UNIVERSITY OF CRAIOVA **Series: Geography**
UNIVERSITATEA DIN CRAIOVA **Seria: Geografie**

Vol. 14 (new series) – 2011
Vol. 14 (serie nouă) – 2011

MAJOR BASINS WITHIN THE DANUBE HYDRO-GEOGRAPHICAL REGION WITHIN BULGARIA

BAZINELE MAJORE DIN REGIUNEA HIDRO-GEOGRAFICA BULGĂREASCĂ

Nelly HRISTOVA [1]

Abstract: The present paper discusses the division of some sub-basins in the Danube River Basin Directorate. It proposes the division of the main river basin the Ogosta and the rivers west of the Ogosta and the unification of the catchment of the Erma and the Nishava River in a major river basin. This suggestion is based on the similarity of natural features, hydrographic and hydrological parameters and typification of water bodies according to UE Water Framework Directive. The result will be a better water management in these river basins.

Key-words: the Danube River Basin Directorate, major basins, hydrographic and hydrological parameters
Cuvinte cheie: Administraţia Bazinală a Fluviului Dunărea, bazine principale, parametrii hidrografici şi hidrologici

Introduction

EU Water Framework Directive (2000/60) establishes a single classification of surface water system for the first time. It separates the aquatic ecosystems in several groups arranged in strict subordination: eco-regions, categories water ecosystems (river, lake, coastal waters and transitional water), types of water ecosystem, water bodies – unit for assessment and management of waters. Meanwhile, at the core of the Directive is an integrated approach for sustainable water management in the river basin. According to Water Framework Directive, the EU member states have to identify all the river basins lying within their territory and assign them to individual river basins. For the management of the water basin, 4 Basin Directorates were established by the Ministry of Environment and Water in 2002-2003 – Danube district, Black Sea district, East Aegean district, West Aegean district. The Danube River Basin Directorate coincides with the Danube hydro-geographical region and covers 47,235 sqkm (42.5% of Bulgaria). It includes the catchment areas of the tributaries of the Danube River. There are 15

[1] Sofia University St. Kliment Ohridski, Faculty of Geology and Geography, Bulgaria

tributaries of the Danube on the territory of Bulgaria. Fourteen rivers flow into the Danube directly. The Nishava River is a tributary of the Juzna Morava. The Danube Dobrudja Rivers, which have surface runoff in their upper sections, flow into the main river in the underground. Each of the tributaries forms its own river system and can be regarded as the main river in the Danube hydro-geographical region. The River Basin Management Plan (2003, 2010) identifies nine major river basins into the Danube drainage area without any criteria. This division does not correspond to the natural differentiation and to the scientific investigations, published in Hydrological Atlas of Bulgaria (1964).

This work proposes the division of the river basin "Ogosta and rivers west from the Ogosta" and the unification of the basins of the Erma and the Nishava rivers. This idea is based on complex parameters: hydrographic characteristics, river regime, annual river discharge, number of water bodies, dominant flowing water types, use of water resources.

Data and methods

In the hydrological literature of Bulgaria there are not strict rules or scientific methodology for defining the major river basins. The only differentiation, published in Hydrological Atlas of Bulgaria (1964), used is the size of the catchment area. Thus, in the Danube hydro-geographical region there are identified nine major river basins – the Lom, the Ogosta, the Iskar, the Vit, the Osam, the Yantra, the Russenski Lom, the Danube Dobrudja Rivers and the Nishava. The other three tributaries - the Topolovets, the Tsibritsa and the Skat, are defined as watersheds of the first rank with catchment areas above 500 sqkm. The Voinishka, the Vidbol, the Archar and the Skomlja rivers have not been included in any category. Sarafska (2000) uses the catchment area (the length of the river) for the hydrographic classification and proposes six categories (extra small - up to 10 sqkm and up to 20 sqkm, small – L = 10.1 - 20.0 km, F = 20.1 - 100.0 sqkm, medium – L = 20.1 - 50.0 km, F = 100.1 - 500.0 sqkm, medium-large – L = 50.1 - 100.0 km, F = 500.1 – 2,000.0 sqkm, large – L = 100.1 - 200.0 km, F = 2000.1 – 10 000.0 sqkm, extra large (L above 200.0 km, F above 10,000.0 sqkm) for scientific investigation and three categories for simple usage. The parameters for the characterization of the flowing water types using System A according to WFD are: Altitude (high > 800 m, mid-altitude – 200 - 800 m, lowland < 200 m), Catchment area (small: 10 – 100 sqkm, medium: 100 – 1,000 sqkm; big 1,000 – 10,000 sqkm; very big 10,000 sqkm) and Geology (calcareous, siliceous, organic). This classification refers to the water bodies, which are defined for each river, but this work will use it for the classification of major rivers. So, the size of watershed is the first mark for establishing major river basins. The mean annual stream flow and water regime are important hydrological characteristics and they are the next sign for differentiation in this work. The type of stream flow regime for Bulgaria is defined by Hristova (2004) and this work will use it. Arguments for the proposed changes in the definition of major river basins are flowing water types, specified in the River Basin Management Plan (2010) and prevalent type of water consumption.

Discussions

There are more than 500 streams in the Danube river basin in Bulgaria. The density of the river network is between 0.1 (Dobrudja) and more than 3.0 km/sqkm (in the alpine region, above 1800-2000 m). The highest density of the river system from Bulgaria is reached in the West Balkan Mountains - 3.8 km/sqkm. The tributaries of the Danube collect their water from the northern slopes of the Balkan Mountains and Predbalkan. There are some exceptions: the Iskar, springing from Rila and the tributaries from the mountains in southern Bulgaria; the Danube Dobrudja Rivers start from the high plateaus and descend into dry river valleys. The proximity of the Balkan Mountains to the Danube is not conducive to the formation of 'extra-large' watersheds. According to length, the Iskar, the Osam and the Yantra, are extra-large rivers, but they are 'medium-large' according to the surface of their catchment (Table 1). The reason for this peculiarity is the meandering of these rivers - curvature coefficient is 3.1. Category 'large' according to both parameters, includes the Ogosta, the Vit, and the Rusenski Lom. 'Medium' category corresponds to the rivers in northwest of the Danube drainage area. The Topolovets River is 'medium' according to length and 'medium-large' according to the catchment area. According to System A of WFD, the watersheds are of two types – medium and big (Table 1).

In Bulgaria, there were identified 34 types of water bodies, of which 12 types are to be found in the Danube catchment area (Table 2). The types of surface waters are determined by system - B (under Annex II 1.2.1 category of surface water rivers) of EU Water Framework Directive. Most rivers are of type 'small and medium karst rivers', 'foothill stone rivers' and 'small and medium gravel-sandy rivers' (Table 2).

The major river basins in the Danube drainage area according to River Basin Management Plan (2002) are the Ogosta and the rivers west of the Ogosta, the Iskar, the Vit, the Osam, the Yantra, the Russenski Lom, the Nishava, the Erma, the Danube Dobrudja Rivers and the Danube River (Fig. 1). The major river basin – the Ogosta river and the rivers west of the Ogosta, have a total area of 8,022 sqkm. It includes eight tributaries of the Danube. This paper proposes the division of this main catchment in three major watersheds – North-west Rivers, the Lom River and the Ogosta River.

The basin *North-west Rivers* covers an area 1,717.3 sqkm and includes the Topolovets, the Voinishka, the Vidbol, the Archar and the Skomlia rivers. All streams spring from the West Balkan Mountains and run from south-west to north-east. The rivers are 'medium' according to length and catchment area. The density of the river network is below 1 km/sqkm, altitude – under 1,000 m. All sub-basins in this catchment area have similar natural conditions and river regime (Fig. 1).

Table 1

Classification of Danube tributaries according to length and catchment area

River	Length (*L*), km	Area (*F*), (km^2)	Category according to length and catchment area (Sarafska, 2000)	Category according to System *A*, WFD
Topolovets	67.6	582.8	medium *L*/medium-large *F*	medium
Voinishka	55.2	276.5	medium	medium
Vidbol	61.8	329.8	medium	medium
Archar	59.4	365.4	medium	medium
Skomlja	41.6	162.8	medium	medium
Lom	92.5	1139.8	medium *L*/medium-large *F*	big
Tsibritsa	87.5	933.6	medium *L*/ medium-large *F*	medium
Ogosta	144.1	3157.1	large	big
Skat	134.0	1074.1	large *L*/medium-large *F*	big
Iskar	368.0	8642.2	extra large L/ large *F*	big
Vit	188.6	3225.0	large	big
Osam	314.0	2824.1	extra large *L*/ large *F*	big
Yantra	285.5	7861.6	extra large *L*/ large *F*	big
Rusenski Lom	196.9	2946.9	large	big
Nishava	40.0	1137.1	Medium *L*/medium large *F*	medium

All the rivers belong to the continental type of river regime, second below type (Hristova, 2004). The period with high waters is from February till June, the period of low waters – from July till October (about 100-140 days). November, December and January are months with transitional river flow. Maximum flow is 32.5 (the Archar) – 53.7 m^3/s (the Topolovets), minimum flow is between 0.022 – 0.076 m^3/s (Bulgarischen Donauzuflusse, 1994). There are identified three flowing water types - small and medium loess rivers, small and medium karst rivers (62% of the total number bodies), small and medium gravel-sandy rivers (River Basin Management Plan, 2010). This typification improves the similarity in geology of the sub-basins and is a good argument for the differentiation of this basin like major

basin. Water resources are about 200.10^6 m^3. The coefficient of variation is the biggest in the Danube hydro-geographical region. It is between 0.38 (the Skomlj River) and 0.52 (the Topolovets River). There are two irrigation systems and some small dams in this basin. The greatest water consumer is households.

Table 2

Flowing water types

Name of type	Number of water bodies	Total length of water bodies (km)
Big karst rivers	6	406.35
Big gravel-sandy rivers	2	319.31
Small and medium sandy rivers	5	126.41
Very big sandy rivers	1	650.65
Big loess rivers	6	161.56
Small and medium loess rivers	11	223.66
Foothill stone rivers	22	938.436
Temporary rivers	10	481.41
Small and medium karst rivers	35	1595.53
Gravel-sandy rivers	1	245.89
Small and medium gravel-sandy rivers	22	1440.17
Mountain rivers	2	100.41
Total	**123**	**6689.77**

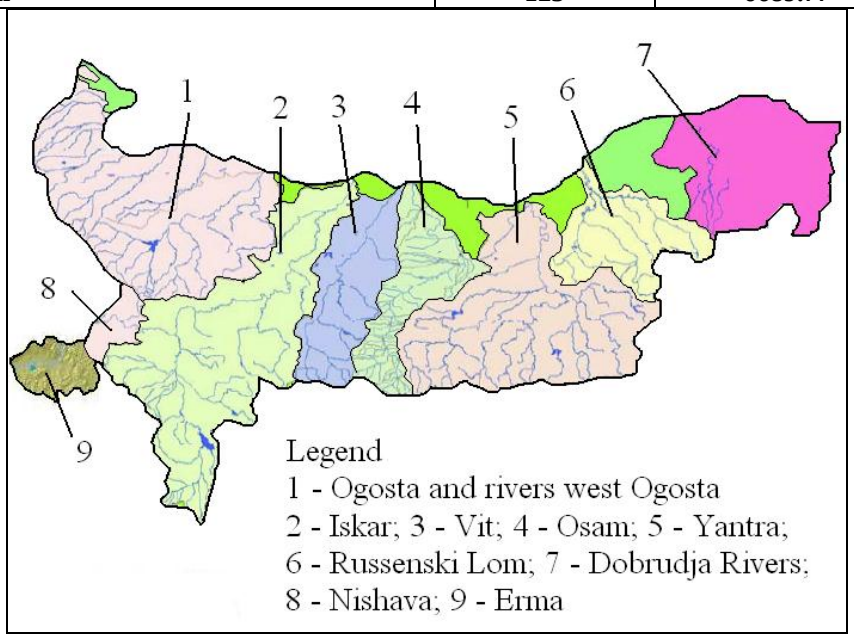

Figure 1. Major rivers in the Danube River Basin District (*source: River Basin Management Plan, 2002*)

The Lom river basin covers an area 2,073.4 sqkm. It includes the Lom River and the Tsibritsa River, which are 'medium' according to length and 'medium-large' according to area. The Lom River springs from the Balkan Mountains, while the Tsibritsa River – from Predbalkan. The density of the river network is between 0.2 and 2.0 km/sqkm. The altitude of the Lom River basin is above 1,000 m; the Tsibritsa River basin is located at mid-altitude and lowland. Both rivers have similar hydrological regime in their lower stream (Fig. 2).

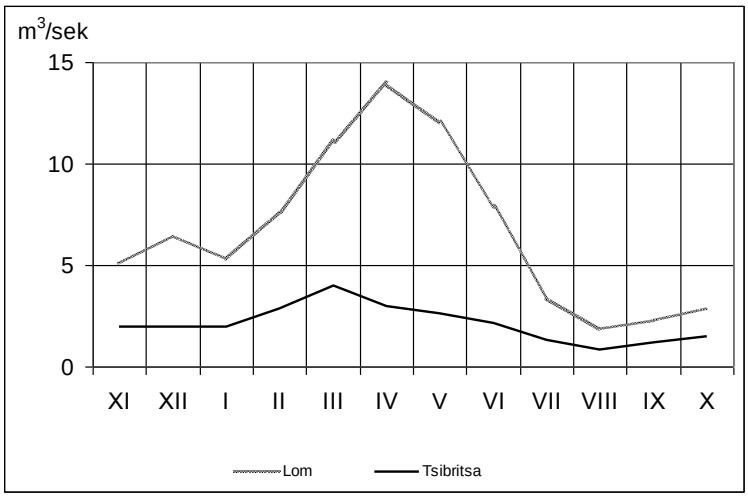

Figure 2. River regime of the Lom River and the Tsibtritsa River

The periods with high waters in the upper stream of the Lom River appears in spring (March – June) and in autumn (November – December). The low flow is typical for summer (July – October) and for winter (January – February). The duration of this period for the Tsibritsa River is 76 – 100 days. The maximum flow is 36.5 (the Tsibritsa) – 170.0 m^3/s (the Lom), while minimum flow is 0.25 m^3/s (Limnologie der Bulgarischen Donauzuflusse, 1994).

There are three flowing water types in this basin - big loess rivers, small and medium loess rivers, small and medium gravel-sandy rivers (River Basin Management Plan, 2010). Loess rivers are dominant.

Water resources are 300.10^6 m^3. The coefficient of variation is 0.32 for the Lom River and 0.40 for the Tsibrista River. In the upper Lom river and its tributaries, there are constructed many small HPS on the fluent water. In the lower basin of the Lom River, there are built irrigation systems. There is not a seizure of water in the Tsibritsa River. The domestic water supply is prevalent.

The Ogosta river basin includes the Ogosta River and the Skat River. The Skat River, after correction in the lower reaches, flows into the Ogosta. This is why both rivers were accepted as one basin. The watershed covers an area 4,231 sqkm. Both rivers are 'large' according to length, but the Ogosta River is 'large' according to the catchment area, while the Skat is 'medium – large' (Table 1). The

density of the river network is between 0.2 and 3.5 km/sqkm. The river system of the Ogosta is composed of a large number of tributaries. Its regime is of continental type (Fig. 3). The high waters are registered in five months (February - June), low waters – four months (July – October), transitional waters – 3 months (November - December). Monthly maximum runoff is in May for the Ogosta River and in March for the Skat River. The maximum flow is 365 (the Ogosta) – 38.5 m^3/s (the Skat), while the minimum flow is between 1.48 and 0.24 m^3/s (Limnologie der Bulgarischen Donauzuflusse, 1994).

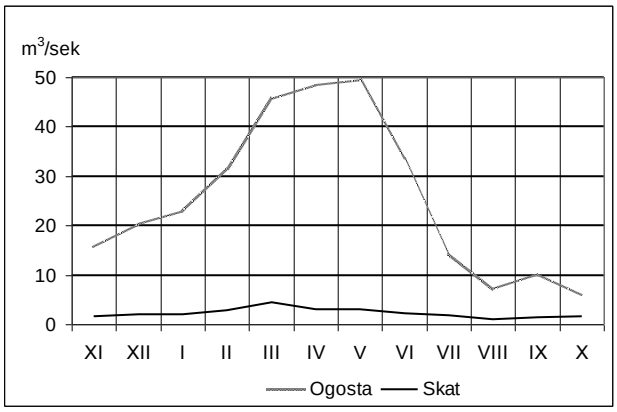

Figure 3. River regime of the Ogosta River and the Skat River (in lower stream)

This major basin includes 14 water bodies with a total length of 753.2 km. Small and medium gravel-sandy rivers (50% of total number) and small and medium sandy rivers (36%) are dominant. The water resources of the Ogosta river basin are 740 million m^3. Their coefficient of variation is 0.46. There are 14 irrigation systems, 8 hydropower plants and more the 50 dams within the catchment. In the upper reaches of the Ogosta is the largest hydropower cascade in Northern Bulgaria – 'Petrohan' (16 MW). Industry and the domestic water supply are prelevant.

The Nishava river basin separates Bulgaria from Serbia. The catchment area is 1137.1 sqkm. It is situated in the western periphery of Bulgaria. The River Basin Management Plan (2002) defines two major basins – the Nishava River and the Erma River. It is known that the Erma River is a tributary of the Nishava River, like the Gaberska River and the Visochka River (Fig. 4). The major river and its tributaries – the Edrma, the Gaberska and the Visochka are cross-border rivers. We propose the Erma and the Nishava to be one sub-basin in the Danube river basin directorate, in view of their natural connection.

The Nishava basin is medium large according to area (Table 1). The density of the river network is 1.09 km/sqkm and varies between 0.85 and 1.30 km/sqkm. There are some karst areas in the Nishava catchment. The river basin is high (above 800 m) and mid-altitude.

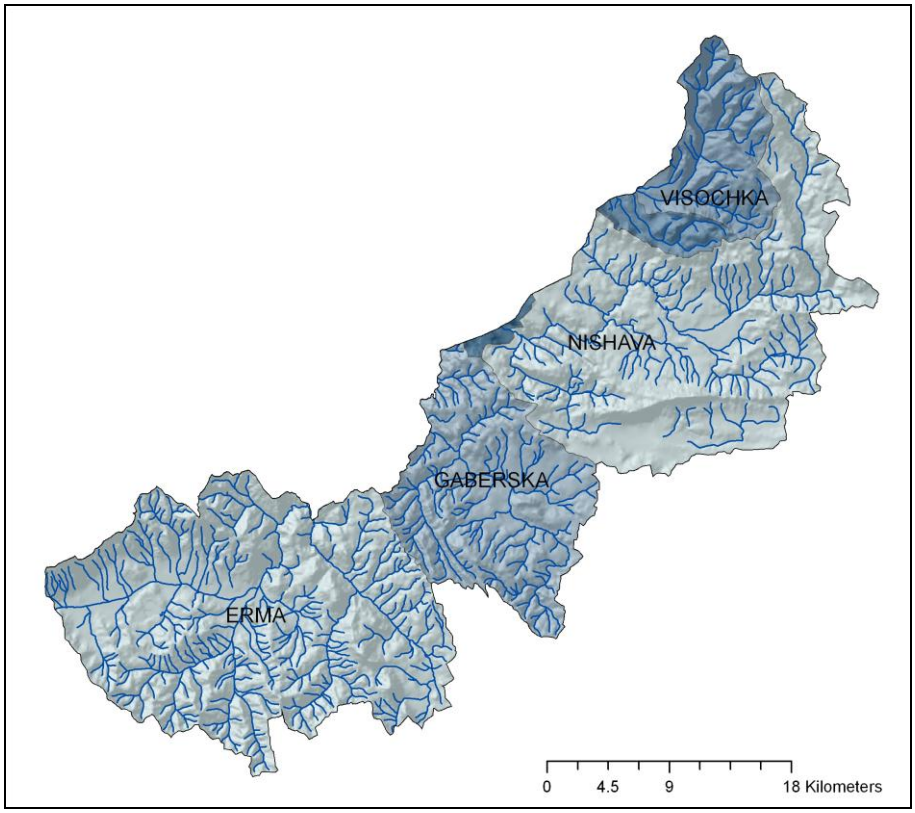

Figure 4. Scheme of the Nishava river basin

The river regime includes a short period of high water (April – June) and a long period with low water (July – October and January – March) in the mountainous basin. The maximum of monthly stream flow appears in March.

The River Basin Management Plan (2002) identified only two water bodies and defines two flowing type of rivers - foothill stone rivers for the Erma and small and medium karst rivers – for the Nishava. There is not a typification for other tributaries of the major rives in the management plan.

The water resources of the Nishava river basin are 173 million m^3. The coefficient of variation – 0.19 – 0.37, shows small fluctuations for the mountainous rivers and big fluctuations for the the lower courses of the Erma and the Nisava. The domestic water supply is prevalent.

Conclusion

The division of the river basin "the Ogosta and the rivers west of the Ogosta into three major basins, as well as the unification of the Erma and the Nishava will be better for the integrate management of water resources and will enable a more equitable distribution of river waters between water users. The Danube River Basin Directorate in Bulgaria has to use more results of scientific research and results.

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