RUNOFF POTENTIAL OF MUREŞ RIVER UPPER BASIN TRIBUTARIES

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ABSTRACT. – Runoff Potential of Mureş River Upper Basin Tributaries. The upper basin of the Mureş River includes a significant area of the Eastern Carpathians central western part with different runoff formation conditions. In assessing the average annual runoff potential we used data from six gauging stations and made assessments on three distinct periods. Identifying the appropriate areas of the obtained correlations curves (between specific average runoff and catchments mean altitude) allowed the assessment of potential runoff at catchment level and on geographical units. The potential average runoff is also assessed on altitude intervals of the mentioned areas. The runoff potential analysis on hydrographic basins, geographical units and altitude intervals highlights the variant spatial distribution of this general water resources indicator in the different studied areas.

Keywords: water resources, Mureş upper basin, geographic units, altitude intervals

1. GENERAL CONSIDERATIONS

The upper basin of the Mureş River includes a significant area of the Eastern Carpathians central western part, also known as Moldavo-Transylvanian Carpathians (V. Mihăilescu, 1963).

In the study area we find a large part of the Eastern Carpathians neoeruptive chain, represented by the southern slopes of Căliman Mountains, eastern and northern slopes of the Gurghiu Mountains and the northern extremity of the Harghita Mountains (Fig. 1). The runoff formation conditions in the vulcanic chain depend of the neoeruptive relief altitude, which is generally decreasing from north to south, and of the exposure to the advection of western moist air masses. The volcanic relief morphology (cones, craters and plateaus, less represented in the study area) influences only the direction of runoff.

The Giurgeu Depression developed along the Mureş until Topliţa, representing 75 km, has a mixed origin (tectonic-erosive and volcanic dam). The lower altitude (600-850 m), the significant sheltering, frequent thermal inversions, foehn circulations does not provide favorable conditions for formation of runoff.

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The relief morphology is represented by meadows, river terraces and piedmont plains with optimal conditions for the accumulation of excess water (especially in the eastern part) derived from the adjacent mountain area. This explains the presence of numerous eutrophic swamps (17) located mainly east of the Mureş.

The eastern part of the basin is closed by the Giurgeu Mountains which develop in the basin only their western extremities. The transition from the main peak of over 1400 m to the Giurgeu Depression is via two lower relief steps of 1100 -1300 m, respectively 850-1150 m (*Geografia României, III, 1987*). The Hăşmaş Mountains appears at the southern extremity of Giurgeu Mountains, between Belcina and Chindeni,

In order to generalize spatially the average annual runoff we established a relationship between the average specific discharge values of the gauging stations and the mean catchment altitude controlled by them (Table 1).

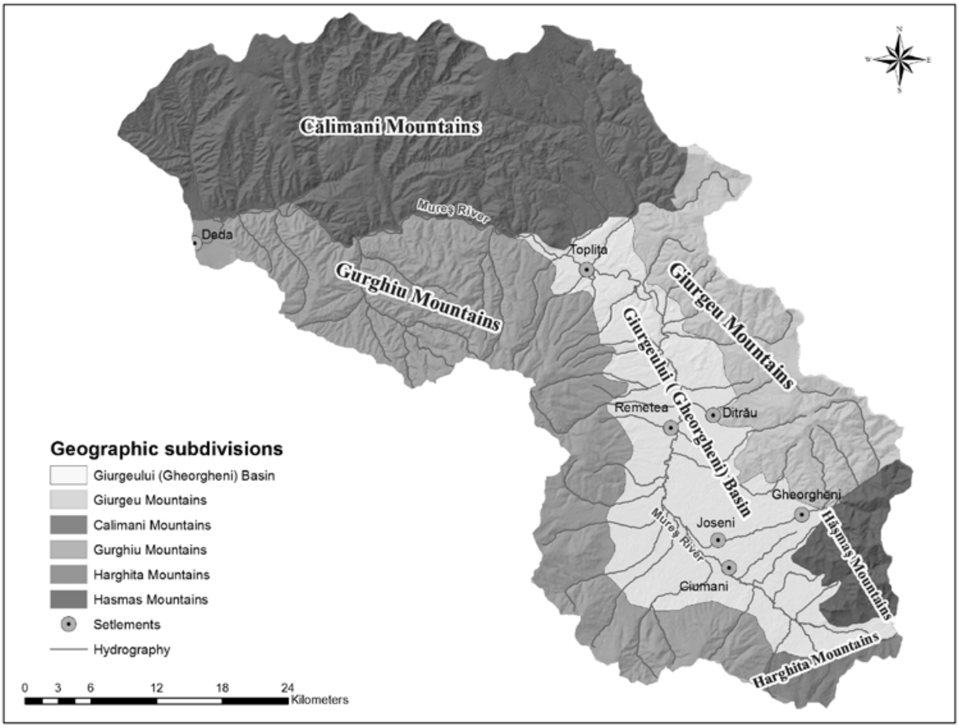

Fig.1. ***Geographic subdivisions of the Mureş River upper basin.***

Identifying the validity areas of the $q = f(H_m)$ relation allowed the evaluation of the average annual flow in the main tributaries and geographical units. The correlation between the specific discharge values and the studied stations controlled catchments mean altitude allowed the identification of three validity curves (Fig. 2).

Table.1. ***Multiannual average runoff database (1986-2008)***

River	Hydrometric station	Surface (km^2)	Mean Altitude (m)	$Q_{med..}$ (m^3/s)	q ($l/s.km^2$)	V ($mil.m^3$)	Y (mm)
Belcina	Gheorgheni	94	1115	1.013	10.766	31.970	340.1
Topliţa	Topliţa	215	1149	2.893	13.455	91.303	424.7
Răstoliţa	Răstoliţa	163	1174	3.289	20.178	103.800	636.8
Bistra	Bistra	92	1104	2.377	25.837	75.018	815.4
Mureş	Suseni	160	987	0.963	6.018	30.392	189.9
Mureş	Topliţa	1171	935	6.717	5.736	211.988	181.0
Mureş	Stânceni	1532	967	14.143	9.231	446.353	291.3
Mureş	Gălăoaia	2135	988	23.665	11.084	746.867	349.8

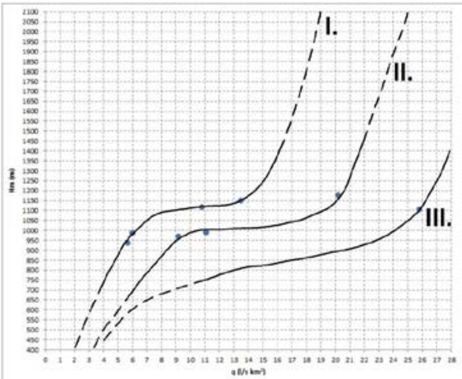

Fig. 2. ***Correlation between specific average discharge values (q) and catchment mean altitude***

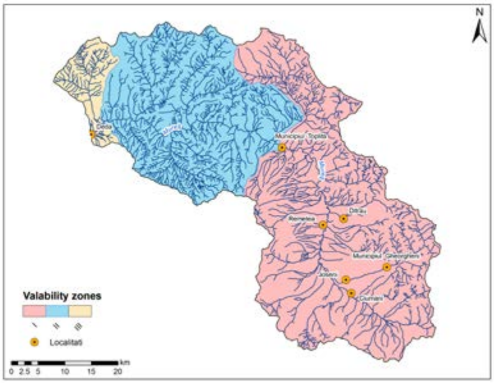

Fig. 3. ***Validity areas of the q=f(H_m) correlation***

To the identified correlation curves in the study area we identified three corresponding validity areas in which the average runoff increases differently with altitude (Fig. 3).

Based on the correlation curves we determined the average specific runoff values for each validity area of the q = f (H_m) function (Table. 2).

The lowest gradients between 0.28 and 0.50 $l/s.km^2$ are met in the Giurgeu Depression and the adjacent mountain area and also in the eastern extremity of the Căliman Mountains on which is superimposed the Topliţa River basin. The mentioned area is in an "aerodynamic shadow" of the western high mountain ridges, rainfall adverse descending movements are in action and are frequent and intense the thermal inversions.

The second area, with moderate gradients, includes the rivers which spring from the Căliman Mountains, which are tributaries to the Mureş between Bistrita and Topliţa (Zebrac, Ilva, Răstoliţa, Iodine and Gălăoaia) and also those that drain the northern part of the Gurghiu Mountains (Gudea Mare, Sălard, Borzia).

Table. 2. ***Average specific runoff distribution on altitude intervals in the validity areas of the q = f (H_m) function***

Altitude interval (m)	q=f(H_m) validity zones			Altitude interval (m)	q=f(H_m) validity zones		
	I	II	III		I	II	III
400-450	-	-	4.25	1050-1100	7.40	19.00	26.25
450-500	2.40	3.75	4.85	1100-1150	11.15	20.25	26.95
500-550	2.68	4.05	5.60	1150-1200	14.95	21.40	27.40
550-600	3.03	4.35	6.50	1200-1300	16.00	22.05	27.80
600-650	3.39	4.65	7.75	1300-1400	16.60	22.60	28.15
650-700	3.68	5.03	9.75	1400-1500	17.03	23.05	28.50
700-750	4.03	5.45	12.50	1500-1600	17.43	23.40	-
750-800	4.38	5.90	15.50	1600-1700	17.80	23.80	-
800-850	4.75	6.45	19.00	1700-1800	18.20	24.25	-
850-900	5.17	7.13	22.00	1800-1900	18.50	24.70	-
900-950	5.58	8.00	23.75	1900-2000	18.75	25.10	-
950-1000	6.03	13.00	24.90	2000-2067	18.95	25.20	-
1000-1050	6.53	18.00	25.55				

The third area with the highest runoff gradients overlaps the western extremity of the Căliman Mountains, which corresponds to the Bistra catchment and has a favorable exposure to the western humid air masses advection.

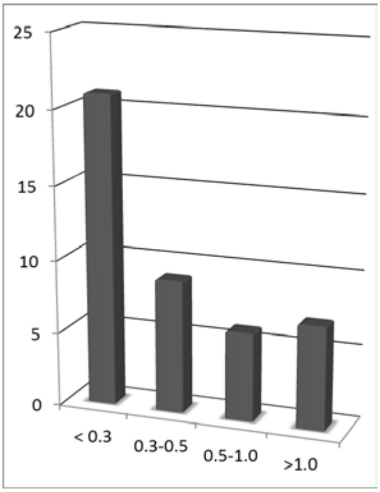

Fig.4. ***Number of streams based on annual average flow (m^3/s)***

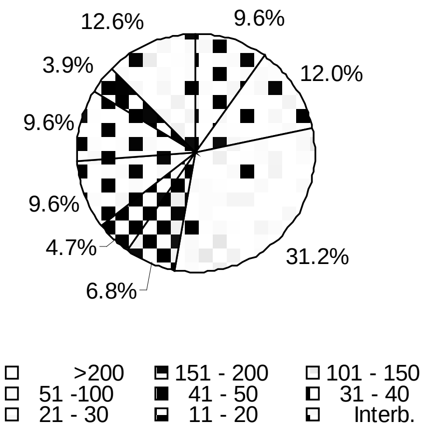

Fig.5 ***Different tributaries catchment size weight in the Mureş River***

Knowing the average specific discharge values and the areas corresponding to each altitudinal interval from the validity zones of the relationship q = f(H_m) we computed at the basins, sub-basins and geographical units level the main indicators of the water resources (discharge, volume and runoff).

2. MULTIANNUAL RUNOFF DISTRIBUTION

The spatial distribution was analyzed at catchment level (over 10 km^2) and on geographical subunits. On the mentioned areas we also analyzed the distribution of water resources on altitude intervals.

2.1. Average runoff potential spatial distribution at catchment level

The total discharge collected from the studied region it was estimated at 25.1 m^3/s. The majority of streams have low runoff due to limited catchment size and small discharge gradients. So, only seven tributaries have discharge values over 1 m^3/s in contrast with 21 rivers that have runoff values lower of 0.3 m^3/s.

Rivers with significant catchment sizes developed in areas with large discharge gradients have an important weight in the total water volume transported by the Mureş River (Figure 4). Significant water volumes are transported by the rivers with basin areas between 100 and 150 km^2, which represents 31.2% of the total volume (Figure 5).

Table.3. Average annual runoff potential of Mureş tributaries in the Giurgeu Depression

Hydrographic basin	Area (km^2)	Q (m^3/s)	q l/s.km^2	V (mil.m^3)	Y (mm)
Topliţa	215.5	2.4	11.2	76.2	353.6
Călimănel	62.4	0.7	10.6	20.8	334.0
Mermezeu	12.5	0.1	11.1	4.4	351.5
Gudea Mare	48.5	0.8	16.5	25.2	520.9
Zebrac	23.4	0.3	12.9	9.5	408.1
Ilva Total	125.8	2.3	18.7	74.0	588.2
Salard	126.8	1.9	15.2	60.8	479.6
Rastolita	168.4	3.0	18.0	95.5	566.9
Iod	28.1	0.4	14.0	12.4	440.4
Galaoaia	35.5	0.6	15.7	17.6	496.2

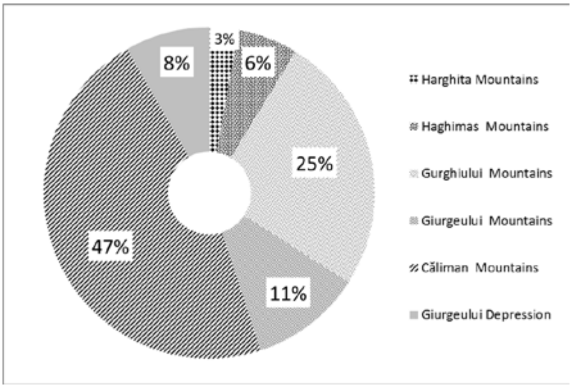

Fig.6. ***Geographical units' contribution in % to the average runoff potential in the upper basin of the Mures River***

Mureş River discharge increases from 0.963 m^3/s at Suseni to 6.717 m^3/s at Topliţa section. The increased runoff values are due to the tributaries contributions which descend from the Giurgeu Depression bordering mountain region (Table 3).

At the defile gauge the discharge values increase because of the tributaries which originate in the Căliman and Gurghiu Mountains (Table 3).

2.2. Geographic subunits average runoff potential spatial distribution

Depending on the occupied area and the humidity, the runoff potential is different from a geographical unit to another (Figure 6).

From the total estimated volume about half comes from the Călimani Mountains (47%), where the runoff gradients have very high values, this is followed by the Gurghiului Mountains where a quarter of the assessed water is generated, this is due to the significant area which the subunit represents in the studied region.

Table 5. ***Mures River upper basin geographical subunits' average runoff values***

Geographic subunit	Average runoff				% of total runoff
	Q	q	V	Y	
	(m^3/s)	($l/s.km^2$)	(mil. m^3)	(mm)	
Harghita Mountains	0.716	9.09	22.58	286.7	2.8
Hăşmaş Mountains	1.484	11.52	46.80	363.4	5.9
Gurghiului Mountains	6.367	12.33	200.78	388.8	25.3
Giurgeului Mountains	2.748	10.33	86.66	325.9	10.9
Căliman Mountains	11.755	21.88	370.71	690.0	46.7
Giurgeului Depression	2.082	4.29	65.66	135.3	8.3
Total	25.152	12.50	793.19	394.1	100

The average water layer was evaluated at 335 mm. Compared to this average value appear obvious differences between the major geographic subunits imposed by humidity. Thus, in territories with high humidity (Călimani) the average water layer has significantly higher values than those in the Giurgeu Depression and the adjacent mountain area (Table 5.).

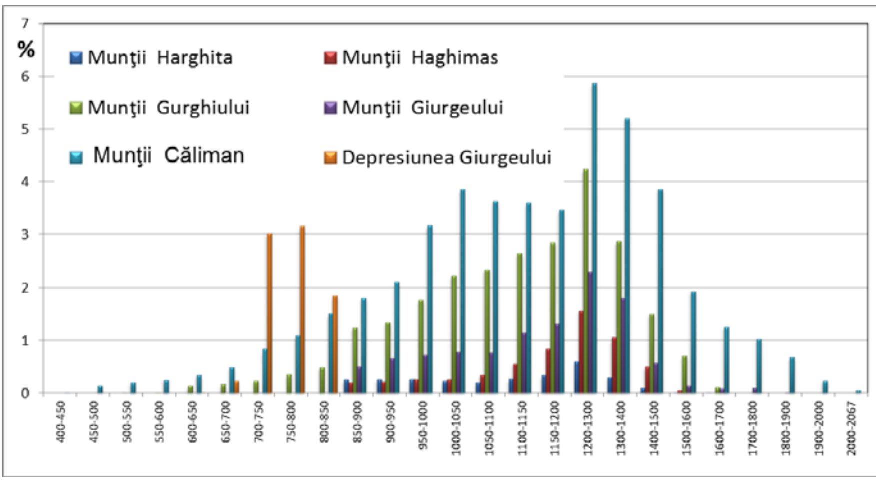

Fig.8. ***Runoff volumes distribution on altitude intervals in the Mureş River upper basin geographical subunits***

Compared to the presented average situation, obvious differences appear imposed by the reliefs altitude. Concomitant increasing of runoff and altitude highlight the different weight of altitudinal intervals in completing the average runoff volume.

Thus, there is a gradual increase in the drained water volume from the lower intervals to the altitude range between 1200 and 1400 m, where the highest volume is achieved, and representing 25.8% of the average runoff in the entire study area (Fig. 8)

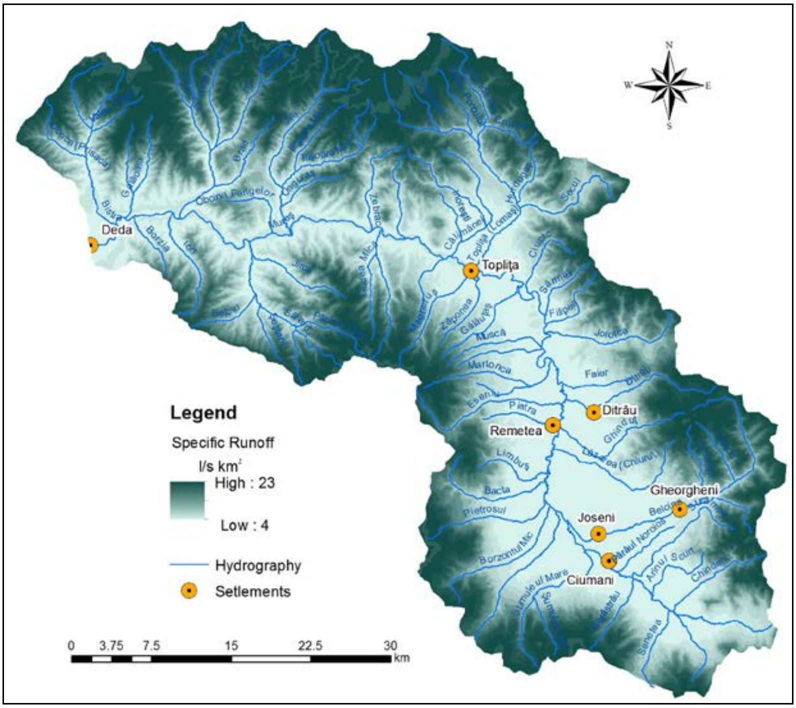

Fig. 9. ***Mureş River upper basin specific runoff***

3. CONCLUSIONS

The average runoff potential distribution analysis on river basins, geographical units and altitude intervals reveals regional differences imposed by morphometric and morphologic features of the landscape and the humidity gradient of the analyzed territories (Fig. 9.). By analyzing the specific runoff map of the Mureş River upper basin, created by integrating the data into the Esri ArcGis software group, we can conclude that the main influencing factor in water resources spatial distribution is the catchment area and indirectly by influencing the humidity gradient, the altitude.

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