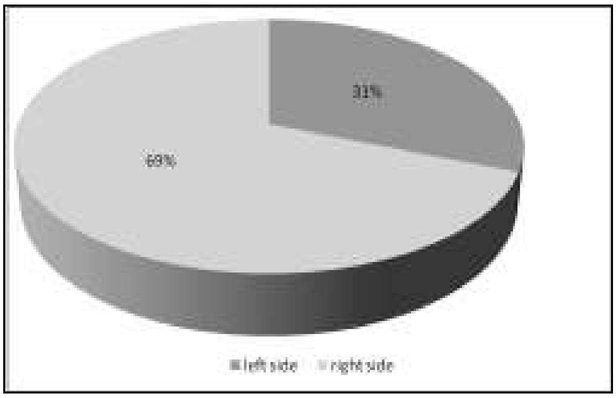
The length of the basins is variable on their different sectors. Thus, the basin of Călmăţui river is very well developed in the central part (over 25 km), while in the north part of the basin the width decreases to less than 5 km. The average width of Călmăţui basin is of 17.56 km, but we note values close to the average widths in the case of 4th order basins, varying between 2.33 km (Totiţa) and 2.76 km (Urluiul).

2.4. Hypsometry

The hypsometric specificities of Călmăţui hydrographic basin of Teleorman are determined by its development on homogenous lythologic formations with tabular structure, by the positive neotectonic movements that affected especially the south side of the basin, by the oscillations of the basic level as well as the action of external agents. Within Călmăţui basin we notice the concentric layout of hypsometric stages from north to south, their decrease performing along the Călmăţui valley from the spring to the flow. The altitudes decrease step by step from NNW to SSE, the highest altitudes being situated on the watershed, in the north of the basin: Măgura Greci 163.5 m, Măgura Vâlcele 156.23 m, Măgura Greceanca 161.3 m, and the lowest, under 20 m, situated in the south of the basin, where the Călmăţui flows into Suhaia Lake.



a)



b)

Fig. 2. **The share of surfaces in Calmatui basin of Teleorman**
a) regarding the ax of the valley; b) regarding the main ax of the basin

Table nr.1 **Morphometric data for Călmăţui basin and main sub-basins**

Basin	Maximum length (km)	Maximum width (km)	Average width (km)
Călmăţuiul	78,32	28,62	17,56
Călmăţuiul superior	38,95	12,14	2,50
Călmăţuiul Sec	36,71	7,34	2,46
Totiţa	19,42	6,75	2,33
Urluiul	41,23	12,25	2,76

The histogram performed for this basin presents a powerful symmetry, as the surfaces with values under 90 m as well as the ones with values over 90 m represent 19% of the basin's surface, while the hypsometric stage of 90–120 m extends on a surface of 852.3 km², occupies about 62% of the basin's surface, including the largest part of the interfluves (F. Grecu, L. Comănescu, 1998).

Analyzing the cumulated diagram of the hypsometric stages (fig. 3) we can easily observe the convex shape of the curve in the inferior part, which indicates a process of powerful and fast deepening of the valleys. Comparing the shape of the hypsometric integral curve, reduced in the unit (Rădoane M., Dumitru D., Rădoane N., 2001), with Strahler's stages of relief evolution (fig. 4), we observe that Călmăţui hydrographic basin is close to the maturity stage of its evolution.

2.6. The deepening of fragmentation shows the depth reached by the linear erosion. The largest part of the surface of Călmăţui basin, respectively 53%, present values of fragmentation deepening under 10 m. The surfaces with value of fragmentation depth between 10 and 20 m occupy 22% of the surface of the basin and are situated especially along the valleys in the superior Călmăţui basin. The surfaces with values of fragmentation depth between 20 and 30 m represent about 6% of the basin's surface and are especially disposed long the Călmăţui valley in the middle sector and in the superior sector of Urlui valley.

A specificity of the relief's fragmentation depth is represented by the surfaces with values of fragmentation depth between 40 and 50 m as well as the one with values larger than 50 m, situated in the inferior sector of Călmăţui valley, values large enough for a plain area and which together occupy about 7% of the basin's surface. This fact is due to:

- the presence of loess deposits highly friable;
- the positive neotectonic movements of about +2 mm/year (D. Zugrăvescu et al., 1998);
- the accentuated descend of the basic level represented by the Danube.

2.7. The fragmentation density in Călmăţui hydrographic basin of Teleorman is characterized by reduced values, specific to the plains area (Grecu, Comănescu, 1998). The values of relief fragmentation density vary between 0 and 5 km/km², the average density being of 1.25 km/km², also considering the valleys with torrential character.

The surfaces with very small values of fragmentation densities, under 1 km/km², are characteristic to the interfluves between the main rivers and occupy 40% of the basin surface. The surfaces with values of fragmentation density between 1 and 2 km/km² represent about 23% of the basin's surface, and the ones with values between 2 and 3 km/km² hold about 23% of the surface.

We must note the fact that the surfaces with values of fragmentation density greater than 3 km/km², represent an important share of 17% of the basin's surface. These high values of the fragmentation density are due to the friability of rocks in which the basin is carved, as well as to the presence in the studied region of numerous springs and spring lines that appeared as a result of the intersecting of the phreatic aquifer layer quartered in "Frăteşti Strata" by the powerfully deepened valleys.

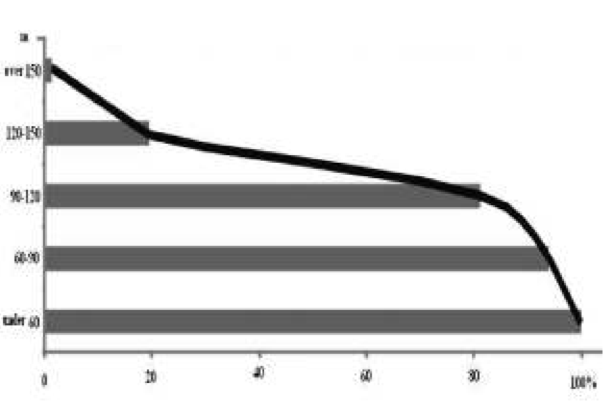


Fig. 3. **The cumulated diagram of hypsometric stages in Călmăţui basin of Teleorman**

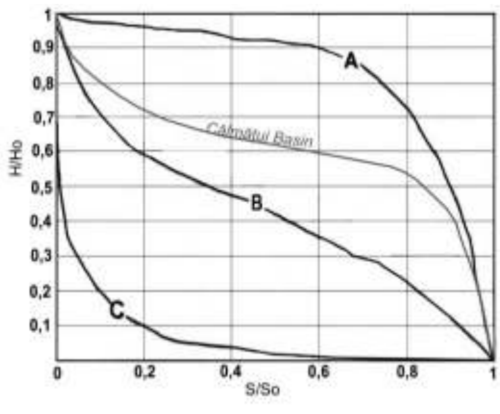


Fig. 4. **The hypsometric integral of Călmăţui hydrographic basin compared with Strahler's stages of relief evolution** (A – youth, B – maturity, C – old age)

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2.8. Geodeclivity of morphologic surfaces in Călmăţui basin is strongly correlated to the geological support, paleogeographic evolution and current modeling (Grecu F., Palmentola G. 2003).

The values of morphologic surfaces inclination were divided into 5 categories. The greatest share is of the qausi-horizontal surfaces in whose case the value of the slope does not exceed 2%, being represented by most interfluves and representing 77% of the basin surface.

The very weakly inclined slopes with values between 2 and 5% represent 12.29% and are characteristic to young valleys, with torrential character, whose profile is transversal as a widely opened „V". While the size order of the river segments increases, the valleys deepen and the slopes become weakly inclined with values between 5 and 10% occupying 6.94%, of the basin surface.

The slopes moderately inclined, with values between 10 and 15%, represent 2.55% of the basin surface and are characteristic for the sides in the middle and inferior sectors of Călmăţui and Urlui, and the moderated ones with values over 15% represent only 1.16% of the basin surface and occupy especially the right side of Călmăţui valley in the inferior sector.

3. Geomorphologic regionalization

Analyzing the morphometric parameters such as: altitude, slope character, valley system, fragmentation degree, we can distinguish within the hydrographic basin Călmăţui of Teleorman three sectors that present different characteristics (fig. 5), thus:

a) *Superior sector*, superposes in most part to Iminog Plain and spreads to the south up to the confluence of Călmăţui with Călmăţuiul Sec. The absolute altitude descends from 163.5 m in then north to about 108 m in the south, and the value of the slope reaches 1.42 m/km, due to the existence at the south end of the alluvial cone Olt-Argeş. This sector is crossed on the direction NNW-SSE by three important valleys: the superior course of Călmăţui valley and its confluents: the valley of Călmăţuiul Sec confluent on the left side and the valley of Sohodol confluent on the right side. The valleys are partially dried during summer, they have a transversal profile as a widely opened "V" in the superior sectors, and then begin to slightly deepen and widen on the base.

This sector is characterized by the absence of springs, and the ground-water table on the level of interfluves is found at great depth (20-25 m). Therefore, the human settlements are few, small and

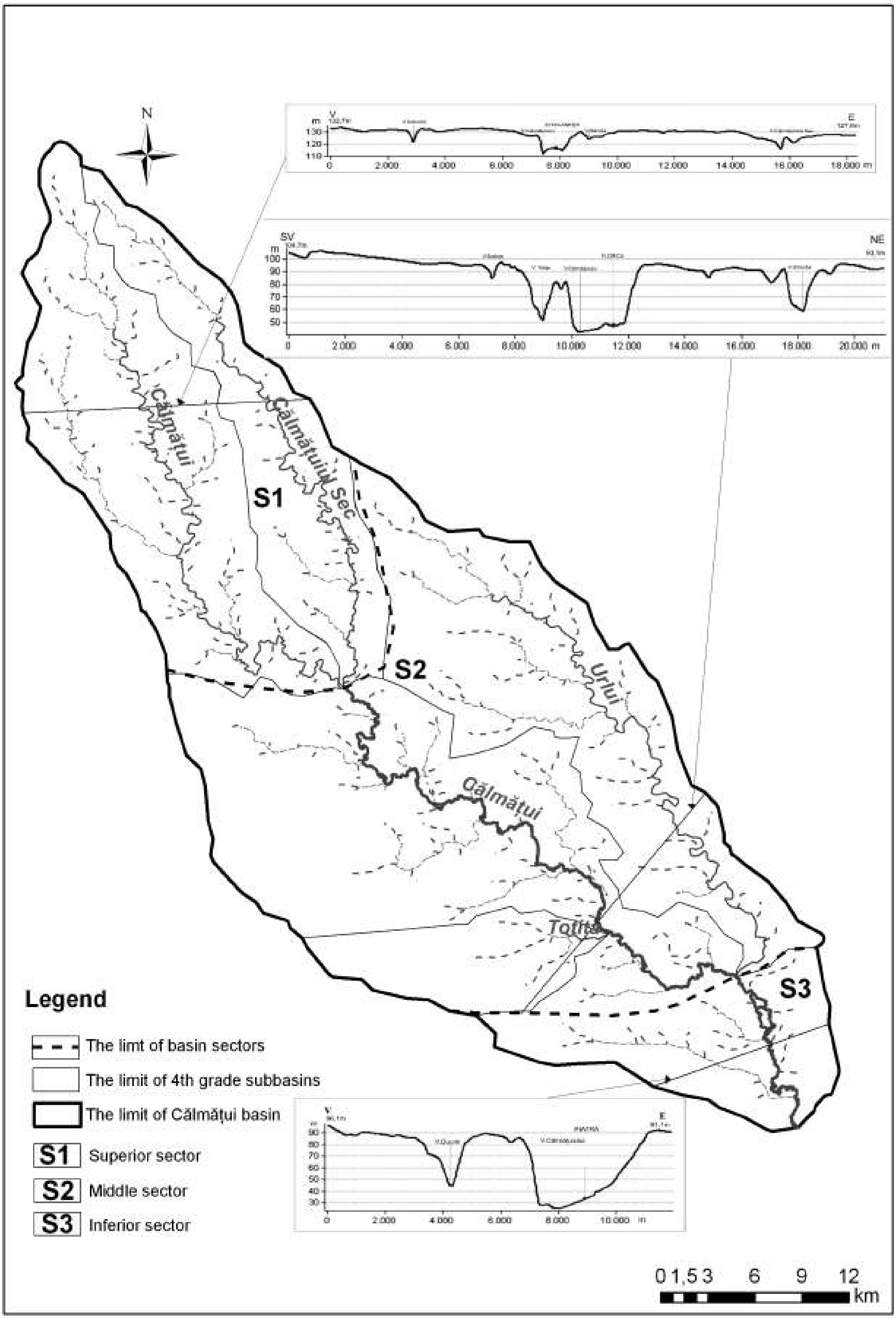

Fig. 5 **Călmăţui basin – Geomorphologic regionalization map**

situated on valleys, where the depth of the ground-water table is smaller. The depth of fragmentation registers values of 10 and even 20 m in the south side, the density of fragmentation of the relief is the highest from the entire basin, being of over 1.5 km/km² (if we consider all valleys, including the ones with torrential character), the meadow is relatively narrow and the sides have values of the slopes of 5-10%.

b) *Middle sector* situated between the confluence of Călmăţui with Călmăţuiul Sec and the confluence of Călmăţui with Urlui is the largest and it is drained by the middle sector of Călmăţui and its left confluent, Urlui. The main valleys have water all year long, presenting wide and complex meadows, with numerous tied up meanders, hills as well as one-two terrace levels as patches. Numerous meanders determine the change of main direction of flow of the rivers that become NW-SE. The sides become more abrupt, the slopes generally have values between 10-15% and even exceeding 15%. The general slope of the relief's surface is very reduced, reaching 0.25 – 0.3 m/km, this due to the extension towards west of the depression groove of Câlniştea. An important characteristic of this geomorphologic sector is its richness of springs, some of them with pretty important debit, appearing in great numbers on the base of the sides of main valleys, marking the end of the alluvial cone (I. Rădulescu, 1956), fact that determined the apparition of numerous settlements. The fragmentation density is of only 1.1 km/km², but the valleys deepen pretty much, the fragmentation depth reaching values of 30-40, 40-50 and even over 50 m.

c) Inferior sector situated on the south of Călmăţui's confluence with Urlui, has a reduced surface. It is drained on the north-south direction by a deep valley of Călmăţui, with "micro-canyon" aspect formed of loess. The fragmentation depth exceeds in this sector 50 m. On the sides with slopes of 10-15 % and even over 15% most of the current geomorphologic processes take place. The two levels of terrace are present only on the left side of the river and have so bevel surfaces that it is difficult to set their altitude only by one value. It appears that during the forming of the terraces, the river used to descend pretty fast towards the current basic level (G.Vălsan, 1915).

The surface of this sector is almost horizontal, a like Burnas Plain. But what distinguishes it is the lack of inverse slope, from south to north and of the rivers with this flowing direction. The altitude difference is about 5-10 m, registered between the northern and southern extremities of this sector is determined by the presence of the 4th terrace of Danube in the south of the basin. Under these conditions the density of the hydrographic network is similar to the central sector, being of 1.2 km/km².

Conclusions

Călmăţui Basin of Teleorman is an important autochthonous basin in the Central Sector of Romanian Plains. Although it started its evolution relatively recently, after the finalization of Boianului Plains, in the inferior Pleistocene, this river has already reached the maturity stage. Its fast evolution was favored especially by the accentuated descent of the basic level, the friability of the rocks in which it is carved but also the climatic variations.

Currently, some confluents of Călmăţui, with torrential character, increase their length by draining certain microdepressions, as in Călmăţui basin of Teleorman the theory of N. Florea (1970) is very well illustrated, theory according to which "the plains with microdepressions represent a stage in the evolution of loess plains".

The acute depth of Călmăţui and Urlui in the middle and inferior sectors led to the intersection of ground-water table and to the apparition of numerous springs and spring lines, preventing the total drainage of rivers during summer.

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