

**Government of the Republic of Serbia  
Ministry of Agriculture and Environmental Protection**

**DRAFT**

**WATER MANAGEMENT STRATEGY FOR THE  
TERRITORY OF THE REPUBLIC OF SERBIA**

**The "Jaroslav Černi" Water Management Institute  
of Belgrade**

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# 1. INTRODUCTION

The analyses and research for drafting the Water Management Strategy for the territory of the Republic of Serbia (hereinafter: the Strategy) have been performed on the basis of the Law on Water (LOW) (Official Gazette of the RS nos. 30/10 and 93/12) and relevant by-laws. The Strategy represents a unique planning document which outlines the course of long-term water management on the territory of the Republic of Serbia. According to the previous Law on Water (Official Gazette of the RS, no. 46/91), the strategic and planning document was the water management basis for the Republic of Serbia which, under Article 9 of that law, represented "long-term planning for the maintenance and development of water regimes on the territory of the Republic of Serbia in one or more water areas or parts of water areas." Therefore, adopting the Strategy will ensure the continuity of long-term planning regarding the function of water sectors, according to the principle of sustainable development, and/or performing water services in its basic fields (waters regulation, water use, protecting water from pollution and waterway regulation and protecting against the harmful effects of waters) as well as institutions and other work and activities required for operation and development (funding, monitoring, etc.).

In light of their nature and importance, the Strategy and other strategic documents and schemes at the federal level (in the fields of spatial planning, sustainable development, the sustainable use of natural resources and goods, environmental protection, and many others as well) must be coordinated with one another. In the process of adopting the Strategy it is mandatory to draw up a strategic EIA, in accordance with regulations governing environmental protection (Article 37 of the Law on Water).

The Strategy is a document which represents the basis of which the water sector will be reformed in order to achieve the required standards for water management, including organisational adaptation and systemic strengthening of professional and institutional capacities at the national, regional and local levels. Strategic orientations and objectives laid down in this document represent the grounds for drawing up a Plan for water management in the Danube River Basin on the territory of the Republic of Serbia and water management plans in water areas, as well as for drawing up proposals for the amendment of the Law on Water, including the funding aspect. At the same time, frameworks outlined in this Strategy must be addressed when strategies and plans for spatial arrangement, environmental protection and other fields which dependant on waters or which have an impact on water are drafted.

The Strategy has been adopted by the Government at the proposal of the ministry competent for water management – the Ministry of Agriculture and Environmental Protection (hereinafter: the Ministry).

The Strategy has been adopted for the period of at least ten years. After a period of six years from adoption has passed, the solutions laid down in the Strategy will be reviewed and, where necessary, amended, and existing groundwork will be updated. Strategy implementation is monitored by the Ministry which, insofar as circumstances critically change, shall propose that it be reviewed and harmonised prior to the expiry of the six year period.

Research for the purposes of the Strategy has been conducted in accordance with the general content defined in Article 30 of the Law on Water and primarily includes:

- evaluation of the current state of water management,
- objectives and orientations for water management,
- water management development projections,
- measures for the achievement of assigned objectives of water management.

Analyses and development projections cover a period of twenty years, i.e. until 2034. It is expected that within this period there should be a significant improvement of conditions in the water sector in comparison to its present state. This improvement will take place in accordance with the social and economic possibilities of the state, subject to EU standards in the field of water. Based on the evaluation of the current state, it can be concluded that a twenty-year period is not a sufficient amount of time in which to achieve standards applicable to EU member states. The highest level of compatibility is expected in water services relating to the use of water for human consumption, whereby a period longer than twenty years will be required to achieve the prescribed standards in water protection.

The observed period of twenty years is a very long period with respect to predicting socio-political, economic, fiscal and other operating conditions and framework projections at the federal level are non-existent. Macroeconomic projections in the growth of gross domestic product and the growth of investments in the Republic of Serbia, on the basis of which development has been planned, exist for a ten-year period. Activities to be realized within this ten-year period are therefore presented in this document in more detail, and for the later period are presented in more general terms.

Research and analyses conducted for the drafting of this Strategy were conducted at the "Jaroslav Černi" Water Management Institute (or IJC), and involved experts from other institutions as well as numerous others. All relevant groundwork, planning and regulatory documentation, studies, as well as strategic and other documentation relevant to water management on the territory of the Republic of Serbia have been used, and expert evaluations have been performed in the absence of valid groundwork and documentation. The period of processing is not uniform for all analysed parameters and is dependent on their nature. 2012 was the last year covered by analyses; however, the Strategy also includes the latest data and know-how, which are of special importance for this document.

In this Strategy, the Autonomous Province of Kosovo and Metohija <sup>1</sup> is addressed only in the chapters relating to natural characteristics, that is, in domains with available data from previous periods.

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<sup>1</sup> Kosovo and Metohija is an autonomous province in the Republic of Serbia and by virtue of UN Security Council Resolution 1244 of 10 June 1990 it is under the interim civil and military administration of the UN

## **2. NATURAL AND SOCIO-ECONOMIC FACTORS**

### **2.1. NATURAL FACTORS**

#### **2.1.1. Geographical location and relief**

The territory of Serbia is approximately located between 41° 53' and 46° 11' north latitude and 18° 49' and 23° 00' east longitude. The territory, which covers a surface area of 88 509 km<sup>2</sup>, includes various relief types, starting from extensive plains in the north to upland areas intersected by river valleys towards the south, and finally to mountainous areas in western, southern and eastern circumferential areas.

From the south, the Republic is surrounded by a mountain belt, the altitude of which decreases from west to east: The Šar Mountains (2,764 m), Skopska Crna Gora (1,651 m) and Mount Široka (1,352 m). The slopes of Prokletije with Đeravica are in the west (2,656 m), as well as Mokra Gora (1,344 m), Kamena Glava (1,463 m), Zlatar (1,827 m), Zlatibor (1,496 m), Tara (1,391 m), Povlen (1,346 m) and Jagodnja (940 m), while in the east the Dukat mountains are found (1,829 m), Čemernik (1,638 m) and Stara Planina, with Midžor's peak (2,169 m).

Map 1 shows the main relief features of the Republic of Serbia, with basic administrative divisions (Geographical location).

#### **2.1.2. Climate and meteorological characteristics**

The majority of Serbia's climate is moderate. The south-western area borders with Mediterranean and continental climates. Mountain ranges surrounding this area are intersected by river valleys which cause climate modifications, both the Mediterranean (from the west) and continental climate (from the north and east).

Moderate continental climate, with warm summers and cold winters and an annual average variation of temperature exceeding 22 °C (January-July), occurs in the northern and central plains of Serbia. Alpine climate occurs on middle and high mountains.

Basic climate characteristics (temperature and relative air humidity, precipitation and evaporation) are shown based on the results of measurements taken by the Republic Hydro-meteorological Service of Serbia (RHSS), i.e. a completed time series of monthly meteorological data from 1946 to 2006.

##### **Air temperature**

Figure 1 shows the spatial sequence of average multiannual values of air temperature in Serbia.

In the north, annual air temperatures range from 10.8 °C to 11.5 °C, and in the plains of Central and Southern Serbia from 10 °C to 12.1 °C. Mountainous areas have lower temperatures. Medium annual temperatures linearly decrease with greater altitudes, with a vertical gradient of -0,6 °C/100 m.

Climatology stations in Serbia have registered the lowest air temperatures recorded as follows: Sjenica -38,0 °C, Negotin -33,2 °C, Smederevska Palanka and Vršac -32,6 °C, Kraljevo -31,7 °C, Vlasina -31,2 °C, Jaša Tomić -31,0 °C, Žagubica -30,8 °C, Požega and Rimski Šančevi -30,7 °C, Leskovac -30,5 °C, Babušnica, Kruševac and Šabac -30,0 °C etc. The absolute maximum air temperatures have been recorded at the following stations: Jagodina 43,0 °C, Čuprija, Prokuplje and Zaječar 42,7 °C, Niš and Vlasotince 42,5 °C, Kruševac 42,4 °C, Smederevska Palanka 42,1 °C, Dimitrovgrad, Knjaževac, Leskovac and Negotin 42 °C etc.

## Precipitation

The precipitation regime is very heterogeneous across the territory. The amount of annual precipitation ranges from approximately 500 mm in the north to over 1,000 mm in mountainous regions, while average precipitation in Serbia amounts to approximately 730 mm/y. All lower areas have annual precipitation below 800 mm, while with an increase of altitude comes an increase of the annual amount of precipitation, with a vertical gradient from 25 mm/100 m to 40 mm/100 m.

Figure 2 shows the spatial sequence of precipitation amounts. A general tendency towards a decrease in the amount of rainfall from west to east has been observed. The minimum annual amount of precipitation is registered in the sub-basins of the Južna and Velika Morava rivers, as well as in AP Vojvodina.

Almost the entire Danube Basin receives the greatest amount of rainfall in the period between May and July, and the least amount between January and March. Generally speaking, the month with the highest precipitation is June, and the lowest is in February and March.

In addition to monthly and annual values of precipitation amounts, extreme daily and annual precipitation amounts are also significant, which are registered at the following stations:

- absolutely maximum daily amounts: Rakov Dol 220 mm, Negotin 211.1 mm, Vršac 189.7 mm, Lazarevac 173.6 mm, Vajska 162.4 mm, Jabukovac 162.3 mm;
- maximum annual precipitation amounts: Krnjača 1,884.7 mm, Pleš 1,641.5 mm, Brežde 1,585.1 mm, Lukovo 1,569.5 mm, Počuta 1,506.5 mm.

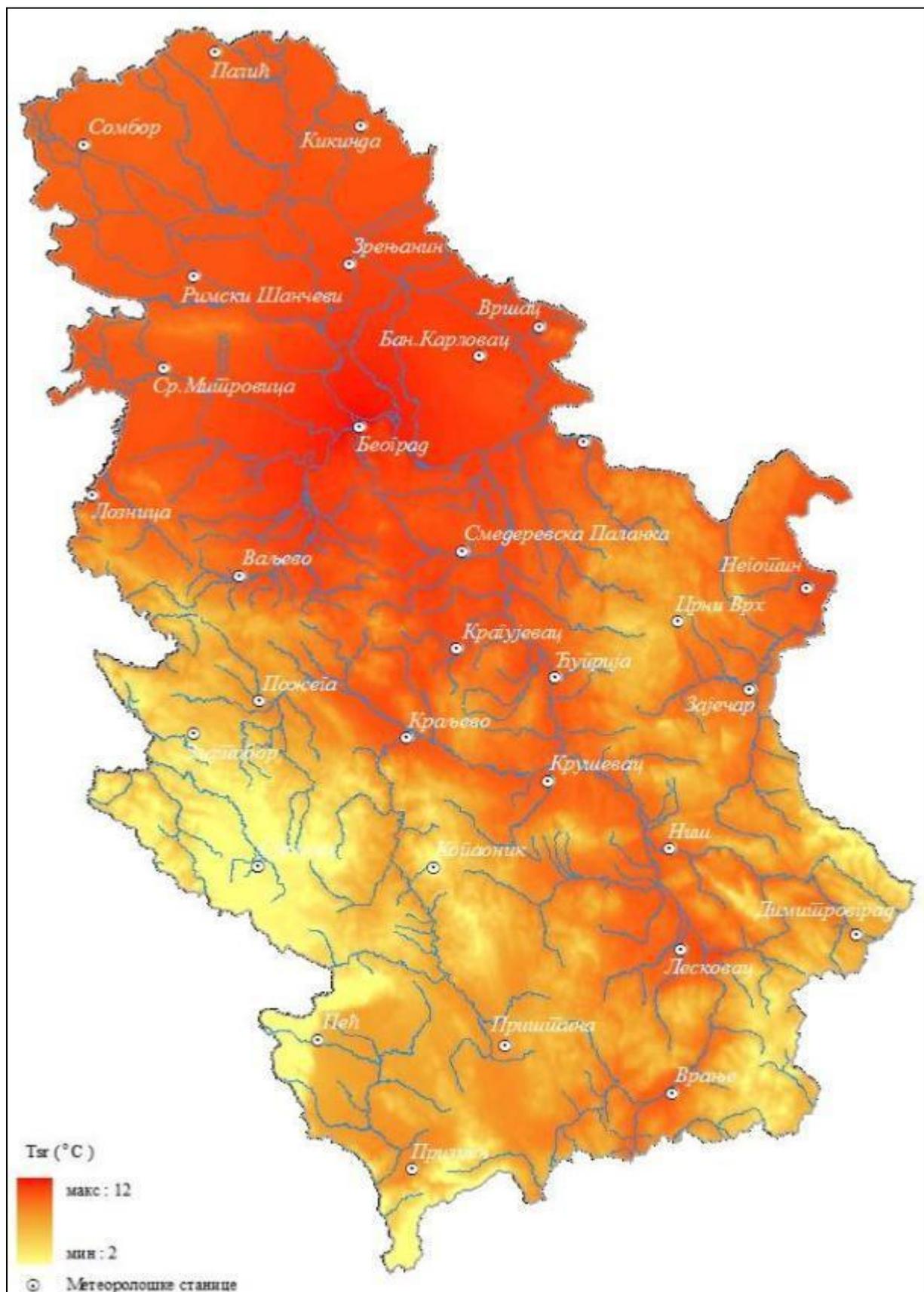


Figure 1: Average multiannual air temperature values

Tsr (°C)

max: 12

min: 2

Meteorological stations

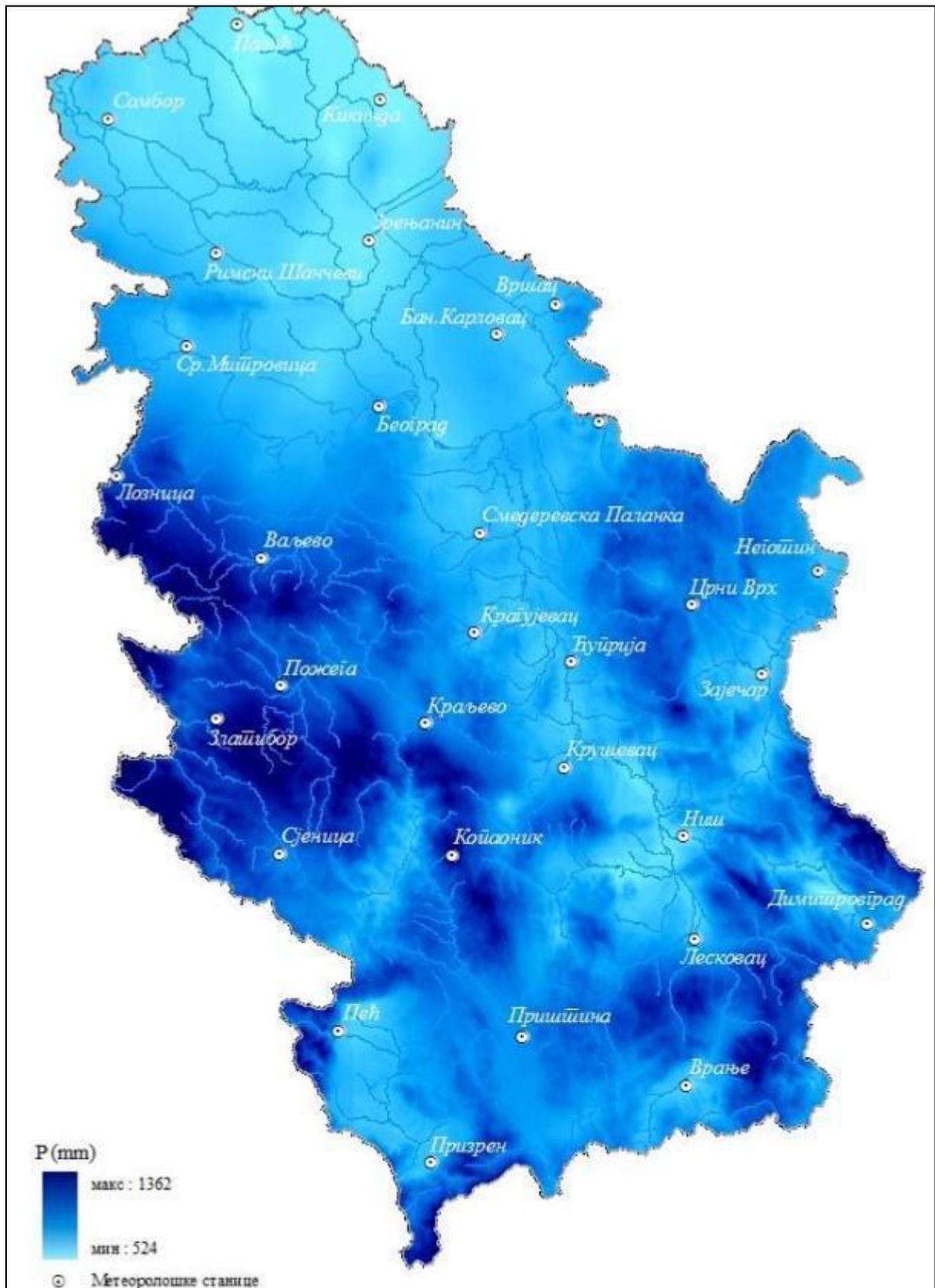


Figure 2: Average multiannual precipitation amounts

P (mm)  
max: 1,362

min: 524

Meteorological stations

### **2.1.3. Surface water**

#### **Hydrographical network and water classification**

##### Basins and sub-basins

In Serbia, waters flow into three seas: the Black Sea (rivers of the Danube Basin), the Adriatic Sea (the Drim and the Plavska Rivers) and the Aegean Sea (the Lepenac, the Pčinja and the Dragovištica).

The largest part of the territory of Serbia belongs to the Black Sea Basin that is, to the Danube Basin (approximately 92%, i.e. approximately 98% excluding Kosovo and Metohija). The Danube River, with the catchment area of approximately 801,463 km<sup>2</sup> and with a medium flux at the confluence into the Black Sea of approximately 6,500 m<sup>3</sup>/s, is the 24th largest river in the world and the second largest river in Europe. It flows from Germany, into the Black Sea on the border areas between Romania and the Ukraine. In Serbia, the Danube enters from Hungary and leaves downwards through the mouth of the Timok, on the border with Romania and Bulgaria. In Serbia, several very important tributaries enter the Danube: The Tisa, the Sava and the Velika Morava, as well as a number of smaller ones.

The southern border of the Black Sea Basin is present in the form of a watershed towards the Aegean Sea Basin, out of which there are parts of the Vardar Basin on the territory of Serbia (the Pčinja, the Lepenac) and the Struma Basin (the Dragovištica), as well as the Adriatic Sea Basin - the Drim Basin (the Beli Drim, the Plavska Rivers).

The largest left tributary is the Tisa (catchment area approximately 157,186 km<sup>2</sup>, in Serbia approximately 10,856 km<sup>2</sup>), which is at the same time the largest Danube tributary according to its total catchment area. It enters Serbia from Hungary, at Banat village Đale, and enters the Danube at Slankamen. Larger left tributaries are the Tamiš, DTD Canal and the Nera. The largest Tisa tributary in Vojvodina is the Begej.

The Sava is the largest Danube tributary (regarding its length and water affluence), which enters the Danube at Belgrade. Its catchment area amounts to 97,713 km<sup>2</sup> (in Serbia approximately 15,147 km<sup>2</sup>). Along its flow through Serbia it meets some important tributaries: the Drina, the Bosut and the Kolubara.

The largest Sava tributary is the Drina, with the total catchment area of 20,320 km<sup>2</sup>, which along its length of 220 km, it represents the border between Bosnia and Herzegovina and Serbia. It enters the Sava at village Crna Bara in Serbia.

The Lim is the largest right tributary of the Drina. It enters the territory of Serbia from Montenegro and leaves it at Priboj, flowing into Bosnia and Herzegovina, where it enters the Drina.

The most important downstream Sava tributary is the Kolubara, which originates from the Obnica and the Jablanica, upstream from Valjevo, and meets the Sava at Obrenovac.

The second largest right Danube tributary is the Velika Morava (approximately 38,207 km<sup>2</sup>), the basin's largest part is in Serbia, with parts in Montenegro and Bulgaria as well. Downstream from the Južna Morava confluence (catchment area approximately 15,696 km<sup>2</sup>) and the Zapadna Morava (catchment area approximately 15,754 km<sup>2</sup>) at Stalać, the Velika Morava meets the tributaries: the Lugomir, the Lepenica, the Jasenica and the Jezava.

The Južna Morava originates from the Binačka Morava and the Moravica, at Bujanovac. The most important Južna Morava tributary is Nišava which originates from neighbouring Bulgaria. Upstream from the Nišava, the Veternica, the Jablanica, the Pusta River and the Toplica enter the Južna Morava.

The Zapadna Morava originates from the Moravica and the Đetinja. The most important Zapadna Morava tributaries are the Ibar, the Rasina and the Čemernica.

Larger right tributaries of the Danube, downstream from the Velika Morava, are: The Mlava, the Pek, the Poreč River, and the most important, the Timok. The Timok originates from the Beli Timok and the Crni Timok, at the Zaječar confluence and from the village Bregovo to the confluence into the Danube (with a length of approximately 15.5 km) and is the border river between Serbia and Bulgaria.

The Beli Drim flows from Serbia towards the Adriatic Sea (catchment area in Serbia is 4,283 km<sup>2</sup>) and the Plavska River (catchment area in Serbia is 399 km<sup>2</sup>), which drains from the western side of the Šar Mountains and enters Albania. The most important right tributaries of the Beli Drim are: the Peć Bistrica, the Dečane Bistrica and the Erenik, and left, the Klinja and the Prizren Bistrica.

Three rivers belong to the Aegean Sea Basin, whose total catchment area in Serbia is less than 2,000 km<sup>2</sup>: the Lepenac (approximately 681 km<sup>2</sup>), left Vardar tributary, the Pčinja (approximately 516 km<sup>2</sup>), which also flows into Macedonia and the Dragovištica (catchment area in Serbia is 691 km<sup>2</sup>), which enters the Struma in Bulgaria.

The territory of the Republic of Serbia is a unique water management area (Article 26 of *the Law on Water*) and covers parts of the Black Sea, the Aegean Sea and the Adriatic Sea Basins, i.e. the parts of the basins and sub-basins of waterways which belong to the abovementioned basins. Map 2 shows the borders of the sub-basins in Serbia, outside the autonomous provinces, laid down in a corresponding by-law.

### Water classification

As all surface waters do not have the same importance for water management, waters are classified into first- and second-order waters. First-order waters, primarily in the part of water activity which is related to waterway regulation and the protection from floods, are under the jurisdiction of the Republic, and/or the autonomous province, while second-order waters are under the jurisdiction of local government. First-order waters (Map 1) are determined by the Government and include:

- inter-state waterways;
- waterways which make up or intersect the state border;
- waterways which run through the territories of two or more local government units;
- waterways on which a high dam with accumulation has been built;
- main waterway HS DTD canals;
- waterways with a catchment area of at least 100 km<sup>2</sup> or waterways which are significant for water use, protection from water or the protection of water against pollution.

All other water is classified as second-order water.

### **Basic indicators of the surface water regime**

Surface water regimes on the territory of Serbia is represented by basic indicators of water regime - average, low and high water, on the basis of the observation and measurements taken by the RHSS on the profiles of watergauge stations from 1946 to 2006. Analysis periods of hydrological data have been chosen on the basis of the cyclicity<sup>2</sup> of the available series of medium annual flows at official watergauge stations in Serbia. Analysis of cyclicity showed that from 1946 to 2006 one (with major

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<sup>2</sup> Cyclicity means the regularity of interchanging humid and arid periods whereby one cycle covers one humid and one arid period.

ivers), and/or two (with minor rivers) full periods are covered of macro cyclicity and are therefore considered statistically applicable periods to process the hydrological data, by which surface water regime is defined.

### Average flows

Table 1 shows medium monthly and multiannual flows for key profiles of watergauge stations. On the basis of average multiannual values of medium annual flows between 1946 and 2006 a map of isolines of run off modules was made and shown in Figure 3.

Table 1: Average medium monthly and annual flows (1946-2006), in m<sup>3</sup>/s

River	Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
The Danube	Bezdan	1,948	2,115	2,432	2,893	2,839	2,870	2,774	2,357	1,858	1,615	1,674	1,837	2,268
The Danube	V. Gradište	5,253	5,481	6,499	7,939	7,237	6,244	5,361	4,306	3,652	3,611	4,279	5,095	5,413
The Tisa	Senta / Novi Bečej	722	834	1,182	1,479	1,182	879	709	522	428	438	559	697	802
The Sava	S. Mitrovica	1,819	1,847	2,104	2,466	2,005	1,412	938	650	709	1,020	1,553	1,893	1,535
The Drina	Kozl/Radalj	381	395	469	620	567	350	199	137	145	241	390	472	364
The Lim	Priboj	92.8	97.2	116.6	167.4	159.5	90.4	51.0	37.1	40.9	61.1	95.8	113.2	93.6
The Kolubara	Draževac	24.51	37.57	43.7	34.89	28.44	21.80	14.00	9.50	7.82	10.21	14.06	21.37	22.32
The Velika Morava	Ljubičevo Bridge	248.1	342.3	413.7	428.6	335.2	242.1	149.5	96.1	86.4	108.8	147.1	208.4	233.9
The Zapadna Morava	Jasika	110.0	149.1	182.1	181.7	146.4	103.2	67.39	45.67	44.07	54.44	77.55	101.2	105.3
The lužna Morava	Mojsinje	104.2	145.8	178.5	180.6	135.9	94.40	48.76	29.87	28.28	38.24	54.60	82.98	93.52
The Ibar	Ribarići/ Batrage	7.94	10.54	15.21	20.63	17.21	9.17	5.42	3.374	3.86	5.55	8.034	10.94	9.83
The Nišava	Niš	28.94	40.26	51.32	55.81	43.89	32.17	17.31	11.09	10.42	13.07	17.20	25.16	28.89
The Veliki Timok	Tamnič	25.34	41.40	60.44	62.27	39.88	23.96	10.24	6.11	5.91	8.62	14.98	23.61	26.90
The Pčinja	Barbace	3.54	4.43	6.17	7.00	5.39	3.78	2.30	1.45	1.46	1.97	2.58	3.34	3.62

### Low and high water

Calculated values of annual minimum flows with 95% possibility of occurrence (on the basis of data from 1946 to 2006) are shown in Table 2, for 58 representative profiles on the rivers in Serbia. Low waters were calculated on the basis of the observed series, which include the effect of the anthropogenic factor - capturing water for different uses, water abstraction into other basins for various purposes, etc. With certain minor waterways this effect can be significant.

Calculated high waters (floods) of the 100-year return period, determined on the basis of from 1946 to 2006, are also shown in Table 2, for the same river profiles.

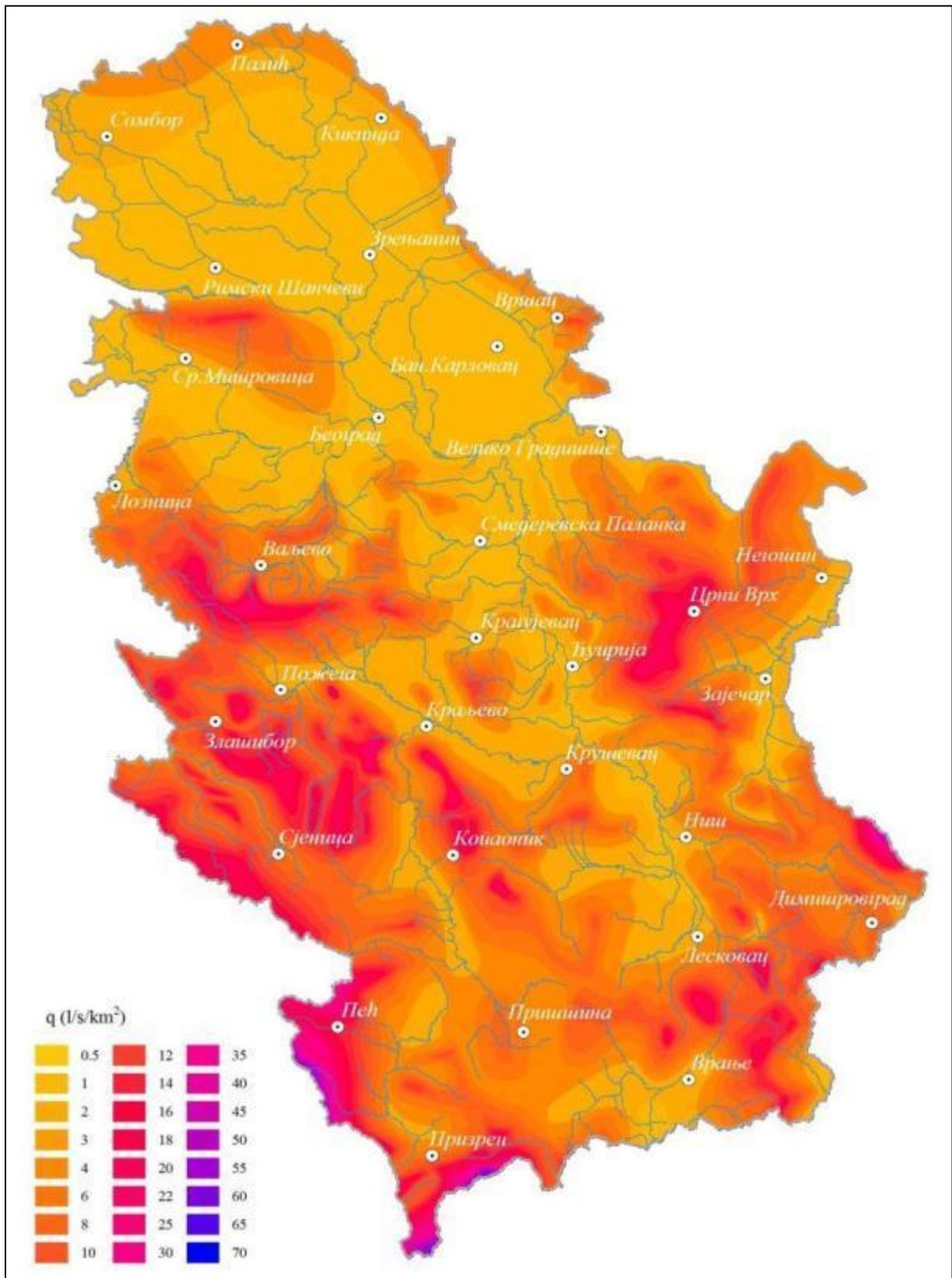


Figure 3: Run off modules

Table 2: Minimum annual flows of 95% possibility of occurrence, average multiannual flows and maximum annual flows of 1% possibility of occurrence

Ord. number	River	Hydrological station	F (km <sup>2</sup> )	Q <sub>95%</sub> (m <sup>3</sup> /s)	Q <sub>av. ann.</sub> (m <sup>3</sup> /s)	Q <sub>1%</sub> (m <sup>3</sup> /s)
1.	The Drina	Bajina Bašta	14,797	53.50	331.00	6,594
2.	The Lim	Brodarevo	2,762	10.70	71.90	1,047
3.	The Lim	Prijepolje	3,160	12.00	77.50	1,167
4.	The Danube	Bezdán	210,250	952.00	2,268.0	8,356
5.	The Danube	Bogojevo	251,593	1,257.00	2,777.0	9,275
6.	The Danube	Smedrevo	525,820	1,976.00	5,264.0	15,323
7.	The Tisa	Senta	141,715	135.00	802.00	4,222
8.	The Sava	S. Mitrovica	87,966	273.00	1,535.0	6,706
9.	The Ibar	Raška	6,268	5.41	40.73	1,171
10.	The Ibar	Ušće	6,883	7.72	46.58	1,260
11.	The Ibar	Lopatnica Lakat	7,818	10.50	56.72	1,368
12.	Studenica	Ušće	540	1.74	7.11	229
13.	Lopatnica	Bogutovac	155	0.16	1.94	128
14.	The Južna Morava	Mojsinje	15,390	11.30	93.52	2,131
15.	The Južna Morava	Korvingrad	9,396	4.72	56.11	1,903
16.	The Južna Morava	Grdelica	3,782	1.78	24.68	687
17.	The Južna Morava	Vladičin Han	3,242	1.14	18.82	657
18.	The Lužnica	Svođe	318	0.34	2.75	298
19.	The Vlasina	Svođe	350	0.78	3.75	331
20.	The Vlasina	Vlasotince	879	1.40	7.84	680
21.	The Južna Morava	Vranjski Priboj	2,775	0.60	12.89	709
22.	The Gradac	Degurić	159	0.35	2.77	189
23.	The Jablanica	Sedlare	140	0.06	1.52	220
24.	The Obnica	Belo Polje	185	0.04	1.75	210
25.	The Kolubara	Valjevo	340	0.18	3.57	295
26.	The Ribnica	Paštrić/Mionica	104	0.05	1.23	473
27.	The Ljig	Bogovadja	679	0.12	4.43	270
28.	The Kolubara	Beli Brod	1,896	1.28	15.78	621
29.	The Visočica	Visočka Ržana	139	0.36	5.44	244
30.	The Nišava	Niš	3,870	3.98	28.89	946
31.	The Kutina River	Radikina Bara	205	0.09	1.29	150
32.	The Visočica	Brajićevci	227	0.00	1.62	169
33.	The Trgoviški Timok	G. Kamenica/ /Štrbac/ D. Kamenica	331	0.21	3.23	218
34.	The Beli Timok	Knjaževac	1,242	0.51	7.93	383
35.	The Beli Timok	Vratarnica	1,771	0.58	9.74	406
36.	The Crni Timok	Zaječar/Gamzigrad	1,199	0.56	10.75	402
37.	The Toplica	Pepeljevac	986	0.55	7.10	478
38.	The Toplica	Doljevac	2,083	0.81	10.34	721
39.	The Kosanica	Visoka	370	0.06	2.14	302
40.	The Toplica	Prokuplje	1,774	0.67	9.65	663
41.	The Velika Morava	Varvarin	31,548	29.20	206.50	3,040
42.	The Velika Morava	Bagrdan	33,446	31.50	217.90	3,079
43.	The Velika Morava	Ljubičevo Bridge	37,320	34.80	233.90	2,738
44.	The Lugomir	Jagodina/Majur	427	0.05	1.78	440
45.	The Resava	Manasija Monastery	388	0.36	3.66	356
46.	The Jasenica	Donja Šatornja	83.60	0.04	0.62	181
47.	The Zapadna Morava	Gugalj Bridge / Kratovska Stena	2,688	3.70	31.77	820
48.	The Zapadna Morava	Kraljevo/Miločaj	4,658	4.58	43.00	1,234

Ord. number	River	Hydrological station	F (km <sup>2</sup> )	Q <sub>95%</sub> (m <sup>3</sup> /s)	Q <sub>av, ann.</sub> (m <sup>3</sup> /s)	Q <sub>1%</sub> (m <sup>3</sup> /s)
	Morava					
49.	The Zapadna Morava	Jasika	14,721	16.40	105.30	1,844
50.	The Đetinja	Stapari		0.44	3.48	320
51.	The Moravica	Ivanjica	475	0.66	6.65	311
52.	The Moravica	Arilje	831	1.38	10.52	436
53.	The Rzav	Arilje		0.92	7.91	306
54.	Skrapež	Požega	630	0.40	4.97	556
55.	The Rasina	Brus	213	0.23	2.40	169
56.	The Rasina	Bivolje	958	0.71	7.62	430
57.	The Zapadna Morava	Trstenik	13,902	15.40	103.50	1,784
58.	The Dičina	Brđani	208	0.10	1.55	238

### Inter-annual flow regimes

River flow regimes in Serbia are very heterogeneous in terms of the location and weather.

During the winter, the largest part of the territory of Serbia experiences snow fall, which is alternately accumulated and thawed, and in conditions of high temperatures there is rain precipitation, particularly in low-lying regions. In the spring, water run off is the result of rain and thawed snow, accumulated in mountain areas. The above processes determine water run off during the year; therefore rivers here mainly belong to rain and snow regimes (the Morava, the Kolubara, the Timok).

Upon entering Serbia, the Danube is highest from April to June and most arid from October to November. Upon exiting Serbia, the Danube is highest from April to May, and lowest from September to October, which is a consequence of the characteristics of the main tributaries which join the Danube on this territory. When observing the seasons, the Danube is most water affluent in the spring, at the point where it exits Serbia, and poorest during the autumn.

The Sava has a mainly snow and rain regime with affluent waters in spring, due to snow thawing and spring rains, with a prominent minimum in August and September and an exceptionally unbalanced autumn maximum (regarding time of occurrence and size). A similar situation is also perceived with the Drina.

The Tisa is most water-affluent in April and poorest in water from September to October.

The rivers in the central and eastern part of Serbia are characterised by the fact that the largest amount of water runoff occurs from February to May, that there are very few fluxes in the summer months (August-September) and that autumn maximums can completely fail (rain and snow type).

The Velika, Južna and Zapadna Morava, the Kolubara, the Timok, the Nišava, the Pčinja, and the Dragovištica are most water affluent in March and April, and poorest in water from August to September. Additionally, the time of occurrence moves from west to east, so the Zapadna Morava and the Kolubara are more affluent in March and the Južna Morava, the Nišava and the Timok in April.

### **Bodies of surface water**

In order to plan measures for preserving or achieving good surface water status, surface water is determined and its elements are clearly defined as is its approximate uniform characteristics.

In the Republic of Serbia water bodies are determined on the waterways and lakes of the Danube Basin and the Aegean Sea Basin (the Pčinja and the Dragovovištica sub-basins). On the territory of AP Kosovo and Metohija, bodies of surface water have not been determined, except for the Ibar River.

Bodies of water are determined on waterways with a catchment area exceeding 100 km<sup>2</sup> and on all important interstate waterways, regardless of their catchment area. In total there are 499 defined water bodies, out of which 492 belong to the Danube Basin. Figure 4 shows the representation of water bodies according to water areas, with a note that some bodies belong to more than one water area.

Considering the natural properties of the area and of the waterway (basin size, altitude, geological composition of the terrain and granulometric composition of the bottom), water bodies on waterways are classified into 38 types, gathered into 7 group types). Out of the total number of water bodies of surface water, almost 70% (342) have been characterised as natural waterways ("rivers"), 16 are artificial, while the remaining (28%) have been preliminary evaluated, with regards to substantial hydromorphological changes, as a substantially altered body of water.

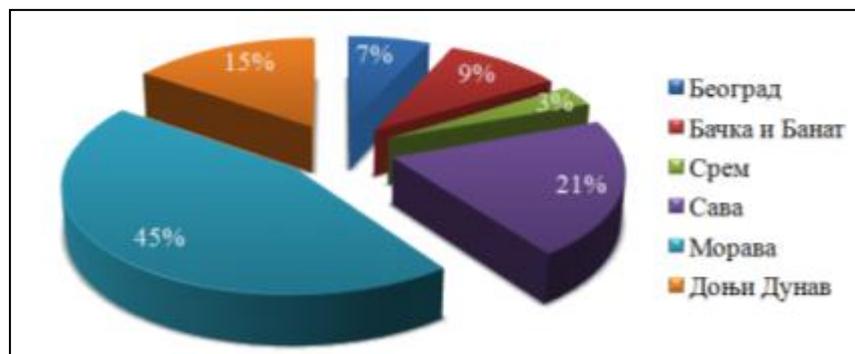


Figure 4: Representation of water bodies on waterways, according to water areas

- Belgrade
- Bačka and Banat
- Srem
- The Sava
- The Morava
- The Lower Danube

The territory of the Republic of Serbia is poor in natural lakes. There are 5 defined bodies of stagnant water in Serbia (natural and artificial lakes): Palić Lake and Lake Ludaš in the water area of Bačka and Banat, Vlasina Lake in the Morava, Srebrno Lake at Veliko Gradište, in the water area of the Lower Danube and Sava Lake in Belgrade.

Map 3 shows the water body borders on waterways and at lakes (Bodies of surface water).

### 2.1.4 Groundwater

Groundwater reservoirs are formed and exist as a result of the structure of geological terrain. At the same time, the quantity and quality of this kind of water is quite heterogeneous and dependent on the type of environment that the resource has been formed in, as well as on the regime of surface water and climate conditions. The effects of groundwater on their quantitative status depends on the size of the aquifer and recharge. It can be substantial (very slow recharging and overexploitation) to practically negligible (exploitation of groundwater in environments which are in direct contact with surface water).

Due to the connection with surface water, groundwater represents an amount of the total water resources and has to be treated in this regard when considering the water balance.

### **Geological structure**

The geological structure of Serbia is characterised as predominantly complex, both with regard to lithofacies and tectonic characteristics. The structure of the terrain includes magmatic, sediment and metamorphic rock, formed from the Precambrian to the contemporary Holocene strata periods. The complexity of the geological structure and make-up is also reflected in the complexity of the territory's hydrogeological characteristics. In such a complex area it is possible to distinguish between several hydrogeological groups which have a characteristic geological composition and specific hydrogeological characteristics. In this sense, the hydrogeological units are as follows (Figure 5):

- area of Bačka and Banat,
- area of Srem, Mačva and the Posava-Tamnava area,
- area of South-Western Serbia,
- area of Western Serbia,
- area of Central Serbia,
- area of Eastern Serbia.

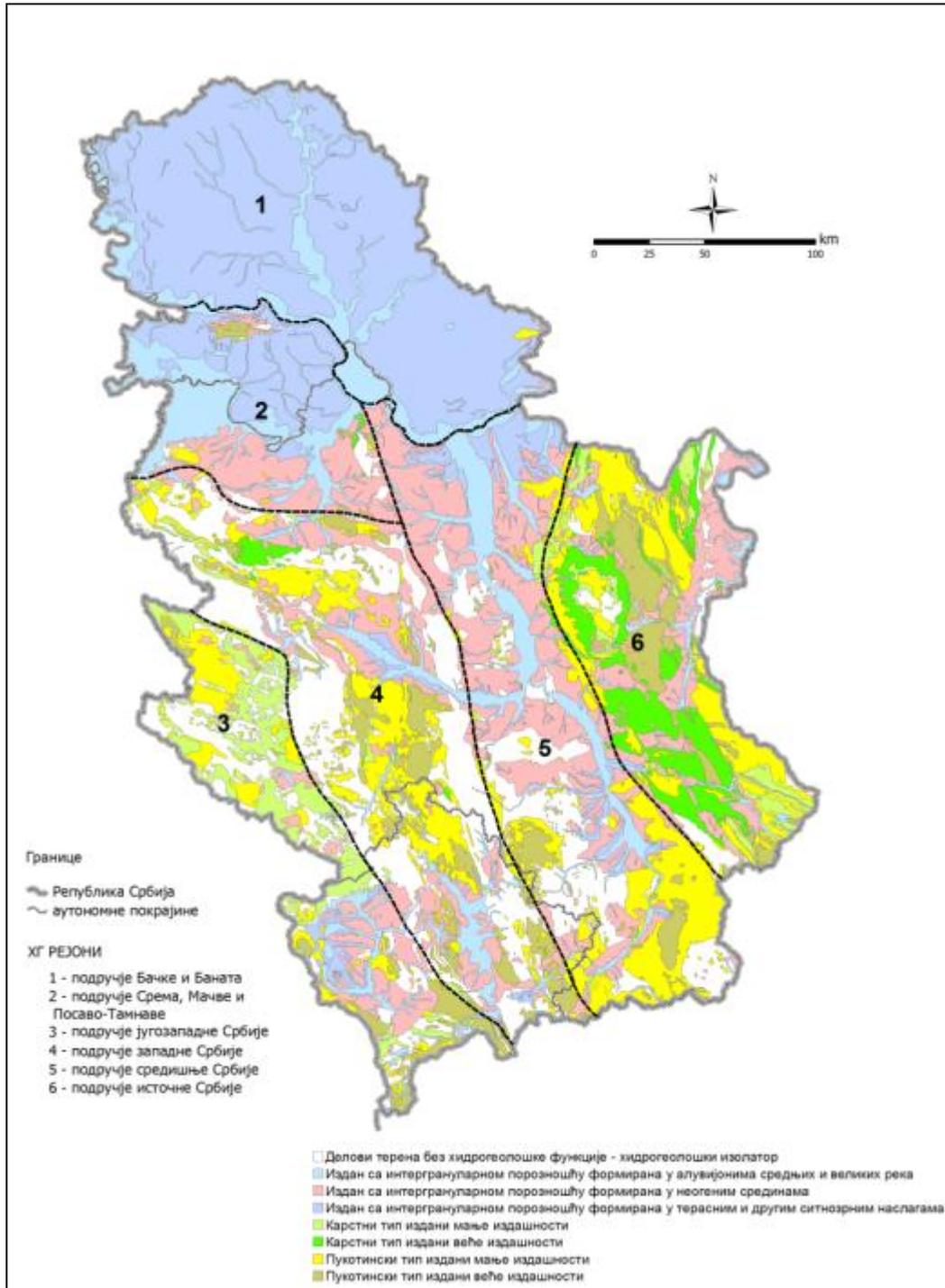


Figure 5: Hydrogeological units - the Republic of Serbia.

Borders  
 The Republic of Serbia  
 Autonomous Provinces  
 HG areas  
 Bačka and Banat area  
 Srem, Mačva, Posava-Tamnava areas  
 South-Western Serbia

Western Serbia

Eastern Serbia

Terrain without hydrogeological function – hydrogeological isolators

Aquifer with intergranular porosity formed in mid-sized and large river alluvions

Aquifer with intergranular porosity formed in Neogene environments

Aquifer with intergranular porosity formed in terraces and other small-grain sediments

Karst type aquifer with slight yield

Karst type aquifer with larger yield

Fracture type aquifer with slight yield

Fracture type aquifer with larger yield

The accumulation of groundwater, on the territory of the Republic of Serbia, is found in rock masses with different porosity types:

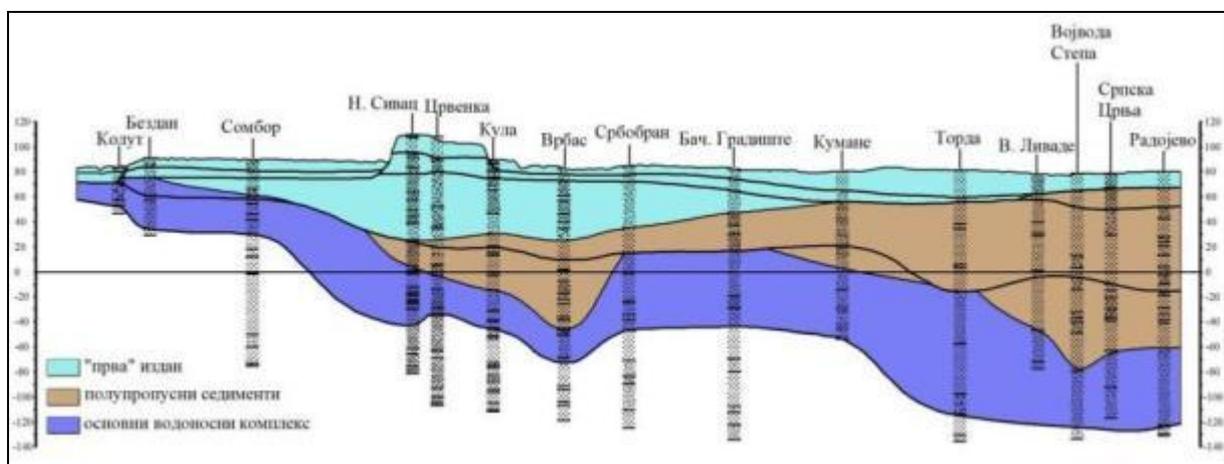
- intergranular porosity (Quaternary and Neogene sediments),
- karst porosity and
- fracture porosity.

From the aspect of capturing groundwater, it is significant to have accumulations in rock masses with intergranular and karst types of porosity.

#### Rock with intergranular porosity types

On the territory of Bačka and Banat the most important areas from the aspect of capturing groundwater are presented by the Late-Quaternary - eopleistocene and mid-pleistocene sand and gravel sediments. These deposits are continuously spreading in almost the entire area of the Pannonian Basin. In their entirety, polycyclic river and river and lake sediments represent the basic aquifer complex in Vojvodina. Over the basic aquifer complex sediments, there are Young Quaternary sediment deposits, sands, sandy gravel in the alluvial plains of the Danube, the lower Tisa flow and in the greater part of Bačka, where there the "first" aquifer is, while in the remaining area there are alevrite and alevrite clay deposits (Figure 6). The depth of the basic aquifer complex sediments ranges from 10m in the coastal area of the Danube, where their thickness is approximately 25m, to lower than 100m in the North-Eastern Banat area, where the thickness is 125m.

Figure 6: Hydrogeological cross-section on the territory of Bačka and Banat



(west-east direction)

Kolut, Bezdan, Sombor, N. Sivac, Crvenka, Kula, Vrbas, Srbobran, Bač. Gradište, Kumane, Torda, V. Livade, Vojvoda Stepa, Srpska Crnja, Radojevo  
first aquifer  
semipermeable sediments  
basic aquifer complex

In the area of Southern, particularly South-Western *Srem*, there are groundwater accumulations which have formed within the sand and gravel Quaternary sediments, which are used for the public water supply. In the Young Quaternary aquifer layers, the unrestricted "first" aquifer was formed, which is hydraulically connected to the Sava. The thickness of the Young Quaternary sediment ranges from 15 to 50m. In the polycyclic river and lake sandy gravel sediments of the Late Quaternary (basic aquifer complex), with a thickness of 15 to 50m, 2-3 sub-confined aquifers and confined aquifers were formed, separated by intercalations of semipermeable alevrites.

On the territory of *Mačva* the basic environment represented by sand and gravel sediments from the early and the Late Quaternary, which are practically directly inter-connected with the entire terrain, that is, that within these sediments a single aquifer exists. The greatest thickness of these sediments is along the Drina from Bradovinci and Prnjavor to Crna Bara and Ravanj and range from 50 to 75m, while in the remaining part of *Mačva* it is between 20 and 40m.

In the Posava-Tamnava area, aquifer environments are of uneven thickness and spreading, and the most significant spreading is in the area of Podgorička Ada and the downflow from Ostružnica to the Sava – Danube confluence. The Pliocene epoch aquifer environments are continually spreading in the *Srem*, *Mačva* and Posava-Tamnava areas. The Pliocene aquifer environments are represented by 2-3 layers of small-grain to middle-grain sand (gravel), which are separated by the semi-permeable to impermeable alevrites and clay areas. Within these sediments, sub-confined aquifer to confined aquifer groundwater accumulations were formed, which are used for the public water supply.

In the area of *South-Western Serbia* the most important alluvial aquifer environments are connected with sand and gravel sediments of the Beli Drim and tributaries of the Peć and Dečanska Bistrica. The alluvion of the Beli Drim is characterized by an uneven thickness and changable filtration properties, the alluvion of the Pećka Bistrica has a great thickness and somewhat lesser permeability, while the alluvial sediments of the Dečanska Bistrica have the most modest characteristics from the aspect of yield. Neogene sediments are present in the Sjenica-Štavalj Basin and the Metohija valley and are generally characterised by low conductivity and yield.

In *Western Serbia* Quaternary alluvial sediments are present in the drifts of the Drina (Bajina Bašta-Loznica sector), the Kolubara, the Zapadna Morava (between Čačak and Trstenik). The most important of these alluvial sediments are the sediments of the Drina in the zone of Lozničko Polje. The alluvial sediments of the Kolubara, the Zapadna Morava and the Ibar are less thick and have weaker filtration characteristics and/or yield. Neogene sediments are present in several basins (Valjevo, Čačak-Kraljevo, Kosovo, Podujevo and Drenica Basins), but they show very modest filtration characteristics and low yield.

In *Central Serbia* the most important Quaternary aquifer environments are connected with the alluvial drifts of the Danube, the Velika Morava, part of Zapadna Morava and Južna Morava. The groundwater accumulation which formed within the alluvial sediments of the Velika Morava, represent the base resource for the water supply in this area. The thickness of sand and gravel sediments of the Velika Morava ranges from 4 to 8m in the area of Stalač, to approximately 60m in Godominski Rit. The Danube alluvion in the Kostolac-Veliko Gradište sector has an average thickness of 15 to 30m, while the alluvion of the Južna Morava has the thickness of 5 to 10m, locally even up to 40m. In the most important groundwater accumulation within Neogene sediments are connected with sandy sediments in the Neogene Basin of Leskovac and Jagodina and Paraćin, where they are used for the public water supply.

In *Eastern Serbia* the most important Quaternary sediments are represented by alluvial drifts of the Nišava and alluvial sediments within the Knjaževac-Minićevo Basin. Generally, these sediments are characterised by relatively good permeability with less thickness so that more substantial quantities of groundwater cannot be captured. Neogene sediments are present within several neogene basins (Knjaževac-Minićevo Basin, the Zaječar valley, Negotin Plain, Svrlijig Basin), which are generally characterised by weak permeability and low yield.

#### Karst porosity type rock

The most important karst aquifers are present in South-Western, Western and Eastern Serbia.

In *South Western Serbia* they are represented by carbonate sediments of the Middle and Upper Triassic which are characterised by great thickness and substantial spreading, which is in the southern part of the area almost continual from Pešter Plateau to Metohija valley, with intense karstification to substantial depths.

In *Western Serbia* substantial masses of limestone are present south of Valjevo and are represented by the so-called "lelić" karst which was formed of the Middle and Upper Triassic limestone, where groundwater has accumulated. This aquifer is emptied through the Paklja and Petnica springs and the Gradac springs.

The main hydrogeological characteristic of *Eastern Serbia* is clearly the substantial presence of masses of fractured and karstified limestone of the Upper Jurassic and Lower Cretaceous period, whose thickness ranges from 50 - 500m. Within these masses of rock there are substantial groundwater accumulation (over 70 recorded, with a minimum flux of 10 l/s and 16 with a flux exceeding 100 l/s), which are emptied through a number of karst springs and whose yield varies throughout the year. The most significant karst springs in this area are Ljuberađa, the Mlava spring, the Krupanj spring, the Radovansko Spring, the Beljevina, Krupac, and Bela Palanka springs, etc.

#### Fractured porosity type rock

Rock with fractured porosity type are significantly spreading, particularly in the area of West and South-East Serbia, but, due to exceptionally poor filtration characteristics, they are not important to the public water supply, except locally (yield below 1 l/s, rarely exceeding 3 l/s).

### **Groundwater bodies**

Groundwater bodies are the basic units used to manage this resource, monitor the status and apply measures to achieve good groundwater status. In the Republic of Serbia there are 153 groundwater reservoirs, which 152 belong to the Danube basin (the Black Sea Basin), and one to the Aegean Sea Basin. The size of these individual reservoirs ranges from 35 km<sup>2</sup> to 2,643 km<sup>2</sup>. Map 4 shows a graphical presentation of separate groundwater reservoirs (groundwater reservoirs)

Figure 7 shows the number of separate water bodies according to water area.

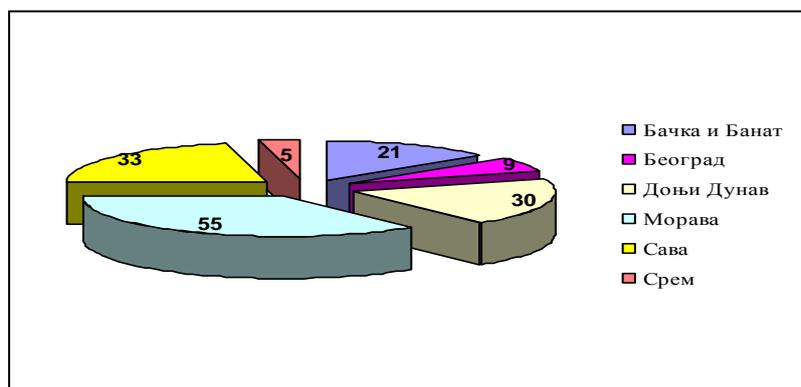


Figure 7: The number of water bodies in the water areas

Bačka and Banat  
Belgrade  
The Lower Danube  
The Morava  
The Sava  
Srem

Of the total number of groundwater bodies, 132 are national, while 22 have been identified as cross-border. Water bodies share borders with Hungary (6 water bodies), Romania (6 water bodies), Croatia (3 water bodies), Montenegro (2 water bodies), Bosnia and Herzegovina (2 water bodies) and Bulgaria (3 water bodies). Only 6 water bodies have been bilaterally harmonized with Hungary, which is the basis for further cooperation in the field of common resources management.

### 2.1.5. Other natural factors

#### Soil

Soil characteristics are conditioned by a number of natural factors, such as physical and chemical properties, geological rootstock, hydrogeological and hydrographical conditions, orography, climate, vegetation, and the presence of macro- and microorganisms. The formation of soil, including its renewal, is an extremely slow process, and soil can be considered a partially renewable resource.

#### The structure of the soil cover

The general classification of soil in Serbia is based on the character of its natural wetting, that is, on the water and physical properties of the soil, which represents not only an appropriate but also a dedicated approach to regulating the water system from the aspect of applying hydro- and agromelioration measures, as well as evaluating the suitability of soil for irrigation.

Serbian soil can be classified into three large groups (the provided surface areas do not include the territory of AP Kosovo and Metohija):

I Automorphic soils -	6,222,350 ha (80 %)
II Hydromorphic soils -	1,445,555 ha (19 %)
III Halomorphous soils -	79,360 ha (1 %)

I Automorphic soils - are characterised by wetting, exclusively on the basis of precipitation, where the water percolation through the soil section is unrestricted, without long retention of excessive water. However, there are subunits in the composition of this soil (particularly in the Morava, then the Sava and partly in Bačka and Banat) which have taken on, due to degradation, certain adverse properties which should be mitigated and/or eliminated by hydro- and agro-melioration measures.

II Hydromorphic soils - are characterized by periodic or permanent wetting under the influence of surface and groundwater, separately or combined, and by additional wetting caused by floods. These soils are located at the lower levels of terrain, in the depressions of loess, lake and river terraces, particularly in large river valleys (the Dunube, the Tisa, the Sava, the Morava and their tributaries).

III Halomorphous soils - cover defective soil (marshes) which are formed under the dominant influence of readily soluble salts. In addition to typical representatives of marshes, some other types are also exposed to the harmful processes of salinization and alkalization to various degrees, mostly heavy soils with hydromorphic and automorphic characteristics. This group of soils is relatively underrepresented

but it is very significant for the water areas of Bačka and Banat, the Lower Danube and Srem, and for drainage and irrigation.

Table 3 and Figure 8 show the representation of all three types of soils according to water areas, excluding Kosovo and Metohija.

Table 3: Classification and spatial representation of the types of soil in Serbia

Water area	Soil (ha)			Total
	Automorphic	Hydromorphic	Halomorphic	
Banat and Bačka	1,228,016	468,150	77,383	1,773,549
Belgrade	203,656	121,028	0	324,684
The Lower Danube	964,049	106,546	0	1,070,595
The Morava	2,853,942	327,660	0	3,181,602
The Sava	686,827	332,952	0	1,019,779
Srem	285,860	89,219	1,977	377,056
<b>TOTAL in the Republic of Serbia</b>	<b>6,222,350</b>	<b>1,445,555</b>	<b>79,360</b>	<b>7,747,265</b>

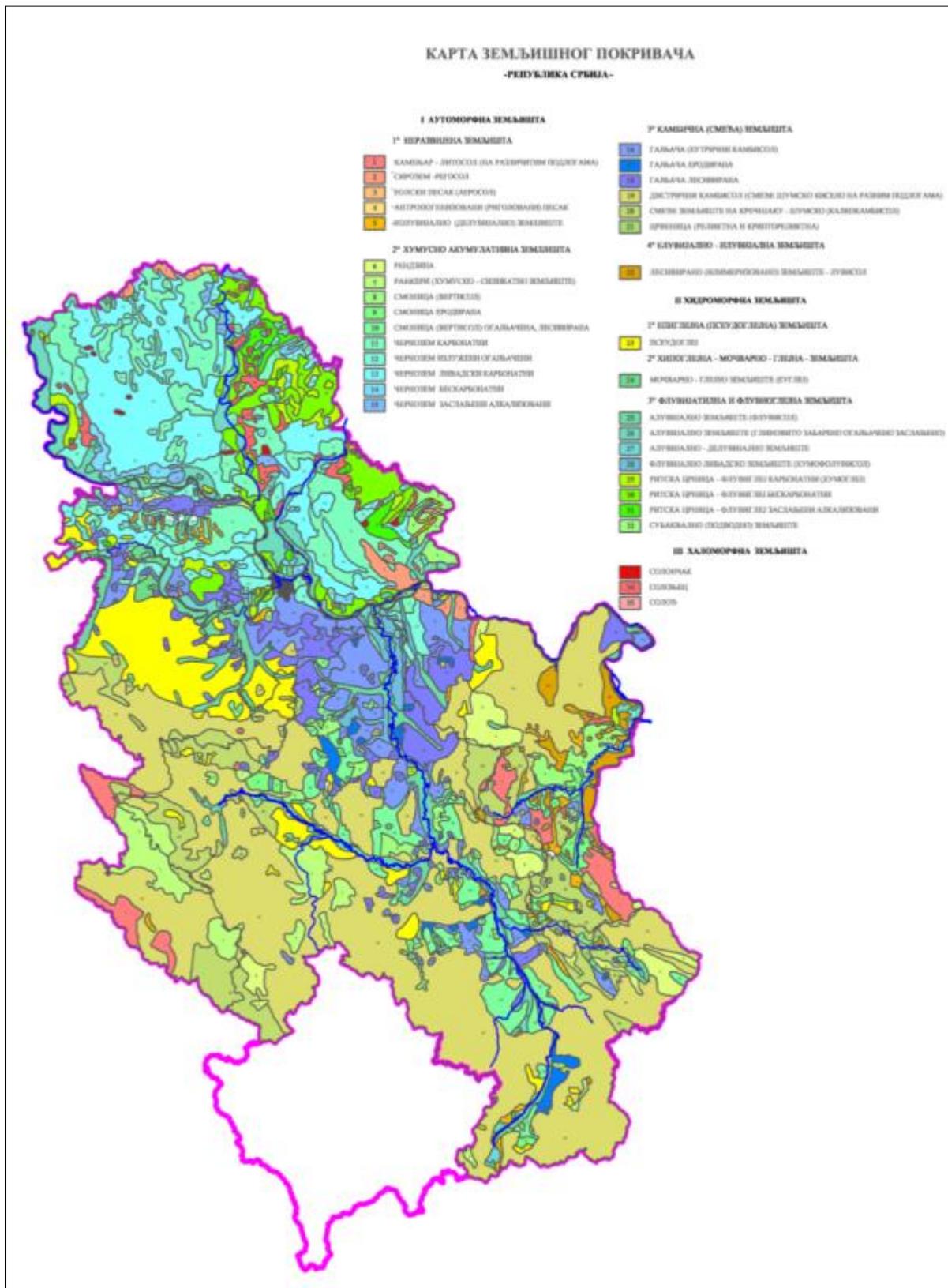


Figure 8: Pedological map (source: documentation database - Institute "J. Černi")

## SOIL COVER MAP

### - The Republic of Serbia -

Automorphic soils  
Undeveloped soils  
Rocky ground – lithosol (on different substrates)  
Syrozem – Regosol  
Aeolian sands (Arenosol)  
Rigosol (anthropogenic sand)  
Colluvial (delluvial) soils

Humus accumulating soils  
Rendzina  
Humus-siliceous soil (Ranker)  
Smonitza (Vertisol)  
Smonitza eroded  
Smonitza (Vertisol) with cambisol and loess  
Carbonate chernozem  
Chernozem with cambisol  
Meadow carbonate chernozem  
Salline chernozem with alkali salts

Cambic brown soils  
Cambisol (Eutric Cambisol)  
Cambisol with loess  
Dystric Cambisol (brown forest acidic on different substrates)  
Black earth on limestone (Calcomelanosol)  
Red soil (relict and pseudorelict)

Eluvial and illuvial soils  
Illimerised soil (Luvisol) with loess

Hydromorphic soils

Epigley (Pseudogley) soils  
Pseudogley  
Hypogley and marsh-gley soils  
Marsh-gley soils (Eugley)

Fluviatile and fluvial gley soils  
Alluvial soil (Fluvisol)  
Alluvial soil (clay cambisol salline with sloughing)  
Alluvial and deluvial soil  
Meadow soil (Humofluvisol)  
Hydromorphic black earth – fluvial gley with carbonates (Humogley)  
Hydromorphic black earth – fluvial gley with carbonates  
Hydromorphic black earth – fluvial gley salline with alkali salts  
Subaqueous soil (underwater soil)

Halomorphic soils  
Solonchak  
Solonetz  
Solodj

### Suitability of irrigation soils

As irrigation effects depend on soil characteristics, from the aspect of irrigation suitability, the following subgroups-classes can be classified:

Class I – deep soils suitable for irrigation without *limitations*, with systematic and periodic quantity and quality irrigation water control and the “the first” aquifer groundwater regime;

Class II – deep and medium deep soils suitable for irrigation *with certain caution*, due to the degradation processes to which they were exposed in the past;

Class IIa - medium deep soils suitable for irrigation *with certain caution/conditionally suitable* (valley soils with variability present with regard to the morphological, physical and chemical properties);

Class III - soils which are *conditionally suitable* for irrigation, characterized by the presence of clay in the mechanical composition, signs of hydromorphism, sloughing, salinity and alkalinity;

Class IIIa - deep soils (predominantly hydromorphic) which require previous appropriate drainage and deep shattering of unfavourable layers;

Class IIIb - medium deep soils which require appropriate drainage, application of small quantities of physical and chemical agents for soil melioration and other measures of complex melioration;

Class IIIc - deep, medium deep to shallow soils (predominantly hydromorphic and halomorphic) which require appropriate drainage, application of substantial quantities of physical and chemical agents for soil melioration.

Class I and II soils are predominant in the north, and class IIa soils are predominantly present in central and southern parts of Serbia.

Class IIIa and IIIb soils are balanced throughout the Republic, while class IIIc soils cover longer parts of the Podrinje and the Kolubara and the whole territory of the upper Morava.

Table 4 shows surface areas suitable for irrigation, according to water areas.

Table 4: The representation of surface areas from the aspect of suitability for irrigation, in ha

Soil class	Water areas						Total
	Bačka and Banat	Srem	Belgrade	The Sava	The Morava	The Lower Danube	
I	444,749	98,633	14,414	1,470	23,000	51,224	633,490
II	706,622	105,560	36,249	7,553	2,636	23,471	883,091
IIa	14,685	1,176	32,690	48,352	221,160	63,990	382,053
IIIa	241,488	42,101	78,600	18,109	278,784	129,181	788,263
IIIb	285,080	92,405	105,841	43,600	413,220	90,618	1,030,764
IIIc	79,122	21,718	38,463	269,692	179,600	150,245	738,840
Poor weather	1,803	14,463	18,427	631,003	2,063,202	561,866	3,290,764
<b>TOTAL</b>	<b>1,773,549</b>	<b>377,056</b>	<b>324,684</b>	<b>1,019,779</b>	<b>3,181,602</b>	<b>1,070,595</b>	<b>7,747,265</b>

According to the table above, approximately 1.9 million ha can be irrigated without limitation or with certain caution, out of which 70% is in Vojvodina. Conditionally suitable soils for irrigation, with substantial prior investments, additionally cover about 2.6 million ha, which amounts to almost 4.5 million ha in conjunction with prior classes.

### Drainage soil characteristics

The classification of soils from the aspect of drainage characteristics covers five drainage classes (the sixth includes unclassified soils), whereby drainage class I is characterised by an immensely high level of threat from excessive waters and very low drainage capability, drainage class II by a high level of threat and low drainage capability, while drainage class III shows moderate threat and insufficient drainage capability. Drainage is required for soils of drainage class I to III, to improve soil characteristics for agricultural production. Agricultural production with soils of drainage class IV takes place almost effortlessly in so far as there is no irrigation; otherwise these surfaces also require the construction of drainage systems.

Table 5 shows the representation of drainage classes according to water areas.

Table 5: The illustration of drainage classes according to the water areas, in ha

Drainage class	Water areas						Total
	Bačka and Banat	Srem	Belgrade	The Sava	The Morava	The Lower Danube	
I	339,383	42,851	51,056	277,333	94,172	29,700	834,495
II	205,280	47,232	31,133	6,313	334,016	112,270	736,244
III	78,802	39,950	102,875	71,528	432,684	220,149	945,988
Total I to III	623,465	130,033	185,064	355,174	860,872	362,119	2 516,727
IV	672,975	148,310	103,835	26,159	213,000	125,242	1,289,521
V	475,306	88,277	18,464	1,420	5,400	22,303	611,170
Unclassified	1,803	10,436	17,321	637,026	2,102,330	560,931	3,329,847
<b>TOTAL</b>	<b>1,773,549</b>	<b>377,056</b>	<b>324,684</b>	<b>1,019,779</b>	<b>3,181,602</b>	<b>1,070,595</b>	<b>7,747,265</b>

### Land use

In addition to natural conditions and processes, soil characteristics and their degradation is immensely influenced by the constant pressure of human activities, including: the development of settlements, infrastructure systems, extraction and exploitation of resources, agriculture, forestry, chemical use, etc. Various forms of land use depend on water, in particular: irrigation, hydroelectric power plants, urban development, etc. On the other hand, the method of land use can affect the quality of water and waterways so that when planning a change of land use, one has to take into consideration the impact this will have on water resources.

Table 6 shows the basic structure of land coverage according to Corine Land Cover 2006, whereby the representation of certain categories is as follows:

- agricultural land 57 %,
- forest soil 38 %,
- urban areas 4 %,
- water and humid areas 1 %.

Table 6: Map Corine Land Cover 2006 (excluding data for Kosovo and Metohija)

Order no.	Categories	Water areas (ha)						Total
		Bačka and Banat	Belgrade	The Lower Danube	The Morava	The Sava	Srem	
1.1	Urban areas 4 %,	79,935	31,845	19,193	58,399	14,866	17,314	221,552
1.2	Industrial and transport units	476	4,897	969	4,637	1,205	1,767	13,951
1.3	Mines, waste disposals and construction sites	1,019	3,226	4,050	1,229	1 083	377	10,984
1.4	Artificial non-agricultural areas	1,632	2,148	153	1,000	454	297	5,684
2.1	Arable land	1,291,335	90,190	90,059	239,329	74 611	231,193	2,016,716
2.2	Permanent (perennial crops)	7,248	3,089	2,561	4,332	139	2,205	19,575
2.3	Pastures	55,288	2,364	13,515	60,291	23 336	2,104	156,897
2.4	Heterogeneous agricultural areas	119,320	132,905	395,024	1,120,810	430 010	37,469	2,235,539
3.1	Woodland areas	63,719	37,168	438,711	1,334,080	329 616	71,062	2,274,357
3.2	Shrubs community	83,163	7,907	88,195	330,228	130 148	8,411	648,051
3.3	Open area with little or no vegetation	9	32	1,239	15,131	3 681	6	20,099
4.1	Terrestrial humid areas	17,003	1,310	954	804	731	1,661	22,461
5.1	Inland water	36,207	6,944	15,132	9,293	6 211	8,027	81,814
<b>TOTAL</b>		<b>1,756,355</b>	<b>324,024</b>	<b>1,069,755</b>	<b>3,179,563</b>	<b>1,016,090</b>	<b>381,894</b>	<b>7,727,682</b>

## Erosion and torrential processes

Land erosion and the occurrence of torrents are two interconnected natural phenomena which, each in their own way, cause immense damage to all areas of life and economic activities in Serbia. Erosion processes are long-term, with visible changes within a one to ten year period, while torrents occur and end in a relatively shorter period.

The intensity and surface distribution of certain forms of erosion in our territory have been subject to monitoring and study for decades, but not in continuity. According to the erosion process classification (so far, Serbia's method has been "erosion potential") erosion is grouped into 5 categories - ranging from very weak to excessive. Figure 9 shows the representation of certain categories of erosion for certain basins, while Figure 10 shows the erosion map on the territory of the Republic of Serbia. The map was taken from the Water Management Basis of the Republic of Serbia (WMB) and was changed only with regard to the surface areas on which there was no anti-erosion work done after 1993. However, the map of the entire territory of the Republic of Serbia was not amended.

The erosion map is an important document because it clearly identifies the surface areas which, from the aspect of threatening erosion, represent erosion or potential erosion areas, for which restrictions and conditions of use are defined, preventive measures are prescribed and required anti-erosion work is performed as a priority, meaning that it is important to have updated maps.

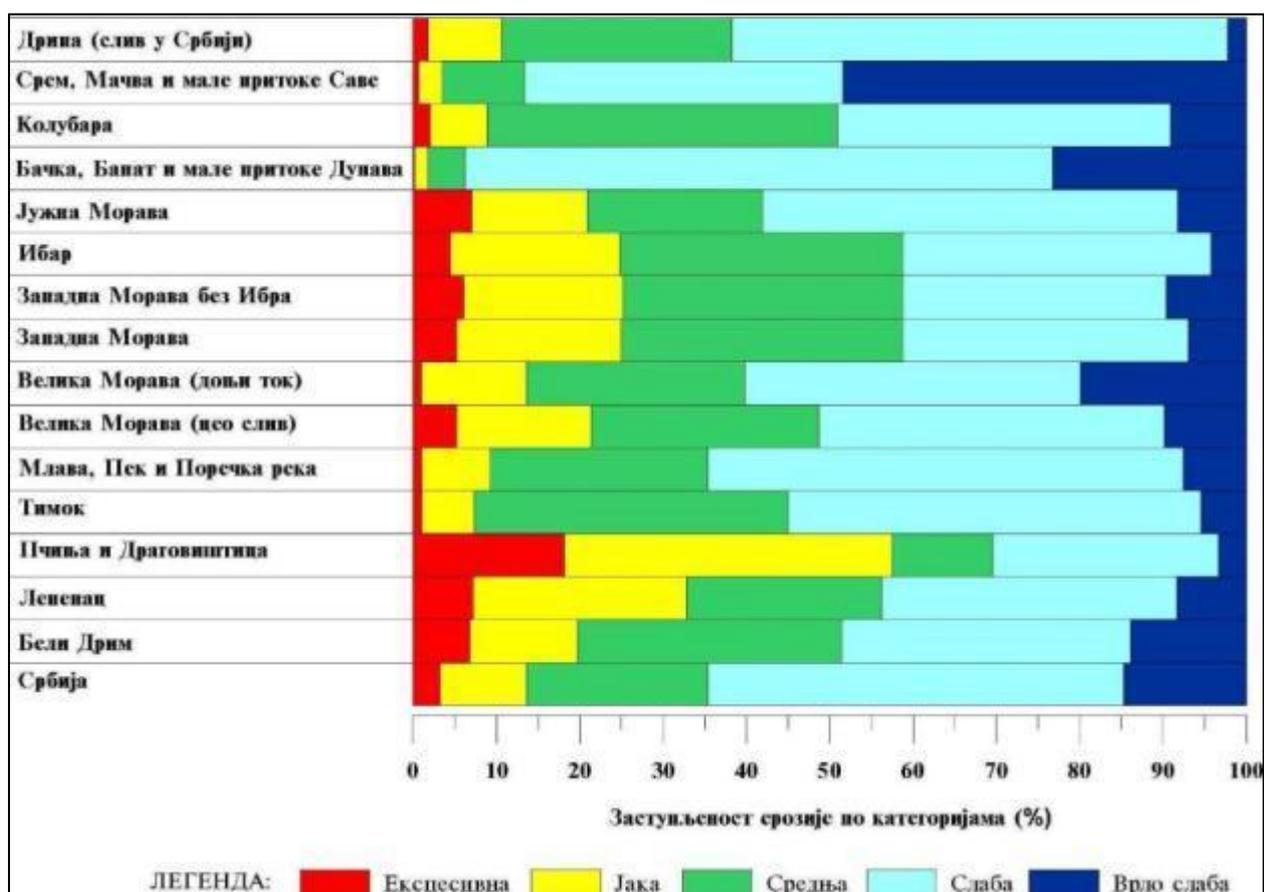


Figure 9: The representation of erosion in percentages, according to categories

The Drina (basin in Serbia)  
Srem , Mačva, small Sava tributaries

The Kolubara  
Bačka and Banat and small Danube tributaries  
The Južna Morava  
The Ibar  
The Zapadna Morava excluding the Ibar  
The Zapadna Morava  
The Velika Morava (lower flow)  
The Velika Morava (entire basin)  
The Mlava, the Pek, the Poreč River  
The Timok  
The Pčinja and the Dragovištica  
The Lepenac  
The Beli Drim

Serbia

Erosion, per category (%)

Legend: excessive, strong, average, weak and very weak

The map of erosion shows that the most represented forms of erosion in the northern plains of Serbia are very weak with weak forms of erosion (medium intensity is much less frequent), while the erosion processes in central and southern parts of Serbia have much greater intensity, with prominent areas of strong and excessive erosion. In this area, very weak erosion is present only in plains and in river valleys.

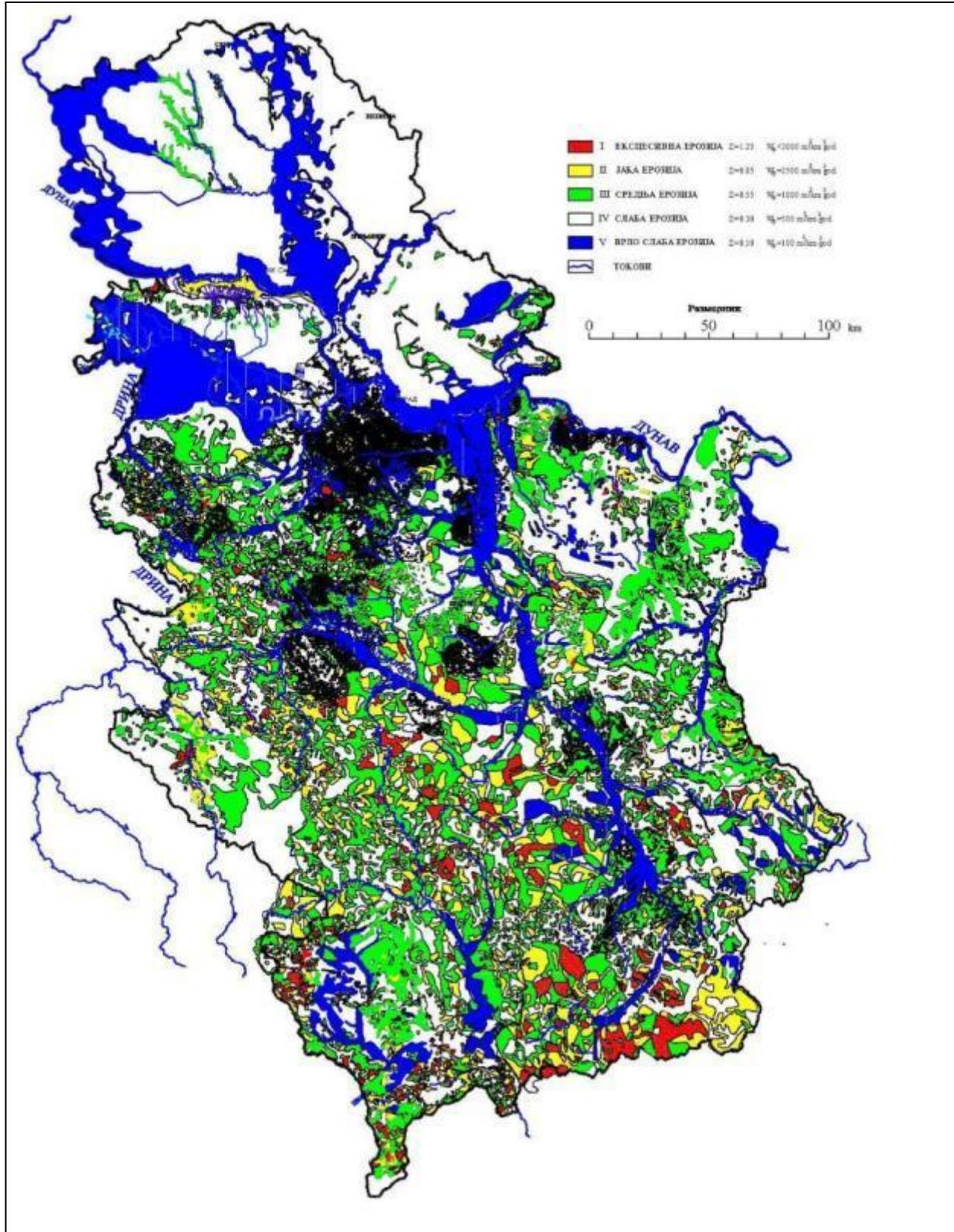


Figure 10: The erosion map shows that The erosion map of the Republic of Serbia (source: supplemented map from WMB)

- I Excessive erosion  $Z= 1.25$   $W_p < 3000 \text{ m}^3/\text{km}^2$
  - II Strong erosion  $Z= 0.85$   $W_p < 2500 \text{ m}^3/\text{km}^2$
  - III Average erosion  $Z= 0.55$   $W_p < 1000 \text{ m}^3/\text{km}^2$
  - IV Weak erosion  $Z= 0.30$   $W_p < 500 \text{ m}^3/\text{km}^2$
  - V Very weak erosion  $Z= 0.10$   $W_p < 100 \text{ m}^3/\text{km}^2$
- Flows

Scale 0,50,100 km

### **Mineral raw materials**

Various geological, tectonic and metallogenic processes brought about the formation of a large number of the deposits of metal, non-metal and energy mineral raw materials<sup>3</sup>. Their exploitation was more or less in collision with the water sector.

Metal mineral raw materials occur in several zones with their characteristics, both with regard to their genesis and in respect of the types and the quantity of ore. The best known is "The Timok zone", in Eastern Serbia, with a long tradition of exploiting and processing metal raw materials, with the most important deposits of copper in the region of Bor and Majdanpek, as well as deposits of gold and tungsten at Blagojev Kamen. Several contemporary mines are active in this zone, in particular: Majdanpek, southern and northern areas, Krivelj-Cerovo, Borska reka and Brezonik (Bor) where they apply open-cast mining. Significant ore reserves are concentrated in the Borska reka area, which are partly exploited underground. Research has shown that there is perspective to exploit ores in this and near-by mining regions, including copper and gold, tungsten and other related metals as well (molybdenum, germanium, selenium, platinum).

Lead and zinc deposits, with related metals can be found in Central Serbia (the most important being Rudnik on Rudnik, and less important Babe on Kosmaj, Crveni Breg and Šuplja Stena on Avala) and complex deposits of iron and copper with related metals in connection with the granitoid massif of Kopaonik (Suva Ruda, Suvo Rudište).

Antimony, lead and zinc deposits are present in Western Serbia. Antimony deposits in Zajača, Stolice, Brasina, Borina, as well as lead and zinc deposits in Veliki Majdan at Ljubovija, are insufficiently exploited.

In Southern Serbia there are lead, zinc, molybdenum ores in the deposits of Mačkat, lead and zinc ores in the deposits of Grot, as well as the deposit of gold in Lece. On the territory of Kosovo and Metohija, significant deposits of lead and zinc can be found, as well as chromium, nickel and other metal mineral deposits.

The exploitation of metals affects the quality of water by means of intensified mineralization through the drainage water of the orebody and through the process of exploitation, but the highest level of impact is achieved through mineral ore processing from primary to metallurgical ore processing and further metal finishing, which is followed by the occurrence of unfavourable composed wastewater and by harmful and hazardous substances which are sometimes inadequately deposited. In addition, the effect of mining is also manifested through more intense erosion by overburdened landfills which, due to atmospheric effects, is displaced into waterways.

Non-metal mineral raw materials are found in several characteristic exploitation zones, be it about specific mineral raw materials or the regional concentration of different types of ore.

Regarding traditional non-metals, Serbia has significant deposits of asbestos (Stragari, Korlace), magnesite (Brezak, Zlatibor, Beli Kamen), phosphate (Lisina-Bosilegrad), fluorite (Ravnaja-Krupanj), gypsum (Gruža), baryte (Eastern Serbia), boron minerals (Baljevac on the Ibar, Lozničko Polje), zeolite (Zlatokop at Vranje, Fruška Gora and Igroš at Brus), etc.

The exploitation of minerals which are used as construction materials or for the production of construction materials is widely spread. The largest deposits of good quality gravel and sand are found in the alluvions of the Južna, Zapadna and Velika Morava and the Danube.

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<sup>3</sup> Spatial plan of the Republic of Serbia from 2010 to 2020

The deposits of quality limestone used as technical stone can be found throughout Serbia, and exploitation is active in: Bistrica and Surduk, Jelen Do, Nepričava, Ba village, Ljig, Slavkovića, Batočina, Raška and others. One of the best known raw materials for producing construction materials is marl cement, deposits of which are exploited in Beočin, Kosjerić, Popovac, and at Vladičin Han and balance reserves have been defined.

There are numerous refractory and ceramic clay deposits in the Šumadija (Rudovci, Krušik, Vrbica, Pločnik, Slatina, etc.) zone, kaolin clays are exploited at Arandelovac and Rudovci, while bentonite clays can be found on a number of sites (Vrdnik, Vlasotince, etc.). Brick clays are used on many sites, particularly in Vojvodina where they represent the raw material base for smaller or larger brickyards.

The exploitation of non-metals is highly developed (particularly the deployment of construction materials) and it can be said that with the proper exploitation and realisation of safeguards, there are no special adverse effects on water quality.

Energy raw materials have been observed in the Strategy regarding Serbia's long-term energy development until 2015, which stipulates that the volume and structure of energy resources in Serbia are very unfavourable. The reserves of quality energy generating products, such as oil and gas, are low and make up less than 1% of the total balance reserves in Serbia, while the remaining 99% of energy reserves include various types of coal, predominantly containing brown coal of low quality (with an over 92% share in the total balance reserves). This particularly applies to brown coal which is exploited in mines with open-cast exploitation, with approximately 13,350 million tonnes as the total exploitation reserve. From the geographical standpoint, there is 14% in the Kolubara Basin, 3.3% in the Kostolac basin, while the Sjenica and Kovin basins contain only 2.7% of these reserves. By far the largest share of brown coal reserves (over 76%) are found in the Kosovo and Metohija Basin. Table 7 shows disproportions between geological and exploitation reserves of coal, oil and natural gas.

Table 7: Total reserves of fossil fuels in Serbia

Energy resource	Exploitation reserves (Mten*)	Geological reserves (Mten)
Brown coal (open-cast exploitation)	2,616	3,753
Hard coal and black coal (underground exploitation)	125	130
Oil and natural gas	20	60

\*million TOE

Brown coal open-cast exploitation significantly influences groundwater management, which can threaten the local water sources near open-cast mining. Therefore the investors of these works are obliged to provide adequate solutions to supply water to all consumers in areas under threat.

The greatest reserves of oil and gas in Serbia have been discovered on the territory of Vojvodina (approximately 97%) with a possibility to discover new reserves under the slightest risk of explorations. Over 220 highly perspective deposits of hydrocarbon were discovered in this territory, on which the production of oil and gas has been based for over 50 years. The highly perspective deposits are located in tertiary depressions in Vojvodina, with sediments of medium thickness 2,000 m (maximum thickness over 4,000 m), with developed bedrock and favourable conditions for oil and gas generation.

There is a risk of incidents in the case of petroleum products at the very source and along the line of oil pipeline installations, particularly at the points of extraction. Therefore, it is necessary to undertake appropriate precautionary measures, starting with remedial measures for exploratory boreholes and the prevention of any form of mixing with neogene aquifers which are often sources of the water supply, to the construction of sealing bundwalls.

Our country has registered a number of oil shale occurrences but until today, excluding the Aleksinac Basin, there have not been serious exploratory activities to determine the reserves, quality and other indicators relevant for the projection of production and processing. It is estimated that the total reserve of category C<sub>2</sub> shales amounts to approximately 8 billion tonnes. Oil shales have the widest distribution in the Timok zone and the eastern part of the Južna Morava Basin at Aleksinac. The oil shale reserves in this deposit are estimated at over 2 billion tonnes, containing 200 million tonnes of organic matter.



Figure 11: Mineral raw materials (Spatial plan of the Republic of Serbia, 2010 - 2020)

## Biodiversity

The general characteristics of biodiversity in the Republic of Serbia is high genetic, species and ecosystem diversity, whereby biological resources, both potential resources and those that are more or less exploited, have relatively restricted capacities, that is, the biodiversity is rich in quality but poor in quantity.

The Balkan Peninsula represents one of the 25 world centres of biodiversity. Although Serbia covers only 1.9% of the European continent, the majority of European ecosystems are present within its territory:

- European vascular flora – 39%;
- European fish fauna- 51%;
- European reptile and amphibian fauna – 49%;
- of European bird fauna – 74%;
- of European mammal fauna – 67%.

Approximately 44,200 taxa have been officially registered in the Republic of Serbia (species and subspecies). With 3,662 defined taxa of vascular plants in the species and subspecies range (39% of total European flora), Serbia has been classified as one of the countries with the highest flora diversity in Europe. Within the Republic, 625 species of fungi (Macromycetes) have been registered and described, as well as 586 species of lichen, whereby it is estimated that the number of fungi species is far greater. Out of 178 species found in the European Red List, there are 42 species present in Serbia, which means 23.6%. Between 98 and 110 fish and cyclostomata species have been registered to date. A total of 13 species have been submitted for the Serbian Red List of vertebrates, and 19 taxa of international importance have been registered. There are 21 amphibian species and 25 reptile species living in Serbia, including approximately 20 subspecies. The number of birds in all categories (breeding birds, birds which spend winter in Serbia, those which are registered when migrating, potentially present birds) is approximately 360, while there are 343 bird species of international importance. There are 94 registered mammal species, making 50.51% of the total European teriofauna. Of that number, 68 species are found in the Serbian Preliminary Red List of vertebrates, with 16 species in the European Red List.

The protection of extinct and endangered species and their habitats represents the manner in which to impede the decline rate of biodiversity in Serbia. This is regulated by the Law on Nature Protection (“Official Gazette of the RS”, nos. 36/09, 88/10, and 91/10 - corrigendum) and by secondary regulatory legislation in this domain.

To implement protection measures and conservation of biodiversity, apart from federal legislation, Serbia also applies the provisions of international conventions as their state signatory:

- The Convention on Biodiversity,
- Ramsar Convention - the Convention on Wetlands with international importance, particularly wetland birds habitats,
- CITES Convention - the Convention on International Trade in Endangered Species of Wild Flora and Fauna,
- Bern Convention - the Convention on the Conservation of European Wildlife and Natural Habitats,
- Bon Convention - the Convention on the Conservation of Migratory Species of Wild Animals.

Basic problems in the conservation and protection of biodiversity are: infringement of prescribed regimes and measures for the protection of plants and animals, landscape and geological heritage, primarily due to excessive exploitation of natural resources, poor coverage by urban planning documentation and the prominent illegal construction of facilities in protected areas, insufficient public investments in the conservation and sustainable development of the most representative areas and key types of biodiversity in the Republic of Serbia, radical change of habitat conditions, fragmentation

and/or destruction of natural ecosystems due to various forms of anthropogenic impacts, change of land use of woodland and agricultural areas, illegal and/or incompetent picking of certain commercial species (mushrooms, herbs, etc.), insufficient implementation of regulations by competent inspection services, insufficient support for keeping cost effective primitive breeds, species, sorts and types of domestic animals and grown plants in the ambient of constant modernisation of the composition of breeds and sorts, which brings about the reduction of the diversification of genetic material in agriculture under market pressure.

National objectives for the conservation of biodiversity in Serbia are laid down in *the Biodiversity Strategy of the Republic of Serbia for the period 2011 - 2018* which includes international principles in this filed.

### **Protected areas of natural goods**

The surface area of protected areas in Serbia currently amounts to 518,003 ha, which is 5.86% of the Serbian territory in total (approximately 6.7% of the Serbian territory excluding the territory of Kosovo and Metohija), while the Spatial Plan of the Republic of Serbia envisages that by 2015 approximately 10% of the total Serbian territory shall be protected and that by 2021 12% of the total territory shall be under some form of protection.

There are 461 natural goods under protection:

- 5 national parks (158,986 ha);
- 16 nature parks (213,303 ha);
- 16 landscapes with exceptional characteristics (45,656 ha);
- 67 nature reserves (88,868 ha);
- 42 protected areas of cultural and historic value (2,507 ha);
- 315 nature monuments (88,868 ha).

Apart from protected natural goods, there are 1,760 strictly protected and 868 protected wild species of plants, animals and fungi. They are protected in accordance with the Law on Nature Protection, on the basis of the Rulebook containing the lists of strictly protected and protected wild species, as well as protection measures.

Based on the implementation of international conventions and programmes, Serbia has so far identified the following areas: nine Ramsar Areas (in accordance with the Ramsar Convention, i.e. the Convention on the Protection of Wetlands with international importance, particularly as habitats of wetland birds, they have been declared as internationally important wetlands); areas of international importance for plants (61 Important Plant Areas), areas of international importance for birds (within the framework of the Important Bird Area/IBA programme - there are 42 areas), and selected areas for prime butterflies (Prime Butterfly Areas/PBA - 40 areas), as well as 61 Emerald areas (nominated for the "Emerald" European Ecological Network, comprised of areas of special interest for the conservation of European wild flora and fauna and their natural habitats, based on the Bern Convention). These areas are part of the Serbian Ecological Network which includes 101 natural goods (the Ecological Network Regulation, "Official Gazette of the Republic of Serbia", no. 102/10).

Based on the aforementioned, a map has been prepared (Figure 12) showing areas for the protection of habitats or species, where an important element of their protection is the maintenance or improvement of the water status.

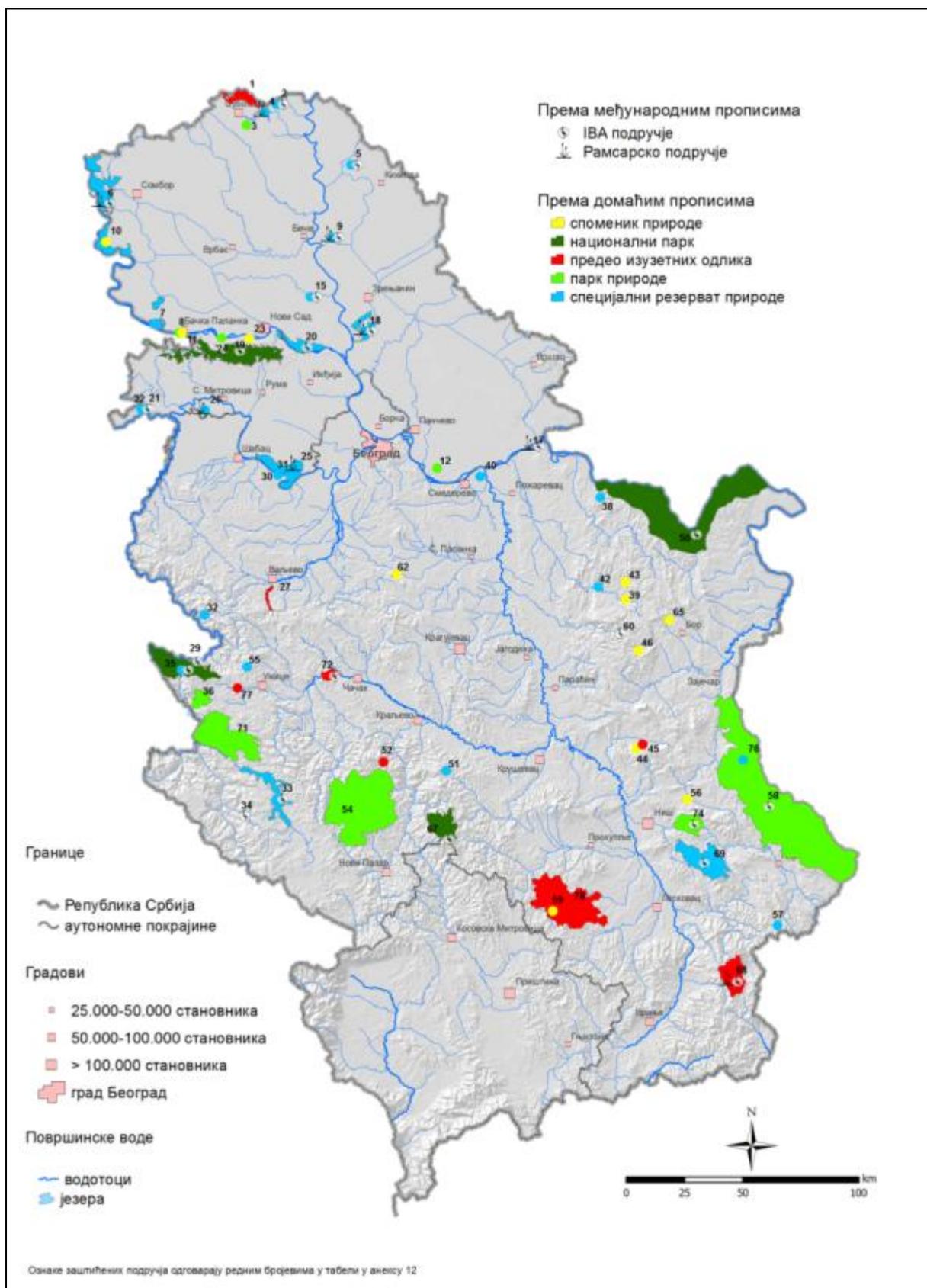


Figure 12: Protected natural goods (source: documentation database - Institute "J. Černi")

According to international provisions

IBA area

Ramsar area

According to domestic provisions

nature monument

national park

landscape with exceptional characteristics

nature park

special nature reserve

Border

The Republic of Serbia

Autonomous Provinces

Towns/cities

25,000 - 50,00 inhabitants 50,000 – 100,000 inhabitants

>100,000 inhabitants

The City of Belgrade

Surface water

waterways

lakes

Protected area labels correspond to ordinal numbers in Annex 12 Table

## **2.2. SOCIAL AND ECONOMIC FACTORS**

### **2.2.1. Demographic indicators**

#### **Population**

According to the results of the population census in 2011, published by the Statistical Office of the Republic of Serbia (SORS), 7,186,862 inhabitants live on the territory of Serbia<sup>4</sup> (Figure 13), or 92 inhabitants per km<sup>2</sup>. Serbia is a moderately populated European country.

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<sup>4</sup> Data in this chapter do not include the data for Kosovo and Metohija due to the fact that its territory was not covered by the 2011 Census.

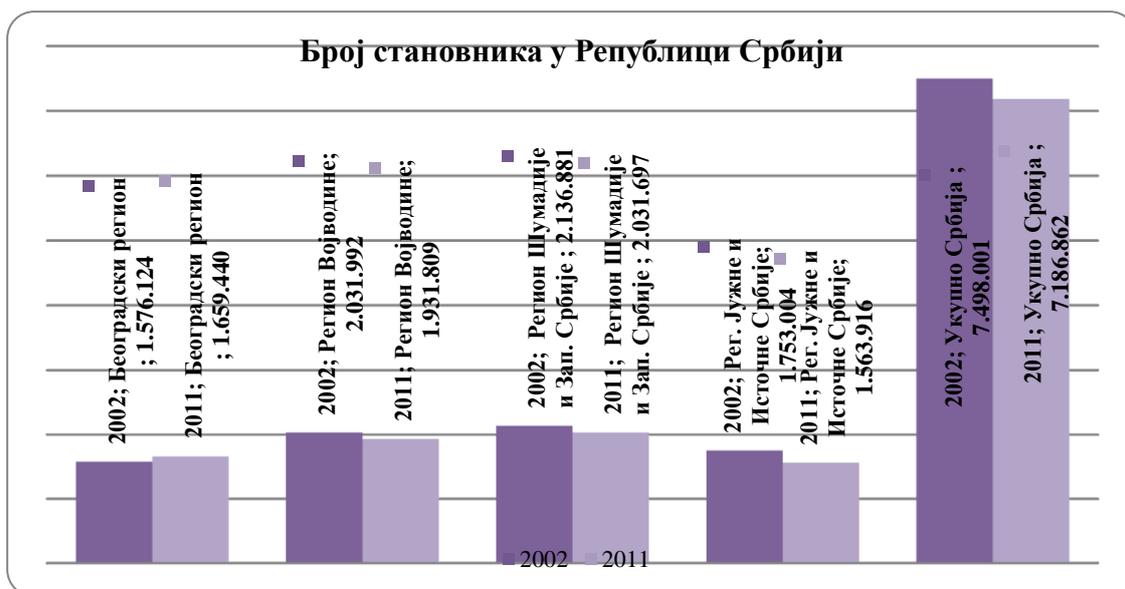


Figure 13: Number of inhabitants per region, in 2002 and 2011

- 2002: Belgrade Region 1,576,124
- 2011: Belgrade Region 1,659,440
- 2002: Vojvodina Region 2,031,992
- 2011: Vojvodina Region 1,931,809
- 2002: Šumadija and Western Serbia Region 2,136,881
- 2011: Šumadija and Western Serbia Region 2,031,697
- 2002: Southern and Eastern Serbia Region 1,753,004
- 2011: Southern and Eastern Serbia Region 1,563,916
- 2002: Total in Serbia 7,498,001
- 2011: Total in Serbia 7,186,862

During the last decade Serbia has faced a population regression, that is, the reduction of the total number of inhabitants due to a drop in natality, an increased rate of mortality, concentration of its population in urban areas and abandonment in rural areas, as well as extreme demographic ageing of its population. Having in mind the dynamics between two censuses, the number of inhabitants was reduced by 78,836, which means an annual reduction of 7,166 inhabitants, or in line with the average annual rate of -1,0%. Depopulation continued after 2002, following even more intense dynamics. On the basis of the above results of the 2011 Census, the number of inhabitants in Serbia dropped by 311,139 (4 %) comparing to 2002. The main reason for the reduction in the number of inhabitants is, apart from a decrease in the natality rate and migration abroad, a boycott of the census in three municipalities in Southern Serbia. The prominent trend of depopulation is primarily common in underdeveloped and borderline municipalities and leads to complete demographic abandonment in these areas.

Figure 14 shows the number of inhabitants according to water areas



Figure 14: The number of inhabitants in water areas according to the data of the 2011 Census

Number of inhabitants;  
 Banat and Bačka; 1,595,055  
 Number of inhabitants;  
 Srem; 336,754  
 Number of inhabitants;  
 Belgrade; 1,659,440  
 Number of inhabitants;  
 The Lower Danube; 448,307  
 Number of inhabitants;  
 The Morava; 2,540,618  
 Number of inhabitants;  
 The Sava; 606,688

### Settlements

In Serbia in 2011 there were 4,710 registered settlements<sup>5</sup>, which is 3 settlements more comparing to the prior census. The average number of inhabitants per settlement is approximately 1,530. The majority of settlements have no more than 2,000 inhabitants (approximately 90%) and they are populated by 1.8 million inhabitants (approximately 25% of the total number), while the share of the number of inhabitants in settlements with more than 100,000 inhabitants amounts to 20% (Table 8). Migration processes have been recorded in settlements with less than 10,000 inhabitants. The level of urbanisation in a great number of settlements, and/or the level of social and municipal standards of the majority of population is not satisfactory.

Demographic data is a basis from which to plan societal development, including the water sector, in order to determine water supply needs and the degree of connectivity to the public water supply system and the collection, abstraction and treatment of municipal wastewater system, to plan and scale these systems as well as other facilities and systems as segments in water management.

Table 8: Settlements and population between the two censuses

Size of the settlement	2002 Census		Number of	2011 Census		Share of the total no. of inh.
	Number of	Number of inhabitants		Number of inhabitants	2011/2002 %	

<sup>5</sup> A settlement is a part of the municipal territory which has infrastructure for habitation and economic activities, basic municipal infrastructure and other facilities to meet the needs of inhabitants who are permanent residents

	settlements		settlements			%
< 2 000	4,208	2,012 385	4,261	1,835,149	91.2	25.5
2 000-10 000	405	1,587,428	358	1,445,375	91.1	20.1
10 000-50 000	68	1,406,701	66	1,459,508	103.8	20.3
50 000-100 000	17	1,115,777	16	1,047,512	93.9	14.6
>100 000	9	1,375,710	9	1,399,318	101.8	19.5
<b>Serbia</b>	<b>4,707</b>	<b>7,498,001</b>	<b>4,710</b>	<b>7,186,862</b>	<b>95.8</b>	<b>100.0</b>
>2 000	499	5,485,616	449	5,351,713	97.6	74.5

Source: RSO

## 2.2.2. Economic factors

### Gross Domestic Product

Gross domestic product (GDP)<sup>6</sup>, which represents the most important macroeconomic aggregate of a national economy and an indicator of its productivity and efficiency in the production of products and services required for different forms of consumption, has been the best indicator of big changes in Serbia's economy over recent years (Table 9). Namely, after high economic growth rates in the period between 2001 and 2008 (an average growth rate of 4.95%) there was a break in Serbia's economic trend in the second half of 2008, resulting from the influence of the negative effects of the global financial and economic crisis on Serbia's economy and finances. The crisis caused economic activity and foreign trade to slow down and decrease, which was the result of decreased foreign and domestic demand and the reduction of foreign capital inflows due to the caution of investors and the degradation of conditions on world financial markets.

Table 9: Indicators of GDP developments between 2008 and 2012

Ord. no.	Denomination indicator	Unit	Amount				
			2008	2009	2010	2011	2012
1	Gross Domestic Product GDP	bil. RSD	2,661	2,720	2,882	3,209	3,349
2	Gross Domestic Product GDP	mil. €	32,668	28,957	27,968	31,472	29,601
4	GDP per capita	€	4,445	3,955	3,836	4,351	4,112
5	GDP real growth in %		3.8	-3.5	1.0	1.6	-1.5
6	Industrial production developments	%	1.1	-12.1	0.0	2.5	-2.2

Source of data: National Bank of Serbia and RSO

The wave of recession had the greatest impact on industrial production in Serbia so that the whole industry growth in the period between 2001 and 2008 was annulled during the crisis in 2009, when a drop of -12,1% was registered (Figure 15). The number of employees in this domain was then halved.

<sup>6</sup> Sum of added values according to activities and total taxes on products minus the amount of subsidies on products and the amount of FISIM, at the gross economic level

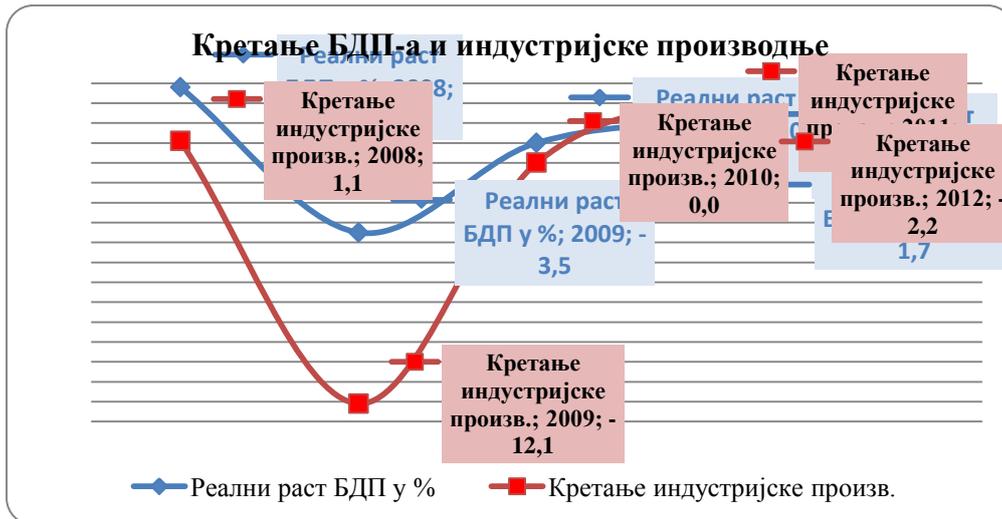


Figure 15: Development rates for GDP and industrial production for the period 2008-2012

Development rates for GDP and industrial production

Industrial production development; 2008; 1.1

Real GDP growth in %; 2008; 3.8

Real GDP growth in %; 2009; 3.5

Industrial production development; 2009; -12.1

Real GDP growth in %; 2010; 1.0

Industrial production development; 2010; 0.0

Industrial production development; 2011; 2.5

Industrial production development; 2012; 2.2

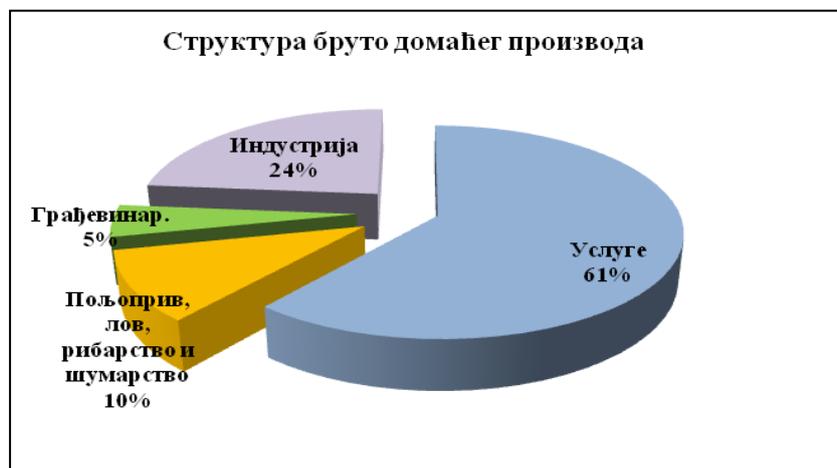
Real GDP growth in %; 2011; 1.6

Real GDP growth in %; 2012; 1.7

Real GDP growth in %;

Industrial production development

In the majority of economic sectors there was a continued drop of activities even after 2009 (the greatest drop was in the construction sector), excluding agriculture sector and the services sector.<sup>7</sup> The services sector has the greatest share in the structure of gross domestic product in 2012 (Figure 16).



<sup>7</sup> Included retail and wholesale services, traffic and storage services, tourist services, financial services, insurance services, public administration services and social and healthcare services, banking services, etc.)

Figure 16: The share of certain activities in the structure of GDP

#### GDP Structure

Industry 24 %

Construction 5 %

Services 61 %

Agriculture, hunting, fisheries, forestry 10 %

The contribution of certain regions in the creation of GDP was monitored during 2012 (Regional GDP). GDP regionalisation is based on the principle of distribution of added value of market operators according to the location of work, i.e. local units where added value is actually generated, and not according to the head office of the market operator<sup>8</sup>.

Serbia is characterised by unbalanced regional development (Figure 17). A necessary, more balanced regional development requires appropriate measures to be taken within the domain of infrastructure development, incentive measures for the creation of an attractive economic atmosphere (industrial zones and business incubators, favourable loans, etc.) and human resources trained for the implementation of development projects.

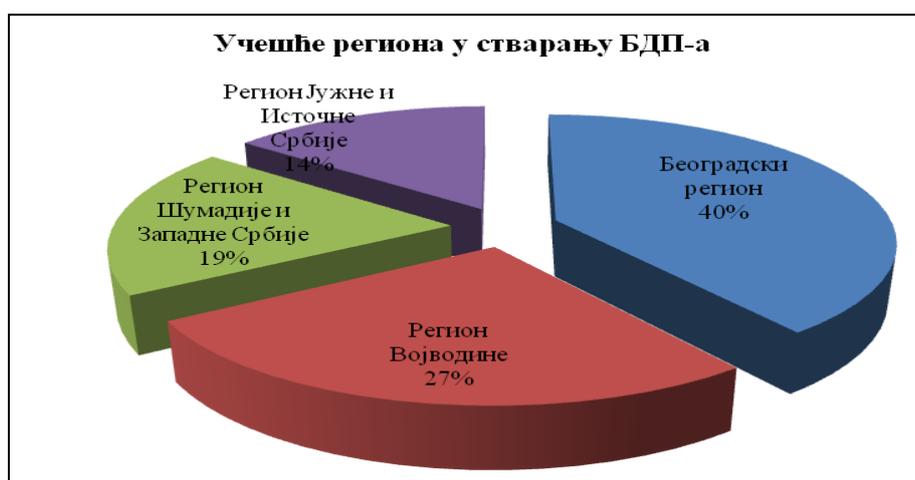


Figure 17: The share per region in the participation of GDP in 2012

The share of regions which participate in the GDP

Southern and Eastern Serbia 14 %

Western Serbia and Šumadija Region 19 %

Vojvodina Region 27 % Belgrade Region 40 %

#### Other economic indicators

The dynamics and the structure of economic growth until 2012 were not adequate for Serbia to create new comparable advantages in international exchange (Table 10).

<sup>8</sup> The principle of regional accounts is of special importance, particularly if you consider that large economic systems, which represent the backbone of the Serbian economy (including public enterprises and public authorities and institutions), as a general rule have a wide geographical dispersion of organisational units (installations, business units, etc.) where each unit represents an important centre of economic activity within the territory of a municipality or region in which it is located (Serbian Post, NIS, the Ministry of Internal Affairs), large retail chains, etc.).

Table 10: Macroeconomic indicators

Ord. no.	Denomination indicator	Unit	Amount				
			2008	2009	2010	2011	2012
1.	Deficit in the exchange of goods	mil. €	-9.049	-5.543	-5.729	-5.809	-5.587
2.	Foreign direct net investments	mil. €	1.824	1.373	860	1.827	232
3.	Investment ratio	% GDP	21.9	16.6	17.1	18.3	14.6
4.	Consumer price growth, Annual average	%	8.6	8.4	6.5	11.0	7.5
5.	Number of employees, average	thsnd.	1,999	1,889	1,796	1,746	1,725.0
6.	Unemployment rate	-	14.4	16.9	19.2	23.0	23.9
7.	Net wages, average of the period	RSD	32,746	31,733	34,142	37,976	41,377
8.	The real growth of net wages	-	3.9	0.2	0.7	0.2	1.0

Source of data: NBS and RSO

Sectors which produce exchange goods (agriculture, processing industry) showed below average growth, while leading service sectors (trade, information and communication activities and financial activities) showed the growth rates above the average value. The reduction of the processing industry's and exchange goods' share in the creation of GDP is a feature of the above period, whereby in the service sector it has become the main generator of economic growth. The underdevelopment of the exchange goods sector has influenced the more rapid growth of import in comparison with export, so one of the features of the observed period is also a high import dependency as well as a small share of export in GDP (approximately 25%). Investments did not provide the kind of export growth of exchange goods which could contribute to the reduction of the external debt. Current investment activity, with regard to developmental needs and despite a somewhat improved macroeconomic atmosphere, is still at a low level. The value of foreign direct net investments and the investment ratio are constantly decreasing. At the same time, Serbia's public debt is very high and shows an upward trend. At the end of 2012, the total external debt of the state, according to NBS data, amounted to EUR 25.7 billion (Figure 18).

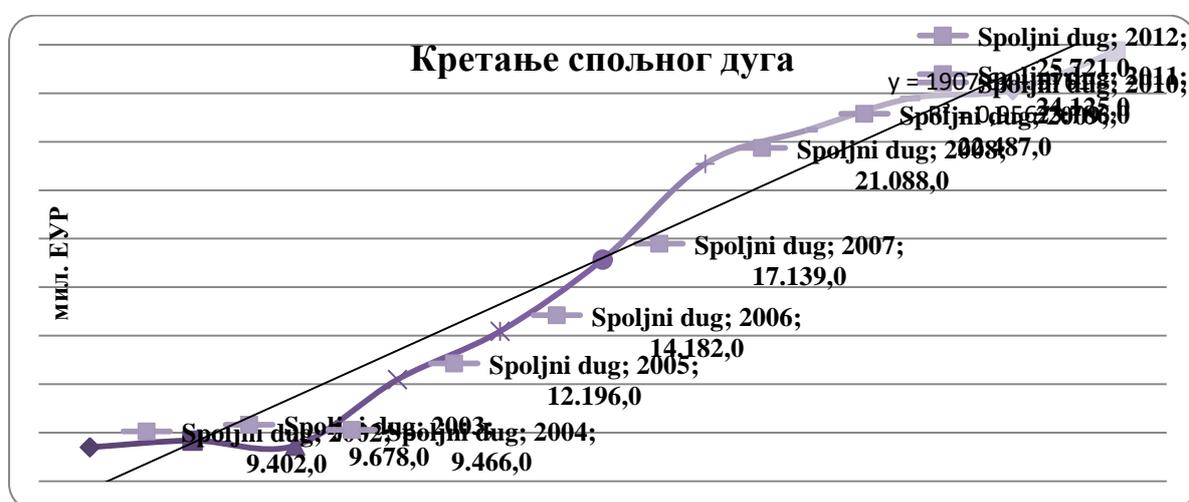


Figure 18: Developments in Serbia's external debt from 2002 to 2012

#### Developments in external debt EUR million

These changes have been reflected in the water sector. Investments in the water sector have decreased significantly in the last ten years, both for the maintenance of existing infrastructure facilities and for the development of new capacities. Table 11 shows the data on total investments in Serbia and investments in the activity of water supply and wastewater collection, abstraction and treatment

(channelling in settlements) on the basis of which it can be seen that the investment share in this activity of total investments is very low and shows a downward trend. For the purpose of investment activities, an average of EUR 120 - EUR 150 million was allocated in all areas of the water sector, in the three preceding years, which is significantly lower than what is required. The maintenance of facilities and systems registered as public property was insufficient and without compliance with corresponding standards, which affected the water sector as well.

Table 11: Total investments and investments in water supply and channelling in settlements<sup>9</sup>

Investments	Total in RSD 000			Total in € <sup>10</sup> 000		
	2010	2011	2012	2010	2011	2012
<b>Total in the Republic of Serbia</b>	<b>425,400,001</b>	<b>493,100,031</b>	<b>608,508,303</b>	<b>4,128,370</b>	<b>4,836,685</b>	<b>4,358,703</b>
Belgrade region	210,458,922	236,662,136	220,957,429	2,042,436	2,321,355	1,953,129
Vojvodina	100,024,608	124,208,129	150,389,309	970,707	1,218,324	1,329,350
Reg. of Šumadija and Western Serbia	63,607,782	70,519,047	157,225,029	617,293	691,702	1,389,773
Southern and Eastern Serbia Region	42,280,261	52,759,235	67,503,873	410,316	517,501	596,693
Unallocated	9,028,428	8,951,484	12,432,663	87,618	87,803	109,897
<b>Activity: water supply and channelling in settlements</b>	<b>13,144,166</b>	<b>12,062,500</b>	<b>12,387,606</b>	<b>127,560</b>	<b>118,318</b>	<b>109,499</b>
Belgrade region	2,456,819	5,259,278	4,200,907	23,843	51,587	37,133
Vojvodina	2,339,545	3,781,136	4,280,080	22,705	37,088	37,833
Reg. of Šumadija and Western Serbia	4,258,793	1,887,473	1,567,806	41,330	18,514	13,858
Southern and Eastern Serbia Region	735,503	1,105,109	2,338,369	7,138	10,840	20,670
Unallocated	3,353,506	29,504	444	32,545	289	4
<b>% share of the activity in total investments</b>	<b>3.09</b>	<b>2.45</b>	<b>2.04</b>			
Belgrade region	1.17	2.22	2.79			
Vojvodina	2.34	3.04	2.85			
Reg. of Šumadija and Western Serbia	6.70	2.68	1.00			
Southern and Eastern Serbia Region	1.74	2.09	3.46			

Source of data: RSO Municipalities and regions in RS 2011, 2012 and 2013.

The socio-economic state in the previous period is characterised by:

- the reduction of the total number of inhabitants, concentration of the population in urban areas and extreme demographic ageing of the population;
- a low level of GDP and an average trend of decrease after 2008 so that in 2012 it was lower by 30%<sup>11</sup> in comparison with 1989 (the last year before transition);
- decrease in industrial production, which is more rapid than the decrease of GDP, so that the service sector becomes the main generator of economic growth;
- a low level of investment activities, in particular with regard to developmental needs, and a constant drop of the investment ratio;
- Serbia's very high public debt which still shows an upward trend.

The described indicators of the socio-economic state of Serbia indirectly influence all areas of the water sector for whose operation and development constantly decreasing resources are provided and set aside. Namely, the maintenance of facilities and systems as public property is performed without the consideration of adequate standards and with limited resources, and investment activities, apart

<sup>9</sup> Investments in the activity of water supply and channelling in settlements have an 85% to 90% share of total investments in the water sector. Others are investments in the protection against harmful effects of waters and in hydro-reclamation.

<sup>10</sup> NBS: average exchange rate in dinars: in 2010 EUR 1 = 103.0431; in 2011 EUR 1 = 101.9502; in 2012 EUR 1 = 113.1277

<sup>11</sup> Other states in transition increased their GDP by an average of over 40% during this same period

from the nominal drop from year to year, also take record of a decreasing share in total national investments. This means that the development of water services was not observed and all investments in that area were significantly lower than those of which were required.

### 3. CURRENT SITUATION IN WATER MANAGEMENT

#### 3.1. SITUATION DEPENDING ON WATER SECTOR ACTIVITIES

##### 3.1.1. Water regulation and usage

This sector of water activity includes water regulation and usage for various purposes (supplying the population and industry with water, irrigation, water-power supply, navigation, fish breeding, sport, recreation and tourism), as well as small water improvement with the aim to assure good conditions in aquatic and coastal systems and increase water quantity during low-water periods.

Through water regulation, better spatial and time uniformity of water resources is provided and basic preconditions are created for the fulfilment of various and complex water needs in space and time. This is achieved thanks to complex hydro-systems, regional and/or multi-purpose, which are shown in a separate chapter owing to their importance.

##### Public drinking water supply

Even though, in the Republic of Serbia, supplying water to separate entities (fortified towns, courts, religious facilities) has been around since the distant past, contemporary water supply lines appeared as late as the end of the nineteenth century. However, their development was not intensive. Prior to the beginning of World War II only 17 settlements had public water supply lines.

Somewhat more intensive development of water supply commenced in the middle of twentieth century. A document entitled the Basics of Long-term Water Supply for the Population and Industry on the Territory of the Socialist Republic of Serbia outside the Territory of Autonomous Provinces, was published in 1977 and was of significant importance. However, during the realisation of this document significant deviations occurred, since, instead of the implementation of complex solutions, the water supply issue was resolved dominantly through so-called transitional solutions.

The number of beneficiaries comprised by the public water supply system increased in time, as well as the specific consumption in cities, amounting to around 100 l per beneficiary per day in the year 1950, over 390 l/ben/day in 1981, and up to 460 l/ben/day in 1991<sup>12</sup> (primarily due to industrial development). In recent times, however, owing to reduced economic activities, specific production decreased to around 320 l/ben/day. As for the quantity of population encompassed by organised water supply, it can be concluded that the percentage of the population connected to public water supply systems amounts to around 81% in recent periods, in Serbia (excluding Kosovo and Metohija) (Tables 12 and 13). This percentage is lowest in Central Serbia (71%), whereas it is significantly higher in Belgrade (92%) and in Vojvodina (91%). It has been estimated that the population comprised by systems is primarily concentrated in a smaller number of settlements (a bit more than one third of the total number of settlements) with higher population density.

Table 12: Population connected to public water supply systems in 2012  
by district

No.	District	Number of citizens (NC), number of beneficiaries (NB) and coefficient of connectivity (CC)
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<sup>12</sup> Data taken from *Water Management Basics of RS*

No.	District	Number of citizens (NC), number of beneficiaries (NB) and coefficient of connectivity (CC)		
		NC	NB	CC
1	North Bačka	186,906	164,674	0.88
2	Central Banat	187,667	173,200	0.92
3	North Banat	147,770	134,673	0.91
4	South Banat	293,730	250,719	0.85
5	West Bačka	188,087	171,806	0.91
6	South Bačka	615,371	577,460	0.94
7	Srem	312,278	279,935	0.90
8	<b>Vojvodina in total (Σ1÷7)</b>	<b>1,931,809</b>	<b>1,931,809</b>	<b>0.91</b>
9	<b>The City of Belgrade</b>	<b>1,659,440</b>	<b>1,518,877</b>	<b>0.92</b>
10	Mačva	298,931	196,767	0.66
11	Kolubara	174,513	131,641	0.75
12	Podunavlje	199,395	137,417	0.69
13	Bраниčevo	183,625	123,992	0.68
14	Šumadija	293,308	258,800	0.88
15	Pomoravlje	214,536	140,266	0.65
16	Bor	124,992	86,958	0.70
17	Zaječar	119,967	103,282	0.86
18	Zlatibor	286,549	193,642	0.68
19	Morava	212,603	170,797	0.80
20	Raška	309,258	238,304	0.77
21	Rasina	241,999	180,937	0.75
22	Niš	376,319	183,098	0.49
23	Toplica	91,754	53,335	0.58
24	Pirot	92,479	72,795	0.79
25	Jablanica	216,304	155,850	0.72
26	Pčinja	159,081	135,701	0.85
27	<b>Total Cent. Serbia (Σ 10÷26)</b>	<b>1,518,877</b>	<b>1,518,877</b>	<b>0.71</b>
28	<b>TOTAL Serbia without Kosovo</b>	<b>7,186,862</b>	<b>7,186,862</b>	<b>0.81</b>

Source: RSO

Table 13: Population connected to public water supply systems in 2012 by water area

No.	Water areas	Number of citizens, number of beneficiaries and coefficient of connectivity		
		NC	NB	CC
1	Bačka and Banat	1,595,055	1,458,279	0.91
2	Belgrade	1,659,440	1,518,877	0.92
3	Lower Danube	448,307	318,360	0.71
4	Morava	2,540,618	1,839,755	0.72
5	The Sava	606,688	405,467	0.67
6	Srem	336,754	293,988	0.87
7	<b>TOTAL Serbia without Kosovo</b>	<b>7,186,862</b>	<b>5,834,726</b>	<b>0.81</b>

#### Abstracted quantities, type of drinking water sources and specific water consumption

At the start of the XXI century, average yearly abstraction relating to the public water supply systems amounted to around 23 m<sup>3</sup>/s of water (around 730 million m<sup>3</sup>) in Serbia, excluding Kosovo and Metohija. The quantity decreased gradually, due to unfavourable demographic movements, increased system rationality in some large cities, as well as owing to lower economic activity, so that around 21.6 m<sup>3</sup>/s, *i.e.* around 680 million m<sup>3</sup> was abstracted for these purposes in 2012. Abstracted water quantities by districts and water areas as well as water source types for 2012 are shown in Tables 14 and 15.

A far more common source of water for the population's drinking water supply is groundwater, both for municipality centres and smaller settlements. 15-17 m<sup>3</sup>/s is abstracted from 157 water sources with different aquifer types for the public supply of municipal centres with water. Most water is abstracted from alluvial sources (over 40%), karst water sources (over 20%), whereas fracture aquifers have been used the least as groundwater water sources(Figure 19).

Table 14: Abstracted water quantities and water sources for the public water supply, by district

District	Abstracted water 2012		Type of drinking water source in %	
	l/s	10 <sup>6</sup> m <sup>3</sup> /yr	Surface water	Ground water
1 Northern Bačka	332	10.48	0	100
2 Central Banat	426	13.43	0	100
3 Northern Banat	302	9.52	0	100
4 Southern Banat	758	23.92	0	100
5 Western Bačka	381	12.02	0	100
6 Southern Bačka	1,612	50.83	0	100
7 Srem	807	25.44	0	100
<b>Vojvodina in total (Σ1÷7)</b>	<b>4,618</b>	<b>145.63</b>	<b>0</b>	<b>100</b>
<b>8 The City of Belgrade</b>	<b>7,146</b>	<b>225.35</b>	<b>45</b>	<b>55</b>
9 Mačva	724	22.85	0	100
10 Kolubara	468	14.77	45	55
11 Podunavlje	475	14.98	0	100
12 Braničevo	430	13.56	0	100
13 Šumadija	851	26.85	71	29
14 Pomoravlje	510	16.09	0	100
15 Bor	462	14.57	17	83
16 Zaječar	520	16.40	42	58
17 Zlatibor	1,149	36.22	51	49
18 Morava	259	8.17	83	17
19 Raška	965	30.45	45	55
20 Rasina	538	16.96	66	34
21 Niš	1,310	41.31	5	95
22 Toplica	97	3.07	48	52
23 Pirot	263	8.30	0	100
24 Jablanica	374	11.80	22	78
25 Pčinja	442	13.94	69	31
<b>Total Cent. Serbia (Σ9÷25)</b>	<b>9,839</b>	<b>310.27</b>	<b>35</b>	<b>65</b>
<b>TOTAL Serbia without Kosovo and Metohija</b>	<b>21,602</b>	<b>681.25</b>	<b>31</b>	<b>69</b>

Source: RSO

Table 15: Abstracted water quantities and water sources for the public water supply, by water area

Water area	Abstracted water 2012		Type of drinking water source in %	
	l/s	10 <sup>6</sup> m <sup>3</sup> /yr	Surface water	Ground water
1 Bačka and Banat	3,785	119.36	0	100
2 Belgrade	7,146	225.35	45	55
3 Lower Danube	1,379	43.48	17	83

4 Morava	7,026	221.61	41	59
5 The Sava	1,433	45.18	19	81
6 Srem	833	26.27	0	100
<b>TOTAL Serbia without Kosovo and Metohija</b>	<b>21,602</b>	<b>681.25</b>	<b>31</b>	<b>69</b>

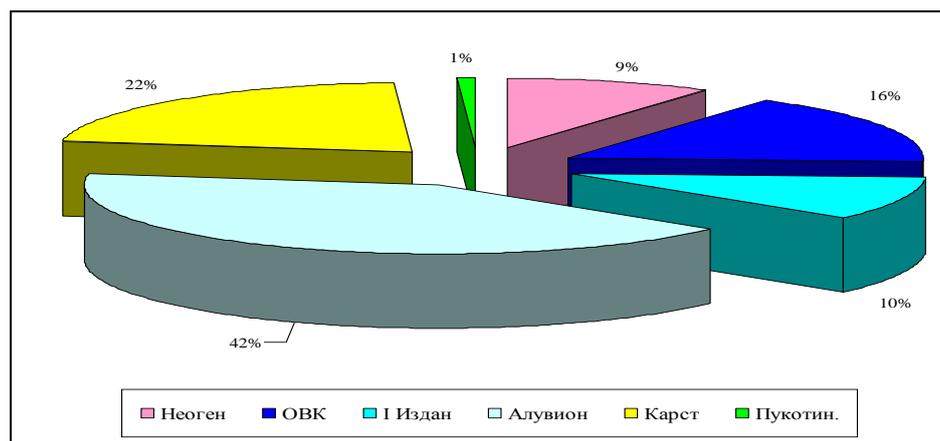


Figure 19: Representation of aquifer types relating to the water supply of municipal centres Neogene, BWC, and Aquifer, Alluvion, Karst, Fracture

RSO data (on abstracted water and beneficiaries of the public water supply) show that heterogeneity related to the value of specific consumption is significant in Serbia, as well as in certain districts, which is derived from the fact that all centres have not experienced the same level of economic development, as well as utility infrastructure (incomplete systems, an insufficiently maintained network, the consequences of which are great losses, etc.). If one observes larger spatial areas, it can be said that Vojvodina has the lowest average consumption (around 230 l/ben/day). This quantity amounts to around 330 l/ben/day in Central Serbia, a slightly higher quantity than the Republic average (around 320 l/ben/day), whereas the city of Belgrade has the largest specific consumption (around 400 l/ben/day).

#### Drinking water treatment according to regional and local water distribution systems

Water in water sources pertaining to regional water distribution systems are mostly treated by complex technological procedures. Water Source Sveta Petka presents an exception when it comes to Paraćin and Čuprija's water supply as well as several smaller systems where the chlorating of water is performed only. Table 16 shows a complete review of regional and local systems by districts, with information on whether the treatment of drinking water is presented within those systems.<sup>13</sup>

Generally speaking, the activities conducted by facilities which prepare drinking water can be evaluated as satisfactory, even though issues regarding how some of these facilities operate exist.

<sup>13</sup> Note: the "no" indicator stands at the territorial units whose water distribution systems do not have any other water treatment, other than disinfection, and capacity info is not provided for said. On the other hand, capacities ed regarding facilities where complex water treatment is performed.

Table 16: The total capacity of drinking water treatment facilities by district

District	Regional (intermunicipal) systems			Local (municipal and countryside) systems		Municipalities with facilities
	Capacit. l/s	RVS	There is a treatment	Capacit. l/s	There is a treatment	
1 Northern Bačka	0		No	400	YES	Subotica
2 Central Banat	0		No	0	No	
3 Northern Banat	0		No	0	No	
4 Southern Banat	0		No	875	YES	Kovin, Opovo, Pančevo
5 Western Bačka	0		No	375	YES	Apatin, Sombor
6 Southern Bačka	1,500	Novi Sad	YES	460	YES	B. Palanka, Bečež, Beočin, Vrbas, Novi Sad
7 Srem	250	Ruma-Irig	YES	500	YES	Reg. of Ruma, Irig; Loc. S. Mitrovica
<b>Vojvodina in total</b>	<b>1,750</b>			<b>2,610</b>		
<b>8. The City of Belgrade</b>	<b>11,000</b>	BVK	YES	<b>1,025</b>	YES	Reg. BVK Loc. Obrenovac
9 Mačva	0		No	207	YES	Krupanj, Šabac
10 Kolubara	0		No	858	YES	Valjevo, Lajkovac, Ljig
11 Podunavlje	0		No	490	YES	Smedrevo, S. Palanka
12 Braničevo	0		No	80	YES	Petrovac
13 Šumadija	1,450	Kragujevac	YES	510	YES	Reg. Batočina, Kragujevac; Loc.: Arandelovac, Topola
14 Pomoravlje	0		No	250	YES	Jagodina
15 Bor	0		No	160	YES	Majdanpek
16 Zaječar	0		No	675	YES	Zaječar, Sokobanja
17 Zlatibor	1,200	The Rzav	YES	1,220	YES	Reg. The Rzav Loc. Priboj, Prijepolje, Užice, Čajetina
18 Morava	0		No	120	YES	G. Milanovac, Ivanjica
19 Raška	0		No	610	YES	V. Banja, N. Pazar, Raška
20 Rasina	650	The Rasina	YES	80	YES	Reg. Aleksandrovac, Loc. Aleksandrovac
21 Niš	300	Bovan	YES	600	YES	Reg: Aleksinac Loc. Niš
22 Toplica	0		No	150	YES	Blace, Prokuplje
23 Pirot	0		No	0	No	
24 Jablanica	0		No	200	YES	Vlasotince, Lebane, Medveđa
25 Pčinja	0		No	765	YES	V. Han, Vranje, Surdulica
<b>Total Cent. Serbia (Σ9÷25)</b>	<b>3,600</b>			<b>6,975</b>		
<b>TOTAL Serbia without Kosovo and Metohija</b>	<b>16,350</b>			<b>10,610</b>		

### Drinking water quality

Indicators (physicochemical and microbiological) relating to the quality control of drinking water in the Republic of Serbia have been taken from the Health Statistical Yearbooks of the Republic of Serbia, published by the Dr Milan Jovanovic Batut Public Health Institute of RS . The review was provided by district (Table 17), relating to years 2008, 2010 and 2012.

Table 17: Physicochemical (PC) and microbiological (MB) quality control of drinking water controlled in public water distribution systems (PWS)

District	Number of public water distribution systems (PWS)														
	contolled			without irregularities*			with PC irregular.			with MB irregular.			with both irregular.		
	2008	2010	2012	2008	2010	2012	2008	2010	2012	2008	2010	2012	2008	2010	2012
1 Northern Bačka	3	3	3	0	1	0	0	0	0	0	0	0	3	2	3
2 Western Bačka	4	4	4	0	0	0	1	0	1	0	2	0	3	2	3
3 Southern Bačka	11	11	11	4	2	3	1	3	2	0	0	1	6	6	5
4 Northern Banat	6	6	6	0	0	0	1	2	1	0	0	0	5	4	5
5 Central Banat	5	5	5	0	0	0	2	0	1	0	0	0	3	5	4
6 South Banat	8	8	8	3	0	1	0	1	0	1	2	2	4	5	5
7 Srem	6	5	5	3	2	2	2	0	2	0	0	0	1	3	1
<b>Vojvodina in total</b>	<b>43</b>	<b>42</b>	<b>42</b>	<b>10</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>6</b>	<b>7</b>	<b>1</b>	<b>4</b>	<b>3</b>	<b>25</b>	<b>27</b>	<b>26</b>
8 Mačva	8	8	8	3	5	8	0	0	0	4	2	0	1	1	0
9 Kolubara	7	6	6	6	6	6	1	0	0	0	0	0	0	0	0
10 Podunavlje	4	3	4	3	2	4	1	1	0	0	0	0	0	0	0
11 Braničevo	8	8	8	7	6	6	1	1	1	0	0	0	0	1	1
12 Šumadija	7	7	7	2	3	2	4	2	3	1	1	2	0	1	0
13 Pomoravlje	6	6	6	4	4	6	0	0	0	2	2	0	0	0	0
14 Bor	5	5	5	3	3	3	0	1	2	1	0	0	1	1	0
15 Zaječar	4	4	4	4	3	3	0	0	0	0	1	1	0	0	0
16 Zlatibor	11	11	11	4	7	1	0	0	0	6	2	10	1	2	0
17 Morava	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0
18 Raška	5	5	5	4	4	4	1	1	1	0	0	0	0	0	0
19 Rasina	6	6	6	2	3	4	2	1	1	1	1	0	1	1	1
20 Niš	6	6	6	4	2	4	1	1	2	1	2	0	0	1	0
21 Toplica	4	4	4	2	4	2	0	0	0	2	0	1	0	0	1
22 Pirot	4	4	4	4	1	3	0	0	0	0	3	1	0	0	0
23 Pčinja	7	7	7	6	6	6	0	0	0	1	1	1	0	0	0
24 Jablanica	10	10	10	6	7	7	2	1	1	1	0	2	1	2	0
<b>Central Serbia</b>	<b>106</b>	<b>106</b>	<b>104</b>	<b>68</b>	<b>70</b>	<b>73</b>	<b>13</b>	<b>9</b>	<b>11</b>	<b>20</b>	<b>15</b>	<b>18</b>	<b>5</b>	<b>10</b>	<b>3</b>
25 <b>The City of Belgrade</b>	<b>7</b>	<b>7</b>	<b>7</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>2</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>4</b>
<b>Serbia without Kosovo and Metohija</b>	<b>156</b>	<b>156</b>	<b>154**</b>	<b>79</b>	<b>75</b>	<b>81</b>	<b>20</b>	<b>15</b>	<b>18</b>	<b>24</b>	<b>21</b>	<b>22</b>	<b>33</b>	<b>42</b>	<b>33</b>

\*less than 5% of microbiologically and less than 20% of physicochemically irregular samples

\*\*59,900 samples of drinking water have been examined in order to check their physicochemical drinkability- 13.9% irregularities

Physicochemical and microbiological irregularity of drinkable water was not recorded in around 50% of the controlled central water distribution centers, whereby the largest number of regular systems was situated on the territory of Central Serbia (65 - 70%). Occasional irregularity was recorded in some samples in the systems in Vojvodina and Belgrade.

Physicochemical irregularity of samples was related primarily to the natural characteristics of groundwater on the territory of Vojvodina, whereas the deviations in Central Serbia are often related to the presence of nitrate.

### Situation assessment

The water supply situation varies in different regions, both regarding infrastructure development and the level of population connected, as well as regarding the reliability of the water supply (in terms of time, quantity and quality). This varies depending on population density, level of economic activity and available water source capacities, network losses and other factors.

The level of population served by public water distribution systems has increased over time. It amounted to 76% in Serbia without Kosovo and Metohija in 2002, whereas nowadays it has reached over 80%. The number of population served by public water distribution systems is still increasing, primarily as a consequence of migrations from rural areas to cities. The largest population served by public water distribution systems (over 90%) is in Vojvodina and Belgrade, owing to well-built water distribution infrastructure in this area as well as in other areas. However, the fact is that there are larger settlements in Central Serbia without public water supply systems.

The condition of built infrastructure differs depending on systems depending largely on the age and the maintenance of facilities. Inadequate maintenance often has as a consequence great losses in the network, amounting to over 30% in some systems. This may also lead to jeopardising the water quality.

There are three types of issues relating to water quality:

- inadequate drinking water quality - present in large parts of Vojvodina (especially in Bačka and Banat), Pomoravlje, parts of Šumadija and numerous small municipalities;
- excessive exploitation of groundwater - present primarily in Vojvodina;
- insufficient protection of water sources (present in many water sources in the country).

The problem of insufficient water quality is more present in smaller places, whereas the quality of water supply systems in larger cities is usually within MACs limits. Trends relating to the decrease of water quality generally have not been noted. The issue of inadequate protection of water sources occurs regardless of the system volume.

An important issue in this segment is also the inadequate price of water, which is lower in some areas than the operating costs of the system itself. The collection system is insufficient, with the exclusion of large systems.

In addition, it should be pointed out that the organisation of utility services varies at the level of local government, as other utility activities are often under their jurisdiction in addition to the general public's water supply and the water supply of other consumers of drinking water and other utilities. To a certain extent this influences their level efficiency. Additionally, a lack of adequately-trained staff is an issue with regard to proper water supply within certain water supply systems.

## **Industrial water supply**

Following World War II, intensive industrialisation occurred in the whole of Yugoslavia (including Serbia), i.e. there was a significant increase in the industry share in the total domestic product. Slowing down of the development of this economic branch started in the 1980s of the last century. In the beginning of the 90s, industrial production suffered additional shock owing to the dissolution of the country and imposed sanctions. When the sanctions were lifted, the situation improved slightly, at the beginning of the twenty-first century. However, in the process of social transformation and the changes to ownership structure, insufficient attention was given to the development of industrial production.

Long-term lack of industrial competitiveness (the average growth rate in physical volume of industrial production in the period between 2001 and 2008 amounted to 2.2% in terms of total industry and 2.0% in terms of the manufacturing industry), together with unfavourable business conditions caused by developments in the global recession, brought Serbia's level of industry to approx. 45% in 2009, in comparison to 1990.

Water usage is in direct correlation with the physical volume of industrial production. Around 136 million m<sup>3</sup> of water was used in 2008 for industrial purposes (Table 18), presenting a significant decrease compared to the previous period and clearly reflecting the total decrease in industrial production, primarily in the domain of manufacturing. Over 16% of the total abstracted quantity of water comes from public water supply systems, whereas individual water intake structures were primarily oriented to surface water. Later on, abstracted water quantities needed for industry decreased.

They amounted to approx. 90 million m<sup>3</sup> in 2012 in the Republic of Serbia (roughly 17 million m<sup>3</sup> came from the public water supply system, which is approx. 19%, whereas, this amount was approx. 27 million m<sup>3</sup>, speaking in terms of groundwater, i.e. approx. 30%, with more than half of the amount of abstracted water being surface water).

Table 18: Abstracted water quantities needed for industry on the territory of Serbia, in 10<sup>3</sup> m<sup>3</sup>

Water source	Year		
	2008	2010	2012
Public water supply system	22,360	15,826	17,326
Individual water intake structure of	groundwater	31,324	28,374
	surface water	82,017	64,744
<b>TOTAL</b>	<b>135,701</b>	<b>108,944</b>	<b>89,425</b>

Source: RSO Eco-bulletin

Data from the Provincial Secretariat for Energy and Mineral Resources regarding WR Bačka and Banat and WR Srem regarding groundwater reservoirs (2010) show that 50 commercial entities have obtained verification of groundwater reservoirs for individual needs or are in the process of obtaining verification. In accordance with the data on verified reservoirs, up to 700 l/s is abstracted from this area in total, out of various water-bearing strata (Table 19).

Table 19: Total groundwater abstraction for industrial needs

Water area	Exploitation l/s					Σ
	I Aquifer	BWC <sup>14</sup>	Neogene	Lime	Fracture	
Bačka and Banat	178.7	242.5	206.28	0	1	628.48
Srem	0	54.8	30.08	21	0	105.88
<b>TOTAL</b>	<b>178.7</b>	<b>297.3</b>	<b>236.36</b>	<b>21</b>	<b>1</b>	<b>734.36</b>

It has been estimated that the total abstraction of groundwater used for the needs of commercial entities in other water areas (breweries, industry, food production, etc.) does not surpass the above-mentioned value.

Thermal power plants utilise water for cooling (using recirculation and flowing) and for the transfer of thermal energy, whereas surface water is the basic water source for technological water used by thermal power plants (Table 20).

Table 20: Water consumption needed by thermal power plants and heating plants

Thermal power plant	Power available at plant gate total (MW)	Cooling systems	The quantity of used water (10 <sup>3</sup> m <sup>3</sup> /yr)		Source of cooling water: river/accumulation
			surface	groundwater	
<b>Nikola Tesla PE Thermal Power Plant</b>					
Nikola Tesla A Thermal Power Plant	1,482	f	1,005,034	879	The Sava
Nikola Tesla B Thermal Power Plant	1,160	f	1,055,858	479	The Sava
Kolubara A Thermal Power Plant	238	f	5,840		Kolubara
Morava Thermal Power Plant	100	f	88,145	52	Vel. Morava

<sup>14</sup>basic water bearing complex- sand and gravel deposits of eopleistocene and older pleistocene sediments

Thermal power plant	Power available at plant gate total (MW)	Cooling systems	The quantity of used water (10 <sup>3</sup> m <sup>3</sup> /yr)		Source of cooling water: river/accumulation
			surface	groundwater	
<b>Kostolac PE Thermal Power Plant</b>					
Kostolac A Thermal Power Plant	281	f	355,560		The Danube
Kostolac B Thermal Power Plant	579	f	560,479	1,104	The Danube
<b>Panonske PE Plant</b>					
Novi Sad Thermal power plant- heating plant	208	f	18,701		The Danube
Zrenjanin Thermal power plant- heating plant	100	r	905		Begej
Sremska Mitrovica	45	f	675		The Sava

cooling system: f-flowing; r-recirculating

### Situation assessment

Stagnation and the fall of industrial production (as well as of other economic activities) have also had an impact on water resource usage. The data, according to which the abstracted quantity of water for industrial needs was lower by a third in 2012 compared to 2008, proves this. The favourable circumstance is that over 80% of water used for this purpose comes from individual water intake structures, with a larger representation of surface water.

It should also be pointed out that the data published by the RSO are not always complete, since some local water intake structures are not registered, while some commercial operators do not fulfill their obligations as defined by law, to register systematically abstracted quantities of water during the exploitation and submission of measuring data to competent institutions. Also, efficient water abstraction control by competent institutions is lacking, which should be amended in the following period.

### **Irrigation**

Irrigation, as an ameliorative measure, was known in the middle Ages primarily in the Southern parts of Serbia. These were individual systems with traditional methods used primarily to irrigate vegetable crops and fruits and field crops, to a lesser extent. The first, larger irrigation systems were built in the nineteen thirties. However, more significant irrigation development occurred after World War II, especially after the development of HS DTD. Economic problems in recent times have resulted in stagnation in almost all economic areas, including agriculture and consequently irrigation.

### Existing irrigation systems

Surfaces adequate for unlimited irrigation and suitable for irrigation with some cautiousness comprise a surface area of around 1.9 million hectares on the territory of the Republic of Serbia (without Kosovo and Metohija). On the other hand, public irrigation hydrosystems have been built on a surface area of around 105,500 ha<sup>15</sup>, which is less than 6% compared to land with favourable irrigation characteristics. However, owing to inadequate maintenance and the negligence of owners and users, systems are operating in significantly lower spaces. It has been estimated the less than 40% of these surfaces are irrigated (Table 21). The largest systems are in Vojvodina (primarily in Bačka and Banat - around

<sup>15</sup>\*data belonging to public water management companies \*\*data belonging to equipment distributors

75%), owing to high-quality agricultural land and significant quantities of transit water (Dunav, Tisa and Sava) in this region.

According to data belonging to irrigation equipment distributors, 45,000 ha are irrigated in addition to the mentioned surfaces (Table 21) by way of privately-owned systems, predominantly irrigation hose reels and drop by drop systems. However, complete records of these systems are unavailable through the RSO. Table 21: Irrigated surfaces on private and public property

No.	Water area	Public property systems*	Total in function (ha)	
			Private property systems** tech. defined	tech. undefined
1	Bačka and Banat	29,028	10,136	6,055
2	Srem	1,134	1,853	1,112
3	Belgrade	1,912	2,435	1,095
4	The Sava	5,000	5,076	2,538
5	Morava	3,840	6,000	2,400
6	Lower Danube	no data	4,500	1,800
<b>TOTAL</b>		<b>40,914</b>	<b>30,000</b>	<b>15,000</b>

There are approx. 2,000 ha used at agricultural experimental stations in technically defined systems, in agricultural schools. There are also approx. 10,000 ha surrounding individual holdings in technically undefined systems, therefore, there are approx. 145,000 ha of land in public and private ownership operating as developed systems, whereas another approx. 100,000 ha of agricultural land is irrigated in different ways.

RSO data show that between 25 and 53 thousand hectares of agricultural land (Table 22) under public and private ownership was irrigated in the period between 2009 and 2012. One has to bear in mind that objective (sufficient temporal and spatial distribution of precipitation) as well as subjective reasons have had an impact on irrigation needs. This is the reason why different values have been shown. The largest surfaces irrigated were in Vojvodina, amounting to 38,000 ha, around 4,000 ha on the territory of Belgrade, 300 ha in Šumadija and Western Serbia and around 11,000 ha in Southern and Eastern Serbia.

Table 22: Irrigated surfaces in the Republic of Serbia by region

Year	Irrigated surfaces by region (ha)				Total
	Belgrade	Vojvodina	Šumadija and Western Serbia	Southern and Eastern regions of Serbia	
2009	2,618	26,713	324	921	30,576
2010	1,583	14,972	329	8,244	25,128
2011	2,520	20,516	289	10,850	34,175
2012	4,165	37,835	300	10,686	52,986

Source: RSO

According to the same source, the predominant manner used to irrigate land in Serbia is artificial rain (85% of irrigated surfaces), while “drop by drop” systems (increasingly represented revegetable crops and fruit) are the least used, (around 5% of agricultural surfaces). Other irrigation types are used on 10% of surfaces.

### Irrigation norms

Irrigation norms are widely limited. On surfaces with occasional irrigation (when crops are estimated as under threat, which is most often the case), norms range from 800 to 1,200 m<sup>3</sup>/ha per year, whereas in other systems norms range from 1,000 to 2,500 m<sup>3</sup>/ha per year (in rare situations over 3,000 m<sup>3</sup>/ha per year).

The largest number of irrigation systems are designed and built with an irrigation hydromodule of 0.5 l/s per ha. However, irrigation norms set while the system is being used usually do not correspond to the projected values, except for long-standing newly-planted plants (with around 3,250 - 3,600 m<sup>3</sup>/ha per year) primarily irrigated by “drop by drop systems”.

#### Water sources and abstracted water quantities for irrigation

Table 23 shows the review of water quantities used, by water areas, for the irrigation of around 86 thousand hectares of agricultural land both state-owned and under private ownership (Table 21).

Table 23: Abstracted water amount

No.	Water area	Abstracted water amount (m <sup>3</sup> /yr)			Total amount of abstracted water
		Public property systems	Private property systems tech. defined	tech. undefined	
1	Bačka and Banat	52,250,400	18,244,800	5,449,500	75,944,700
2	Srem	2,041,200	3,335,400	1,000,620	6,377,220
3	Belgrade	3,441,600	4,383,000	985,500	8,810,100
4	The Sava	9,000,000	9,136,800	2,284,200	20,421,000
5	Morava	6,912,000	10,800,000	2,160,000	19,872,000
6	Lower Danube	no data	8,100,000	1,620,000	9,720,000
<b>TOTAL</b>		<b>73,645,200</b>	<b>54,000,000</b>	<b>13,499,820</b>	<b>141,145,020</b>

Source: public water management companies and JČI

It is estimated that surface water is primarily used for irrigation (around 90%) by direct abstraction from river flows, regional hydrosystems, accumulations and canal network. Groundwater, as a source of water for irrigation are usually wells within the first aquifer.<sup>16</sup>

#### Situation assessment

Having in mind that almost 2 million hectares of land is arable, it can be concluded that extremely small areas are included in irrigation systems (around 7% of arable land in the private and the public sector). However, even developed systems are not being utilised to their full extent, due to inadequate maintenance, a lack of design-defined performance implementation, etc. Also, the lack of regrouping measures, property enlargement, comassation, as well as insufficient participation of system beneficiaries in the processes dealing with agricultural economy, have impacted cost-effectiveness of implementing irrigation into existing systems as well as on the development of new systems.

It should also be emphasized that the RSO, a state-run institution is responsible for collection and data analysis in all relevant areas, this one included, and does not possess all the data re irrigated surfaces and the water quantities used. For example, the RSO official records do not have data on all the modern irrigation systems that have been built by large private landowners in fruit and vegetable production in recent years, as well as numerous systems belonging to smaller individual farmers. This outdated database (abstracted water amounts) has resulted in reduced income based on remuneration for the exploitation of water used for irrigation.

#### **Hydropower**

In parallel with the emergence of hydro power plants in many countries of the developed world, at the beginning of the twentieth century, the first hydroelectric power plants were established in Serbia. Electric power produced in these hydroelectric power plants served mostly to provide settlements with street lighting and to satisfy the needs of local industry. These hydroelectric power plants were low power and were built near their users, since it was not easy at that time to transfer electric power to larger plants. Following World War II, hydro potentials were increasingly used and larger hydroelectric power plants were built.

<sup>16</sup>The first aquifers are accumulations of groundwater formed in water-bearing Young Quaternary environments.

Today, Serbia's electric power system disposes of approx. 6,700 MW of nominal power through the power plant threshold. Hydroelectric power plants account for approx. 30%, whereas the remaining percentage relates to thermal power plants. As for the structure of hydroelectric power plants, 64% are run-of-the-river hydroelectric power plants, 15% are hydroelectric dams, whereas 21% are pumped-storage plants.

According to the WMBS, Serbia's total gross hydroenergetic potential amounts to around 27,200 million kWh/yr. Technically speaking, usable potential amounts to approx. 19,200 million kWh/yr. Of this amount, approx. 17,500 million kWh/yr may be used in facilities larger than 10 MW. Of the total exploitable hydroenergetic potential of facilities larger than 10 MW, around 60% has been exploited thus far, taking into account that half of the potential waterways are shared with other countries.

Table 24 shows a review of existing hydroelectric power plants included in the electric power system's distribution network, with basic indicators.

Table 24: Review of larger hydroelectric power plants, with basic characteristics

No.	of hydroelectric power plants	Waterway	Year Built	$Q_i$ (m <sup>3</sup> /s)	$P_i$ (MW)	Type
1	Ovčar Banja	The Zapadna Morava	1954/57	40.0	5.8	r
2	Međuvršje	The Zapadna Morava	1957	40.0	7.0	r
3	Zvornik	The Drina	1955/58	165.0	52.0	r
4	Vlasina power plants (Vrla I– IV)	Vlasina Vrla and Božička River	1954/58	18.3	50.1	h
				18.5	23.7	
				18.0	29.0	
				18.4	24.8	
5	Uvac	Uvac	1979	43.0	36.0	h
6	Kokin Brod	Uvac	1962	37.4	22.5	h
7	Bistrica	Uvac	1960	36.0	104.0	h
8	Bajina Bašta	The Drina	1966/68	600.0	365.2	r
9	Potpeć	The Lim	1967/70	165.0	51.0	r
10	Đerdap 1	The Danube	1970/72	4,800.0	1,164.0	r
11	Đerdap 2	The Danube	1985/87	4,200.0	270.0	r
12	Pirot	The Visočica	1990	45.0	80.0	h
13	HPP Bajina Bašta		1982	129.2	614	p
14	Gazivode	The Ibar	1981	42.6	35.0	h

r-run-of-the-water, h-hydroelectric, p-pumped-storage

The largest hydroelectric power plants were constructed on rivers with great hydro potential (primarily on the Danube and Drina rivers), as well as on certain smaller, but favourable waterways for generating hydroelectricity (Vlasina, Uvac, Visočica, etc.).

Thanks to ratification of the Treaty establishing the Energy Community, the Republic of Serbia has undertaken obligations defined by Directive 2009/28/EC, dealing, inter alia, with the promotion of electric power produced from renewable energy sources. Aiming to increase the use of renewable energy sources, the Republic of Serbia has joined the list of countries subsidizing the production of electric power from renewable sources and has introduced the widely used model - stimulating fixed purchase prices ("feed-in" tariff), with a period of guaranteed electric power takeover of 12 years. This has resulted in huge interest in developing smaller hydroelectric facilities (<10 MW). Consequently, the number of allocated locations for the construction of small hydroelectric power plants has recently increased, and the number of constructed facilities is also on the rise. This process, however, was not followed by adequate cooperation with other interested sectors.

#### Situation assessment

So far, hydroelectric power plants have primarily been focused on the needs and demands of Serbia's electro power systems, not giving enough consideration to the water regime in waterways. The most unfavourable effects in this respect are present on Zapadna Morava, Južna Morava, Nišava and Drina, from the aspect of non-observance of defined limitations.

The operations of hydroelectric power plants in accordance with the defined exploitation regime, which also includes adequate use of accumulation areas, would assure a more favourable regime in waterways downstream from division areas.

Certain hydroelectric power plants do not monitor accumulation in an organised and systematic manner, so that the measures related to the maintenance of accumulation space areas are not applied.

Allocating locations for the development of small hydroelectric power plants is not synchronised with the needs of the water sector and environmental protection sector, which has to be corrected immediately.

## **Navigation**

All inland waterways in Serbia are directly or indirectly connected to the Danube and with the European network of waterways through the Danube.

The Danube is a very important transportation corridor (Pan-European corridor VII). Its total length through Serbia (from the Timok confluence is 845,5 km, 1,433 km from the Hungarian border) and is classified as an international waterway, which is regulated by the Convention concerning the Regime of Navigation on the Danube, 1948). According to the Convention, the Danube Commission defines the dimensions of water way, hydrotechnical and other constructions on the Danube River, which Serbia is obliged to provide. A large number of regulation works were performed on this waterway, concerning navigation needs, especially in the period from 1965 to 1980. However, there are still "bottlenecks" on the Danube between the Hungarian border (1,433km) and Novi Sad (1,255 km), which has a natural hydrologic and hydraulic regime. In the sector downstream from Novi Sad, to Belgrade (1,166 km) there are backwater areas starting with the Đerdap 1 dam (943 km), therefore, there are several sections which are still unfavourable for navigation. The Danube has backwater sections downstream from Belgrade to the HEPP Đerdap 2 dam (863 km) which excellent navigation conditions.

Starting with the confluence into the Danube to the Hungarian border (164 km), the river Tisa is classified as an interstate waterway, in accordance with the interstate navigation agreement, concluded between Serbia and Hungary in 1955. The Tisa waterway primarily provides favourable navigation conditions.

The river *Sava* is classified as an international waterway, in accordance with the Framework Agreement on the Sava River Basin (Kranjska Gora, 2002) and Navigation Regime Protocol, attached to this Agreement. The Sava's current condition is unfavourable, and therefore navigation is carried out mostly on the territory of the Republic of Serbia (to Sremska Rača) with serious interruptions.

The HS DTD canal network has been designed for multi-purpose usage. Most importantly, it controls the surface and underground water and navigation regime. Canals and canal waterways included in the HS DTD have a total length of 930 km, of which around 600 km has been enabled for navigation, but only 320 km is suitable for ships with a deadweight of 1,000 t. Navigation conditions are generally favourable, but there is an issue concerning poor canal maintenance (the issue is in regard to vegetation and the filling up of drifts).

## Situation assessment

Inland water traffic has certain advantages over other types of traffic (cost-effectiveness, less pollution), but it also has certain drawbacks (low speed, determined direction, dependence on natural

conditions, etc.) compared to other types of transport. A favourable inland waterway fleet and corresponding landing and transshipment capacities, as well as a connection with other transport infrastructure facilities are also necessary in order to increase participation in this form of transport in the total transportation of merchandise and people.

The Republic of Serbia has favourable economic and geographic characteristics in terms of freight, passenger and touristic inland waterway transport. However, infrastructure is not satisfactory, as maintenance was at a standstill following 1990. Serbia's inland waterways have uneven conditions in terms of navigability, owing to uneven legal classification in addition to natural factors. Issues concerning different navigability conditions, navigation safety and the condition on certain waterways have had a negative impact on the cost-effectiveness conducting business related to inland waterway shipping trade and transport, therefore, transport of people and goods is usually conducted by land.

Inland waterway traffic is within the competence of Ministry of Civil Engineering, Transport and Infrastructure and the Waterways Directorate. The competences related to development planning and waterway maintenance are different for international, interstate and state waterways, which is regulated by the Law on Navigation and Ports on Inland Waterways.

The water sector and inland waterway transport are functionally dependent on each other relating to the following:

- uninhibited and secure inland waterway transport demands the provision of required technical characteristics (waterway dimensions, defined in relation to low navigable levels), that is, minimal dimensions that a waterway has to have in order to assure safe and economical inland waterway transport even under the most unfavourable hydrological conditions. Waterway dimensions depend on their legal classification, and their category, and these are provided by executing river bed regulation works;
- infrastructure (landing and transshipment capacities) and vessels are prospective pollutants.

Based on the previously stated, it can be concluded that cooperation between the water sector and institutions competent for inland waterway transport is necessary, in all the phases of planning and exploitation.

### **Fisheries and fish farming**

Serbia's fishing areas have been divided into 6 sections, in accordance with the Decision on Defining Fishing Areas ("Official Gazette of the Republic of Serbia", no. 115/70). Serbia – Vojvodina, Serbia - Western Serbia - South-Western Serbia - Southern Serbia - Eastern and Central Serbia. The management of fishing areas has been allocated to different institutions. Organisation, in terms of collecting data from Serbian fisheries has often times been altered in the period between 1948 and 2011. The number of reporting units decreased from 77 to 35 in 1961; that is to 7 in 1996, and in 2003, only three reporting units submitted data to the RSO.

The number of cyclostomes and fish types is between 98 and 110, and the estimated number of species living in inland waters is over 90<sup>17</sup>.

Open water fisheries are usually separated into two groups: economic and recreational fishing, although pressure on fish resources and aquatic eco-systems can be applied from both sport and illegal fishing, but also from poaching. It is difficult to say what the volume of pressure on different fish resources is, since statistical data is not completely reliable, owing to the inadequate monitoring of this resource and a lack of suitable catch control.

### Existing systems

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<sup>17</sup>In accordance with the report composed by the Environmental Protection Agency of the Republic of Serbia 2010, inland waters of RS are populated by 110 groups and sub-groups of osteichthyes and lampreys.

Fish breeding in Serbia is dominant in warm-water fish ponds (carp) and cold-water fish ponds (trout). In addition to these, there is also a small number of cage systems, enclosed systems with small surface areas, or reconstructed areas with natural or artificial water, used for breeding. Over 90% of fish ponds are privately owned. The total production of fish in fish ponds annually in recent periods ranges from 8,000 to 12,500 tonnes, whereby around 80% of this is fish produced in carp fish ponds.

Between 12,000 and 13,000 ha of land is covered by carp fish ponds, and most are in Vojvodina (around 97%). A part of fish-breeding areas (15-20%) is neglected and not in use. The capacity of carp fish ponds is around 190 million m<sup>3</sup>, whereas around 160 million m<sup>3</sup> of fish-breeding capacities is actively used. The surface area of fish ponds range from several tens of square meters to over 2,000 ha. It is estimated that the total number of carp fish ponds is between 60 and 80, whereas there are around 30 fish ponds with larger surfaces (from 10 to over 1,000 ha)

Trout fish ponds are located south of the Sava and Danube, situated in hilly and mountainous parts of Serbia. It has been estimated that trout fish ponds comprise the surface area of around 12 hectares (currently 2.4 hectares are inactive). Rainbow trout is the most common sort bred, in terms of types of salmonides bred, whereas brown trout is presented sporadically. The production in trout fish ponds ranges on average from 12 to 15 kg/m<sup>3</sup> of the pool's capacity. Even though intensive breeding systems of rainbow trout have been applied, the relatively small quantities of fish produced per m<sup>3</sup>/water is a consequence of decreased operational capacities (5-50% capacity) of these ponds, primarily owing to the lack of working capital.

#### Abstracted water amount

Carp fish ponds are supplied with water from the rivers flowing near these fish ponds (Tamiš, Tisa, Begej, Danube, Sava and others), HS DTD canal network and rarely from underground water (through wells). The amount of water abstracted for the needs of carp fish ponds on an annual basis is approx. 420 million m<sup>3</sup>. The most frequent water abstraction with this aim takes place in the period between February and May (around 60% of total amount), somewhat less in the period from June to August (10-11%), whereas from November to January a significantly lower amount is abstracted (around 5% of total abstracted amounts). The volume of abstracted water is around 2.6 times larger compared to the total volume of carp fish ponds.

Amounts of water abstracted for the needs of trout fish ponds per unit of surface area are significantly higher than the amount of water in carp fish ponds, owing to the fact that these are free-flow systems. Total amounts of water abstracted per year for the needs of trout fish ponds (on around 9.6 ha are active at the moment) equals around 475 million m<sup>3</sup>, owing to the fact that water is changed approx. 37 times on average within a 24 hour period.

#### Situation assessment

In Serbia, the dominant type of fishing on open water is commercial fishing (carp and trout fish ponds).

Although carp fish ponds require relatively large quantities of water, a favourable circumstance is that these quantities are abstracted from surface water, usually during the spring. Wastewater may present a far more serious problem, both regarding carp fish ponds and trout fish ponds, which jeopardise the quality of recipient water unless required quality is assured.

#### **Sport, recreation and tourism**

During the twentieth century a very wide spectrum of water usage for tourism and recreation on rivers, lakes and accumulations was developed. Thanks to the natural potential and already established traditions, spa tourism in Serbia saw the most development. The development of spa and recreational tourism was most intensive after World War II. After 1960, spas began to be classified as natural health resorts in accordance with the Law. This had an influence on the development of

accommodation capacities, at first private accommodation and later on, the development of modern hotels. Numerous modern health resorts and rehabilitation centres were built.

### Spa tourism

Spa tourism represents the most developed form of tourism in Serbia, with a rather long and rich history (starting with the Roman era, through the Byzantine and Ottoman Empires and continues today).

The vastness of thermo-mineral water (in Central Serbia alone totals 155,000 m<sup>3</sup>/day) enabled the formation of around 40 specific urban health and tourist centres. A large number of these spas is well-equipped in terms of all types of balneotherapy (baths, hydro-therapy, outdoor and indoor pools, equipped water sources). In addition to the well-known balneo-rehabilitation centres, there are roughly smaller centres currently being developed in Serbia, which are of importance locally, and are somewhat less well-equipped.

These spas are divided into three groups: spas with prospective international significance, spas with national and regional importance (Spatial Plan of the Republic of Serbia, 2010). The mentioned classification into groups was performed on the basis of affirmed criteria (realised turnover, valorised natural conditions, resources and values, as well as created conditions and structures) and perspectivity/potential criteria compared to defined tourist destinations, transit directions and cities (location, additional/specific valorisation of natural factors and their inclusion in specific tourist destinations, the constituents that make up the actual spas, in addition to other factors).

Spas that are of national importance and prospective international importance are: Vrnjačka Banja, Niška Banja, Sokobanja, Mataruška Banja, Bukovička banja, Banja Koviljača and Vranjska Banja. Among the spas of national importance from the perspective of their potential development are: Prolog Banja, Gornja Trepča, Ribarska banja, Kanjiža and Junakovič. This second group cannot be defined as international spas, owing to their remote locations from individual tourist destinations.

A number of spas and mountain resorts with moderate climate have been built, without the necessary documentation, which has resulted in inadequate infrastructure (primarily, utility infrastructure). Owing to the seasonal character of tourism, the number of tourists increases significantly during the high season compared to the general population, which may lead to utility infrastructure overload.

In addition to spas rich with water with healing properties, there are also air spas, which have been classified as climatic health resorts thanks to favourable climate conditions offered by their location.

Available data regarding the drinking water supply show that spas are better supplied, with significantly larger quantities of water coming from water distribution systems than are mountain resorts, as they are often connected to urban areas. The level of sewage connectivity is also significantly higher in spas than in mountain resorts, with the exception of Zlatibor and Kopaonik which have adequate sewage systems.

### Other types of recreation and tourism

One of the most important types of recreation is swimming. 57 public bathing areas and recreational facilities were registered in Serbia intended for river, lake and water accumulation recreation, being under the administration of competent authorities. However, there is an unidentified number of swimming pools not registered within the control system. It is necessary to establish monitoring, govern water quality and inform the public on the quality of water found in public bathing areas. However, these requirements have yet to be fulfilled within these jurisdictions. .

The most well-know public bathing areas on rivers and lakes in Serbia are: Ada Ciganlija in Belgrade, Lido beach in Zemun, Štrand in Novi Sad, Jugovo near Smederevo, Užice beach, Lakes in Bela Crkva, Palić Lake, Srebrno jezero near Veliko Gradište, Borsko jezero and Perućac.

There are many rivers in Serbia where water sports are engaged in: sailing, kayaking, rowing, water-skiing, etc. Rafting can be enjoyed on Drina, Uvac, Lim and Ibar rivers. Regattas take place on some rivers, while international tourist cruises are organized down Corridor VII on the Danube.

In addition to this, numerous protected natural areas are used under certain conditions for tourist and recreational purposes, including 5 national parks, 16 nature parks, 16 areas with extraordinary characteristics and other protected natural resources.

Serbia's main tourist destinations are (cities, spas, mountains, rivers and lakes, cultural and natural goods) are shown in Figure 20.

### Situation assessment

Spas situated near larger settlements usually have resolved the problem of water supply, by connecting to the public water distribution systems, which most often is not the case with mountain climatic resorts. Owing to the seasonal character of this type of tourism (except for certain spas with prospective international character) there are specific requirements, primarily for utility services relating to the water supply and collecting and treatment of wastewater, with the aim of providing the necessary amounts of water needed and environmental protecting.

In cases when surface water is used for other types of recreation, water quality protection requires the greatest amount of attention (facilities on river basin land, vessels). Also, with the aim of human health protection and improvement of environmental quality, non-registered bathing areas have to be decreased/closed, whereas a monitoring system should be established and the quality of water should be managed.



Figure 20: Serbia's main tourist destinations

### **3.1.2. Water protection**

Regarding the implementation of water protection, the main regulations are: the Law on Water and the Law on Environmental Protection, which anticipate the development of adequate plans for water protection. Drafting of the Protection of Water from Pollution Plan, which presents an obligatory Act in accordance with the Law on Water, is in its final phase.

Adequate relations were not established in Serbia in the previous period regarding the protection of water from polluting, even though the concept of protection was clearly and well-defined in the regulations. Water protection was based on so called “emission” criteria, i.e. defined values of water quality in waterways. The values of these parameters, i.e. water classifications, have been determined by an adequate by-law, according to which water has been divided into four classifications (and two sub-classifications within the second classification), primarily from the aspect of the possibility of their usage for different purposes. Water that has a parameter value parameters higher than the limit values, was not included in the classification. Also, all waterways in Serbia were classified into categories in accordance with the adequate by-law, i.e. required quality classification of certain waterway sections were defined.

As opposed to previous regulations in water protection, where the possibility of water usage was the basic criterium, the emphasis in this area is on the ecological aspect, that is, the realisation of environmental goals in accordance with the Law on Water and with EU Directives. A combined approach was adopted, including pollution control at the spot of occurrence, through the establishment of emission threshold values and environmental quality standards. The “polluter pays” principle was introduced. This should enable a greater level of self-financing of the water sector, in addition to better protection of water quality.

The existing situation regarding water protection is primarily the consequence of a lack of (or unappropriated use of) funds, primarily for the development and maintenance of facilities for the treatment of wastewater for settlements, as well as for industrial and other users, and not a consequence of the lack of adequate regulations.

#### **Pressures and influences on water resources , from various sources of pollution**

Water pollution sources can be generally divided into two categories: point and nonpoint source pollution. Point source pollution is pollution which comes from a single point, and release into the recipient, wastewater whereas nonpoint pollution sources are generated over a wide land area. The population connected to the sewage system and industrial plants are major point pollution sources. Nonpoint sources of pollution include all surface water and groundwater pollution reaching waterways directly or indirectly and originate from: inhabitants or from the population that is not directly connected to the sewage system, also from farmed agricultural land, forest and soil surface stripping, and also from livestock, unregulated municipal landfills and other human activities.

An analysis of population pressures is performed on settlements and is divided into five categories (Table 7), whereby settlements with over 2,000 inhabitants are given more importance in accordance with EU Directives. This approach is justified even under conditions present in Serbia, given the demographic trends shown.

Almost 75% of the general public of Serbian live in settlements with over 2,000 inhabitants, where the average level of connectivity to public sewage systems amounts to 72%, and to individual systems (septic tanks) around 27%. In settlements with less than 2,000 inhabitants, public sewage systems are represented sporadically, so that the level of connectivity in this group is lower than 5%.

Pressure related to agriculture and land use is divided into two sub-categories:

- pressure related to livestock (point and nonpoint pollution) and
- pressure related to land use (nonpoint pollution sources, in accordance with the CORINE 2006 land use classification).

### Point sources of pollution

The level of development of collection and evacuation systems (primary and secondary sewage network and main sewage collectors) as well as wastewater treatment in settlements wastewater (plants - PTWW) are at a low level compared with European standards. This primarily refers to the level of development of PTWW, so that the majority wastewater generated in settlements wastewater is released into recipients without being properly treated.

Basic indicators regarding the connection of the population to public and individual sewage systems, at the level of the river basin districts water area/ sub-basins are shown in photos 21 and 22. The level of connectivity to public sewage systems in settlements with over 2,000 inhabitants is over 70%, except for WR Bačka and Banat and WR Srem. The level of connectivity to public sewage systems in settlements with over 2,000 inhabitants is over 70% regarding basins/sub-basins, except for the Tisa and Sava basins. The level of connectivity to public sewage systems amounts to 54% compared to the total number of inhabitants in the Republic of Serbia.

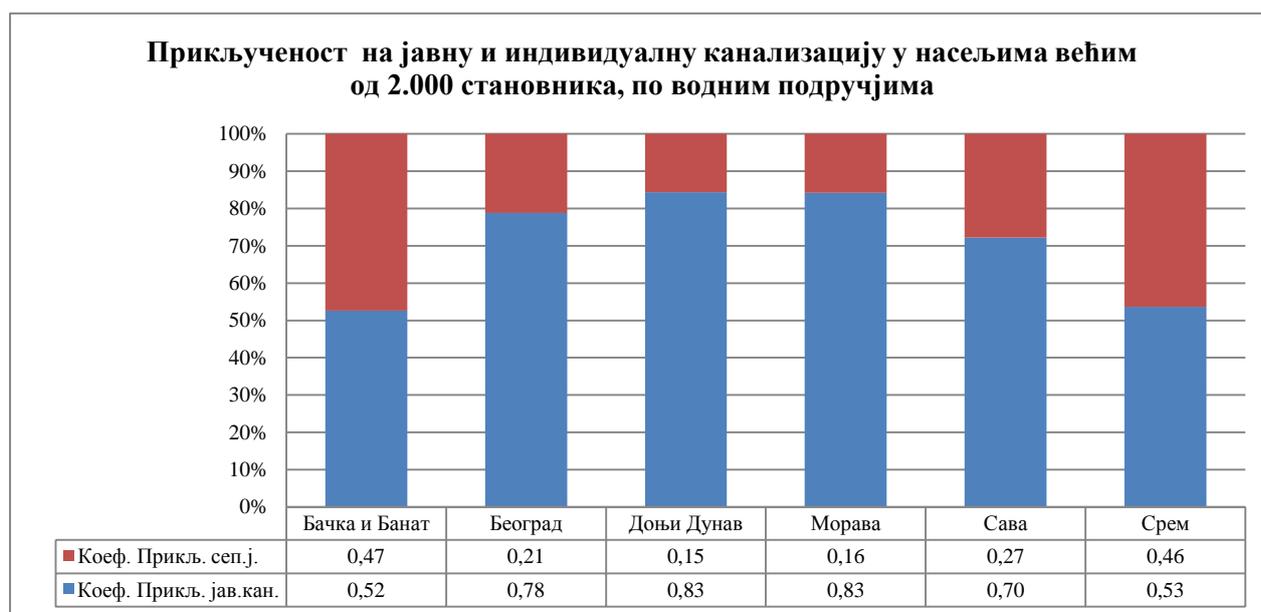


Figure 21: The level of connectivity to public sewage systems, by water area

Level of connectivity to public and individual sewage systems in settlements with over 2,000 inhabitants, by water area

Coef.connect. to sept.t., coef.connect. to pub. sewer.

Bačka and Banat, Belgrade, Lower Danube, Morava, Sava, Srem

**Прикљученост на јавну и индивидуалну канализацију у насељима мањим од 2.000 становника, по сливовима**

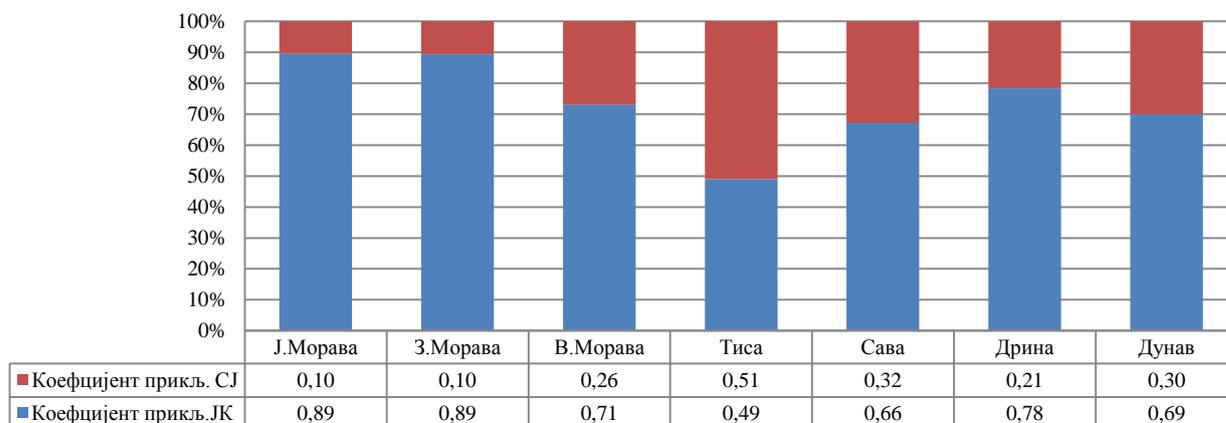


Figure 22: The level of connectivity to public sewerage systems, by basins

Level of connectivity to public and individual sewerage systems in the settlements with less than 2,000 inhabitants, per basin

J. Morava, Z. Morava, V. Morava, Tisa, Sava, Drina, Danube

Coef. connect. to sept.t. 0.10, 0.10, 0.26, 0.51, 0.32, 0.21, 0.30

Coef. connect. to pub. sewer. 0.89, 0.89, 0.71, 0.49, 0.66, 0.78, 0.69

There is a significant difference regarding the level of connectivity to public sewage systems compared to the level of connectivity to the water distribution system, especially in settlements with less than 50,000 inhabitants, which presents the threat of the pollution of groundwater, owing to specific water quality parameters such as nitrates.

In Serbia, over the last several decades, over 50 wastewater treatment plants have been constructed in cities with over 2,000 inhabitants. Of these 50 constructed plants, 32 plants are active (Picture 23) but few operate according to their design criteria, while others operate far below the efficiency rate that they were designed with. The effects of wastewater treatment in settlement (re the selected criteria) are provided in Table 25, at the basin level.

Table 25: The effects of wastewater treatment

Basin	Level of connected population	Effective treatment			Number of plants
		BOD <sub>5</sub> , EC	total N, EC	total P, EC	
J. Morava	40,766	23,903	10,054	9,325	5
Z. Morava	22,988	13,793	4,598	4,598	1
V. Morava	242,178	151,114	73,379	39,684	8
The Tisa	124,547	90,130	59,422	61,577	6
The Sava	82,967	44,886	32,582	16,479	3
The Danube- direct basin	90,814	61,236	26,547	17,922	9
<b>TOTAL</b>	<b>604,260</b>	<b>385,061</b>	<b>206,582</b>	<b>149,584</b>	<b>32</b>

Source: RSO

Existing and active plants provide services for approx. 600,000 residents, whereas their total effective treatment equals approx. 385,000 PE. It can be concluded that less than 10% of the population is covered by a certain level of wastewater treatment. The overall effect of removing organic burden (as a form of treatment) is less than 65%, nitrogen components - less than 35% and phosphorus components - less than 25%.

The spatial distribution of constructed plants in Serbia is uneven. Most plants are situated within the WR Morava region (Figure 23).

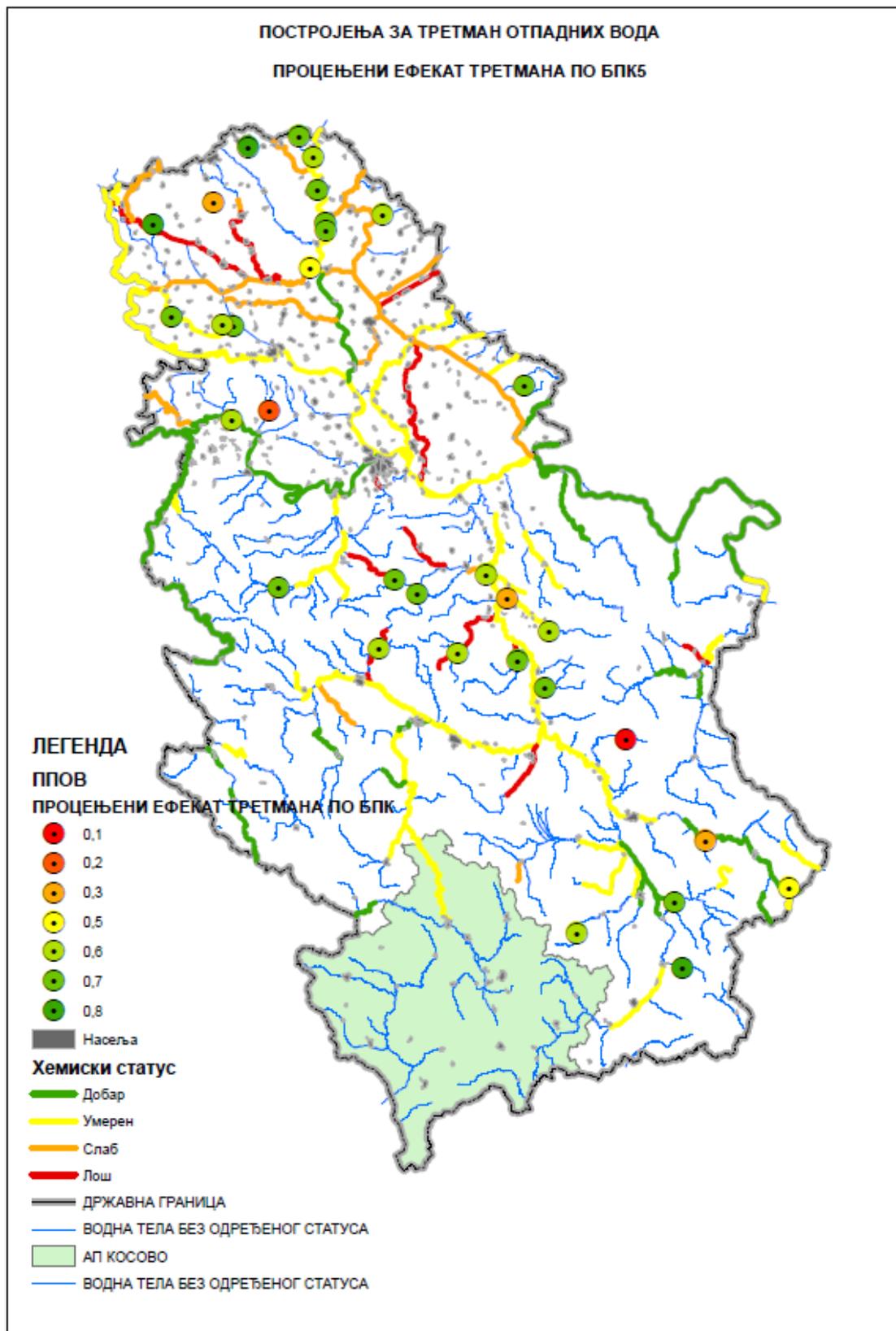


Figure 23: Spatial distribution of existing PTWW  
Wastewater treatment plants, estimated treatment effect per BOD5  
LEGEND, WWTP, estimated treatment effect per BOD5

0.1, 0.2, 0.3, 0.5, 0.6, 0.7, 0.8, Settlements, Chemical status, satisfactory, moderate, weak, poor  
STATE BORDER, WATER BODIES WITHOUT DEFINED CLASSIFICATION, AP  
KOSOVO, WATER BODIES WITHOUT DEFINED CLASSIFICATION

Pressure generated by the population is expressed in mass per year (t/yr) of organic pollution (BOD<sub>5</sub>), total nitrogen (N), total phosphorus (P) and chemical oxygen consumption (COC). Since wastewater generated by households has a stable composition, standard burden per person, burden is calculated using coefficients dealing with wastewater evacuating.

Table 26: Burden coefficients regarding pressures related to population

Pressure related to population	BOD <sub>5</sub>	COC (dichr) gr/cit/day	Total N	Total P
connected to public sewerage systems	60	110	8.8	1.8
not connected to public sewerage systems	30	11	1.76	0.09

Burden from settlements with wastewater treatment plants has decreased, in accordance with the provided level of treatment.

Point sources of pollution originating from settlements with over 2,000 inhabitants comprise around 80% of the total pressure per phosphorus parameter and around 70% per nitrogen parameter produced by the population (Table 27).

Table 27: Pressure originating from the population connected to sewage in settlements with over 2,000 inhabitants

Water area	Population size	Population connected to the systems	Coeff. of connect. to PS	Total pressure in t/yr			
				BOD <sub>5</sub>	COC	Nitrogen	Phosphorus
Bačka and Banat	1,381,255	1,025,748	0.52	13,551	24,844	3,054	624
Belgrade	1,556,626	575,548	0.78	26,566	48,705	1,849	378
Lower Danube	246,171	33,525	0.83	4,494	8,239	108	22
The Morava	1,554,847	1,328,193	0.85	24,386	44,708	4,180	861
The Sava	320,267	283,142	0.70	4,056	7,437	909	186
Srem	292,547	597,662	0.53	3,076	5,640	1,920	393
<b>TOTAL</b>	<b>5,351,713</b>	<b>3,843,818</b>	<b>0.72</b>	<b>76,129</b>	<b>139,573</b>	<b>12,019</b>	<b>2,465</b>

Existing industrial capacities in settlements are usually connected to the public sewage system. No reliable data exists on the type and quantities of industrial wastewater originating from existing industrial facilities in the extent necessary to reach adequate conclusions. Owing to the production decrease in the country, the share of industrial wastewater in settlements has significantly decreased. It is estimated to amount to less than 20% (it amounted to around 45% in the nineteen eighties).

Regarding industry, it is evident that more often than not, plants have not been constructed for the pre-treatment of industrial wastewater, prior to its release into the sewage system, i.e. recipient, or that the activities of the very few plants of this type are inefficient, which may jeopardise the way existing wastewater treatment plants in settlement areas operate, as well as the flora and fauna found in the water and coastal areas. It should be emphasised that there were over one hundred pre-treatment industrial wastewater plants, which primarily meant neutralisation in the metal processing industry. There were also several independent, final treatment plants, most often used by pulp and paper mills, as well as sugar mills. Owing to the weak economic situation in the country, which resulted in

privatisation and economy restructuring, numerous facilities were closed or their business activities were changed, leaving their pre-treatment plants neglected or unable to respond to real needs.

Records regarding industrial water pollution re major polluters are kept in the Polluting Sources National Registry (Environmental Protection Agency), and those of smaller polluters are kept in the registry at the local level of government. In practical terms, most polluters do not submit reports regularly nor as scheduled. Those who do, submit incomplete data, rendering it nearly impossible to quantify pressures from the industrial sector. In the absence of relevant data, Figure 24 indicates locations where wastewater is released by large wastewater industrial facilities.

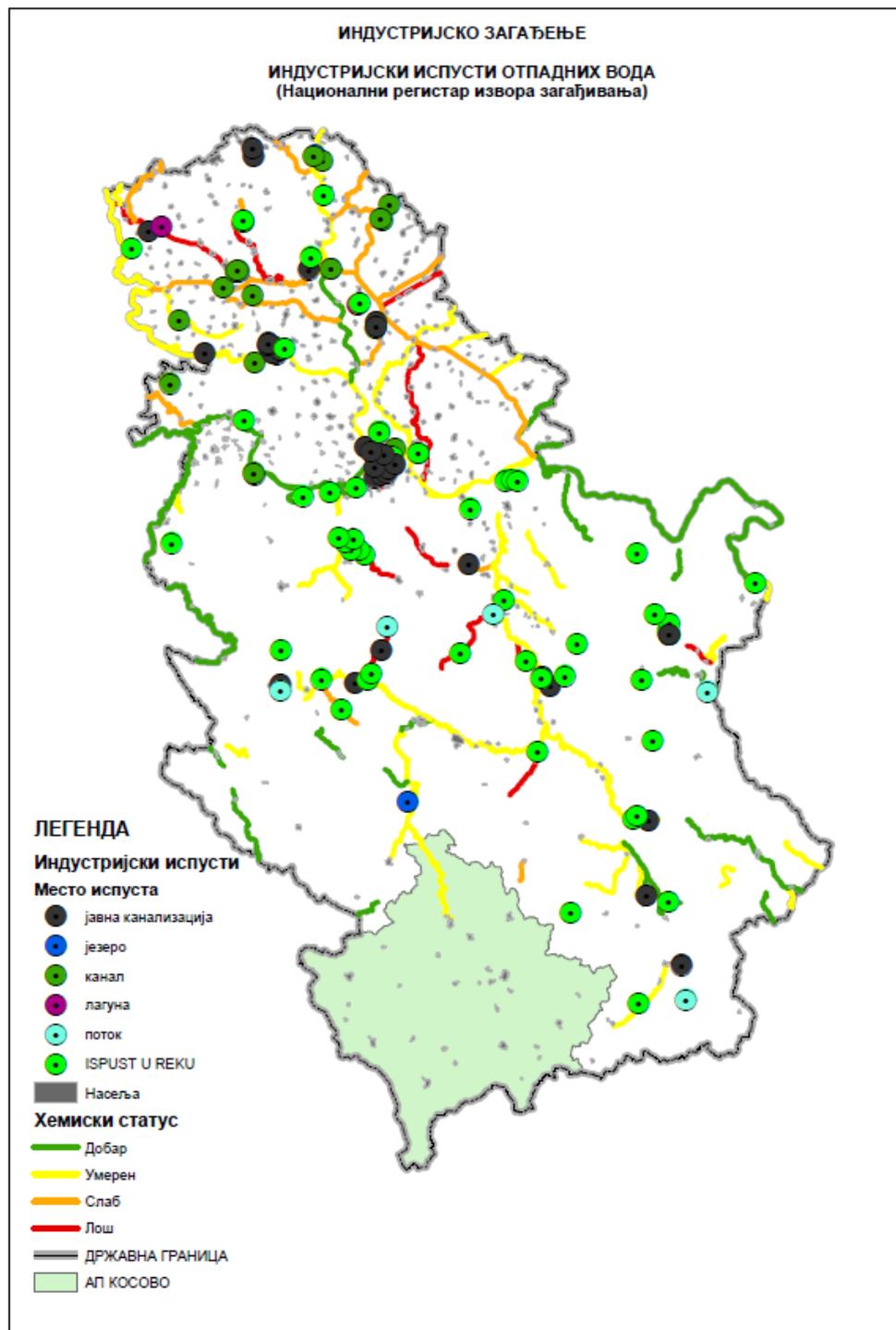


Figure 24: Locations and type of industrial wastewater outlets

INDUSTRIAL POLLUTION, INDUSTRIAL WASTEWATER OUTLETS (National Registry of Pollution Sources)

LEGEND, Industrial outlets, Outlet area, public sewage, lake, canal, lagoon, stream, RIVER OUTLET

Settlements, Chemical status, satisfactory, moderate, weak, poor

STATE BORDER, AP KOSOVO

Nonpoint sources of pollution

One source of nonpoint pollution stems from residents not connected to public sewage system, but rather to private sewage systems (or other types of sanitation with a negligible impact in terms of water protection). Owing to the implementation of adopted coefficients referred to in Table 26, pressure coming from the population not connected to public sewage systems has been calculated (Table 28).

Table 28: Pressure from the population living in settlements with over 2,000 residents with individual sewage systems

Water area	Population size		Nonpoint pollution originating from population in t/yr			
	Settlements with over 2,000 inhabitants	Connected to ind. sew. sys.	BOD <sub>5</sub>	COC (dichr)	Total N	Total P
Bačka and	1,381,255	467,138	1,023.03	1,381,255	300.08	15.34
Belgrade	1,556,626	204,925	448.78	822.77	131,644	6.73
Lower Danube	246,171	58,823	128.82	236.17	37.78	1.93
The Morava	1,554,847	419,356	918.39	1,683.71	269.39	13.77
The Sava	320,267	193,174	423.05	775.59	124.09	6.34
Srem	292,547	133,173	291.64	534.68	85.55	4.37
<b>TOTAL</b>	<b>5,351,713</b>	<b>1,476,589</b>	<b>3,233.72</b>	<b>5,928.50</b>	<b>948.51</b>	<b>48.50</b>

Quantifying the impact of nonpoint pollution owing to terrain runoff, primarily from agricultural land, is performed on the basis of targeted monitoring. As this sort of monitoring has yet to be established in Serbia, an evaluation based on the database of land use (CORINE 2006) and expert evaluation of pressure (in kg/ha/yr) have been made regarding the function and manner in which land is used. Adopted prospective burden coefficients are provided in Table 29, whereas burden depends on how and in which manner the land is used, which is shown in Table 30, according to water areas. It has been estimated that 12% of organic pollutants, 15% of nitrogen and 15% of phosphorus make their way into water.

Table 29: Prospective burden coefficients of water expressed in kg/ha/yr, in accordance with CORINE 2006

CORINE classification	Classification name	Pressures		
		BOD <sub>5</sub>	N	P
111	Settlements (>80% developed)	30	15	3
112	Settlements (<80% developed)	26	13	2.6
121	Industrial or business facilities	16	8	1.6
122	Roads with pertaining land	15	7.5	1.5
123	Ports with pertaining land	14	7	1.4
124	Airports with pertaining land	14	7	1.4

131	Mines	18	9	1.8
132	Landfill sites	32	16	3.2
133	Construction sites	14	7	1.4
141	City greenery	7	3.5	0.7
142	Sport and recreational facilities	8	4	0.8
211	Arable land	24	12	2.4
212	Irrigated agricultural areas	24	12	2.4
221	Vineyards	12	6	1.2
222	Orchards	10	5	1
231	Meadows and intensive pastures	7	3.5	0.7
242	Different forms of agricultural use	23	11.5	2.3
243	Agricultural areas with a lot of natural vegetation	22	11	2.2
311	Deciduous forest	7.2	3.6	0.72
312	Coniferous forest	5	2.5	0.5
313	Mixed forest	5.6	2.8	0.56
321	Natural grasslands	5	2.5	0.5
324	Forest succession (overgrowing land)	5.2	2.6	0.52
331	Beaches, dunes, sand	5	2.5	0.5
332	Deforested areas	3	1.5	0.3
333	Areas with scarce vegetation	4	2	0.4
334	Fire-gutted areas	10	5	1
411	Inland marshes	4.6	2.3	0.46
511	Flowing water	6	3	0.6
512	Still water	6	3	0.6

Table 30: Nonpoint pollution conditioned by land use, in t/yr

Water area	BOD <sub>5</sub>	Total N	Total P
Bačka and Banat	4,510.97	2,819.36	37.59
Belgrade	787.57	492.23	6.56
Lower Danube	1,858.96	1,161.85	15.49
The Morava	5,315.84	3,322.40	44.30
The Sava	1,803.39	1,127.12	15.03
Srem	472.45	295.28	3.94
<b>TOTAL</b>	<b>14,749.19</b>	<b>9,218.25</b>	<b>122.91</b>

Pollutants from livestock are defined based on the number of livestock units (LU) and adopted burden coefficients per LU (Table 31), whereas the evaluation of total livestock pressure per water area, is provided in Table 32.

Table 31: Livestock pressure coefficients, in kg/LU\*/yr

Type of pollution	BOD <sub>5</sub>	COC	Total N	Total P
Generated pollution coef.	2.85	5.25	2.3	0.25

\*one livestock unit (LU) is equivalent to the pressure generated by a young bull of 400 kg

Table 32: Water pressure originating from live stock, in t/yr

Water area	Number of LUs, 2012	BOD <sub>5</sub>	Total N	Total P
Bačka and Banat	724.87	4,124.54	4,001.31	43.49

Belgrade	111.84	636.40	617.38	6.71
Lower Danube	206.34	1,174.08	1,139.01	12.38
The Morava	802.55	4,566.51	4,430.08	48.15
The Sava	460.99	2,623.07	2,544.71	27.66
Srem	141.24	803.67	779.66	8.47
<b>TOTAL</b>	<b>2,447.85</b>	<b>13,928.30</b>	<b>13,512.16</b>	<b>146.87</b>

Total pressure originating from nonpoint pollution sources are shown in Table 33.

Table 33: Total water pressure originating from nonpoint pollution sources, in t/yr

Non-point sources of pollution	BOD <sub>5</sub>	Total N	Total P
Population with individual sewage systems	3,233.7	948.5	48.5
Livestock	13,928.3	13,512.2	146.9
Land use	14,749.2	9,218.2	122.9

Cattlestock produces 57% of the total nitrogen burden and around 46% of the total phosphorus burden, whereas the population not connected to the public sewage systems participates at 4% of the nitrogen burden, 15% of the phosphorus burden and 10% of organic pollutants.

Landfill sites also present a type of prospective nonpoint form of pollution. A land-registry of active public landfill sites was established at the federal level, according to which (data from 2010) there are 164 landfill sites of various types: sanitary, regulated, unregulated, etc. Two regional landfill sites opened in Jagodina and Užice following 2010. Some landfill sites are often situated near waterways and lakes (sometimes in waterway beds and shores). According to data from the Environmental Protection Agency, over 6% of landfill sites are less than 500 m away from existing sources of water for the water supply. Based on research done to date, the total production of municipal waste in Serbia has been estimated to approx. 2 million tonnes per year, an average of 0.76 kg per person.

In addition to the above-mentioned, it is evident that there are also illegal landfill sites, whose participation in the total solid waste pressure amounts to around 50%, according to estimations. There is also an issue regarding disposal of specific types of waste such as: industrial, metal, dangerous, medical, tyres, mud (municipal and industrial), etc. In recent years, significant efforts have been made to establish waste management systems, including recycling, as a method by which to decrease the quantity of waste.

Wastewater from the mining industry should also be mentioned. There are no reliable data on the quality and quantity so that it is not possible to determine pressure, as well as accidental pollution sources, which occasionally occur, as sudden and uncontrolled events (accidents), and therefore they are not evaluated with regard to pressure.

Total pressure on water originating from point and nonpoint pollution sources, excluding technological wastewater from the industrial sector (owing to the lack of high-quality data), are shown in Table 25.



Figure 25: Total pressure on water originating from point and nonpoint pollution sources

Total pressure on water in tonnes per year

Tot. P non-point, Tot. N non-point, BOD non-point, Tot. P point, Tot. N Point, POD point  
BOD point, Total N point, Total P point, BOD non-point, Total N non-point, Total P non-point  
Bačka and Banat, Belgrade, Lower Danube, Morava, Sava, Srem

### Situation assessment

With regard to the development of sewage infrastructure, Serbia falls within the group of average-developed countries, whereas with regard to wastewater treatment, it is positioned at the very bottom of this group. Namely, 55% of the population is connected to the sewage network, while less than 10% of the population has access to a certain level of wastewater treatment. A small number of industries possesses facilities for pre-treatment of technological wastewater, prior to their release into the sewage systems or other recipients.

In addition, the quality of water of larger waterways on the territory of Serbia has not been jeopardised, from the aspect of most water quality parameters (Chapter on surface water quality).

### **Hydromorphological changes**

Hydromorphological changes occur as a consequence of anthropogenic activities, i.e., the development of hydrotechnical (and other) facilities, which assure conditions for different types of water use (hydropower, navigation, water supply) and/or protection from the harmful affects of water. They occur on water bodies (water regime and drift changes, hydrological and hydraulic waterway characteristics, loss of floodplains, etc). They exert a certain amount of pressure on the ecological status of water bodies.

The most important changes occur on water bodies during the development of dams and during water accumulation. These are interruptions in the continuity of water flow, drifts and fish movement down the waterway, change in waterway morphology, change in coastal area characteristics. Other facilities which produce obstructions on waterways (locks, dams, gates) give similar effects regardless of

whether or not they are constructed as a form of protection from water, (protection from floods and fluvial erosion) or to create conditions for water use. The construction of line facilities aimed at protection from water may present significant pressure in terms of the ecological status of water bodies, primarily on small waterways, since the water corridor is narrower, natural floodplains are reduced and the flood regime is changed. In cases of regulatory works, certain changes in the hydrological regime and drift regime occur, as well as morphological changes and a loss of aquatic species habitat. Contact between the river and coastal area is also lost, owing to shore coating.

Hydromorphological changes have an influence on the state and quality of water ecosystems. Therefore, it is necessary to monitor these changes in the scope of monitoring and defining water status during the water management process. Three categories of water bodies can be defined from the aspect of hydromorphological risk: (1) there are no changes or they are insignificant, (2) hydromorphological changes occur on the largest part of the body of water but are not obvious or significant, so that the risk level should be determined via adequate monitoring and (3) there are obvious hydromorphological changes (accumulation, both-side drifts developed near river beds, regulated waterway sections through urban areas, etc.), the body of water is “at hydromorphological risk” and it is preliminary defined as significantly changed. Water bodies which have been changed to the extent that they can no longer reach a favourable ecological state, without significant consequences to the environment or human activities in terms of sustainable development, are classified as “significantly changed water bodies”. It is necessary for water bodies in this category to reach favourable ecological potential, implying changed hydromorphological parameters, as well as the implementation of measures for the improvement of conditions.

It is necessary to prove that activities leading to morphological changes on water bodies that are of social and economic significance and their return to a former condition (where the body of water can achieve a favourable status) would have significant adverse effects on: the environment, water use (navigation, drinking water supply, electric power production or irrigation), protection from the negative impact of water or other equally important human activities in sustainable development and that this economic and social interest cannot be provided by other means, which is significantly better for the environment, because of technical feasibility or undue costs.

### **Surface water quality and status of water bodies (surface water)**

#### Quality level

Evaluating the quality level of surface water is the starting point for all planning documents that define measures for achieving and maintaining good water conditions and enables monitoring of human activities in respect to any changes in quality.

For several decades, RHSS was the only institution in the Republic of Serbia competent to systematically observe and measure parameters of surface water quality. As of 2011, institutions competent to monitor water quality are the Environmental Protection Agency, the administrative authority within the Ministry and RHSS.

The level of quality of surface water is monitored systematically at approx. 140 stations, covering 103 of 500 water bodies, as defined by Law. In the period from 2004 to 2012, which was adopted as a reference period within this domain, the lists relating to observed parameters of surface water quality as well as certain observation stations were changed.

Evaluation of surface water quality was performed by examining their average quality and observed long-term trends, primarily according to the parameters which include an indicator related to pollution entry into surface water, whereby this pollution originates from different polluter groups. Classification in respect to 103 water bodies covered by monitoring station networks for surface water quality was performed on the basis of available data (Picture 26).

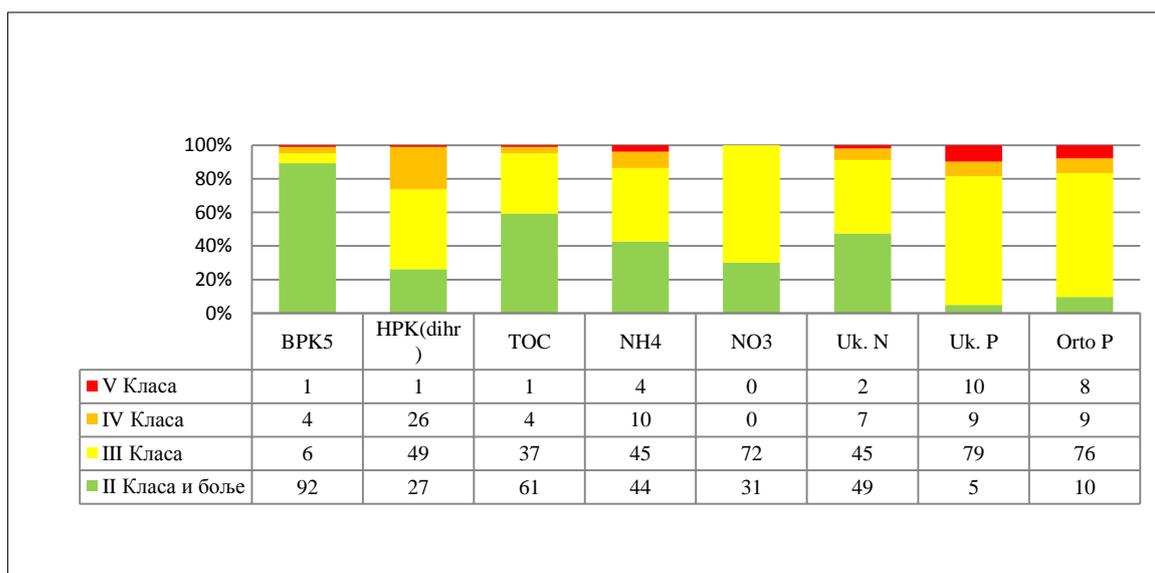


Figure 26: Water bodies according to the Regulation on Threshold Values of Pollutants BOD5, COC (dichr), TOC, NH4, NO3, Tot. N, Tot. P, Orto P Class V, Class IV, Class III, Class II and higher

Most water bodies are classified in the II and III quality class (over 80% of monitored bodies), whereas less than 20% belong to quality classes IV and V.

It should also be noted that bodies on large waterways, primarily on the Danube, Sava, Tisa and Drina, generally fulfill criteria for II quality class, except for the contents of ortophosphate in the outgoing sector of Danube, belonging to the III class. Increased levels of ortophosphate in this section of the Danube is probably the consequence of applied sampling methodology<sup>18</sup>. The deteriorated quality of certain bodies has been noted mostly on smaller waterways and canals in Vojvodina, as well as near large settlements (Figure 27).

It can be generally concluded that the quality level of surface water is relatively high, bearing in mind that less than 10% of wastewater is treated adequately. It is especially significant that the quality of the Danube river water, when leaving Serbia, is significantly higher than when entering Serbia, i.e. it gets better as it courses through Serbia (Figure 28).

<sup>18</sup>Samples on the reference station for this body of water are gathered on the right bank (state border follows the middle of Danube course), and not on the middle of the course, which is usual for other observed profiles.

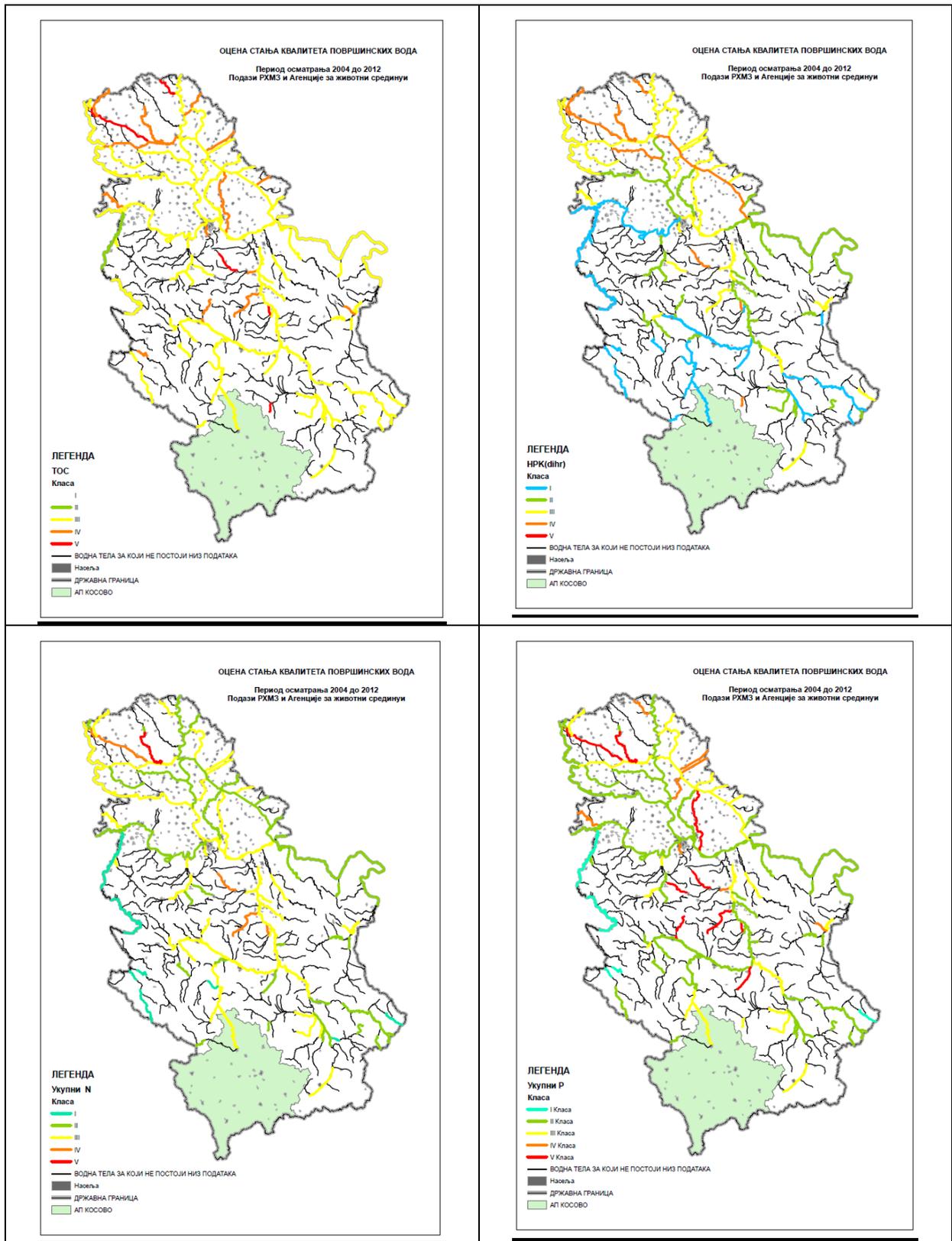


Figure 27: Water bodies according to the Regulatory Act on Ecological and Chemical Status Parameters

SURFACE WATER QUALITY EVALUTATION, Monitoring period 2004-2012, HMSS and Environmental Protection Agency data

LEGEND, TOC, Class, Water bodies without a sequence of data, Settlement, STATE BORDER, AP Kosovo

LEGEND, COC (dichr), Class, Water bodies without a sequence of data, Settlement, STATE BORDER, AP Kosovo

LEGEND, Total N, Class, Water bodies without a sequence of data, Settlement, STATE BORDER, AP Kosovo

LEGEND, Total P, Class, Water bodies without a sequence of data, Settlement, STATE BORDER, AP Kosovo

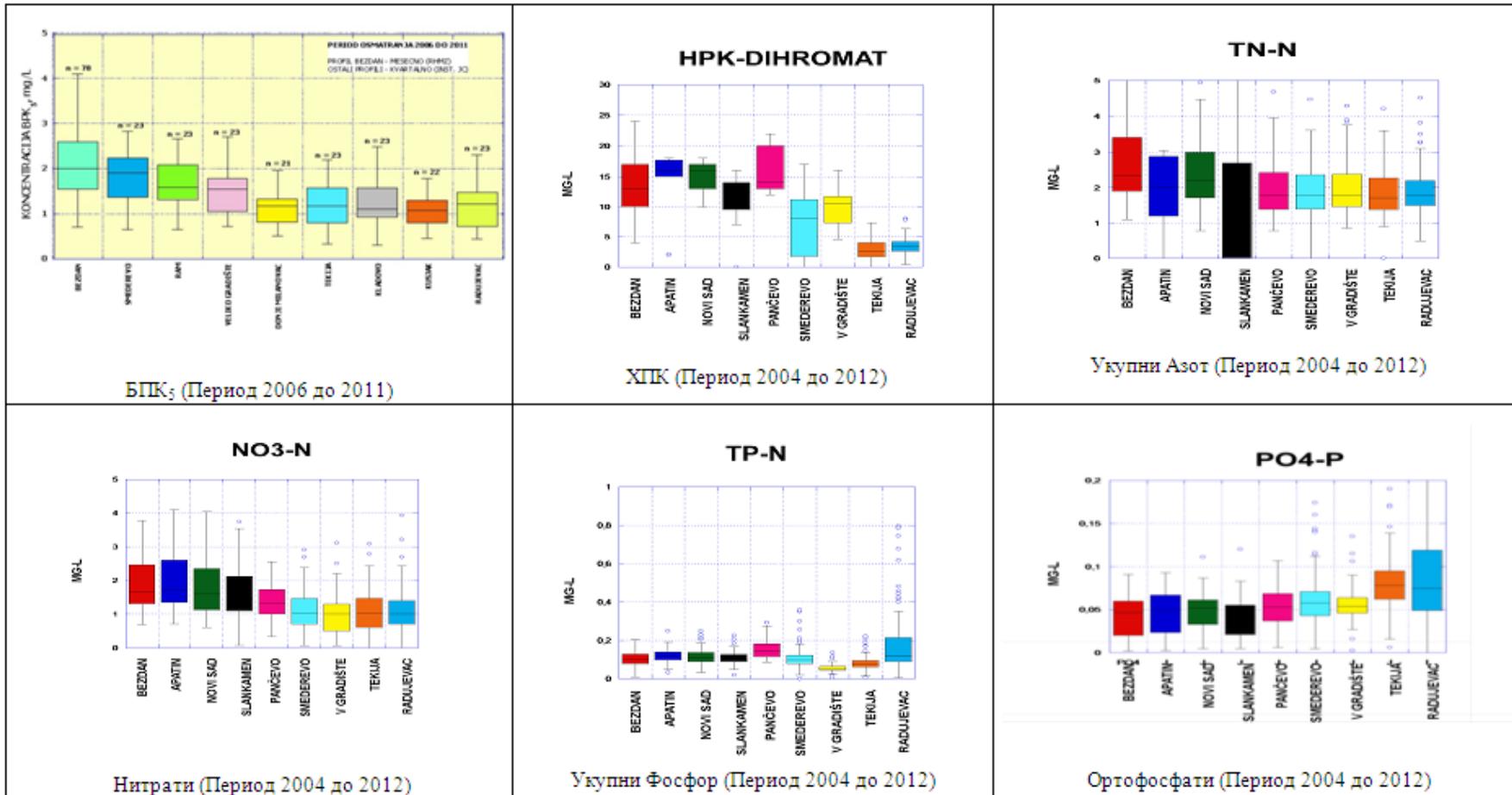


Figure 28: Observed trends related to the quality of water of the Danube as it courses through Serbia

### Status of water bodies (surface water)

Under the new approach, the assessment of the state of quality is given for water bodies, as special and significant elements of surface water. The evaluation is provided on the basis of ecological and chemical status, by taking the lesser status of rivers and lakes, as well as on the basis of ecological potential and chemical status of artificial and significantly changed water bodies. Ecological standards define the values of biological (aquatic invertebrates, algae, macrophytes, micro-organisms) and selected physico-chemical quality parameters (oxygen parameters, acidity, nutrients) relative to the undisturbed, natural state (reference condition) for every type of aquatic ecosystem, whereas chemical status<sup>19</sup> is defined by environmental quality standards in respect to prioritised, prioritised hazardous and other specific substances.

Ecological status and ecological potential are defined on the basis of the following criteria:

- biological (algae, aquatic macrophytes, aquatic invertebrates and fish);
- physico-chemical, having significance for biological parameters for the given category of surface water and the provided type of bodies (surface water);
- hydromorphological, having significance for biological parameters for the given category of surface water and the provided type of bodies (surface water);
- microbiological.

Based on the ecological and chemical status parameters,<sup>20</sup> a classification of surface water has been performed on the territory of Serbia without Kosovo and Metohija, for the following type groups:

- large lowland rivers dominated by fine drifts (Danube, Sava, Velika Morava, Tisa, Tamiš, Begej and Stari Begej) - type 1;
- large rivers dominated by medium drifts; except for the rivers in the Pannonian basin - type 2;
- small and medium waterways to 500 m dominated by massive base - type 3
- small and medium waterways over 500 m dominated by massive base - type 4
- waterways in the Pannonian basin (away from type 1 waterway) - type 5;
- small waterways away from the Pannonian basin that are not included in other types and waterways not defined by the Regulatory Act defining this domain - type 6.

Observance capacity and quality is the greatest for bodies on large rivers and artificial bodies, whereas the least available data relates to small and medium waterways (with an altitude up to and over 500 m) and small waterways away from the Pannonian basin that cannot be evaluated owing to the lack of relevant data. Therefore the review covers only about 45% of the total number of water bodies (Figure 29).

Pictures 30, 31 and enclosed map (Dž) show the evaluation of the body of water status. Deviations from favourable ecological status (with moderate ecological potential) and chemical status are conditioned by different anthropogenic pressure. According to the data, wastewater from settlements and industry, farms, coal mines, landfills are most dominant types of pressure, whereas agriculture is a nonpoint pollution source, with the largest influence.

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<sup>19</sup>legal documentation that would define the entire chemical classification of water have not been completed yet

<sup>20</sup>measurements in the period between 2007/12, on 140 profiles located on 66 waterways, 26 accumulations and 5 lakes, as well as the results of other research, especially related to biological parameters

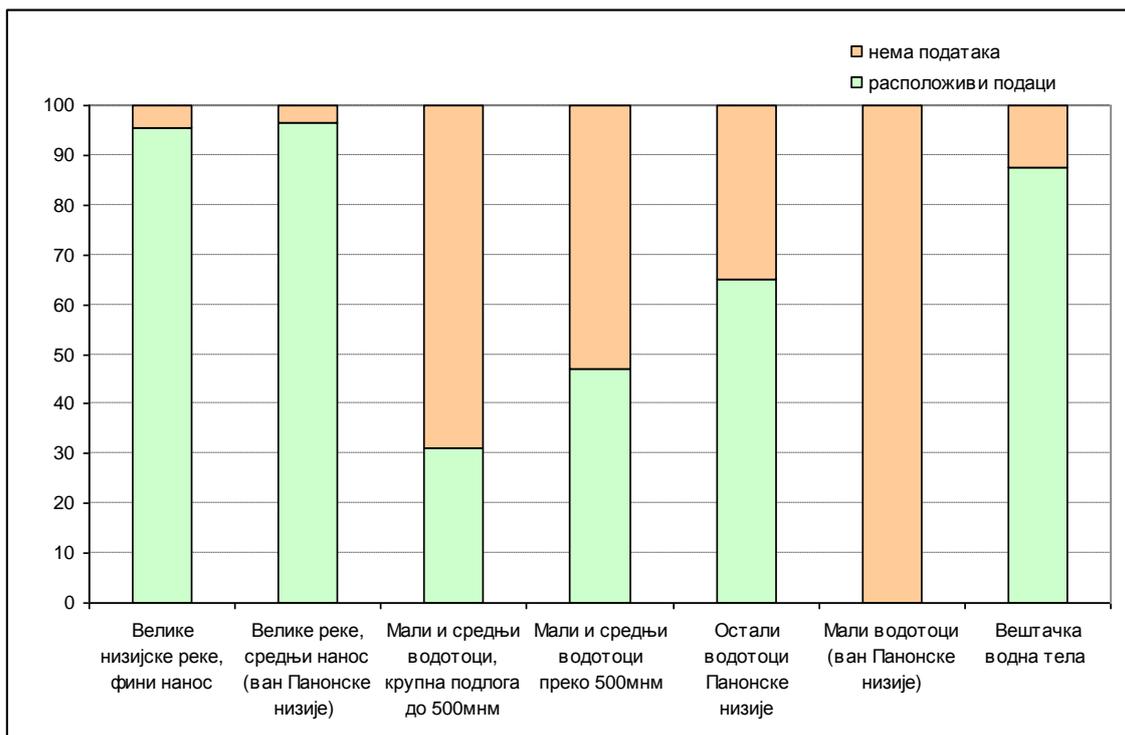


Figure 29: Data availability related to water quality

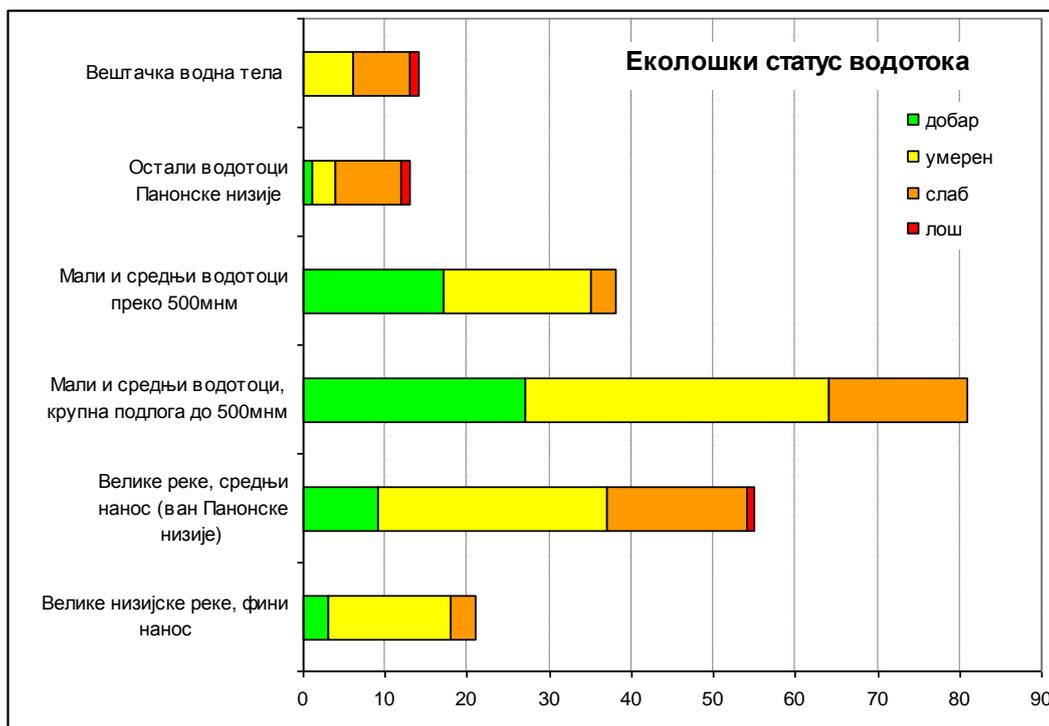


Figure 30: The review of ecological status/water potential evaluation

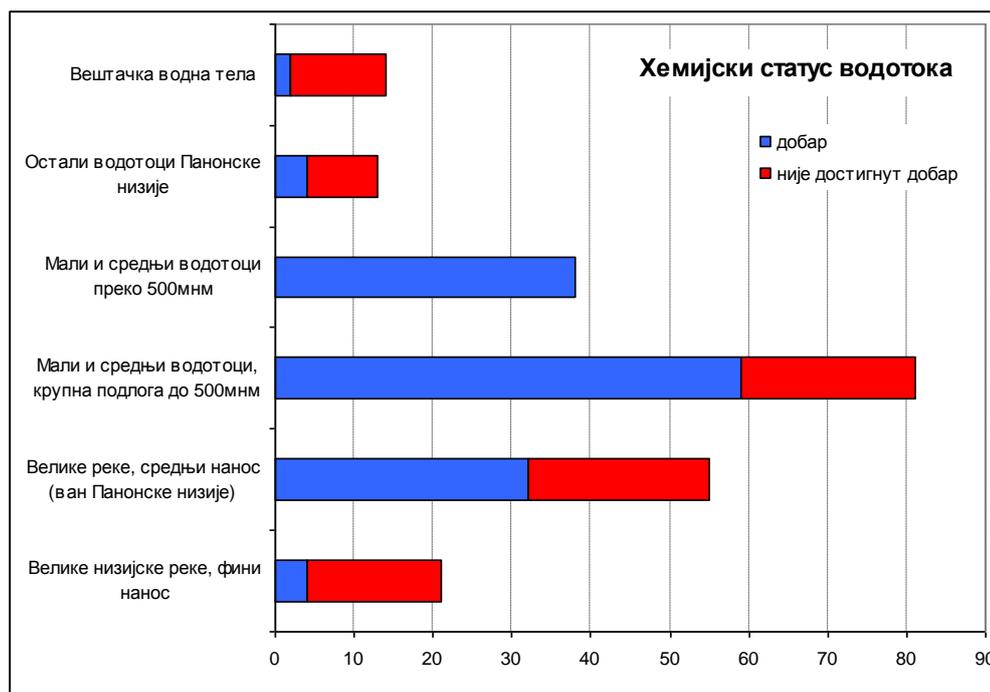


Figure 31: A review of the chemical status evaluation of water

Most frequent deviations of physico-chemical parameters are registered for orthophosphates. As for the contents of biodegradable organic substances, ammonium ions and nitrates, the quality of waterways is satisfactory, except for bodies downstream from large settlements. Mercury and arsenic are distinguished in certain samples as prioritised and specific pollutants.

Low quality of waterways according to biological criteria has been defined on around 25% of water bodies, including parts of the Južna Morava, Rasina, Kubršnica, Nišava, Begej, Zlatica, Turija, Ljig, then accumulations of Potpeć, Sjenica, Bovan, Gruža, etc.

The Vrbas-Bezdan canal, on HS DTD and rivers Krivaja, starting at the DTD canal confluence to the Zobnatica dam and Pek - Kaona canyon, starting at the Lješnica confluence to the Kučajska River confluence are defined as water bodies under the greatest threat - with low quality, according to ecological and chemical parameters.

It should be emphasised that a changed approach to water quality level evaluation (in the domain of water areas, relative to the ecological and chemical status of water bodies) demands an adjustment to the monitoring system to new conditions in coming period, including the harmonisation of relevant regulations and adequate selection of monitoring stations. The existing monitoring system does not cover a considerable part of bodies defined by regulations. Numerous quality parameters (indicators) for the evaluation of ecological status, according to biological parameters, have not been monitored systematically thus far. This is why the shown evaluation of ecological status, performed on the basis of incomplete data, pressure analysis and expert evaluation, is insufficiently reliable. The establishment of an adequate monitoring system, in accordance with the Law on Water and accompanying by-laws, harmonised with an adequate Regulatory Act on Natural Water Quality that are in the process of being adopted, are a priority activity for the provision of relevant data needed for reexamining the preliminary evaluation, i.e., defining the status of water bodies in the scope of revising water management plans.

## Groundwater quality and status of groundwater water bodies

### Quality level

The group of physico-chemical and microbiological characteristics of groundwater defines the quality and usability of water for certain purposes. Drinkable groundwater that may be used for the public water supply, sanitary-hygienic needs, cattle feeding, small consumer needs and industrial needs, as industry requires high-quality water, is especially significant.

Quality level evaluation relating to groundwater resources in the Republic of Serbia has been provided on the basis of available data of competent Ministries, monitoring results, technical documentation and results of individually conducted works and surveys.

Systematic monitoring and data updates on the quality of groundwater are preconditions for adequate evaluation of water status, understanding changing trends and evaluating the effects of undertaken protection measures. Spatial and time factors, as well as the volume of parameters being examined, have a direct impact on the quality of data defining water quality.

From the aspect of the strategy related to groundwater quality management, karst, alluvial and first aquifers, with the greatest anthropogenic influence, are especially important. On the other hand, these resources are characterised by significant spatial heterogeneity, dynamic water exchange and changeable hydro-chemical conditions that require different “sensitivity” of groundwater to certain pressures.

Groundwater quality level can be defined from the aspect of:

- parameters defining the natural quality of water, being dominantly the result of water and bed interaction;
- parameters defining the condition of resources when influenced by anthropogenic factors.

The natural quality of groundwater in the Republic of Serbia is quite uneven, which is the consequence of different mineral and petrographic composition of aqueous environments, groundwater genesis and aquifers, water age, different intensity of water exchange, etc, ranging from exceptional quality that does not require treatment to water requiring rather complex procedures prior to being used in the public water supply.

The chemical composition of groundwater relating to the first aquifer on the territory of Western and Southern Bačka is characterised by the mineralisation from 250 – 500 mg/l in the coastal area of the Sava and Danube, to 400 – 800 mg/l in the area of Varoška Terasa, whereas in some parts of Bačka the value of this parameter is over 2,000 mg/l. Total hardness ranges from 10 – 30° dH. In some areas it is even higher, with increased values of iron and manganese. In the area of North-Eastern Bačka the basic aquifer is characterised by mineralisation ranging from 240 – 480 mg/l, whereas this value ranges from 350 – 635 mg/l in the southern part. Water hardness is also lower in the northern part (6.5 – 10° dH), and higher in the southern part (up to 20° dH). Consumption of  $\text{KMnO}_4$  is below 10 mg/l, whereas the iron concentration may reach 3 mg/l.

It is possible to distinguish between three regions in the area of Banat in terms of basic aquifer quality: the region north of Begej and Plovni Begej, the region of Middle Banat (Zrenjanin- Žitište) and the Southern Banat region. Mineralisation ranges from 500 – 700 mg/l, iron concentration 0.2 – 1 mg/l, ammonium 0.2 – 1 mg/l, whereas the consumption of  $\text{KMnO}_4$  amounts are from 10 – 40 mg/l in the area north of Begej and Plovni Begej. Mineralisation amounts to over 1,200 mg/l, iron concentration ranges from 0.4 to over 2 mg/l, ammonium exceeds 10 mg/l and the consumption of  $\text{KMnO}_4$  exceeds 200 mg/l in the Zrenjanin-Žitište region. Mineralisation ranges from 310 – 460 mg/l, hardness is increased, amounting to 18 ° dH, whereas the concentration of iron is steadily over 0.5 mg/l in the Southern Banat region.

The quality of the first and basic aquifer in the area of Srem is similar to that of Banat, having in mind the hydrological connection between these two aquifers. Mineralisation ranges from 600 – 850 mg/l, hardness exceeds 20 ° dH, consumption of  $\text{KMnO}_4$  is low (from 3 – 7 mg/l), whereas iron has increased (0.5 – 3.5 mg/l).

One of the main characteristics of groundwater in the basic aquifer on the territory of Vojvodina is an increased concentration of arsenic. Increased concentrations occur in Central and Northern Banat (10–50 µg/l and over 50 µg/l), Central and Northern Bačka (10 – 50 µg/l, even exceeding 50 µg/l) and Western Srem (10 – 50 µg/l). Water quality of deep aquifers in the area of Bačka and Banat is not satisfactory (increased mineralisation, iron, organic substances, blurriness), whereas the quality is significantly higher in Srem.

Diversity related to groundwater chemical composition is present in the remaining area of the territory of the Republic of Serbia (area south of the Sava and Danube). A review will be provided according to the types of aqueous environments.

The type of water within quaternary alluvial deposits is usually sodium-calcium or magnesium-calcium sulfate-hydrocarbonate. Mineralisation ranges from 450 – 750 mg/l, hardness equals 12 – 16 ° dH, pH value ranges from 7.1 to 7.4. Increased concentration of iron and manganese is typical.

The type of water in neogene deposits is usually the sulfate-hydrocarbonate type, with changeable mineralisation ranging from 500 – 1,400 mg/l. The concentration of iron is locally increased.

The type of water belonging to karst aquifers is usually the calcium-hydrocarbonate type, with mineralisation from 200 – 500 mg/l, hardness from 10 – 15 mg/l, with a pH value from 7.2 to 8.

Nitrates, nitrites and ammonium ions are within limited values, except for parts of Velika Morava, where increased concentrations of nitrate values have been registered (settlements Požarevac, Lapovo, Velika Plana, Žabari and Svilajnac).

#### Groundwater quality in the alluvions of large rivers in Central Serbia

General characteristic of these aquifers is relatively low mineralisation, with rather changeable concentration of iron and a low level of manganese. Increased values of electric conductivity above 1,000µS/cm can be considered as indicators of anthropogenic influences and usually occur in combination with increased concentration of nitrates, chlorides and, not rarely, sulfates.

Basic characteristics of the groundwater of the Ibar, Zapadna Morava, Južna Morava, Velika Morava and Sava alluvions have been systematised and are shown in Table 34. The same table also contains characteristics of groundwater of the first aquifer in the area of Mačva.

Table 34: Basic characteristics of groundwater on the territory of Central Serbia and Belgrade

Aquifer	General indicators and sensitivity indicators	Impact indicators	Level of oxicity	Comment
The Ibar alluvion (Žičko Polje, Konarevo, upstream of Kraljevo)	pH 7.3- 7.9 Average TC mg/l ( 216 – 481) 328 Good water exchange T -8.3 to 18.6 °C Iron and manganese are below detection threshold	335 – 745µS/cm KMnO <sub>4</sub> 1.26-7.9 mg/l Nitrates 4 mg/l - 20 mg/l Chlorides 10-25 mg/l	Usually oxic	-prospective threat from occasional Ibar pollutions (from locations upstream of Raška) - phenol and heavy metal - area sensitive to nitrate intake
The West Morava alluvion (particulars related to HMSS monitoring)	pH 7.1- 8.3 Average TC mg/l ( 200 – 880) 450 Iron 0.01 - 1.84 mg/l and manganese 0.01 to 0.73	430 – 1570µS/cm KMnO <sub>4</sub> 8 – 24 mg/l Nitrates (1 /93) med. 15 mg/l Chlorides 10-25 mg/l NH <sub>4</sub> <sup>+</sup> below 0.2 -mgN/l	Regional differences	- nitrate concentration changeable by time and area - nitrate concentration occasionally over MAC - the lowest quality of water in Kruševac area
The South Morava alluvion (4) and confluences of Nišava (2 loc.), Vetrnica (2 loc.) and Toplica (1 loc.) tributaries	pH 5.9- 8.1 Average TC mg/l (150 – 1320) 500 Iron 0.01 - 1.6 mg/l and manganese 0.01 to 0.73 of med. MAC 0.5	300 – 1990µS/cm KMnO <sub>4</sub> 3 – 16 mg/l Nitrates (1 – 145), med. 28 Chlorides 10-25 mg/l NH <sub>4</sub> <sup>+</sup> below 0.2 -mgN/l	Regional differences	- nitrate concentration changeable by time and area -occasional increased concentration of nitrate (max.) 0.55 mg/l, aver. 0.02 mg/l)
The Velika Morava alluvion (the best researched area, justifiably owing to its significance today and in future)	pH 6.6- 7.8 TC mg/l (300 – 1300) Iron and manganese 0 – 1.5 mg/l Higher concentrations by V.M. waterway (in areas of Lapovo, Trnovča and village Šalinac, iron and manganese concentrations are above average) - concentr. Mg > 50 mg/l, natural characteristic	640 – 2000µS/cm Average KMnO <sub>4</sub> (1 -10) 6.5 mg/l) Nitrates (1 – 262), med. 35 Chlorides 10-25 mg/l NH <sub>4</sub> <sup>+</sup> 0.015 – 4.18 mgN/l nitrite sporadically over MAC	Usually oxic	- UWL decrease due to V. Morava bottom elevation (anthropogenic influences) - majority of settlements downstream of Bagrdan without utility infrastructure - quality change by time without rules - poor drinking water quality in numerous settlements (without water distribution systems, but also with centr. water distr. system)
The Sava alluvion – confluence - km 50: Water course Belgrade 4 m <sup>3</sup> /s and Obrenovac 250 - 300 l/s	pH 7.2- 7.9 Wells by the river TC mg/l ( 250 – 400) T -11 to 18 °C Iron 0.2 to 5 mg/l, on average 1.6 and manganese most often from 0.2 to 0.5 mg/l	wells 450 – 700µS/cm KMnO <sub>4</sub> 4 – 6 mg/l by the river, 4 – 10 mg/l in the hinterland Usually low nitrates Chlorides 10-25 mg/l NH <sub>4</sub> <sup>+</sup> to 0.5 -mgN/l, anthropogenic influence above	Annoxic, only locally oxic	- industry, urban centres and agr. widely represented - locally, water quality changed: electr. chlorides on one locality and with solvent occurrences - locations with increased arsenic are registered (naturally)
Mačva- the first aquifer	pH 7.1- 8.3 Average TC mg/l 400 T -11 to 18 °C Iron 0.02 – 1.2, aver. 0.2 mg/l and	365-1520, aver. 770µS/cm KMnO <sub>4</sub> 0.4 – 6.4, aver. 3.2 mg/l) Nitrates 0.1 – 98, med. 15 mg/l Chlorides 10-25 mg/l (max. 60	Oxic and annoxic	- nitrate concentration changeable by time and area (constant exceedance in Bogatić) - visible influence in Nočaj as well - nitrite concentration occasionally over MAC

Aquifer	General indicators and sensitivity indicators	Impact indicators	Level of oxicity	Comment
	manganese 0.01 – 1.14, aver. 0.14 mg/l	NH <sub>4</sub> <sup>+</sup> below 0.2 mg N/l,		

- Increased concentrations of nitrates are frequent (Table 35); nitrate values over MAC are registered sporadically. This has had an influence on the quality of water used in public water distribution systems (according to RAPWQ), being of low-quality in many settlements used for individual shallow wells, as well as on water sources Garevina, Žabari, Livade, Meminac and Ključ. Different methods are applied in order to assure a high water quality of these water sources (active hydraulic protection, combination with other resources and termination of exploitation).

Table 35: The presence of nitrates in the groundwater with systems depending on alluvial aquifer of V. Morava

Nitrate concentration (mg /l)	Number of analysed locations
No (<20)	14
30- 40	10
Over 50 (>MAC)	18
<b>TOTAL</b>	<b>42</b>

#### Groundwater quality in the area of Vojvodina

In Vojvodina groundwater used for the public water supply is abstracted from the Young Quaternary aqueous environment - the first aquifer, then from the basic aqueous environments of the Eopleistocene and old Pleistocene - basic aquifers and aqueous environment of Pliocene - sub-artisian and artisian aquifers in deep terraine areas.

The use of the first aquifer is usually present in the Western and Southern Bačka regions, and partially in the region of Southern Srem (depending on recharge from the Sava and Danube and from hinterland areas. A prospective area with all the conditions for the abstration of the first aquifer for the regional water supply is in Južna Bačka - Kovin depression.

Deeper aquifers have significantly greater importance relating to the water supply, whereas their quality is monitored via delivered water characteristics in public water distribution systems.

Even though data for the first aquifer are not of primary importance for water supply issues in the area of Vojvodina, the Agency performs systematic monitoring of groundwater for this aquifer only. It should be mentioned that the condition of the first aquifer in many locations is significantly worse than the conclusion reached following the analysis of facility monitoring data. Strong negative impacts have been registered in destroyed oil industry industrial plants (Novi Sad, Pančevo), in the region of certain waterways (Veliki Bački canal, etc.), in the zones of numerous settlements without sewage systems, farming zones and industrial-processing plants.

Characteristic parameters for raw abstracted groundwater, whose exceedance relative to MAC values is registered in Vojvodina are provided in Table 36.

Table 36: The results of examining hygienic drinkability of raw water (physico-chemical parameters), by district

District	Total number of samples	% of irreg.	Parameters over MAC values
Southern Bačka	790	77	colour, KMnO <sub>4</sub> consumption, electric conductivity, ammonium, arsenic, chloroform, nitrites, iron, manganese, blurness, odour, magnesium, pH, chlorides, trichalomethanes, sodium, phosphate, nickel, flourine, suspended solid particles

District	Total number of samples	% of irreg.	Parameters over MAC values
Western Bačka	132	92	colour, blurness, iron, KMnO <sub>4</sub> consumption, manganese, ammonium, chlorides, evaporating residues
Northern Bačka	493	94	colour, odour, blurness, ammonium, iron, arsenic, manganese, nitrites, potassium, mineral oils, aluminium
Northern Banat	412	98	colour, blurness, KMnO <sub>4</sub> consumption, ammonium, iron, odour, electric conductivity, chlorides
Central Banat	624	100	colour, blurness, KMnO <sub>4</sub> consumption, ammonium, iron, phosphates, nitrites, chlorides, arsenic, electric conductivity
Southern Banat	43	88	colour, blurness, KMnO <sub>4</sub> consumption, ammonium, iron, electric conductivity, chlorides, odour
Srem	360	25	manganese, ammonium, colour, nitrites, iron, blurness

Source of data: The Strategy of Water Supply and Water Protection in AP Vojvodina (2009)

#### The status of groundwater bodies

Groundwater status is defined based on quantitative status and chemical status, by taking the worse of the two.

Quantitative status comprises the level until which a groundwater body is under threat owing to direct or indirect abstractions. Good quantitative status of groundwater body is achieved when the median multi-year abstraction of groundwater does not exceed the available resource of groundwater, there is not an abating trend in the level of groundwater being the consequence of abstraction and there is no threat of water coming from dependent surface eco-systems.

A body of water is considered to be at risk from the aspect of achieving good quantitative status until the end of the plan period, when the trend in groundwater abating is registered, that is, available resources of groundwater are lower than the quantities for which it is expected realistically to be abstracted in the observed period. Risk evaluation related to achieving good quantitative status of bodies regarding a ten-year period has been performed based on the estimation of available groundwater amounts, estimation of future groundwater abstractions for different needs, as well as registered data on the regime of groundwater and trends in the changes of their level (Table 37).

Table 37: Quantitative risk assessment of groundwater in Serbia - number of groundwater bodies according to risk categories

Bodies	Water areas						Serbia in total
	Bačka and Banat	Srem	The Sava	Belgrade	The Morava	Lower Danube	
At risk	9	4	0	1	3	1	18
Probably at risk	0	0	0	0	4	0	4
Probably not at risk	0	0	0	1	2	0	3
Not at risk	12	1	33	7	46	29	128
<b>TOTAL</b>	<b>21</b>	<b>5</b>	<b>33</b>	<b>9</b>	<b>55</b>	<b>30</b>	<b>153</b>

According to the results of quantitative pressure, of 153 bodies, 18 are at risk (around 12%), 4 are at probable risk (around 3%), 3 are not at risk (around 2%), whereas 128 bodies are considered not to be at risk (around 83%).

When it comes to chemical status, an estimation of chemical risk related to groundwater (risk not to attain good chemical status) has been performed in two ways, depending on the availability of data on groundwater quality.

As for bodies for which there are data on the groundwater quality, risk analysis has been performed using the results of existing RHSS monitoring of groundwater, results of drinking water examining in the scope of regular analysis of public water distribution systems according to RAPWQ and/or results related to examining the quality of water in the scope of different studies, projects, surveys on water reserves and surveys on water source sanitary protection zones.

As for groundwater bodies without quality monitoring or with insufficient data, risk assessment has been performed based on the evaluation of how groundwater quality is affected by diffuse pollution. Risk assessment for such cases has been performed on the basis of the combination of two criteria:

- natural vulnerability of groundwater (expressed through vulnerability categories) and
- diffuse pollution sources (expressed through percentage coverage of terrain surface with different types of usage).

Table 38: Chemical risk assessment of groundwater in Serbia - number of groundwater bodies according to risk categories

Water bodies	Water areas						Serbia in total
	Bačka and Banat	Srem	The Sava	Belgrade	The Morava	Lower Danube	
At risk	0	0	2	1	2	2	7
Probably at risk	2	1	5	3	6	10	27
Probably not at risk	10	2	25	5	36	16	94
Not at risk	9	2	1	0	11	2	25
<b>TOTAL</b>	<b>21</b>	<b>5</b>	<b>33</b>	<b>9</b>	<b>55</b>	<b>30</b>	<b>153</b>

According to the assessment results (Table 38), 34 bodies (23%) are at risk or at probable risk, whereas 119 bodies (around 77%) are considered not to be or probably not to be at risk.

Dominant pressure considered to be the cause of the weak chemical status of bodies as pollution sources are: agricultural activities and settlements and urban zones without canals, whereby other pressure should not be neglected, such as municipal and industrial landfills, that can cause significant local groundwater pollution.

### 3.1.3. Regulation of water flow and protection against harmful effects of water

Regulation of water flow includes the construction and maintenance of water facilities for regulating waterways and works related to maintaining the stability of banks and riverbeds and increasing or maintaining the flow capacity for water, ice and sediment.

Protection against harmful effects of water means the implementation of a series of works, facilities, measures and other activities which protect people, natural and man-made material goods and resources from floods and water erosion in a rational way. With regard to the origin of water and nature of its adverse effects, this field is usually divided into three major segments:

- protection against floods resulting from spillage of water from the riverbed of larger - permanent waterways ("*protection from fluvial flooding*"),
- protection against all forms of water erosion and torrents and

- protection against excess rainwater and groundwater (*“protection from pluvial and groundwater flooding”*).

Today, in Serbia, the system of flood protection facilities, with a network of regulated waterways, represents a very important infrastructure system, on whose operation depends the survival and development of urban and economic centres, as well as infrastructural corridors in the river valleys.

### **Protection against fluvial flooding**

Seasonal fluctuations in the level and flow of water, as well as flooding of coastal areas, represent typical characteristics of waterways. However, floods are situations of extreme water discharges, when human lives, property and infrastructure come under threat. On a global level, they are classified as the worst natural disasters.

The problem of flood protection is also present in Serbia, due to frequent occurrences of high water in many waterways. There were particularly serious situations in 2006 and 2013 on the Danube, in 2006 on the Tisa, and in 2010 on a great number of the basins (the Timok, Juzna Morava, Drina, Kolubara), when the existing structures for protection provided successful flood protection. In May 2014, catastrophically high water, resulting from extreme hydro-meteorological conditions, caused the extensive damage of protection structures. This further led to the flooding of protected areas in the basins of the Sava and Drina rivers, Zapadna and Velika Morava, Mlava and to extremely large losses.

Waterways on the territory of Serbia vary considerably by their characteristics; hence the occurrences of high water differ as well. However, from the point of view of high water, we can generally distinguish two basic categories of waterways.

- large lowland waterways, characterised by large fluctuations in water levels, but lower range of flow, slow wave growth (more than 7 days) and a long duration of high water;
- torrential flows with large longitudinal riverbed fall, a large range between large and small flows, short duration flooding waves, characterised by high-speed water and massive movement of river and surface drifts.

Due to the large lowland waterways the water level rises relatively slowly, there are more possibilities for forecasting and undertaking measures for mitigation, such as flood protection and evacuation of people and goods. In case of flooding, damage can be significant, owing to the size of the flooded area and concentration of people, goods and infrastructure.

Torrential floods are usually a local phenomenon. They occur suddenly and often trigger landsliding. Although torrential floods are common for smaller areas than in cases of flooding of major rivers, they represent a significant danger and sometimes lead to human casualties. This is a consequence of their rapid emergence, which limits the possibility of forecasting and emergency action, as well as of the devastating effects of the high water speeds and surface sediments and other materials.

In Serbia, there are also a large number of smaller waterways characterised by the torrential nature of the hydrological regime and specific genesis, rapid concentration and short duration of high water. The torrential character does not always occur equally, but depends on the distribution and intensity of rainfall in the basin, as well as the state of basin erosion.

The upper parts of the major river basins in Serbia (the Danube, Tisa and Sava rivers) are largely located on the territory of several countries, which means that the floods are mainly formed outside the borders of Serbia. The most serious threat to the lowland areas in Serbia is the simultaneous emergence of high water in these rivers, which may lead to catastrophic consequences.

The Drina, Tamis, Timok, Neru, Karas, Nisava, Beli Drim, as well as a number of smaller waterways (the Zlatica, Stari Begej, Plovni Begej, Brzava, Moravica, Bosut, Lepenac, Pcinja, Jerma, Dragovistica

and other) are cut across by state borders or represent border rivers, hence their regime of high water is influenced by the conditions outside the territory of Serbia.

So far, different structures, works and measures have been used for flood protection, depending on the hydrologic-hydraulic, sediment and morphological characteristics of the waterway, as well as the purpose and method of use of waterways and coastal areas. Thereby, a dominant role was played by standard - investment (construction) works and measures providing the protection of the adopted "applicable" flow (the flow to which the protection system is dimensioned). A second set of measures - "non-investment measures" (administrative, regulatory and institutional measures for the prevention and reduction of direct, indirect and potential damage from floods) has so far been poorly represented, but it is now gradually being introduced and implemented.

The backbone of the existing flood protection system consists of "passive measures" (protective embankments and other types of "linear" protection), while "active measures" (the increase of riverbed bandwidth, retaining part of the flood wave in the reserves of single-purpose / multi-purpose reservoirs or retention basins, directing a part of the flood wave to the overflow channels) are less applied.

Built structures and systems for flood protection, systematised by water areas, are shown in Table 39 and Figure 32.

Table 39: Flood protection facilities on first-order water

Water area	Embankments	Length of linear facilities (km)				Reservoirs and retentions	
		Regulated riverbed with embankments	Regulated riverbed without embankments	Revetments / quay	High terrain	Reservoirs for flood protection	Multi-purpose reservoirs
Banat and Backa	915.90	422.47	9.48			1	2
Srem	114.27	5.50				2	E
Belgrade	263.03	202.74	2.26	12.41	3.52	1	2
The Lower Danube	248.81	22.24	15.22	6.64	1.47	E	6
The Sava	150.60	113.24	27.26	7.60	5.80		9
The Morava	640.70	343.19	62.16	2.91		4	20
Kosovo and Metohija	116.95		18.50				5
<b>TOTAL</b>	<b>2,450.26</b>	<b>1,109.38</b>	<b>134.88</b>	<b>29.56</b>	<b>10.79</b>	<b>11</b>	<b>47</b>

Source: Operational plan for flood control in 2013

The state of flood protection systems by waterway is shown below.

Flood control along *the Danube* is provided by left bank embankments from the border with Hungary (1,433 km) to the mouth of the Nera (1,075 km), as well as the right bank embankments or quay walls erected on particular locations in Srem and Belgrade and continuously from Smederevo (1,116 km) to Golubac (1,040 km).

From the Hungarian border to Novi Sad (1,255 km) the left bank embankments are 182 km long. After the devastating floods in 1965, embankments were rebuilt and new ones built to secure the 100-year high water, with a safety superelevation of 1.2 m. Along the major part, the embankments are higher than 5 m, with a crown width of 5 - 10 m. On the embankment line there are a great number of other water structures (locks, floodgates, pumping stations, etc.).

In the accumulation zone of "Djerdap 1" (downstream from Novi Sad) the conditions of flood control have significantly changed after the construction of the dam. The reconstruction of existing and the construction of new dams has been completed, several villages moved to a higher terrain, while others have been protected by revetments and protective walls. Today, the embankments protect the area from the 100-year high water, with the superelevation of 1.2 to 1.7 m. The floodgates at the dams of

"Djerdap 1 and 2" hydropower plants are fully open during the flow of high water, since the "Djerdap 1" hydropower plant reservoir cannot accept a flood wave due to its relatively small volume.

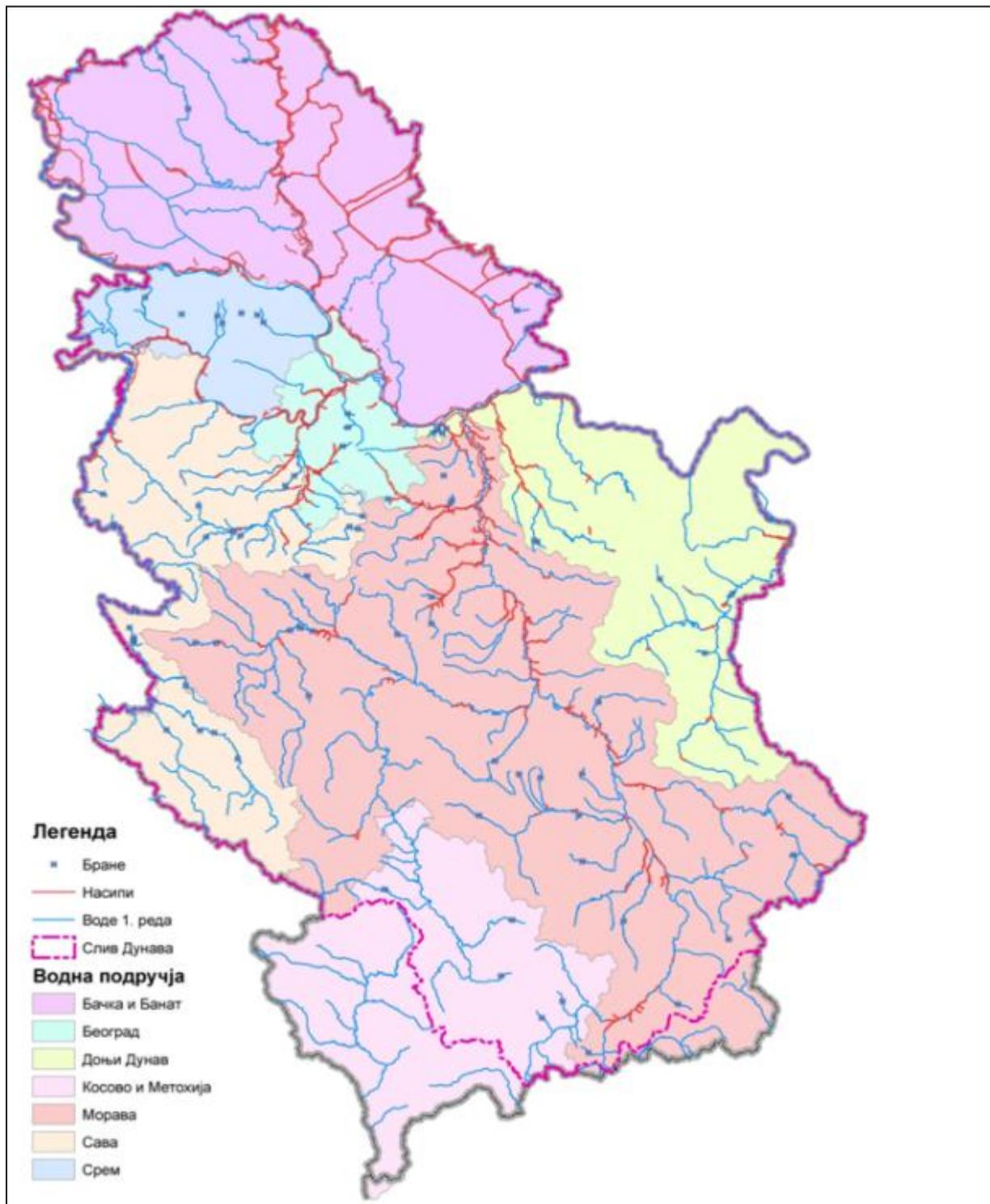


Figure 32: Existing flood protection system

Legend

Dams

Embankments

First - order water

The Danube River Basin

Water Areas

Backa and Banat

Belgrade

The Lower Danube

Kosovo and Metohija

The Morava River

The Sava River

Srem

Flood protection in 2006, during which the biggest problems were in the towns and settlements along the Danube, initiated the reconstruction of protective facilities in Novi Sad, Zemun, Smederevo, Stari Kostolac (Pozarevac), Veliko Gradiste and Golubac. Reconstruction is either completed or in progress. The protection of Belgrade in previous plan documents has always had first rank priority on the territory of Serbia, however, the required level of protection has yet to be provided, while construction in areas under the potential threat of flooding continues.

*The Banatski vodotocand* Stari and Plovni Begej, Tamis, Brzava, Rojga, Moravica, Caras and Nera are transboundary rivers, whose basins are largely located in the Carpathian Mountains in Romania. Flood protection provides a flexible system which consists of main HS DTD canals and intercepted waterways with embankments and allows for the redistribution of high water depending on the water level of the Danube and Tisa.

On *the Tamis* there are two parts: "The Upper Tamis" (from the floodgate of Tomasevac to the Romanian border), which is protected on both sides by embankments and "The Lower Tamis" (from the floodgate of Tomasevac to the confluence with the Danube), located in the same hydro-system, along with the floodgates of Tomasevac, Opovo, Pancevo and Centa. After catastrophic floods in both 2000 and 2005, (which occurred due to the demolition of an embankment in Romania), embankments on "The Upper Tamis" were reconstructed, and the corridor (in the sector of common interest) was cleaned.

Protection structures have not been built on *The Karas*, and thus damage is frequently caused by flooding, as well as on the Nera, where there are only local protective structures.

On *the Tisa* two-sided embankments were built, in the total length of 278 km. The embankments were reconstructed after the flood in 1970 and 2006, and they provide protection from the 100-year high water, with 1 m safety superelevation. The conditions of high water flow have significantly improved by the control works in the riverbed (expanding and cutting meanders) and at the floodplains (fixing the embankment line). In some areas, the floodplains are protected by summer embankments against the floods of the 10-year high water.

On *the Sava River*, double-sided non-continual embankments were built, on the left bank in the area from Kupinovo to Sremska Mitrovica, natural flood zones have been retained for the take-up and partial transforming of the flood wave. The left bank embankments were mainly reconstructed after the flood control in 1974 and 1981, and provide protection against the 100-year high water, with 1 m

safety super-elevation. On this embankment line, there are a large number of water structures (floodgates and pumping stations). The quay walls in Sremska Mitrovica should be surpassed to ensure a proper level of protection of the city.

The reconstruction of the defensive line on the right bank has not been finished, including the section between Šabac and the confluence of the Drina River, in the area of Mačva. In May 2014, the very difficult defense of some sections in this area, demonstrated that the urgent reconstruction of the embankment is necessary. It should be taken into account that the disastrous consequences along the Serbian sector of the Sava River would have been much worse had it not been for the breakdown of the embankments and water discharge onto territories in Bosnia and Herzegovina and Croatia, which is why the flood peak was decreased. Considering that another, or even more disastrous scenario may occur in future, the concept of flood protection on the Sava River should be reconsidered, in order to now secure centres under threat which have already experienced damage (cities, populated areas, industrial zones and infrastructure). In the case of the City of Belgrade, it can be concluded that the quay walls and embankments in the city's central zone (which is planned for further urban development), do not provide an adequate level of protection. Quay walls and embankments in Belgrade's central zone (which is planned for further urban development) do not provide an adequate level of protection.

*On the Kolubara River and its tributaries* (The Tamnava with the Ub, Turija, Beljanica, Vranicina, Lukavica, Toplica, Ljig, etc.) structures have been built with the aim of protecting populated areas, industrial plants and agricultural land. The content and position of the defended areas have influenced the choice and types of structures (embankments, regulation of "urban" and "rural" type). Particularly large scale flooding in 2014 requires a complete review of the concept of flood protection in the basin of the Kolubara.

*The Bosut* flows into the Sava River through the floodgate of "Bosut", located at the left bank embankment of the Sava. The floodgate is there to regulate water levels of the Bosut, except during high water from the Sava, when it is to be closed (around 3/4 of the Bosut basin is lower than the level of high water from the Sava). During this period, Bosut's water is pumped through the "Bosut" pumping station. Since 2/3 of the Bosut basin is located in Croatia, matters concerning the operation of the floodgate and pumping station are of interstate significance.

Protective structures along *the Drina River and its tributaries* were constructed primarily with the aim of protecting larger populated areas where important industrial plants are located (Loznica, Ljubovija and Bajina Basta on the Drina River, Prijepolje and Priboj on the Lim). Protection of farmland areas was performed only in the sector of the highest downstream of the Drina (protection of Mačva), in the Jadar valley and other tributaries. Various structures are used, depending on the contents of the defended area and the characteristics of a particular waterway: embankments, revetments and quay walls, as well as the regulation of "urban" types, in sections of smaller waterways of torrential type, running through populated areas or "rural" types, through agricultural areas, such as the Jadar valley. The flood protection system also includes dams and reservoirs on the Drina, Lim and Uvac. After high water from the Drina River in 2010 and in 2014, it is necessary to review the protection system, in cooperation with Bosnia, which is launching the construction of a dam in Semberija. In May 2014, extreme flows were recorded along the right tributaries of the Drina river basin, resulting in flooding and severe damage.

So far, in *the Morava* flow, different structures, works and measures have been used for flood protection:

- The construction of protective embankments, quay and protective walls, aimed at preventing direct discharge of high water from the waterway. The total length of the embankment, which is of federal importance, along the Južna Morava River is 293 km, the Zapadna Morava 99 km and along the Velika Morava and its tributaries it is 718 km. The embankment system is not continual, so that there are sections on the main flows and tributaries without embankments or

with embankments built only along one river bank. Generally, the larger populated areas are protected from flooding, while farmland is mainly left to flooding. The fact is that the protection of agricultural land against floods and fluvial erosion has not had a high priority in the concept of waterflow regulation in the past, nor does it today.

- Improving the flow capacity of the river section (by reducing flow resistance, increasing the flow profile or shortening the water flow). "Urban" type regulation, implemented in large cities and populated territories are particularly significant. In the Južna Morava river basin, the sections of waterways passing through Niš, Pirot, Vladičin Han, Leskovac, Prokuplje, Vranjska banja, Kuršumljija and other populated areas have been regulated. In the Zapadna Morava basin, regulation has been done in Užice, Požega, Čačak, Kraljevo, Novi Pazar, Kruševac, as well as in populated areas such as Guča, Lučani, etc. In the immediate Velika Morava river basin, river sections are regulated in towns and numerous other populated areas (Paraćin, Jagodina, Kragujevac, Svilajnac, Despotovac, Arandelovac, Rekovac, etc.).
- Retention of a part of the flood wave in reserved spaces multipurpose reservoirs and reservoirs intended for flood control.
- Directing a part of the flood wave into the relief channel (Hisar Channel in Leskovac).

Damages caused by flooding in the Morava river basin are recorded almost every year, mostly on agricultural land. Some of the major floods occurred in 1999 (spillage from the tributaries of the Zapadna and Velika Morava, with large scale damage caused to the populated areas, industrial plants, infrastructure facilities and agriculture), in 2007 and 2010 (both in the Juzna Morava river basin). In this basin, two floods were recorded in 2014: a smaller one in April (which affected a part of the basin of the Zapadna Morava and Toplica) and an extreme one in May, which affected the entire waterflow of the Zapadna Morava (except the Ibar) and some tributaries of the Velika Morava (the Belica, Crnica, Ravanica, Lugomir, Jasenica, Rača, Resava, Jezava, Rajka, etc.). Many facilities were heavily damaged, as applicable conditions for their dimensioning were obsolete. The concept of flood protection in the basin of the Morava should also be reviewed, starting with experience from previous floods.

The defensive lines along *the Mlava and Pek* were more recent, with the level of protection against fifty-year high water.

The defensive line along the lower course of *the Timok River* with the Danube embankment protects the most fertile land. In the basin local works have been done to protect against high water (embankments and "urban" regulation), which protect the populated areas, agricultural land and roads. The current level of protection is not satisfactory, which was also concluded during the flood of Zajecar in 2010.

*The Pčinja and Dragovištica* are transboundary waterways in the basin of the Aegean Sea. The Pčinja is cut by the Serbian-Macedonian and the Dragovištica by the Serbian-Bulgarian state border. Flood control is not satisfactory, which was proved by the flood in Trgovište on the Pčinja in 2010.

In addition to the above facilities for flood protection, numerous summer, localisation, border and other embankments have been built, which in certain circumstances serve to protect against flooding. It should be noted that the defended areas are often spacious, without a sufficiently dense network of localisation embankments, so that should breakdown of the first line of defense occur, a significant area would be under threat. In other words, the arrangement of the protection system, for the most part does not provide efficient localisation should the possible breakdown of an embankment occur. Flood localisation facilities are required particularly on the territories of larger cities, which could be under the threat of the breakdown of embankments in upstream waterway sectors.

As a part of the active measures for flood protection, 58 existing reservoirs and retentions are used to mitigate the flood waves of high water. A number of reservoirs have reserves with capacities to receive high water flood waves to a specific probability of occurrence, while with others, the

participation in flood protection is achieved through cooperation of reservoirs' users and the competent authorities. Today, reservoirs and retentions have a secondary role in flood protection.

The DTD hydrosystem, as a multipurpose water management system, and plays an important role in the active flood protection of large areas on the territories of Banat and Backa. Particularly positive effects have been achieved in the Banat waterways.

#### Assessment of the state of flood protection

The current state of flood protection in Serbia is not satisfactory, despite the fact that embankments and other types of "linear" protection have been built along 3,550 km (first order) for the purpose of flood protection, that the riverbeds of many river flows have been regulated and numerous waterflow, sediment and ice conditions improved (the length of about 135 km with first order water, i.e. a total of about 400 km for all waterways), as well as the fact that a number of existing reservoirs and retentions are involved in flood protection, to a greater or lesser extent. There is still a risk of flooding on a large part of the territory, while the potential risk of flooding is also present in the places where protective systems have been built. This was confirmed in May 2014, with the flooding of Obrenovac and other cities and populated areas.

It is estimated that floods have potentially affected approx. 18% of the country, primarily in the coastal region of the Danube, Tisa and Sava, then the Morava, Drina, Kolubara, Timok, etc. In the *Preliminary flood risk assessment* (2012) flood-risk areas were identified on the territory of Serbia, where there are or may occur significant risks of fluvial flooding. Maps marking the areas under threat and flood risk maps, which are the basis for the valuation of real or potential damage and flood risk management and planning, have been developed for significant floodplains along the Danube and in the Velika Morava river basin, and in future, these maps will be developed for other important floodplains.

In Serbia, damage caused by flooding has, in the past and recent years, occurred on both defended and undefended areas, but there is no systematic review of data for a multi-year period, neither by the area covered nor by the extent of the damage. Individual recorded values show that the damages caused by the floods are significant (damage caused by flooding to private facilities, infrastructure and agricultural land in Zaječar and surrounding areas reached almost EUR 4.5 million in 2010 alone), as well as that the implementation of flood control requires substantial resources (the cost of successful operational flood protection on the Danube, Tisa and other waterways in 2006 was approx. EUR 10 million). In May 2014, the amount of direct and indirect damage to 24 municipalities caused by flooding was approx. EUR 1.5 billion.

The worst situation is in minor waterways, where existing measures and facilities (control and protection), of mainly local in nature, limited to larger towns, major industrial facilities or agricultural complexes. Frequent and severe damage usually occurs due to unplanned urbanisation, with a change in conditions in coastal areas, as well as enclosed defense systems and/or obsolete levels of protection. On these waterways, due to the rapid approach of short duration high water, operational measures of flood control cannot be applied, so the activities of the competent authorities usually amount to warning, public assistance, documenting damage, and reparations to facilities after the flood wave has run its course.

The deterioration of flood protection in Serbia has been brought about by many anthropogenic causes, such as damaged water facilities, deforestation, unplanned urbanisation, construction on the rivers (especially of small bridges) and more. Further deterioration may be caused by improper water facilities management (the reservoirs, retentions, relief channels, floodgates), as well as possible climate change.

## **Regulation of waterflow**

Deformation of the riverbed, caused by natural or anthropogenic impacts, is a significant problem, considering the damage caused to the facilities located in the waterway bed or inundation area. Among significant anthropogenic impacts the uncontrolled exploitation of material from waterways and floodplains is included.

In order to prevent and stop the process of deformation of the riverbed, secure the necessary waterflow capacity, waterflow, sediment and ice, but also secure the necessary navigational capacities, numerous regulatory structures have been built in Serbia, primarily on the large waterways (the Danube, Sava, Tisa, Velika Morava) and the riverbeds of smaller water bodies of numerous medium and small regulated waterways. The most common regulation structures are revetments. The condition of regulated structures is often unsatisfactory, due to inadequate maintenance.

## **Exploitation of materials from riverbeds**

Dredging materials from riverbeds is done primarily to maintain or improve the water regime, with the economic aspect being of secondary importance for the water sector. Dredging is therefore a means to secure the necessary riverband capacity, and it is carried out within the defined limits and in accordance with the designed dynamics.

On larger waterways, the exploitation is mainly carried out from riverbeds (smaller), and from floodplains. If exploitation is done outside the designed capacities and established dynamics, it can potentially lead to unwanted deformation of the riverbed and thus compromise its stability. For larger waterways (the Danube, Sava, Morava and Drina) a permitted volume of annual exploitation has been estimated, which provides a framework for the issuance of water permits. The problem is the exploitation of river sediments on small and medium waterways (a negative example is the Kolubara), where the problem includes the uncontrolled exploitation of materials in the floodplains, which is not accompanied by adequate rehabilitation of borrow pits after completion of exploitation, and has a considerable effect on the environment and autochthonous ecosystems, and also reduces agricultural areas.

## **Erosion and torrents**

Production of sediment in the river basin and its transport into waterways are two components of natural, global processes. High intensity erosion processes affect the genesis of high water in the torrential river basin, increasing the maximum rate of flow.

The problem of erosion and torrential processes is complex and goes beyond the framework and competence of the water sector. From the aspect of the water sector, the greatest concern is the protection of water facilities from erosion sediments, especially reservoirs, while the protection of industrial facilities and transport infrastructure should be the responsibility of the entities in charge.

### Protection from erosion and torrents

Systematic works aimed at reducing the harmful effects of erosion and torrents in Serbia have been carried out for more than one hundred years now. These began in 1907, with the regulation of torrents in Grdelica Gorge, in order to protect the railway Belgrade-Skopje-Athens and have continued throughout Serbia, to a greater or lesser extent, to the present day.

Comprehensive technical works concerning protection from torrents (torrential partitions and regulations, etc.), and various biological works related to the erosion processes (afforestation, grassing, etc.), as well as various combinations of these two types of works and measures for anti-erosion land management have brought about the reduced production and release of sediment into the recipients.

The effect in the case of reservoirs is of great importance, as it now reaches a smaller percentage of the produced quantity of sediment, which is a function derived from the scope of works and their maintenance.

Table 40 shows the extent of the conducted works for the typical periods, starting from the second half of the twentieth century, and Figure 33 shows the spatial coverage of various densities of these works.

Table 40: Anti-erosion works in Serbia (from 1955 to 2010)

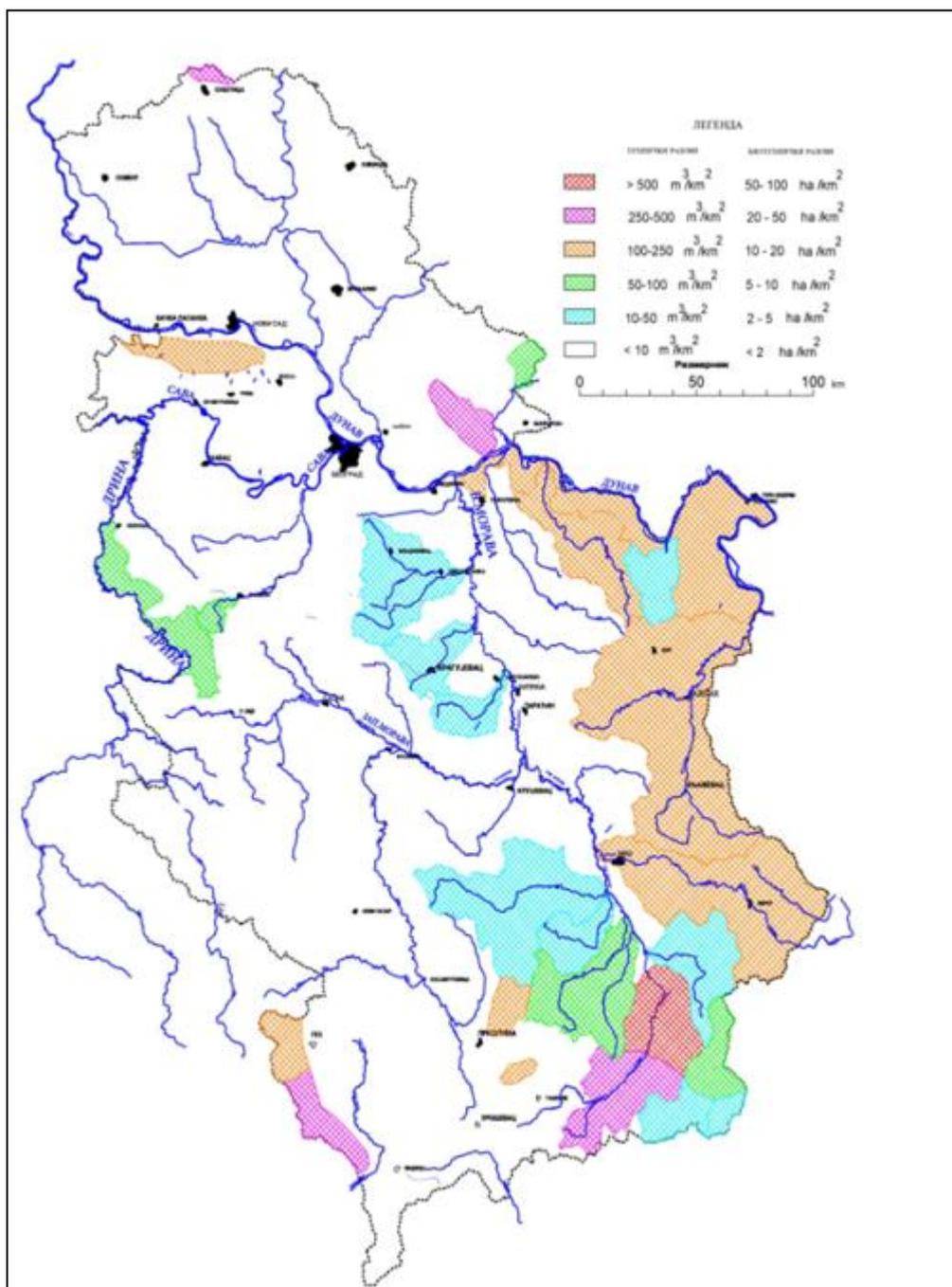
Period	Years	Technical		Biological	
		Total m <sup>3</sup>	Average per year m <sup>3</sup> /per year	Total ha	Average per year ha/per year
I	1955-1966	386,334	32,194	16,008	1,334
II	1967-1977	476,505	43,318	16,194	1,472
III	1978-1988	421,234	38,294	55,011	5,001
IV	1989-1991	84,557	28,185	10,810	3,603
VI	1992-2000	7,085	787	9,328	1,037
VI	2001-2006	11,672	1,945	12,598	2,100
VII	2007-2010	15,920	3,980	11,480	2,870
<b>TOTAL</b>		<b>141,145,020</b>	<b>25,059</b>	<b>131,430</b>	<b>2,347</b>

#### Situation assessment

High-volume works on anti-erosion land management and torrent regulation in the period up to 1991, saw significant progress achieved, as average erosion intensity was reduced by one, and in some areas even by two categories, and the eroded areas resulted in areas which are highly suitable for agricultural production, especially for planting fruit. However, in the last twenty years, due to a reduction of the necessary funds for investments in this domain, new anti-erosion activities and the maintenance of existing activities, have been significantly reduced. As a result, in recent years there have been floods throughout Serbia caused by torrential flows (the Jadar - 2005, the Bjelica - 2006 and 2013, the Veternica and Vlasina - 2007, the Pčinja - 2010). Particularly large flooding, with catastrophic consequences, occurred in 2014, affecting a large territory of the republic.

It should be noted that for numerous torrential flows and their waterways, there are general designs for the regulation of erosion and torrential areas, the implementation of which has not been carried out.

Figure 33:



Representation of technical and biotechnical works on the part of the Danube basin in Serbia

## Legend

### Protection from inland water (drainage)

In Serbia, drainage measures have existed since the time of the Roman Empire. In the eighteenth and nineteenth centuries, on the territory of Vojvodina significant works were carried out on draining the wetlands, primarily the construction of fluvial water protection systems, and then the construction of a drainage canal network, thus creating large areas suitable for agriculture.

The most significant drainage development took place in the second half of the twentieth century, with the construction of the HS DTD in Vojvodina, allowing for excess water to be received from over one

million hectares. Significant drainage works were carried out during the construction of the "Djerdap 1" and the Tisa River dam, for regulating the internal water regime under conditions when backwater occurs. By the year 1990, numerous drainage systems have also been built in other sub-basins.

In the last 40 years, construction of drainage pipes was initiated, and in the same period a certain number of drainage channels began to be used for two purposes: for both drainage and irrigation.

#### Systems built

Of the total land fund of Serbia without Kosovo and Metohija, arable land (of various quality) makes up approx. 4.5 million hectares. Drainage covers approx. 2 million hectares, which includes about 390 drainage systems, with a canal network over 24,000 km long, 210 major, and several dozen smaller pumping stations, with a total capacity of 543 m<sup>3</sup> / s and 252 gravity dischargers.

For the most vulnerable lands in the alluvial plains of the Tisa, Begej and Tamis, canal network density is 10-14 m / ha, with drainage hydromodule between 1.0 and 1.6 l / s per ha. On the Danube riverbanks the canal network is about 10.6 m / ha, with hydronic from 0.5 to 1.0 l / s per ha, while the canal network in the areas on loess terraces with drainage hydromodule of 0.5 l / s per ha.

Horizontal pipe drainage has been built on an area of approx. 66,000 hectares; it is most common in Banat, slightly less so in Bačka, and least of all on the water area of the Morava.

Table 41 shows the areas under irrigation systems, by water area.

Table 41: Areas under irrigation systems

Water area	Areas under systems (ha)	Pipe drainage (ha)	Canals (km)
Bačka and Banat	1,390,881	37,226	15,000
Srem	305,551	7,929	5,071
Belgrade	166,817	7,400	1,900
The Lower Danube	30,522	3,678	320
The Sava	76,171	1,315	1,250
The Morava	43,930	4,460	597
<b>TOTAL Serbia (without Kosovo and Metohija)</b>	<b>2,013,872</b>	<b>62,008</b>	<b>24,138</b>

#### Situation assessment

The existing inland water protection systems on the territory of the republic do not provide the corresponding groundwater regime in all areas, because the depth/level of groundwater in some cases does not meet the required criteria for either agricultural land or parts of populated areas.

Causes of inadequate operation of the existing drainage system include:

- incomplete construction of protective drainage systems;
- inadequate technical solutions in certain areas;
- inadequate and insufficient maintenance of constructed systems;
- lack of funds necessary to run the system;
- insufficiently precise mechanisms of calculating user fees for drainage, which results in an insufficient volume of collected funds in order to run the system;
- use of land reclamation canals for wastewater drainage/wastewater;
- illegal construction of buildings on the catchment area.

Reduced efficiency is noted in the way in which drainage pipes operate.<sup>21</sup> Such phenomena are more evident in regions with small water-permeable capabilities, mainly on the hydromorphic soils, which are predominantly represented in the drained areas on the water area of Bačka and Banat.

### 3.1.4. Regional and multipurpose hydrosystems

Improvement of the water regime on the territory of the Republic of Serbia, that is, the removal of temporal and spatial disparities between the available water resources and the demand for water, for water protection and protection from water, is provided by complex hydrosystems, which are conditionally divided into two distinct groups:

- regional systems for the drinking water supply, whose primary task is securing and the use of high quality water (primarily for supplying the public), with water protection and protection from water;
- other regional and multipurpose hydrosystems, which provide general water protection, water use for users who do not require drinking water level quality, with protection against the harmful effects of water.

In addition to the above, division is conditioned by the fact that the institutional organisation and competence is different for the two groups.

Among the above mentioned groups, there is mutual impact, and often their reservoirs are joined, which are shown separately.

#### Reservoirs

In the first half of the twentieth century, dams were purposefully built primarily to generate energy (i.e. the large dam on the Djetinja, 1930), also, as a source of water supply (Grošnica near Kragujevac, 1937). After World War II, during accelerated electrification of the country, high dams were built and the first large reservoirs formed, with capacities of over 10 million m<sup>3</sup> (Vlasinsko lake, Međuvršje, Zvornik). In Serbia today, there are 28 individual reservoirs with a capacity of over 10 million m<sup>3</sup> (Table 42), with a total accumulation area of about 6 billion m<sup>3</sup>. In addition to these large ones, a greater number of smaller reservoirs with different functions has been built.

Table 42: High dams built with reservoirs larger than 10 million m<sup>3</sup>

No	Reservoirs	Waterway	Year construction	Type	Dam height (m)	Length (m)	Dam body volume (10 <sup>3</sup> m <sup>3</sup> )	Total accumulation volume (10 <sup>6</sup> m <sup>3</sup> )	Purpose
1	Vlasina	The Vlasina	1949	E	34	239	365	176	D, E
2	Međuvršje	The Zapadna Morava	1953	G	31	190	38	18	E
E	Zvornik	The Drina	1955	G	42	269	316	89	E
4	Borsko lake	The Brestovacka reka	1959	R	54	350	345	12	I
5	Kokin Brod	The Uvac	1962	R	82	1,227	2,480	273	E
6	Gracanka	The Gracanica	1965	E	54	270	527	32	D
7	Bajina Bašta	The Drina	1966	GE	90	461	995	340	E
8	Batlava	The Batlava	1966	E	46	302	380	39	D
9	Potpeć	The Lim	1967	G	46	212	116	44	E
10	Đerdap I	The Danube	1972	G	61	1,278	3,000	2,550	E

<sup>21</sup>Study - The development and improvement of the effects of the construction of pipe drainage on agricultural land in Vojvodina, J.Černi, 2006.

No	Reservoirs	Waterway	Year construction	Type	Dam height (m)	Length (m)	Dam body volume (10 <sup>3</sup> m <sup>3</sup> )	Total accumulation volume (10 <sup>6</sup> m <sup>3</sup> )	Purpose
11	Gazivode	The Ibar	1977	R	108	520	5,100	370	E, F, IR, D
12	Tisa	The Tisa	1978	G/E	25	341	823	160	IR, F
13	Lisina*	The Božička River	1978	R	53	244	467	10	E
14	Čelije	The Rasina	1978	R	52	220	409	60	D, F
15	Bovan	The Moravica	1978	E	52	151	297	59	D, F
16	Uvac	The Uvac	1979	R	110	307	2,500	213	E
17	Paljuvi Vis	The Kladnica	1984	E	16	760	349	14	I
18	Vrutci	The Đetinja	1984	A	77	241	83	54	D
19	Lazici	The Beli Rzav	1984	R	131	218	2,000	170	E
20	Gruza	The Gruza	1984	A	52	288	78	65	D, F
21	Brestovac	The Pusta reka	1985	R	31	330	240	10	D
22	Đerdap 2	The Danube	1987	G/E	52	899	14,738	868	E
23	Grlišće	The Grliška reka	1988	R	32	101	103	12	D
24	Zavoj	The Visočica	1989	E	86	262	1,470	170	E
25	Barje	The Veternica	1991	R	75	326	1,300	41	D, F
26	Prvonek	The Banjska	2005	R	88	250	1,300	20	D
27	Rovni	The Jablanica	under const.	R	74	430	2,022	52	D
28	Selova	The Toplica	under const.	R	73	210	1,830	70	D

Main purpose of the dam: V/ D - drinking water supply, I - industrial water supply, E - energy, IR - irrigation F - flood protection

Dam type: E - earth-filled dam, R - rock-filled dam, G - gravity GE - gravity eased A - arch dam

\*reservoirs used for transferring water from the Božička reka basin to the Vlasina reservoir

### Situation assessment

Today, most reservoirs, although planned as multi-purpose reservoirs, are used as single-purpose, where a number of these are included in flood protection.

Due to inadequate approach to arrangement of the basin area of reservoirs and protection from sediment, at some reservoirs there has been a significant loss and siltation of the reservoir space (Sokolovica, Ovčar Banja, Parmenac, Zvornik, etc.).

Status of water quality in certain reservoirs intended for supplying water to the public (Vrutci, Gruža, Čelije, Bovan, etc.) is not generally unsatisfactory, and therefore, it is necessary to record the causes of deterioration and take adequate measures to remove them.

According to the WMB and other design documents, a number of reservoirs built for the needs of energy or some other use, will in future be used to supply the population with water. Given the current situation in terms of water requirements, it is necessary to review their purposes. The situation is similar with dams with reservoirs whose construction is in progress (Selova, Stuborovni).

## Regional systems for the supply of drinking water

Water supply from regional systems, with the exception of necessary large investments, has multiple advantages, whereby safety, in terms of the provision of water from different sources (or even different source types) is of special importance. For existing regional systems, and in Vojvodina and Central Serbia, the main sources are groundwater, but in Central Serbia reservoirs are also used, although to a lesser extent.

The most important water systems may include regional water supply systems<sup>22</sup> (RVS) Novi Sad, Belgrade, Niš, Kragujevac, RVS "Rzav" and RVS "Rasina". Smaller regional water supply systems include RVS Sremska Mitrovica, RVS Ruma-Irig, RVS "Djetinja", and water supply systems in Čuprija and Paraćin, that are connected through the "Sveta Petka" source.

*The regional water supply system in Novi Sad.* Today, this is the most developed water supply system in Vojvodina. Current water production is approx. 1.1 m<sup>3</sup>/s, and the water is supplied to almost 300,000 people in Novi Sad and Sremski Karlovci, which is approximately 1/8 of the total population of Vojvodina. The water is used from the aquifer formed in the alluvial deposits of the Danube, by way of wells along the riverbank. In Novi Sad, there are three sources: the Strand, Petrovaradin ada and Ratno ostrvo. The oldest one is the Strand, which, due to pollution, has had operational issues since 2008. Currently catchment from the Petrovaradin ada source is 300 - 400 l/s, while it was previously up to 600 l/s. The most powerful source, according to capacity is Ratno ostrvo, which could potentially provide over 1,000 l/s. Today, from this source, approx. 600 - 800 l/s is obtained.

*The regional water supply system in Sremska Mitrovica.* This regional water supply has a facility for deferrisation. The water supply covers the needs of the population of the entire municipality, but it is still necessary to expand its capacity and modify drinking water preparation technology.

*The regional water supply system in Ruma - Irig.* This regional water supply system uses Ruma's alluvial source, and in addition to this municipality, it provides the municipality of Irig with a supply of drinking water.

*The regional water supply system in Belgrade.* The capital's regional water system (BVK) now serves the population and the economy of central urban municipalities and the suburban municipality of Barajevo and part of the municipality of Grocka. This RVS obtains water from the alluvial aquifer from the coastal area of the Sava River, as well as through direct catchment of river water through the WTP "Makis I" and WTP "Jezero", while the construction of WTP "Makis II" is in its final stages. Smaller quantities of water are obtained with WTP "Bele vode" and WTP "Vinča". In recent years, water consumption has been significantly rationalised, so that the current average production of pure water in WTP BVK is below 7 m<sup>3</sup>/s. The system is sensitive to accidental pollution, and during critical periods in very hot years, reductions in the production of drinking water are possible, which is mainly obvious in the suburbs.

*The regional water supply system in Niš.* This system supplies approx. 240,000 inhabitants with water, as well as supplying a number of industrial consumers. Today, Niš's water supply comes from the "Mediana", with a capacity of 200 l/s, from the "Studena" spring, with a capacity of 300 l/s, as well as from the system of springs "Ljuberada-Divljana-Mokra-Krupac", with a capacity of 700 l/s.

*The regional water supply system in Kragujevac.* This system relies on the reservoirs of Gruža, as well as the source of "Grosnički vodovod", with a capacity of about 120 l/s, which provides water supplies to villages in the municipalities of Kragujevac, Knic and Batočina, and "Moravski system", with a capacity of about 350 l/s, which uses groundwater from alluvion of the Velika Morava (the source of the Brzan). The main problem with this system is water quality, i.e. the eutrophication process of a reservoir. In addition to the main purpose – to supply drinking water, the Gruža reservoirs successfully

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<sup>22</sup> The regional water supply system means the system for drinking water supply for two or more municipalities.

protect downstream areas from flooding. From the Gruža reservoir, water is transported to Kragujevac, and through the “Šumari” reservoirs, Kraljevo is provided with extra quantities of water.

*The regional water supply system "Djetinja".* The system, from the Vrutci reservoir, supplies water for the populated areas of Užice and Sevojno and industrial consumers. This system has not developed as planned, because the need for water, especially of industrial users was lower than anticipated by the project. Therefore, at this point the reservoir has available amounts of water for other purposes, as well.

*The regional water supply system "Rzav".* The system now supplies water to the population and economy of the populated areas in the municipalities of Arilje, Požega, Lučani, Čačak and Gornji Milanovac. Water is taken from a live stream of the Rzav River on the "Ševelj" barrier and purified at WTP "Rzav", with a capacity of 1,200 l/s. With a capacity of 650 l/s, the plant was put into operation in 1984, and preparations are currently in progress for its expansion. WTP "Rzav" has been conceived on the use of accumulated water of the same river; however, due to the time discrepancy between the construction of the dam and the remaining part of the water system, the water is temporarily taken from the living flow of the river. The construction of the dam and reservoir will provide wider water management operation of this system.

*The regional water supply system "Rasina".* The system relies on the Čelije reservoir on the Rasina and provides the populated areas with water in the municipalities of Kruševac and Aleksandrovac, as well as the populated areas in the municipalities of Čičevac and Varvarin, whose accession is in progress. The regional system has not been implemented within the planned scope, mainly because a number of settlements, whose inclusion in the system was envisaged, solved the water deficit problem urgently by constructing their own water sources. It is necessary to provide adequate protection of water quality in the basin of this water source, as soon as possible.

*The regional water supply system "Barje".* The system relies on the reservoir of the same name on the Veternica River. The reservoir was formed in 1994, but until the construction of drinking water treatment plants, in 2010, it was not used to supply water to the population of Leskovac, but as a flood protection source. Planned connections with other areas have not yet been realised.

*The regional water supply system "Bovan".* The system relies on a multi-purpose reservoir from the Morvica River, built in 1978. Today it is used to supply water to the town of Aleksinac, and a planned water supply of settlements in the municipalities of Ražanj and Sokobanja has not yet been realised.

*The regional water supply system "Prvonek".* The water source of this system is the Prvonek reservoir located on the Banjska River, completed in 2005. The reservoir is used to supply water to the settlements in the municipality of Vranje, while the connection with the settlements in the municipalities of Bujanovac and Preševo has not yet been realised.

### **Other regional and multi-purpose hydrosystems**

Other regional and multipurpose hydrosystem on the territory of the Republic of Serbia have a long history of development. The first such systems appeared in the third century on the territory of Srem (Jarčina), in the fifth century, in the region of Pusta reka (the Zlatna and Caricina river), and from the eleventh to the fourteenth century the regulation of rivers and drainage on the territory of Vojvodina was carried out. More intensive work in this area began in the early eighteenth century, also on the territory of Vojvodina and with varying intensity they continue until present day.

*The regional multipurpose hydrosystem "Danube-Tisa-Danube",* implemented after the Second World War, solves the problem of water regulation in Banat and Backa in a unique, comprehensive and complex way, and is one of the most complex water management systems in Europe. As a whole, it has continuously been in operation since 1977, but the use of certain parts of the hydrosystem began much earlier, i.e. in the course of construction.

The DTD hydrosystem is designed so that the network of main channels, with a dam on the Tisa in Novi Becej and the accompanying major water facilities, connects the Danube with the Tisa in Bačka and the Tisa with the Danube in Banat. The hydrosystem connects, and partly or entirely, includes cut waterways and large canals in Bačka (Bajski channel, Plazović, Mostonga, Krivaja, Jegrička and the old Great canal Bezdán-Becej) and in Banat (the Zlatica, Stari and Plovni Becej, Tamis, Brzava, Vršački channel, Moravica and Caraš), altering their natural water regime. Thus, the basic HS DTD canal network, cut waterways and the detailed canal network for drainage and bringing water connected to them, creates a together functionally indivisible whole - hydrosystem DTD, which allows the maintenance of the unique water regime in Bačka and Banat.

The backbone of the DTD hydrosystem is the Main canal network (MCN) with its accompanying structures and includes a network of main channels about 695 km long (with cut waterways, a total of about 930 km), around 600 km of which are navigable, the dam on the Tisa in Novi Becej and 47 accompanying water facilities.

The main channels are also the main discharge and supply of water with 27 water stairs (1.5 to 9.0 m high), which form 14 basins. Through all the main channels, the flow is gravitational, with controlled levels and water flows, allowing the acceptance and removal of redundant internal water, foreign water, large water of intersected waterways (flood protections), irrigation, water supply for industrial capacities and fisheries, navigation, tourism and recreation.

The dam on the Tisa near Novi Becej, with seven spillways and ship lock for ships up to 1,000 t capacity, was built in 1977 and is the largest structure of the hydrosystem. Its construction and raise of the level of the Tisa upstream has made possible the gravitational water supply to the HS DTD Banat area. The road bridge was constructed on the pillars of the dam, as a traffic link between Banat and Bačka.

The major waterworks of the system are: 25 floodgates, 3 of which are water intakes ("Bezdan", with the capacity of 60 m<sup>3</sup>/s, "Novi Becej", 120 m<sup>3</sup>/s and "Padej" 20 m<sup>3</sup>/s), 17 are for regulation and 5 for safety; 5 pumping stations, 2 of which are reversible, for the abstraction and discharge of water ("Bezdan II", 12 m<sup>3</sup>/s and "Bogojevo", 15 m<sup>3</sup>/s), 2 are used for the discharge of very high inland water ("Žabalj" 16 m<sup>3</sup>/s and "Becej", 20 m<sup>3</sup>/s) and one for the abstraction of water at very low water levels of the Danube ("Bezdan", 6 m<sup>3</sup>/s) and 17 ship locks, 12 of which are for 1,000 ton ships. Apart from the above, in defense of the backwater impact of the Danube ("Djerdap 1") the following floodgates were built: "Centa", "Opovo" and "Pančevo", with a ship lock and pumping station.

Functions of the hydrosystem DTD are the following:

- drainage of excess inland water - realised fully within the project, by collecting, accepting and removing redundant inland water with about one million hectares of catchment areas on the territory of Vojvodina (and about 160,000 ha from the Hungarian and 285,000 ha from the Romanian territory);
- use of water for irrigation - achieved significantly below the planned volume, due to the low level of construction and operation of the irrigation systems;
- use of water from the HS DTD for industrial and other users - achieved according to its needs, but is considerably below the envisaged volumes;
- use of water for fishing and taking water on emptying fisheries - achieved to the approximate amount of 50% of the total volume planned;
- abstraction and discharge of wastewater - achieved, but not in the manner designed, since the canal network receives insufficiently refined or raw sewage water;
- navigation of the OCD facilities - achieved significantly below the possibilities offered by the hydrosystem;
- tourism, sport and recreation - the system is used well below its potential, fishing being the most common type of use.

*The regional hydrosystem "Severna Bačka" is designed to provide the redistribution of water for several purposes, the most important being the irrigation of land in the area between the Tisa, HS DTD (channel "Bezdan-Bečej") and the Yugoslav-Hungarian state border. So far completed are the subsystems "Tisa-Palić" and "Beljanska bara" and initiated are "Plazović", "Mali Idjos" and "Orom-Cik-Krivaja". The water is taken from the Tisa and Danube, through the HS DTD.*

The multipurpose regional hydrosystem "Nadela" has numerous functions (drainage, irrigation, protection of the backwater of the Danube, industry water supply, receipt of used water, etc.), upon the completion of the first phase, with 82 km of the regulated riverbed of the Nadela, two pumping stations and the system of floodgates. The system is now used primarily for drainage and coastal protection from backwater of the Danube, and much less for other purposes.

Except for the regional and multi-purpose hydrosystems on the territory of Vojvodina, in the rest of the territory of Serbia there was no significant formation of regional hydrosystems, which has led, in many cases, to the reduction of usability from the waterway downstream from the place where, due to abstraction of water, the water regime is changed. The exceptions are multipurpose regional hydrosystems "Radonjić" with the reservoir of the same name and "Ibar", with "Gazivode" reservoir on the territory of Kosovo and Metohija, which was also intended for the industrial water supply, irrigation and other business functions.

## **3.2. CURRENT LEGAL AND INSTITUTIONAL SOLUTIONS AND FINANCING OF WATER MANAGEMENT**

### **3.2.1. Legal framework**

#### **Regulations governing the field of water**

The right to a healthy environment and water as an important element is guaranteed by the Constitution of the Republic of Serbia. The Republic of Serbia regulates and provides a system for the protection and improvement of the environment.

The basic legal act in the field of water is the *Law on Water* ("Official Gazette of RS", nos. 30/2010, 93/12), which "regulates the legal status of water, integrated water management, management of water facilities and wetland areas, water sources and funding of water-related activities as well as other issues of importance for water management." This law applies to all surface water and groundwater on the territory of the Republic of Serbia, including thermal and mineral water, except groundwater from which useful mineral raw materials and geothermal energy are obtained, then the waterways that form or intersect with the Republic of Serbia's borders and the related groundwater, as well as the exploitation of river sediment which do not contain the ingredients of other useful minerals.

Water, according to the *Law on Water*, is within the domain of public welfare and is under state ownership. Water must be used rationally and economically, and the right to use water, with the exception of certain purposes<sup>23</sup>, is acquired by a water permit, or on the basis of contracts (special water use).

The territory of the Republic of Serbia represents a unique territory for integrated water management<sup>24</sup>. Within this territory there are seven water areas defined as basic units for water management, including the following water areas: the Sava river basin, Belgrade, the Morava, the Lower Danube, the Srem, Bačka and Banat and Kosovo and Metohija. This concept of water management is also provided by the management plan for the Danube river basin, which includes over 90% of the total territory of the Republic.

Water management falls under the responsibility of the Republic of Serbia and all documents are adopted at this level providing a normative framework for the integrity of the water system, the Water Management Strategy in the Republic of Serbia, Water Management Plan for the Danube River Basin, management plans for water areas, as well as plans for flood control, flood risk management, and water protection. At this level, international cooperation in the field of water management is organised and implemented. A number of competencies in the field of water management are transferred to the autonomous region, the capital city and local government. This primarily refers to the planning segment, within which the autonomous province and the city of Belgrade adopt water management plans for water areas and their implementation measure programmes, as well as plans for flood risk management, on the territory of their jurisdiction. Administrative authorities in these areas are in charge of issuing water-related acts for the construction of new and reconstruction of the existing facilities and implementation of other works that may permanently, periodically or temporarily affect changes in the water regime, as well as for the preparation of planning documents for spatial planning and forest management. Local government is responsible for enacting water-related policies for facilities whose impact does not exceed its limits, for planning and implementing protection from the

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<sup>23</sup> According to Article 67 of this Law, all persons are permitted to use water without prior treatment, i.e. without the use of special equipment or the construction of water facilities (general use of water) for the following purposes: drinking, livestock feeding, sanitary-hygiene needs, recreation, including swimming, fire-fighting and boating

<sup>24</sup> Integrated water management, according to the *Law on Water*, creates a set of measures and activities aimed at maintaining and improving the water regime, provisions defining necessary water quantities of required quality for different purposes, protection of waters from pollution and protection against the harmful effects of water

harmful effects of second-order water, as well as for protection from erosion and torrents within their own jurisdiction.

The water management plans, made for water areas and the Danube river basin, represent a new type of a planning document, the content of which is largely compliant with the requirements of the Water Framework Directive and include all the necessary elements which provide the concerned area with rational use and protection of water, as well as protection from the damaging effects of water. Planning documents are also the plans governing the protection from harmful effects of water (flood risk management plan, general and operational plan for flood protection), as well as plans regulating water protection (water pollution protection plan and monitoring program).

The Law on Water also regulates the area of funding activities of general interest related to water management. Funding for these activities is generated from the budget of the Republic of Serbia (for the territory outside the AP), the budget of the autonomous province (on the territory of AP), water charges, concession fees and other sources of financing (own funds of investors, loans, public loans, grants, etc.). The operations of waterways and protection from the harmful effects of water, water management and use, construction and reconstruction of regional and multi-purpose hydrosystems and other activities of general interest laid down by the Law are financed from the budget.

A new, and essential component of the Law on Water is the introduction of the public into water management, which is ensured by involving the public in the processes of preparation and adoption of water management plans, as well as on the institutional level, by establishing the National Water Conference<sup>25</sup>, consisting of the representatives of local government from the water areas, representatives of users of water and associations representing the general public.

In particular, it should be noted that the requirement for full implementation of the *Law on Water* is the adoption of the supporting bylaws, taking into account the relevant EU directives, as well as regulations regarding environmental protection, which includes the protection of water as an important segment of the environment. This primarily refers to the policies which establish the methodology, criteria and other necessary elements for the implementation of integrated water management on the territory of the Republic of Serbia.

As water represents a natural resource that is a raw material and a habitat, foodstuff and means of labour, energy and much more, it is reasonable that water is subject to regulations defining a wide range of activities and other ministries. Water or systems dependent on water are dealt with by the following laws:

- *Law on Environmental Protection*, *Law on Environmental Impact Assessment*, *Law on Integrated Prevention and Control of Environmental Pollution* and *Law on Strategic Environmental Assessment* (“Official Gazette of RS”, nos. 135/04, 36/09, 72 /09 - other laws, 43/2011- decision), taking into account the amendments to the regulations governing the integrated system of environmental protection, including water as a significant component of this system.
- *Law on Emergency Situations* (“Official Gazette of RS”, nos. 111/2009, 92/2010), which deals with emergencies and natural disasters, which, *inter alia*, include flooding, torrents and ice accumulation on waterways.
- *Law on Mining and Geological Exploration* (“Official Gazette of RS”, no. 88/2011), which stipulates the conditions and manner of programming and performing geological exploration of underground water as mineral resources.
- *Law on Public Utilities* (“Official Gazette of RS”, no.88/11), which regulates the field of water treatment and distribution of drinking water and treatment and disposal of rainwater and wastewater, as well as utility services of general interest.

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<sup>25</sup> The decision was adopted on the establishment of the National Water Conference, on 21 July, 2011, and the members of the conference have not yet been appointed

- *Law on Local Government* (“Official Gazette of RS”, no. 129/2007), which contains provisions on utility activities of water treatment and distribution of drinking water and water treatment and drainage of atmospheric and wastewater, which are under the jurisdiction of local government.
- *Law on Local Government Finance* (“Official Gazette of RS”, nos. 62/06, 93/12, 99/13), which stipulates the income and defines the authority of local government in their formation and use, including as well the public utilities in the field of water.
- *Law on Navigation and Inland Waterways* (“Official Gazette of RS”, no. 121/12), which establishes conditions and responsibilities for ensuring safe navigation on inland water, method of categorisation and maintenance of waterways, conditions of use of the land along the bank and inland waterways, construction of ports, docks and other facilities on a waterway.
- *Law on Planning and Construction* (“Official Gazette of RS”, nos. 72/09, 81/09 - correction and 64/10 - Const.), as amended in 2011, 2013 and 2014 (“Official Gazette of RS”, nos. 24/11, 54/13, 145/14), which prescribes the conditions and manner of spatial planning, development and use of construction land and construction conditions, including water facilities and structures that may have impact on water and for whose construction the building permit is issued by the ministry in charge of planning and construction (now the Ministry of Civil Engineering, Transport and Infrastructure).
- *Law on Public-private Partnerships and Concessions* (“Official Gazette of RS”, no. 88/2011), which defines a public-private partnership (with or without elements of concession) as a long-term cooperation between public and private partners, to ensure funding, construction, reconstruction, management or maintenance of infrastructure and other facilities of public importance and provision of services of public interest.
- *Law on Competences of the Autonomous Province of Vojvodina - "Omnibus Bill"* (“Official Gazette of RS”, nos. 99/2009 and 67/2012 - Decision), by which this AP is authorised to enact, implement and supervise, as delegated activities in the field of water management, the regular and extraordinary measures of protection from fluvial, pluvial and groundwater in accordance with the adopted plans of AP Vojvodina and the Republic of Serbia, manages water resources and artificial and natural waterways on the territory of AP Vojvodina, adopts a water management plan for the territory of AP Vojvodina, in accordance with the water management master plan of the Republic Serbia, establishes public companies for water management on the territory of AP Vojvodina and performs inspections in the field of water management in AP Vojvodina.
- *Law on the Capital City* (“Official Gazette of RS”, no. 129/2007), by which Belgrade, in addition to the jurisdiction of the municipality and the city established by the Law on Local Government, receives the authority to regulate within its territory and provide integrated water management, including financial and inspection aspects, as well as to establish public water management companies.
- *Law on Public Enterprises* (“Official Gazette of RS”, nos. 119/2012, ... 44/2014), regulating the public companies as well as companies engaged in activities of general interest, which include water management as well as utilities activities.
- *Law on Public Health* (“Official Gazette of RS”, no. 72/2009), which regulates public interest - the preservation and promotion of public health, within which the preservation of the environment is a significant activity.
- *Law on Emergency Situations* (“Official Gazette of RS”, nos. 111/09, 92/11, 93/12), which, among other things, regulates the operation, announcement and management of emergencies, the system of protection and rescue of people, material and cultural goods and the environment from natural disasters (including floods, torrents, heavy rains, ice accumulation on the waterway), the competence of state bodies, autonomous provinces, local government and the participation of the police and the Serbian Army in protection and rescue, as well as the rights and duties of other operators related to emergency situations.

In addition to the aforementioned laws and the bylaws required for their implementation, in the process of planning and realisation of investment projects, the provisions of the Law on Sanitary Inspection, the Forest Act, the Agricultural Land Act, the Nature Protection Law, Energy Law and other laws dealing with water, or having an impact on water management, should be observed.

A special place is occupied within the *Property Law* (“Official Gazette of RS” nos. 72/2011, 88/13), which deals with the forms and holders of property rights, including water resources and water facilities. The law defines three types of ownership:

- the right of ownership of the Republic of Serbia - state property,
- the right of ownership of the autonomous province - provincial ownership, and
- the right of ownership of the local government - municipal or city property.

Water structures, as well as the facilities used to perform water-related activities (regulation of waterways and protection from harmful effects of water, landscaping and water use and protection of water from pollution), are defined within the *Law on Water* as goods of general interest, and as such are owned by the Republic of Serbia, apart from the facilities constructed by other legal entities and individuals for their own needs. From the above there arises the right of public ownership of all water facilities constructed by budget funds, regardless of their purpose.

If the constructed water facilities or facilities under construction are being built by pooled resources from different holders of public property, as well as the holders of public property and other legal entities and individuals, the Republic of Serbia has the exclusive right of ownership over these properties. This does not exclude the possibility of joint investment of public property right holders and other persons in the construction of goods of public interest, goods in public use and other goods, by which confers the right to use or other rights (concessions, etc.) and the right to levy income on this basis.

The above Law has introduced innovation in terms of ownership of facilities used for performing water-related activities and public utilities, and which can be considered a category of the network<sup>26</sup>. This also applies to water supply facilities and settlement channels, as well as the canal network for drainage and irrigation, if it is not a part of the waterway. Over these facilities, which were, until the adoption of the *Law on Public Property* used by the Autonomous Province of Vojvodina, i.e. local government, the right of public ownership of the autonomous region, i.e. the right of public ownership of the local government was established. A special law may establish that these facilities can be owned by a legal entity founded by the Republic of Serbia for rendering services or by its subsidiary. The network, or part of a network used exclusively for the purposes of one or more persons may be owned by the same person or persons. The network may be privately owned, if there was the right of private property at the time of the adoption of the *Law on Public Property*.

The above law provides that in the field of communal activities, all real estate, movable property and other assets where the right to use is held by a public company founded in the Republic of Serbia, Autonomous Province of Vojvodina or local government, becomes the property of public companies, with the exception of the utility networks which become the property of the local government. Such transfer of ownership should improve the level of functionality of the utility sector:

- responsibility for maintenance and investment in utility infrastructure would be held by local government;
- local government could, as owners of communal infrastructure and facilities, merge into larger regional public utilities, as envisaged by the *Law on Public Utilities*;
- local government will have the right to conclude contracts on lease or use of property, as well as the right to a corresponding share of the compensation for use.

These changes in the regulatory framework should increase the interest of private investors to participate in the field of water supply and channelling. In addition, according to the *Law on Public Utilities*, the drinking water supply may be carried out exclusively by public enterprises or companies where the major shareholder owning at least 51% is the Republic of Serbia, or a unit of local

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<sup>26</sup> network is a collection of items intended for the flow of matter or energy for their distribution to users or taking away from the user, the concept of which is established by special law

government, while this is not the case with a company performing the activities of channeling and treatment of wastewater.

Assets of public enterprises and other forms of companies engaged in activities of public interest include, inter alia, the right to use the goods of public interest which are state-owned.

### **Strategic and planning documents important for the water sector**

Strategy, planning and normative policies that are the basis for water management on the territory of the Republic of Serbia are defined by the *Law on Water*. Mutual compliance of these and other strategic and planning documents adopted at the federal level and including the aspect of water, is mandatory and applies to:

- *Spatial plan of the Republic of Serbia from 2010 to 2020* (“Official Gazette of RS”, no. 88/2010), which establishes a long-term basis of organisation, development, use and protection of territory of the Republic of Serbia. In the section related to water resources, special importance is given to their sustainable and strictly controlled use, as well as protection of water from irrational privatisation, pollution and improper use. Large waterways (the Danube, Sava and Tisa) play a multifunctional role, surface water should be of special significance for the supply of arid and waterless regions, groundwater as a public good must be under special control, while other rivers, lakes, marshes and ponds should be protected and used in accordance with international standards.
- *National Sustainable Development Strategy* (for the period 2009 - 2017), which promotes the principles of integration of environmental matters into other sectoral policies and inclusion of costs related to the environment in the product price (the "user pays" and "polluter pays" principle). In the water sector, sustainable development means optimal water management, with the preservation and improvement of water quality and its rational use.
- *National Strategy for Development of Agriculture of Serbia* (“Official Gazette of RS”, no.78/05), sees that improvements in the water sector through the policy of sustainable water management, initiation of the economy, European integration and constitution of water systems compatible with EU requirements<sup>27</sup>.
- *National Environmental Protection Programme*, which “represents the means to rationally solve priority issues in the field of environmental protection in the country” and covers the period until 2019. For the water sector, estimated resources for the implementation of this Programme for the period from 2010 to 2019 amount to about EUR 860 million.
- *National Strategy of Sustainable Use of Natural Resources and Goods* (“Official Gazette of the RS”, no. 33/2012), which should ensure, together with the Spatial Plan of the Republic of Serbia, strategic planning of the sustainable use and protection of natural resources in the Republic of Serbia.
- *Water management basis of the Republic of Serbia* (“Official Gazette of RS”, no.11/2002), which represents, until the adoption of Water Management Strategy in the Republic of Serbia, a basic document establishing the basic strategy for water use, water protection and protection from water on the whole territory of the Republic of Serbia until the year 2021. The basic postulate applied in the Water Industry basis is to manage the whole territory of Serbia in a unique and rational manner, in terms of integral development, use and protection of all resources and potentials.

In addition to the above, in preparing planning and investment documentation within the domain of water, other documents, both on a regional or local level, must be taken into account, which could have an impact on water management or within which certain issues from this area could be discussed and resolved.

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<sup>27</sup> *Draft The Agriculture and Rural Development Strategy of the Republic of Serbia (2014 - 2024), at a public hearing*

### 3.2.2. Institutional solutions

#### Existing institutional system and competences

An appropriate institutional framework and good organisation of the water sector, with sufficient and competent professional staff and satisfactory material base, is a precondition for successful operation and development of the water sector.

Water management falls under the responsibility of the Government of the Republic of Serbia. This activity is realised through the Ministry and other ministries, autonomous province authorities, bodies of local government and public water-related companies. It should be noted that between the above mentioned entities there is a functional dependence (Figure 34) and only through their coordinated activity can the successful operation and development of the water sector be provided.

The Ministry has the highest administrative jurisdiction in water management and environmental protection, including water as a resource. Within the field of environmental protection, the Ministry, among other things, carries out activities related to the "protection of water from pollution in order to prevent deterioration of the quality of surface and groundwater; identification of environmental requirements in spatial planning and construction of facilities" and inspection in this area.

Activities of the Ministry in the field of water management are specified by the *Law on Water*. According to this Law, the Ministry prepares and/or adopts bylaws, develops strategic and planning documents for the territory of the Republic of Serbia and gives consent to the acts adopted by the AP and capital, performs a regulatory function, in terms of licensing companies for performing activities in the water sector, applies the international policy in the water sector, maintains the information system within the domain of water, resolves cases in the second instance on the appeals against policies issued by the authorities of the autonomous province and local government, carries out the environmental inspection. The Ministry also manages the budget for the Water Fund of the Republic of Serbia, established by the *Law on Water*.

The Republic Directorate for Water (The Water Directorate), which is a body within the Ministry, is responsible for water management. In accordance with the *Law on Ministries*, the Water Directorate performs state administrative and professional activities relating to "water management policy; multipurpose use of water; water supply, except for water distribution; protection from water; implementation of measures for water protection and planned rationalisation of water consumption; water regime management; monitoring and maintenance of waterway regimes forming or intersecting the border of the Republic of Serbia, inspection in the field of water management, as well as other duties specified by law." Water Directorate prepares the bylaws and strategic and planning documents for the territory of the Republic of Serbia and approves planning documents adopted by the bodies of the AP and the capital. The Water Directorate is the national body responsible for coordinating the activities of the International Commission for the Protection of the Danube River (ICPDR). The Directorate is also responsible for transposition of many EU directives relating to the issues of water into the national law, as well as for the preparation and coordination of the implementation of bilateral cooperation with neighboring countries and multilateral cooperation, particularly with countries in the Sava, Tisa and Danube basins.

Within the Ministry, there is the Environmental Protection Agency, the administrative authority in charge of, inter alia, water protection. Activities of the Agency in the domain of water include "the implementation of state monitoring of water quality, including the implementation of prescribed and harmonised programmes for the quality control of surface and groundwater first aquifer and precipitation" (until 2011, this fell under the jurisdiction of the Republic Hydrometeorological Service). This solution has divided monitoring of the two main determinants of water flow and water balance - into quantity, which remains under the jurisdiction of the RHMS (Republic Hydrometeorological Service) and water quality, being implemented within the Agency. This division of responsibilities is not an adequate and rational solution. Within the Agency there is also a National

Laboratory which, inter alia, determines the indicators (physical, physical-chemical, chemical, biological and radiological) of the surface water quality of waterways, reservoirs and water sources, sediment, precipitation and groundwater, with the exclusion of deep aquifers.

In addition to the competent Ministry, other ministries also deal with activities in the water sector.

The Ministry of Mining and Energy is responsible, according to the *Law on Ministries*, to perform tasks relating to the strategy and policy of the development of natural resources, research relating to the exploitation of natural resources, development of programmes of research works in the field of natural resources, as well as the preparation of the balance of the groundwater reserves.

The Ministry of Civil Engineering, Transport and Infrastructure performs activities related to municipal infrastructure and utility services, including inspections in these areas as well.

The Ministry of Health, among other duties prescribed by law, is responsible for health and sanitary inspection in the domain of public supply of hygienically safe drinking water and other areas stipulated by the law, control of sanitary and hygienic state of the facilities under sanitary supervision, as well as establishing sanitary-hygienic and health conditions of facilities under sanitary supervision in the construction or reconstruction procedures and regular control of those facilities.

In addition to the above, in the event of extraordinary events resulting from natural disasters, competent is the Ministry of Interior. This ministry, inter alia, prepares the Draft of the national strategy and the proposals of the long-term planning for the development of the system and national plan for protection and rescue in emergency situations. Its competence also includes the work coordination of all entities of the system of protection and rescue in the matters of organisation, planning, preparation and implementation of measures and activities for prevention and risk reduction, protection and rescue, organisation of the monitoring system, informing, early warning and alert system, providing the participation of the police and other organisational units of the Ministry in the implementation of measures and executing tasks of protection and rescue, as well as performing other tasks in accordance with the Law on Emergency Situations.

It is evident from the above that the water sector falls under the competence of several ministries, which implies that rational and efficient integrated water management requires their successful and efficient cooperation.

In addition to ministries dealing with the affairs of state administration at the federal level, water management is also dealt with by the autonomous province, the City of Belgrade and local government units, each within its own jurisdiction.

The autonomous province and the city of Belgrade, through its administrative (Provincial Secretariat for Agriculture, Water and Forestry of Vojvodina and the Secretariat of Economy, the Secretariat for Environmental Protection and the Secretariat for Utilities and Housing Services, in Belgrade) and other institutions, implements water management within its administrative boundaries, including the adoption of planning documents (water management plans, plans for flood risk management) and administrative acts. The autonomous province also manages the budget for the Water Fund of the AP, established the *Law on Water*.

According to the *Law on Water*, the local government is responsible for second-order water management, issuance of water policies for facilities of local importance, as well as the documents for wastewater discharge into public sewers. Among its most important activities is the performance and development of utility activities (water treatment and distribution of drinking water, collection and treatment of wastewater, etc.), which is regulated by a special law. At the local level, administrative and other activities related to water are performed within various organisational bodies (secretariats, directorates, bureaus and other forms).

The activities of public interest related to water management on a specific territory are operationally carried out by public water management companies. These companies prepare plans and programs, organise maintenance of water facilities and systems in public ownership and flood control and protection from erosion and torrents, prepare opinions for the issuance of water acts, perform identification of water bodies of surface and groundwater intended for human consumption, keep registers of protected areas<sup>28</sup> and maintain the information system for their territory, and as a delegated job, they do calculations and debt balance of payers for the statutory fees.

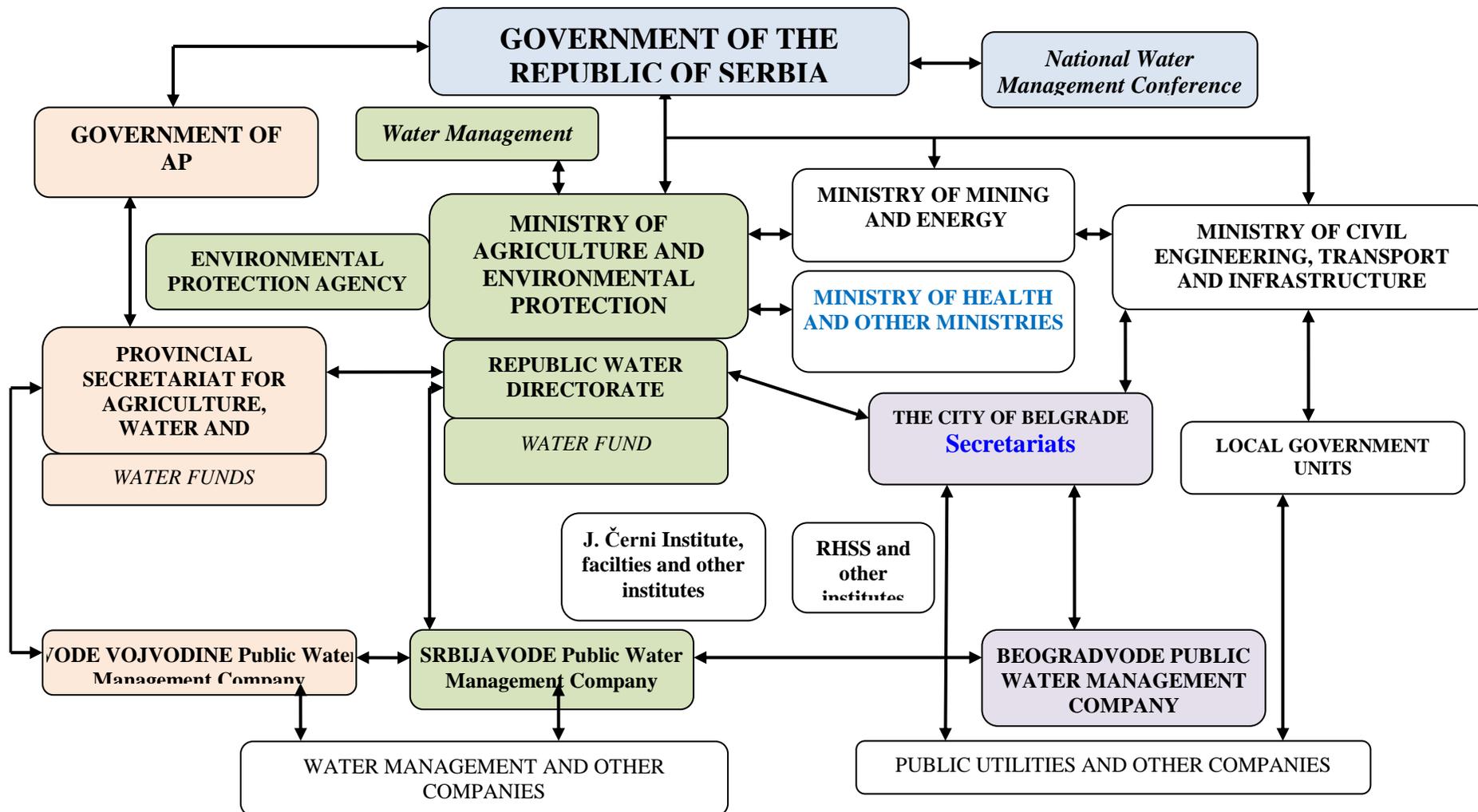
There are three public water management companies on the territory of Serbia: "Srbijavode", "Vode Vojvodine" and "Beogradvode" Public Water Management Companies (PWMC).

Internal organisation of "Srbijavode" PWMC is made of a Directorate, based in Belgrade, and two water management centres: the "Sava-Danube" (in Belgrade) and the "Morava" (in Niš). "Vode Vojvodine" PWMC (based in Novi Sad) covers the territory of AP and it is organised into five sectors, the sector with the largest number being the one for Hydrosystem DTD. Beogradvode, a Public Water Management Company was established by transforming the social water management enterprise, also called Beogradvode, by the decision of the Assembly of the City of Belgrade.

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<sup>28</sup>According to the Law on Water (LOW), protected areas are zones of protection of water sources of public water supply, areas intended for the abstraction of water for human consumption, water bodies designated as recreational waters, nutrient-sensitive areas, areas designated for the protection of habitats or species dependent on water, as well as the areas designated for the protection of economically important aquatic species

Figure 34: Organisation of integral water management in Serbia:



Operational implementation of water activities, such as the implementation of flood control and ice, maintenance and management of water facilities and systems and performance of other entrusted tasks of public interest, are carried out by water management and other companies, which, according to the *Law on Water*, require a proper license in terms of the technical equipment and organisational and personnel training, issued by the ministry responsible for water management. In the previous period, a large number of water management companies have provided the proper license.

It should be noted that ownership transformation has occurred with a large number of water management companies. This, however, must not affect the reduction of potential for the successful performance of activities in the water sector, among which we may underline the implementation of flood control and operational management of water facilities and systems. It is thus important to establish the appropriate instruments that will ensure that these activities are still performed by water management companies that have experience and traditions within these fields.

Special attention is given to utility companies that are engaged in the water supply and channeling, which operate in accordance with the law regulating public utilities and the law relating to local government. These companies, usually with the status of public utility companies (PUC) established by local government, provide the organised supply of drinking water to the population and other users and implement wastewater collection, its treatment and discharge it into the recipient. The obligation of obtaining the appropriate licenses for technical and technological equipment and organisational and personnel qualifications is existent for these companies as well, which is a prerequisite for a satisfactory and uniform level of service in this area throughout the entire Republic. The National Water Directorate conducts the licensing process for these companies.

In addition to the above entities, the field of water is also dealt with by special organisations within the state administration and local government and public companies and other organisations that operate outside the water sector.

Republic Hydrometeorological Service is a special organisation responsible for the matters of meteorological, climatological, agro-meteorological and hydrological measuring and observation, weather conditions and changes in water and other relevant activities in the field of meteorology and hydrology. Supervision of the activities performed by this Institute is performed by the Ministry.

In addition to this, there are other institutes, of importance to the the water sector such as public health, occupational safety, and nature conservation in Serbia. Chambers of commerce also hold their position, within which certain activities in the field of water are supervised and directed, as well as public enterprises related to forest management and energy resources.

Scientific-research organisations and institutes (the most significant one being the Jaroslav Černi Institute for the Development of Water Resources of Belgrade, or JSC Belgrade), universities, design and planning organisations, as well as building, industrial and other enterprises with the service activity represent a substantial part of the successful operation and development of the water sector.

## **Capacities**

Based on the analysis of available capacities involved in the water management activities on the territory of the Republic of Serbia, bearing in mind the obligations in the process of the EU accession, it can be concluded that, particularly with administrative authorities at all levels, the number of employees and personnel structure does not allow for the efficient execution of all the legally stipulated tasks.

The capacity of the Water Directorate, which is the most important public authority in the field of water management is inadequate (39 employees in 2012, 18 of which are water management inspectors) for carrying out all administrative tasks defined by the *Law on Ministries* and the *Law on Water*. Therefore, the Directorate must rely, for the purpose of strategic and planning documents,

international cooperation and joining the EU, on the results of research and analysis carried out by scientific and expert institutions.

In 2012, the Environmental Protection Agency employed a total of 19 employees in the Department of water quality control, while there were 20 employees in the National Laboratory. The number of employees almost fully corresponds to the number of systematised jobs.

The Provincial Secretariat for Agriculture, Water and Forestry (administrative authority within the domain of water in AP Vojvodina) overcomes the lack of expert personnel by engaging PWMC "Vode Vojvodina" in the implementation of certain professional activities within the water sector.

At a local level, administrative and other activities related to water are performed within various organisational bodies (Secretariats, in Belgrade, i.e. directorates, institutes and other forms in other local government units), which often lack professional capacities.

The situation in public water management companies is different. The most numerous, with very complex issues in water management, is PWMC "Vode Vojvodine", which has adequate professional staff, in number and in qualification structure, (at the end of 2012 the number of employees was 460, most of which were engaged with HS DTD). It can be said that PWMC "Srbijavode", which in late 2012 had 140 employees (64% of employees have a university level education), does not have sufficient human resources (cover only 54% of the systematised number), in regard to the area it covers. PWMC "Beogradvode" with 165 employees, most of whom are university and college graduates, carries out operational activities within the water sector.

The capacity of enterprises to carry out operational activities within the water sector (water management and other companies) may be considered satisfactory by employee numbers. However, the assessment is that their personnel structure and equipment with necessary machinery are not appropriate in all cases, which is to be determined in the process of licence issuing.

For public utility companies, it is estimated that the total number of employees is larger than the optimum required, but that the personnel structure is not appropriate in all enterprises.

Regarding other capacities, the general conclusion is that within our country, there is a lack of proper professional and scientific personnel in the field of water. For instance, data from the Serbian Chamber of Engineers from 2009 show that there are around 1,400 licensed civil engineers specialised in hydroengineering. In Belgrade, there are more than 700, in Niš and Novi Sad together there are around 200, eleven towns have individually more than 10,217 in total, while in all other towns or municipalities there are less than 300 civil engineers specialised in hydroengineering.

The situation is to some extent improved by institutes belonging to the government sector. The "Jaroslav Cerni" Water Management Institute (in 2012 there were 254 employees, 174 with university level education) stands out by its capacities, then the institutes within the technical faculty, and to some extent, institutes outside this sector.

### **3.2.3 Economic policy and financing of water management**

#### **Economic policy holders**

In the process of harmonising federal legislation with EU regulations and directives, recently in our country, a series of new regulations has been adopted, including those relating to holders of economic and managerial functions within the water sector and in the field of public utilities - water supply and channeling of settlements. The changes compared to the previous regulations are in accordance with the relevant changes made in other countries, especially in countries in transition, and the essence is in the greater decentralisation, i.e. transfer of competencies from the central federal level to the level of local government. Decentralisation was particularly associated with the economic policy of the water sector and the organisation of drinking water supply services and channeling (Table 43).

Table 43: Holders of economic and managerial functions in the water sector

Functions	Holders of the pre-transition period	Holders of the post-transition period
Management and supervision of water sector		
Managerial function	Republic of Serbia	Republic of Serbia
Pricing policy	Republic of Serbia	Local government <sup>29</sup>
The function of control and supervision	Republic of Serbia	The Republic of Serbia and local government units
Communal services		
System operations and maintenance	Utility company	Utility company by contract with a local government
Income from operations	Utility company through tariffs and subsidies of the founders	Utility company through tariffs and subsidies (lower level)
Assets management	Republic of Serbia	Utility company and the owner (usually the local government)
Financing assets	Republic of Serbia	Utility company and the owner (usually the local government)

### Financing water management

The basis for stable sources of funding is provided by the appropriate legal and institutional solutions, which determine the sources and scope of required resources, competencies and payment mechanisms, payers. The *Law on Water* provides the basis for securing real revenue from the fees charged for the use and protection of resources, introducing "user pays" and "polluter pays" principles.

The following are the sources of financing water management: the water price, after establishing its economic level; the means of the budget fund for water of the Republic of Serbia and the budget fund for water of the autonomous region, i.e. funds from the fees for water; IPA funds of the European Union; original revenue of local government; investors private funds; donations and other funds (international financial institution, bank loans with the banks engaged in financing infrastructure projects, etc.).

#### The price of water

The structure of water price includes the prices and fees relating to the use and protection of water as a resource, and the qualification and purpose of income depends on the source of funds (Table 44).

Table 44: Water price structure

Water price elements	Purpose	Revenue assignments
Water supply service price	Functioning and maintenance of utility system for water supply	Public utility company
Channelling service price	Functioning and maintenance of utility system for channelling	Public utility company
Fee for the use of water resources	Activities of public interest pursuant to Article 150 Law on Water	Budget for water funds
Fee for discharged water	Activities of public interest pursuant to Article 150 Law on Water	Budget for water funds
Fee for water pollution*	Activities of public interest pursuant to Article 150 Law on Water	The budget of the Republic of Serbia
Value added tax	According to the Law on Budget of the Republic of Serbia, are not related to the water sector	The budget of the Republic of Serbia

\*paid after determining the emission limit values per group, i.e. polluter category

<sup>29</sup>In accordance with the *Law on Water*, the government adopts a methodology for calculating the price of water.

The current price level of the utilities of drinking water supply and channeling is such that it hardly covers the operator's operating costs. Water prices (delivered and used) for the population in Serbia at the beginning of 2014 varied from 30.30 din / m<sup>3</sup> to 94,00 din / m<sup>3</sup> (VAT excluded), which does not reflect the real value, but is mostly the result of different approaches its formation. Within these prices the only constant is the fee for water use and fee for discharged water, which together amount to 0.4375 din / m<sup>3</sup> and are equal for all citizens of Serbia<sup>30</sup>. Pollution charges have yet to be added.

The decision on the water price amount is adopted by the administrative authority PUC, but cannot be implemented without the consent of the competent authority of the founder, i.e. a unit of local government. In practice, the price is a compromise between the economic and social conditions. The consequences of low prices, and often low collection rates, are insufficient resources for financing current operations and maintaining utility systems. There is a practice of local authorities to finance, by allocating current and capital subsidies to public utility companies, current and investment maintenance of utility systems from their original income funds. The development of the system and financing of capital investments from the water price, based on the long-term financial planning, cannot be discussed as of yet.

#### Budget Fund for Water of the Republic of Serbia and Budget Fund for Water of the Autonomous Province

In the framework of the budget funds for water, recorded are the funds provided from the appropriations in the budget of the Republic of Serbia or autonomous province, as well as the collection of fees for water (Table 45), as follows:

- The fee for the use of water resources,
- The fee for discharged water,
- The fee for drainage and
- The fee for the use of water facilities and systems (including the use of irrigation systems).

The average annual inflow of the above fees in the budget fund for water of the Republic of Serbia and the autonomous province in the past few years amounted to the total of approx. EUR 70 million.

The fees for water represented a significant source of financing for all operations of the water sector, i.e. amounted to 80 to 90% of the total funds allocated to the water sector (the rest were appropriations from the budget). The practice has shown that this volume of funds does not provide adequate current and investment maintenance of the facilities and systems in accordance with the standards, with the development function being marginalised.

The main reasons for the insufficient volume of funds from the fees primarily included:

- The level of fees limited by the inflation growth;
- The outdated database of the fee payers;
- Inadequate mechanisms for collection of receivables from legal entities (in long court proceedings);
- Low collection rates

In future, water fees should be the main source of funds for investment in the water sector, maintenance of the existing and construction of new facilities and systems.

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<sup>30</sup>Regulation on the water fee for 2014 ("Official Gazette of RS" no.15/2014)

Table 45: The water fees in the *Law on Water*

Type of fee	Basis	Paid for	Measure unit	Purpose	Note
Fee for the use of water resources	- use of water - use of wetland areas	- use of abstracted water for various purposes - use of water for irrigation - water for bottling - <u>water supply activity</u> - electricity production  - <i>sediment exploitation</i> - <i>economic use of land</i> - <i>mooring of a vessel</i> - <i>use of wetland areas for recreation, sport and tourism</i>	$m^3$ + quality $m^3$ or ha l $m^3$ kWh  $m^3$ + <i>borrow pit</i> $m^2$ + <i>activity type</i> $m^2$ + <i>category of face water</i> $m^2$ + <i>purpose+use</i>	- regulation of waterways and protection from fluvial water - water regulation and use - construction, maintenance and management of regional and multipurpose hydrosystems  - <i>regulation of waterways and protection from fluvial water on the territory of fee collection</i>	- owner of the irrigation system pays 50% of the fee - <u>Sum of the fees for public utilities of the supply of drinking water and discharged water at a public utility service amounts to <math>\geq</math> 10% of the reference price of water (rpw)</u> - rpw- includes operating costs of public water supply and canalisation, maintenance and waer and tear of facilities
Fee for discharged water	- direct or indirect discharge of water in the recipient's or public sewage	- discharge of water in the recipient's or public sewage - <u>Collection, discharge and treatment of waste and rain water through the public sewage system</u> - Electricity generation in thermal power plants with open - free-flow cooling system	$m^3$ + examined water type  $m^3$ + examined water type  kWh	- classification of water bodies - monitoring - development of water protection plans - construction and reconstruction of facilities for water protection in public ownership	- fees are increased if the recipient is a protected area
Fee for water pollution	- direct or indirect water pollution	- vessel (owner) - discharge of wastewater into the recipient's and own sewage system - collection, discharge and treatment of waste and rain water through the public sewage system - discharge of pollutants to the agricultural, construction or forest land - production / import of fertilizers and chemical substances for protection of plants and weed removal, as well as	engine power $m^3$ + emission type  $m^3$ + emission type    kg	- water protection	- revenues are of the budget of the Republic of Serbia - fees are increased if the recipient is a protected area - fees are reduced according to the treatment effects - the sum of the fees for discharged water and water pollution can not be less than the cost of water treatment to the emission limit values

		phosphorus-based detergents.	kg		
Drainage fee	- regulation of water regime of the land through the drainage systems	- drainage of agricultural land - drainage of forest and construction land and goods in general use - drainage of construction land under commercial and residential buildings	ha + class ha m <sup>2</sup>	- construction, maintenance and management of land reclamation systems	- the owner of a detailed drainage canal network pays 50% of the fee - it is not charged if the fee for the use of water for irrigation of agricultural land is paid for. (Article 173) - the basis for the amount of fee are the annual costs of managing and maintaining the system - used in the land reclamation area where it is implemented
Fee for use of water facilities and systems	- use of facilities in public ownership for irrigation and water supply, wastewater disposal of industries and other users, navigation in channels	- irrigation and fisheries - water supply of the industry and other users - wastewater disposal from the industries, fisheries and other users - navigation in channels	depends on the user category, and whether there are measuring devices	- construction, maintenance and management of land reclamation systems - construction, maintenance and management of regional and multipurpose hydrosystems	- the basis for the amount of fee are the annual costs of managing and maintaining the system - used in the area where it is implemented

### Funds from the water pollution fee

Article 167 Of the *Law on Water* stipulates that the funds from the fees for water pollution are income of the budget of the Republic of Serbia and are allocated for financing activities of public interest in the field of protection from water pollution. The competent ministry, through bylaws, establishes the limit values of pollutants' emissions proposes the fee amount for pollution for all who discharge wastewater into their own sewers, waterways, canals, lakes, reservoirs and similar. Until the adoption of this bylaw, the fee for discharged water shall be paid, and is a source of revenue for the water fund.

### Use of European Union funds

In recent years, the European Union has developed several instruments, which were important funds for implementation, direction and acceleration of both political and economic, and overall reforms in the countries of the Western Balkans.

For Serbia, by the year 2012, for national, regional and horizontal programmes and administrative expenses, EUR 976.8 million were granted, and for 2012 and 2013 a total of EUR 426.8 million, or an average of EUR 213.4 million, per year. Funds approved for the water sector in the period up to 2012 were mainly related to projects in the field of water protection within the First component of the EU Pre-Accession Assistance, amounting to a little over EUR 50 million.

### Source revenues of local government units

Units of local government, as an investor or financier of annual and long-term projects, should ensure a high level of own source revenues.

The most important source of income of local government units is the fee for land development, which is dedicated and used for land development, acquisition of construction land and construction and maintenance of utility infrastructure. Apart from this, revenues from the alienation and leasing of construction and agricultural land in public ownership, for construction, represents an important source of revenue which local government units can realise by the planned use of land resources.

### Owner resources of investors

Potential investors should place their capital in the construction of their own water intake structures for the process water and wastewater treatment devices, especially when the applied technological process produces wastewater which, by its direct discharge into the recipient, may cause pollution of the recipient and pose a threat to the immediate environment. Moreover, the owners or direct users of agricultural land, in order to increase yields, can invest their funds to increase the capacities for irrigation, as well as to protect its assets from the adverse effects of water.

### Bank loans of the bank involved in financing of the infrastructure projects

*The European Bank for Reconstruction and Development (EBRD)* in the framework of its activities provides financial support to the projects that aim to promote sustainable development and environmental protection of the local community (the supply of drinking water, collection and treatment of wastewater, solid waste management, district heating, public transport, etc.).

*The European Investment Bank (EIB)* finances projects relating to drinking water supply and sewerage service development in the EU and partner countries. Together with the European Commission (EC), the Bank is financing, through its own funds and donations of the EC, many investment projects and capital development projects in the water sector. EIB lends funds to the public or private utility companies, federal or local authorities or performs the direct activities of project financing.

*KfW Development Bank of Germany*, which finances investments and provides consulting services in developing countries, has been present in Serbia for many years now. From the KfW credit line, almost EUR 100 million has been withdrawn for the implementation of various projects in more than 70 locations throughout Serbia. A part of the funds was used for the reconstruction of the sewage network and the supply of settlements with drinking water. The realisation of the Programme of water supply and wastewater treatment in medium-sized municipalities in Serbia III (Loan Agreement signed on 18.12.2012, In Belgrade), is expected, under which KfW provides loans in the amount of up to EUR 46 million and grants of up to EUR 14,818,000.

### **3.2.4 International cooperation and obligation**

Long-term trends in water management must be based on the fact that Serbia belongs to the region of the UNECE (United Nations Economic Commission for Europe) and for the most part of the territory of the Danube basin, where the countries have established multilateral coordination and cooperation in water management (in the basin of the Aegean Sea, a cooperation mechanism has not been established as of yet). Moreover, since the Republic of Serbia is in the pre-accession process to the EU, there is the obligation to adapt its strategic decisions in the field of water gradually to the documents that apply to EU member states. The overall assessment of the level of the state's readiness to join the EU will depend on the proper introduction of internationally accepted principles of water management into strategic documents and the establishment and their implementation at the federal level and in the framework of international cooperation in this area.

#### **Forms of international cooperation**

International cooperation with neighbouring states and the wider international community, which is essential and very important for the water sector, is regulated by international treaties, conventions and agreements that are or are to become an integral part of the regulatory framework for water management on the territory of Serbia. Below are listed the most important documents as the basis of co-operation within the domain of water.

*Cooperation in the region of UNECE countries* is based on the Convention on the Protection and Use of Transboundary Waterways and International Lakes (Helsinki, 1992), which is a binding framework for the protection of international surface and groundwater by prevention, control and environmentally friendly water management. It is ratified by a special law<sup>31</sup>.

*International cooperation in the Danube River Basin* is based on the Convention on Cooperation for the Protection and Sustainable Use of the Danube River (Sofia, 1994), whose adoption in Serbia is regulated by special law<sup>32</sup>. States Parties are obliged to strive for sustainable and fair water management, including conservation, improvement and rational use of surface and groundwater. For the implementation of this Convention, the International Commission for the Protection of the Danube River<sup>33</sup> (ICPDR) has been established with its headquarters in Vienna, with Serbia being its legal member since 2003. Within the ICPDR, and on the basis of the Memorandum of Understanding signed in 2004 in Vienna<sup>34</sup>, international cooperation in the Tisa River Basin is carried out.

*International cooperation on water management in the Sava River Basin* was established with the signing of the Framework Agreement on the Sava River Basin (Kranjska Gora, 2002) and with its

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<sup>31</sup> Law on Ratification of the Convention on the Protection and Use of Transboundary Waterways and International Lakes and the amendments to Articles 25 and 26. Law on Ratification of the Convention on the Protection and Use of Transboundary Waterways and International Lakes ("Official Gazette of RS" - International Treaties, No. 1/2010)

<sup>32</sup> Law on Ratification of the Convention on Cooperation for the Protection and Sustainable Use of the Danube River ("Official Gazette of FRY" - International Treaties, no. 2/2003)

<sup>33</sup> International Commission for the Protection of the Danube River – ICPDR (<http://www.icpdr.org/>)

<sup>34</sup> Towards a River Basin Management Plan for the Tisza river supporting sustainable development of the region - Memorandum of Understanding ([www.icpdr.org/icpdr-files/8200](http://www.icpdr.org/icpdr-files/8200))

ratification by special law<sup>35</sup>. The International Sava River Basin Commission was established in 2003, and in 2006 a secretariat was established in Zagreb. Special Protocol on flood protection to the Framework Agreement, whose ratification is in progress, the cooperation aimed at preventing and/or reducing the risk of flooding will be regulated by taking proper measures and activities. The matters related to the navigation on the international waterway along the Sava River Basin are regulated by the relevant Protocol, which was ratified within the law relating to the Framework Agreement on the Sava River Basin.

*Navigation on the Danube*, the river which has the status of an international waterway, takes place in accordance with the Belgrade Convention on the navigation regime on the Danube<sup>36</sup>, which represents the framework for managing navigation between 11 EU member states in the basin of this river. The Convention aims to strengthen economic relations in the region and addresses the need for maintaining navigability of the entire Danube. The implementation of this Convention is coordinated by the Danube Commission, headquartered in Budapest.

Current state of *bilateral cooperation* in the water sector is not satisfactory, neither by quality nor by its scope. Only bilateral commissions with Romania<sup>37</sup> and Hungary<sup>38</sup>, formed on the basis of the agreement from 1955, are active. Cooperation with Bulgaria has been interrupted since 1982. Cooperation with the neighbouring countries in the former Yugoslavia (Croatia, Bosnia and Herzegovina, Montenegro and Macedonia) has not been regulated to present date.

## **EU directives governing the water sector**

EU water regulation holds great importance not only for member states but also for all countries that intend to cooperate or become members of the Union.

The most important act in the area of water policy is the *Water Framework Directive*<sup>39</sup>, which is the operational tool for achieving the key objectives of the European water policy: the comprehensive protection of all water, taking into account the natural interaction among them in quantitative and qualitative terms, by applying the principles of integrated water resources management. The concept of integrating all relevant segments (water resources at the basin level, environmental protection, water use, regulation, levels of decision-making, water management of transboundary basins through international cooperation, etc.) is the key to achieving the proclaimed goals.

The adoption of the Water Framework Directive, the water resources in the EU have become a concern of the whole Union, including the obligation of each Member State to harmonise the regulatory, technical and economic approach to water management and provide a coherent strategy for water management. This obligation applies to the countries that are in the process of joining the EU.

WFD is an "umbrella" directive which includes and connects other important directives that directly or indirectly relate to the water sector, most important being the following:

- Directive on urban wastewater treatment (Directive 91/271/EEC concerning urban wastewater treatment), which determines the obligation of urban wastewater treatment for all agglomerations of more than 2,000 p.e;

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<sup>35</sup> Law on Ratification of the Framework Agreement on the Sava River Basin, "Official Gazette of the SCG" - International Treaties, no. 12/04)

<sup>36</sup> Adopted at the International Conference in Belgrade in August 1948, published in the "Official Gazette of FRY", no. 4/1949

<sup>37</sup> Agreement between the Federal Republic of Yugoslavia and the Romanian People's Republic on hydro-technical issues in hydro-technical systems and waterways at the border or intersected by a state border ("Official Gazette of SFRY" - International Treaties no. 8/56)

<sup>38</sup> Agreement between the Federal Republic of Yugoslavia and the People's Republic of Hungary on water management issues ("Official Gazette of SFRY" - International Treaties no. 15/56)

<sup>39</sup> Directive 2000/60 / EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy

- Directive on the protection of water against pollution caused by nitrates from agricultural sources (Directive on the protection of water against pollution caused by nitrates from agricultural sources), which specifies the vulnerable areas exposed to pollution by nitrates and promotes good agricultural practices;
- Directive on the abstraction of drinking water (Directive 75/440/ECC on the quality required of surface water intended for the abstraction of drinking water), which deals with quality requirements of the water used or intended for the abstraction of drinking;
- Directive on the quality of water intended for human consumption (Directive 98/83/EC on the quality of water intended for human consumption), which sets standards of quality and control of water intended for human consumption (water supplied by public water supply systems, water used in the food industry);
- Directive on the management of bathing water quality (Directive 2006/7/EC of the European Parliament and of the Council concerning the management of bathing water quality and repealing Directive 76/160/EC), which sets quality standards and monitoring of water used for swimming and recreational facilities;
- Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community), which specifies the list of dangerous substances whose release into the natural receivers is restricted or prohibited, as well as monitoring measures;
- Directive 2006/118 / EC on the protection of groundwater against pollution and deterioration, aimed at preventing deterioration of groundwater through special measures for prevention and control of their pollution;
- Directive concerning integrated pollution prevention and control (Directive 2008/1/EC concerning integrated pollution prevention and control), which stipulates that industrial plants with a high pollution potential must be licensed only if the requirements of environmental protection are met;
- Directive on environmental quality standards in the field of water policy (Directive 2008/105/EC on environmental quality standards within the domain of the water policy, amending and subsequently repealing Council Directives 82/176 / EEC, 83/513 / EEC, 84/156 / EEC, 84/491 / EEC, 86/280 / EEC and amending Directive 2000/60 / EC of the European Parliament and of the Council), which aims to establish environmental quality standards relating to the presence of certain pollutants or groups of substances identified as priority on the basis of risks to the environment;
- Directive establishing technical specifications for chemical analysis and monitoring of water status (Directive 2009/90/EC establishing Pursuant to Directive 2009/60/EC of the European Parliament and of the Council, technical specifications for chemical analysis and monitoring of water status), which establishes minimum criteria for their execution in monitoring, as well as rules that prove the quality of analytical results.
- Directive on the assessment and management of flood risks (Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks), whose purpose is to establish a framework for the assessment and management of flood risks in order to reduce their adverse effects on people, environment and economy.

### **Obligations arising from EU directives and international cooperation**

In the framework of the EU integration process, as well as the fulfillment of obligations under the international conventions and agreements, Serbia has started the transposition into federal regulatory legislation of directives vital to the water sector and environmental protection. The *Law on Water* from 2010 and the accompanying bylaws have or will incorporate the provisions of the WFD and the Floods Directive, and the provisions of other directives relating to water, to the extent that takes into account the socio-economic situation in the Republic of Serbia, Full transposition of the European regulations into the federal regulatory legislation on water is planned by 2018.

Serbia participates in the international activities in the basins of the Danube, Sava and Tisa. As a result of multiannual activities of the ICPDR on the implementation of the WFD, The Danube River Basin Management Plan<sup>40</sup> was adopted in 2009, and the Tisa River Basin Management Plan in 2011. Work on the implementation of the Floods Directive is in progress, which should result in 2015 in the Plan of flood risk management in the Danube basin. Sava River Basin Management Plan was developed and adopted at the Fifth Meeting of the Parties of the Framework Agreement on the Sava River Basin (December 2014). Each of these plans is determined by the Joint program of measures implemented in order to improve the environmental situation in the basin.

Bilateral cooperation is of particular importance for Serbia, given the fact that large parts of the basins of major waterways (except the Velika Morava) are located outside its territory. Therefore, the draft agreements with neighboring countries have been prepared, initiatives taken or negotiations initiated in order to regulate the bilateral cooperation, which will, inter alia, be based on the joint implementation of the provisions of the WFD and the Floods Directive on transboundary water.

### **3.2.5 Other factors with relevance to water management**

#### **Monitoring of surface water and groundwater**

Characteristics (quantitative and qualitative) of surface water and groundwater are determined based on the monitoring of relevant parameters. The results of monitoring are used to define the state of the level in rivers from the point of regulation of waterways and protection from harmful effects of water, including forecasts and works on flood protection.

The Republic Hydrometeorological Service has for several decades, conducted monitoring of parameters of surface water and groundwater of first aquifer, according to the annual programme, the contents of which are laid down by Law. As of 2011, this program has been implemented by the Environmental Protection Agency and RHSS.

There is a developed network of hydrological stations (Basic network) for monitoring of quantitative parameters of surface water, on all major waterways on the territory of the Republic, consisting of 184 stations (without Kosovo and Metohija), 69 of which are reporting. Water level is monitored at all stations, the water temperature measured at 74 and hydrometric measurements of water flow performed at 148 stations. The emergence of ice is monitored at 172 stations, while 29 stations are in the system of determining waterborne floating (suspended) sediment. The processed data are published in the RHSS almanacs and are available to the public.

Monitoring of surface water quality in Serbia is done on river flows, some channels and reservoirs, and in recent times on groundwater as well, but only on the first aquifer. The position of measuring points, as well as the number and frequency of measurement parameters are not appropriate at all waterways and observations on small and medium waterways are insufficiently represented, which is reflected in the reliability of estimates of the quality status of surface and groundwater and the status of water bodies of surface and groundwater. The observation of deep aquifers underground water is also neglected, which must be overcome in the following period.

Monitoring of river sediment was an integral part of the surface water monitoring programme carried out by RHSS, but since 2008 this activity has been neglected. The Environmental Protection Agency carries out, within its competencies, and on selected river profiles and reservoirs, monitoring of the quality of sediment once per year.

Monitoring and measurement of quantitative and qualitative characteristics of the sediment is carried out only within the framework of specialised studies for the purposes of monitoring reservoirs and implementing specific facilities and systems.

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<sup>40</sup> *Danube River Basin Management Plan* ([http://www.icpdr.org/icpdr-pages/danube\\_rbm\\_plan\\_ready.htm](http://www.icpdr.org/icpdr-pages/danube_rbm_plan_ready.htm))

## **Water Information System**

The Water Information System represents, given the level of information and data, an important segment in the process of monitoring and improvement of the water regime, planning of water infrastructure and operational management of water and water systems. It is kept in the Ministry, for the whole Republic of Serbia, and in the public water management companies, for the territory of their competencies. Public water management companies obtain the data and information relevant to the operation and development of the water sector from the public companies and other legal entities whose activities are related to water management. In addition to water, also kept at the Ministry (in the Environmental Protection Agency) is the environmental protection, federal information system, which includes the water sector. The relevant data of these systems must be well harmonised.

Exchange of relevant information with other information systems at the federal and international level is done at the level of the Ministry, unless otherwise provided for in a special act by which a public water supply company is authorised.

### **3.3. SYNTHETIC ASSESSMENT OF THE CURRENT SITUATION**

Our country has a tradition relating to the domain of water that is over two hundred years long. The first works concerned protection from detrimental effects of surface and groundwater, and, as a result, considerable areas were turned into fertile soil. The first water cooperatives were established over 150 years ago.

Water resource management became an industry right after the Second World War, and the first institutionalised form was the Water Resource Management Department with the Federal Planning Commission. Later changes in organisational forms resulted from the re-organisation of state administration and corresponding regulatory arrangements.

The most important works in the area of water management, completed between 1950 and 1980, were based on strategic planning. This all brought about a sound situation in the area of water use and water protection, however, the protection of water was neglected. The strategic planning system was maintained in the later period through the adoption of water resource management basic documents (of the Republic of Serbia and the autonomous provinces) even though investment activity was considerably reduced.

Investment activities (rather intense in the period up to the 1980-s, and reduced in the recent period) resulted in a significant level of development of water management infrastructure, the value of which, had it been built, could be assessed at approximately EUR 20 billion today. This is a respectable amount which can be preserved only through appropriate investment and ongoing maintenance of facilities and the system itself.

As a consequence of inadequate investment in the last two decades, the situation in the water sector can be described as follows:

- Organised supply of drinking water covers over 80% of the population, and water supply in most cities and settlements in Serbia operates at a satisfactory level; however, losses of water in distributive networks and other uninvoiced water are above the tolerance level. In some regions (such as a part of Voivodina, a portion of the Velika Morava river valley) the quality of water supplied is not satisfactory, while in some areas there are also issues concerning the quantity of water as well (Šumadija, South of Serbia, etc). In addition, certain settlements still do not have an organised public water supply.
- In the area of water resource management, water protection lags considerably behind. The level of development of sewage systems, and most notably, the facilities for treatment of wastewater from settlements and industry, is low, (in Serbia, the network covers about 55%, in

settlements with over 2,000 inhabitants about 72%, while approximately 10% of the population is covered by low level of wastewater treatment. There are very few facilities for pre-treatment of technological wastewater before release into sewage networks or other recipients. Therefore, relatively sound quality of water in larger water bodies is not the result of the application of water protection measures, but rather the consequence of a considerable drop in industrial production. However, in terms of small water bodies on which larger city centres are situated, the situation is often much worse, and it is increasingly becoming apparent that substantial investment into this area is called for in the immediate future. Especially at risk are the Morava basin as well as the canal network of the DTD system.

- Only a small portion of publicly owed agricultural land is covered by irrigation (about 40,000 ha), even though the existing water systems spread over the area of about 105,000 ha, which is the reason why the yield of crops is unstable. In addition, it has been estimated that individual, privately owned systems irrigate another 45,000 ha of land. One of the reasons for the inadequate level of utilisation of the existing systems is the fact that their users are not involved in the processes comprising the economics of agriculture (from planning, through production, to processing and marketing of agricultural products).
- Flood embankments and other types of “linear” protective structures have been built over the length of over 3,500 km, the river beds of a large number of waterways have been regulated so as to improve the flow of water, silt and ice (in the length of about 270 km on first order water bodies, or, more specifically, about 400 km in all), in addition to a certain number of existing reservoirs and retention structures which also play a part in flood protection. Nevertheless, a large part of the territory is still at real or potential risk from water, as demonstrated by floods in 2014. Based on the most recent experience, it has become apparent that the level of protection of vital infrastructural systems needs to be improved (the largest thermal power plants and supporting facilities) as well as large urban centres; however, the essential attitudes towards protection from detrimental effects of water also need to change. In addition, recent experience has shown that local government is often unable to rise up to the challenge, in terms of organisation and funding, as well as available capacities.
- Comprehensive technical works concerning flood protection and various biological works on reclamation of eroded soils, together with various combinations of the two and the measures for anti-erosion land management had halved the production of sediments and their release into the recipients up to several years ago. However, intense rainfall, in particular in the spring of 2014, brought about severe deterioration in the situation in many river basins, that is, intensified erosion processes. In addition, the failure to perform technical works on the regulation of torrential beds is the reason why there is still substantial erosion of river beds and river banks, even in regulated areas with anti-erosion land management measures firmly in place. As often as not, local government lacks capacities and planning for responding to extreme weather events.
- Drainage systems spread over about 2 million ha and play a significant role in carrying off excess water from soil. However, due to inadequate maintenance, incompleteness, misuse (sometimes for receiving and carrying off untreated wastewater) and the like, in certain locations they do not perform adequately in keeping with required regimes.
- Exploitation of river sediment is often uncontrolled. In larger waterways where the river bed serves as the borrowing pit, exploitation in excess of envisaged dimensions and dynamics can potentially cause undesirable deformation of the river bed and compromise the stability of structures and ecosystems in the waterbed and on the riverbanks. In medium sized and small water bodies, random exploitation of material in inundation areas poses a problem as reclamation measures are not applied after exploitation; agricultural soil is shrinking and the environment and autochthonous ecosystems suffer damage.
- Maintenance of publicly owned structures and systems has been unsatisfactory for years (insufficient and substandard), affecting the situation in all areas of the water management

system (still high levels of water loss in public water supply, reduced capacity of irrigation canals, compromised safety performance of flood protection structures).

- Activities in the water management system are financed from public funds at the federal level (budgetary allocation and water rates), as well as from the price of water. Budgetary allocations have been insufficient, and the price of water was determined in proportion to inflation (rather than in accordance with regulations). Because of this, in addition to ineffective collection rates, the amount of funds (about EUR 300 - 350 million) was insufficient for maintenance and construction of water facilities. In addition, the situation has been only made worse by changes in legislation concerning the budget, so that even the public funds intended for this purpose have not been invested in the water sector in full.

In addition to the lack of funds, the following factors have also contributed to the current situation in the water sector:

- Effective and cost-efficient water management could not always be ensured since activities within this domain were, under the jurisdiction of ministries other than the competent Ministry, with poor coordination between them as regards the planning, execution and financing of infrastructural projects, for many years. Another problem is posed by the fact that the water sector has no jurisdiction over the utility service of the public water supply, as well as the collection, removal, treatment and release of wastewater, in the part concerning their development, that is, the planning and financing of water facilities in accordance with the LOW.
- The capacity of WD/RS is insufficient to fulfil all requirements envisaged in the *Law on Water* and other laws, and especially in the conditions brought about by the pressing need to develop the water sector and the intense activities relating to EU accession.
- The status of public water management companies has not been precisely defined (pending restructuring), which, together with the lack of adequate funding, reflects on the execution of legal responsibilities within their mandate. Territorial division into three public water management enterprises further compromises difficult conditions in which public water companies operate.
- The transformation of ownership has been completed in a considerable number of water management enterprises which perform operative works in the area of water management. This is why suitable instruments need to be introduced ensuring further operation of these enterprises, in line with their experience and tradition, and with suitable licensing in respect to technical-technological equipment and capacities in terms of organisation and staff.
- A certain number of public facilities have not been entered in the Real Estate Cadastre, so that there is no adequate information as to their situation, making their management all the more difficult.
- At this time very few projects in the water sector have been prepared in the manner allowing for application for funding at an international level. Documentation at the level of general planning is most often financed at the federal level; what is lacking is the initiative of local government to provide project documentation at a higher level which constitutes the basis for the realisation of investment activities. In addition to financial reasons, this is one of the other reasons why very few facilities and systems have been completed recently.
- According to the legislation in force, planning, preparation and realisation phases of investment projects require compliance with numerous procedures and the provision of a large number of documents (special studies, conditions, approvals, permits). This all resulted in protracted duration of the realisation of projects, since administrative procedures required for them usually took several months.
- Monitoring of surface and groundwater does not include underground deepwater wells; not all parameters are monitored for determining the status of water in compliance with modern

requirements of the sector, and the amount of data necessary for cost-effective water management is not provided.

- International cooperation with neighbouring states and the wider international community is governed by international contracts, conventions and agreements. Bilateral cooperation is considered to be lacking both in quality and in quantity, as cooperation with some of the neighbouring states has still not been established (Bulgaria and former Yugoslavian states), while cooperation with some countries is still operating under agreements concluded as far back as 1955 (Hungary and Romania).

The above assessment of the current situation and issues leads to the conclusion that the water sector is facing serious challenges for achieving sustainable water management in the coming period. However, there is room for optimism as favourable future development stemming from the fact that there still exists a sound professional and scientific core within the administration, in institutes and at universities, as well as in projects and other organisations. However, the role of the government is essential, since it is required to provide the necessary regulatory, institutional and other preconditions for launching the involvement cycle, and creating a favourable environment for the participation of domestic and foreign financial institutions. Capacities of state bodies in the water management sector need to be reinforced through close connections with scientific and other organisations. Building up capacities in all basic and supporting industries is also a necessary prerequisite for the successful accomplishment of investment in the water sector for the upcoming planning period.

#### **4. THE CONCEPT, OBJECTIVES AND GUIDELINES IN WATER MANAGEMENT**

As the Strategy constitutes a basic document for the implementation of reform of the water sector, the pursuit of core strategic and operative goals set by this document needs to be based on the adopted concept of water resource management and determined basic assumptions, in keeping with the priorities set in it.

Moreover, it must be taken into account that water management is conditional upon natural conditions, social and economic frameworks, as well as regulatory and other accompanying requirements (Figure 35). An effective water management system demands corresponding institutional and organisational arrangements which are able, in terms of structure and capacities, to fulfil the requirements in all phases of development (from planning to construction) and operation of the water sector, together with determined sources and mechanism for obtaining necessary funding. The improvement in the water sector can be ensured only through proper implementation of appropriate measures, that is, if all necessary functions relating to ongoing operation (exploitation, maintenance and monitoring) as well as those relating to development (planning, preparation of investment and construction) are carried out in a suitable manner. At that, regulations, funding, information systems, international cooperation and public participation are common to both groups of activities.

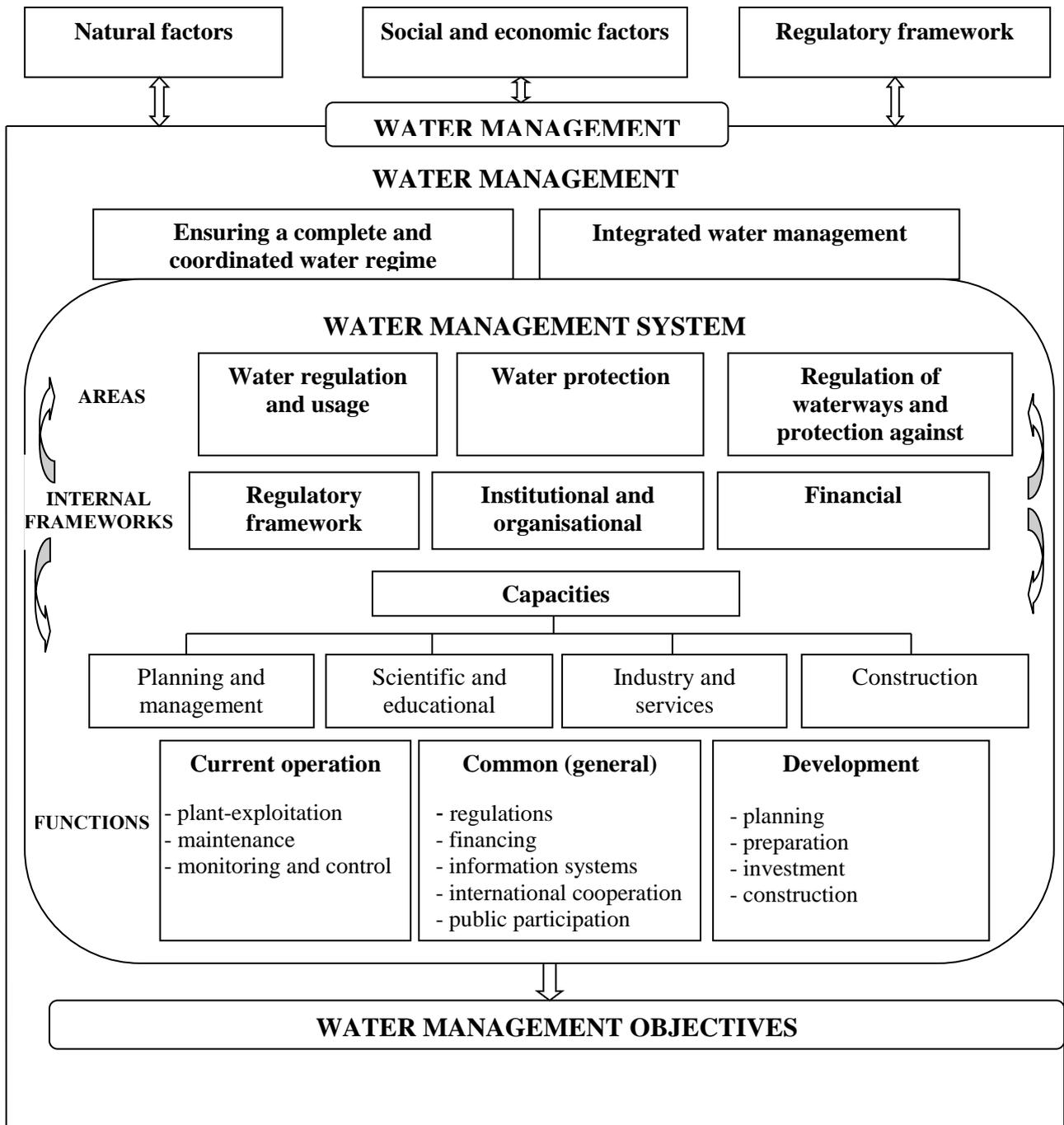


Figure 35: Water management system

## 4.1 CONCEPT OF WATER MANAGEMENT

The concept of water management rests, primarily, on the basic natural characteristics of the territory of the Republic of Serbia, the current water and water management situation, the necessity of satisfying the need for water, the need for water protection as well as for protection from the detrimental effects of water, taking into account the need for compliance with international standards in this domain (most notably, those applying to the European Union). The concept adopted is based on priorities which deal with key issues in the water sector, in keeping with long-term strategic objectives of all areas of the water industry.

In general, the attitudes surrounding water has changed over time, starting from the period of plenty, when water use and pollution was negligible in proportion to total resources, through the period of unbridled overuse and pollution, to the late nineteen sixties when the consequences of intense industrial development, both in our country and globally, began to raise concerns about the environment, including water as well.

<sup>41</sup>With this in mind, the World Commission on Environment and Development<sup>42</sup> has promoted the concept of sustainable development, defined as: “Sustainable development means the development which fulfils current needs without compromising the capabilities of future generations to satisfy their needs”. Water, as an important element of the environment, followed this concept, so that the basics of the international law relating to water gradually became incorporated into the provisions concerned with sustainability. Tremendous efforts are being made all over the world for the achievement of sustainable water resources management. However, substantial differences between certain parts of the world are apparent, as well as between certain countries, since many countries have not reached a sufficient level of economic development to be able to ensure fully sustainable management of their water resources. This fact, together with ever more obvious signs of changes in climate factors, gave rise to the increasingly frequent use of the concept of *adaptive water management*<sup>43</sup>. This type of management allows for flexible water management, capable of adapting to changeable natural, social and economic factors.

Water management arrangements depend to a large extent on the economical power of the state and water resources available (Figure 36).

It can be seen that countries with similar incomes and water resources mostly have similar water management arrangements. Therefore, in developed countries rich in water resources, decentralised water management is most often applied, which, in some cases, comes close to sustainable development. With a gross national income of approx. \$6,000 per capita annually, the Republic of Serbia falls within the group of medium developed countries, economically speaking. This, together with water resources of about 4,000 m<sup>3</sup> per person annually (including a section of transit water), Serbia falls within the group of countries which should, in the following period, maintain a considerable level of centralised water management. This means that priority capital projects still need to be defined at the federal level, taking into account the needs for the development of capacities at the regional level as well. In addition, at this level of economic development, the concept of adaptive water management is more acceptable, with a view of its evolution into sustainable development over time.

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<sup>41</sup>“Report by the World Commission on Environment and Development: Our Common Future”, better known as the Brundtland Report

<sup>43</sup> This concepts usually means structured, iterative process of taking optimum decisions in the conditions of uncertainty, aiming to reduce such uncertainty over time through monitoring.

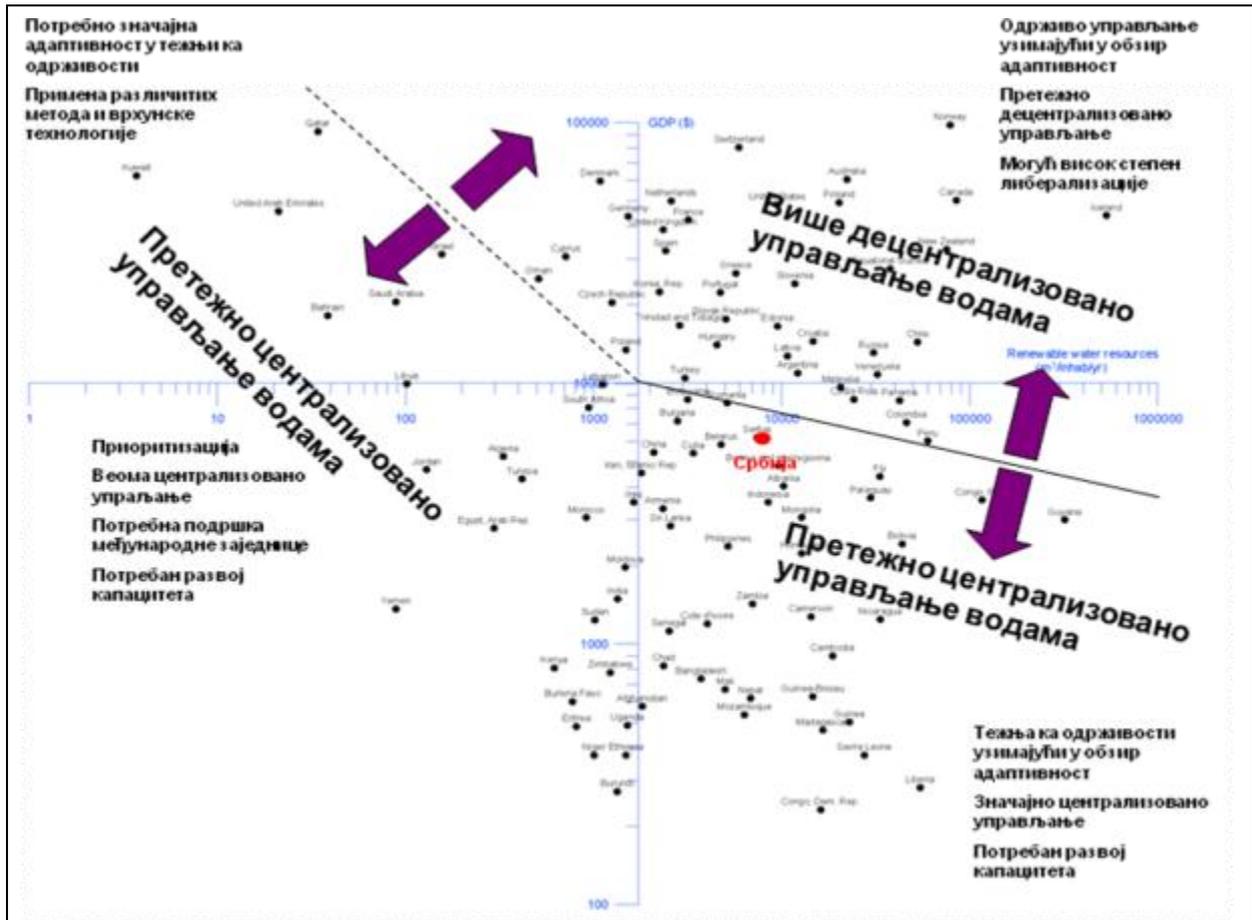


Figure 36: The economic power of the country and the wealth of water resources as indicators of the situation in water management<sup>44</sup>

## PREDOMINANTLY CENTRALISED WATER MANAGEMENT

Needed considerable adaptivity in the pursuit of sustainability  
Application of various methods and high end technology

Prioritisation

Highly centralised management

<sup>44</sup>on the horizontal axis - renewable water resources (m3 per person annually – data from FAO); on the vertical axis - gross national income (US\$ per person annually - data from the World Bank)

Needed support from the international community  
Needed capacity building

#### MORE DECENTRALISED WATER MANAGEMENT

Sustainable management taking into account adaptivity  
Predominantly decentralised management  
Possible high level of liberalisation

Seeking sustainability taking into account adaptivity  
Considerably centralised management  
Needed capacity building

It should be noted that Serbia was once in a better economic position, and therefore the development of water systems is at a higher level than one befitting a country with its current gross income. This is a favourable circumstance as it reduces the amount of works necessary to satisfy all the requirements demanded from the water sector; however, on the other hand, it creates issues of its own, since the current economic situation does not allow for adequate maintenance of the existing water structures and systems.

In addition to sustainable and adaptive water management, the international law also recognises the concept of *integrated water management*, defined as “the process which promotes harmonised development and management of water, land and accompanying resources with the aim of generating maximum economic and social benefit in a fair manner, without compromising the sustainability of vital ecosystems”.

Since the concept of integrated water management has been adopted for the Republic of Serbia, it will constitute the foundation of this Strategy as well. Nevertheless, the achievement of integrated water management is a lengthy process, which requires the following:

- an appropriate regulatory framework;
- suitable institutional and organisational solutions, with sufficient and competent expert staff and a satisfactory material base;
- appropriate financing system, with defined sources of funding and achievable dynamics for their provision;
- striking a balance between the central and local levels of water management.

Basic principles of integrated water management in Serbia are as follows:

- the unity of natural processes of which water constitutes an important part, which underpins the interconnectedness and mutual dependence of aquatic and riparian ecosystems.
- the unity of the water system - water management must be performed within the unique water area of the Republic of Serbia in accordance with its level of development;
- water is also a social and economic category;
- full prices need to be paid for the use of water goods and water systems of public interest (“user pays”);
- subjects whose activities pollute water must bear the costs of remedial or reduction measures relating to the pollution in question (“polluter pays”)

- protection of the public and their property from the detrimental effects of water must take into account the lawfulness of natural processes and protection of natural values, as well as the cost-effectiveness of protection;
- the public has the right to be informed of the condition of water and the operation of competent authorities within this domain, as well as to participate in the process of developing and adopting plans for water management and monitoring their implementation.

Taking into account the unity of the water system and the unity of water areas under water management, the division into water areas, which constitute basic water management units, must not pose limitations for the uniform water management system on the whole territory of the Republic of Serbia. This is especially important as, in the designation of water areas (due to legal regulations in force relating to the competences belonging to the autonomous province and those belonging to the capital city) the territorial principle was applied in parallel with the hydrographical principle, so a single river sub-basin/a basin (the Danube, the Sava, the Tisa, the Morava) can belong to two or more water areas. This is why the following is called for:

- competent authorities and professional bodies in charge for the development of water management plans need to ensure a high level of coordination in the development of such documents;
- when issuing water-related acts relating to the construction of certain structures and performance of works on a water area, competent authorities must take into account the impact on neighbouring water area.
- arrangements and activities of common interest for neighbouring water areas should be implemented with joint funding and joint monitoring and control.

## 4.2 WATER MANAGEMENT OBJECTIVES

The Strategy for Water Management in the Republic of Serbia is a comprehensive planning document determining long-term water management policy to be pursued on the territory of Serbia, that is, the directions of sustainable action in the areas of water use, water protection, the regulation of waterways and protection from the detrimental effects of water. This implies that integrated water management is applied on the whole territory of the Republic of Serbia, in line with basic principles laid down, with the possibility of adaptive management.

Taking this into account, and starting from the natural characteristics of the territory of Serbia, spatial and time layout of water resources of Serbia, as well as mutual interactions between human and nature, the main strategic goal has been defined - **achieving integrated water management, that is, the uniformity of the water regime on the whole territory of the Republic of Serbia and establishing water management which ensures maximum economic and social effects in a fair and sustainable manner in compliance with international agreements.**

In order to achieve the main strategic goal, it is necessary to:

- establish an appropriate water management system, or, more specifically, ensure regulatory, institutional, financial and other capacities and conditions underpinning the pursuit of the strategic goal of water sector development;
- understand water resources as factors in the integrated development of the society as a whole, and ensure necessary quantities of water of appropriate quality for various purposes, and most notably, for the public drinking water supply;
- achieve sound ecological and chemical status/potential of surface water bodies and sound chemical and quantitative status of groundwater bodies;
- ensure protection from surface and groundwater as well as protection from erosion and floods, in order to reduce the detrimental effects on the health of people, the environment, cultural heritage and economic activity.

In addition to all of the above, it is necessary to:

- harmonise the different interests of water users and other users of the space;
- improve cooperation with neighbouring and other countries in order to achieve integrated water management on waterways.

Each individual area within the water sector has its own separate strategic goals which need to be in line with the main goal; for this, numerous activities and measures with varying characteristics are called for. The water sector can realise some of these measures independently within its mandate, while others can be achieved only in cooperation with other federal institutions, local government and industry.

The Water Management Strategy applies to the period until 2034; however, it is apparent that the main strategic goal, as well as the goals within individual areas of the water management industry, cannot be achieved in the set period, since funding needed for their completion exceeds the economic power of the society.

The achievement of the long-term goal will be possible only if effective organisation of the water sector is ensured, together with appropriate institutional support, and the establishment of a system for sustainable, long-term financing based on stable sources of funding, continuous influx of funds and

established mechanisms for their collection, all the while seeking to implement the principle of self-financing in the water sector, as a long-term goal.

It should be also borne in mind that Serbia belongs to the group of states which are in the process of accession to the EU, that it belongs to the UNECE region and for the most part, to the territory of the Danube river basin, on which the countries have established multilateral coordination and cooperation in water management, so that activities in this area must be brought in line with internationally agreed upon principles and international cooperation relating to water bodies of common interest. This is the reason why internationally agreed upon principles concerning water (especially those laid down by the EU) have been complied within the defining of starting assumptions and objectives in individual areas of the water sector, in addition to the needs concerning the establishment of the water sector in the Republic of Serbia.

## **4.3 STARTING ASSUMPTIONS AND GUIDELINES FOR WATER MANAGEMENT**

### **4.3.1. Starting assumptions and guidelines for maintenance and improvement of the water management system**

With the aim to improve water regimes and for the general benefit of the society, the policy within the domain of water management starts from the following assumptions:

1. Water is an irreplaceable, renewable resource which not only constitutes a prerequisite for the proper operation and development of a society, but also represents an essential condition for the survival of the environment and of mankind as a whole. Water, riparian and aquatic ecosystems are all interconnected and mutually interdependent.
2. Water management must not compromise the health of human, animal and plant life, natural and cultural values and goods and the determined water regimes (in terms of quantity and quality) of surface and groundwater, as well as the rational needs of downstream users and other stakeholders within the area of water.
3. Water, as well as the development and management of water infrastructure, constitute both national interest and national responsibility. Against this background, planning at the level of government also contains a component relating to the development of the water supply and channelling utility service (part of the infrastructure concerning the network in settlements remains within the jurisdiction of local government).
4. Water is a source of natural wealth within the ownership of the Republic of Serbia, and as such cannot be disposed of; however, concessions or the right to use water can be granted to the public without ownership. Wetland areas can be both in private and in public ownership (for small water bodies without riverbeds), and can only be used in compliance with existing requirements, prohibitions and limitations. Water and other facilities can be in public ownership and in the ownership of legal entities and natural persons who have had facilities built for their own needs. The holder, that is, the user of water facilities is obliged to hold them, i.e. manage them in the prescribed manner and maintain them in keeping with the law.
5. Water planning and management must be performed at the basin level (the catchment area from which the entire surface runoff flows into the sea), which means that water management on territory of the Republic of Serbia which belongs to the Danube basin (over 98% of the area, without Kosovo and Metohija) must be done in harmony with federal planning of all countries within the basin.
6. Water management must be done in an integrated manner, taking into account natural (surface and groundwater, the quantity and quality of water in terms of space and time, land, ecosystems, and the like), economic (optimum development in all segments of the water area and their conformity with other branches of industry), as well as socio-political (regulatory frameworks, organisational and expert staff structure, etc.) conditions.
7. The territory of the Republic of Serbia is a unified water area in terms of integrated water management, with a 'water area' taken as a basic unit, designated primarily on the basis of the hydrographical principle (or, as an exception, of the territorial principle). Planning and water management in a water area must not be in contravention of planning and water management on the territory of the Republic of Serbia.
8. Water management must observe the principles of sustainable development, that is, it must be performed in such a manner that satisfies the needs of present day generations and does not put

at risk the possibility for future generations to fulfil their needs, and does not compromise the environment. Water resources must also be managed in an adaptive manner, taking into account the need for adaptation not only to climate, but also to social, economic and other changes.

9. The public water supply which supplies drinking water to households, to industries that require high quality water or is rooted in urban areas, as well as supplying other users, including public sectors (schools, hospitals, institutions, street cleaning, watering landscaped areas, and the like), constitutes public interest and holds priority over all other forms of water use.
10. Protection of water and the protection of protected areas constitute the public interest and are of federal priority, and must unfold under the direct supervision of competent government institutions.
11. The achievement and maintenance of minimum good status of water through the use of necessary measures within an integrated programme of measures is the objective which needs to be pursued in the period longer than the one planned. In addition, for underground water, every continuous rising trend to increase the concentration of any pollutant, needs to be suppressed.
12. The institutional framework must clearly delineate mandates relating to water management of individual administration bodies and other subjects at the level of the government, in order to avoid competition and duplication of competences.
13. The institutional framework must ensure the necessary extent of decentralisation, with clearly determined competencies at the federal level, of the autonomous province and at the local level. The water resource management strategy is developed at the federal level, standards and regulations are adopted, planning is carried out, as well as all other activities with relevance for the whole territory of the Republic. At this level the conditions and the criteria are set for financing projects with relevance for regional development and the development of the local government. The autonomous province carries out water management in the water areas within its boundaries, which also comprises the adoption of plans for water management and flood risk management, as well as the issuance of water-related acts. The local government holds the mandate for planning and implementation of protection from flooding on second order water, declaring erosion prone areas and setting out conditions for their use and protection, for issuing water-related regulation for facilities of local significance, and, above all, for the provision and development of utility services (preparation and distribution of drinking water, collection and removal of waste and atmospheric water and treatment of wastewater).
14. Stable financing and operation based on the principle of self-financing must be applied in full, in order to make the water sector less dependent on government funding. This calls for stable sources, projected amounts of funding needed and the manner in which it is to be provided, updated databases of payers and suitable mechanisms for the collection of revenue, the engagement of the government in creating favourable environments for the use of EU funding, and larger investments of private capital, as well as the collection of the largest part of financing necessary for the operation of the water sector through the introduction of economic prices for water according to the principle of full cost recovery and the principles “user pays” and “polluter pays”.
15. The real (economic) price of water and water-related services must be introduced gradually, taking into account the economic power of the public and the economy; however, the timeframe for its achievement must not exceed 5 to 6 years, so as not to compromise the dynamics of development.

16. The need for realisation of concrete projects of relevance to the water sector or of those affecting water as a resource must be proved from the aspect of social, technical-economic and ecological conditions and criteria.
17. The construction of water infrastructure (water facilities within the meaning of the *Law on Water*, and utility infrastructure facilities in the area of water) must be funded from various sources (funds for water, primary income of local government units, water rates, IPA and other funds, investor's own funds and credits), with respective proportions depending on the significance, size and purpose of the facilities.
18. Maintenance of water facilities is an ongoing activity which must be carried out in compliance with technical standards and norms. Funding for such purpose for facilities in public ownership must be provided from public funds at the federal level, the level of the autonomous province and at the level of local government, as well as from the fees collected for the services these facilities and systems provide.
19. The present requirement by law, that the services provided by the public water supply can be performed only by public enterprises or companies in which the majority shareholder, owning at least 51%, is the Republic of Serbia, or a local government unit, should be kept.
20. The joining together of the public water supply and/or public channelling operators, on the territory of one or more local government units should be encouraged through public policy measures when it is socioeconomically justifiable.
21. Standardisation (licencing) of enterprises in the water industry and utility services related to water (supplying drinking water through the public water supply network, as well as collecting, removal and treatment of wastewater through public sewage systems is required by law and a precondition for ensuring appropriate and a more uniform quality of services on the whole territory of the Republic of Serbia.
22. The right of the public to be informed and to directly participate in the development of water management plans in water areas must be implemented, and the operation of the National Conference on Water, in its capacity as a public institution at the federal level, must be upheld. It is also necessary to ensure the continuous education of the public and raise public awareness on the importance of water resources, their limitations and the need for their rational use and protection, as well as on the significance of water facilities for the use and protection of water and protection from water. If necessary, a separate body at the level of the water area, should be established.
23. In order to make water management more effective and cost-efficient, it is necessary to put in continuous, planned and coordinated efforts towards building up capacities (institutional, performance, planning, services, then in the segment of maintenance, as well as monitoring and control) both at the federal and local levels, as well as creating better material and an informational basis for their operation.
24. In order to build a stronger foundation for the development of the water sector, it is necessary to encourage/intensify cooperation with scientific-research organisations and institutes, faculties, planning and design organisations, and suggest the need for multidisciplinary education of technical staff, most notably, in the areas of: the environment, economy and law.

## 4.3.2. GUIDELINES BY AREAS OF WATER INDUSTRY

### Water regulation and usage

The main task of the water sector is to provide (with appropriate reliability) sufficient quantities of water of suitable quality for present needs and development, including the following: supplying the public and other users with drinking water within the public water supply system, supplying water for irrigation, production of hydro energy, industry, navigation, fish farms, bathing, sport, recreation and other,

The water sector must rely on domestic and transit water for providing sufficient quantities of water. Domestic water is relatively modest, somewhat under 500 m<sup>3</sup>/s annual average, or, more specifically, about 60 m<sup>3</sup>/s in the low-water period (low-water of 95% provision).<sup>45</sup> In addition, such water tends to present an unfavourable interannual regime, that is, there is the least amount of water in the period when it is needed most. The improvement of water regimes of such waterways can be brought about by supplying additional quantities from water-rich areas, through the construction of regional or multipurpose hydro-systems, or by the construction of reservoirs in the particular area.

Due to modest quantity of domestic water, satisfying the need for water relies heavily on the use of water inflowing into the territory of the Republic of Serbia (about 5,000 m<sup>3</sup>/s on average, annually, that is, about 1,500 m<sup>3</sup>/s in the low-water period). When using such water, it is necessary to take into account their international character, that is, that their use, regulation and protection are governed by corresponding international agreements.

Another key element which must be taken into consideration in long-term planning in water management is climate change. The mean interannual increase in temperature in Serbia stands at about 0.6°C/100 per year. The average trend of summary annual precipitation in Serbia, based on a sixty-year observation period, stands at about zero, however, its spatial distribution is uneven - it is positive in the (south)western part of the country and negative in the east. Some correlation can be found between hydrological trends and the climate trends observed, bearing in mind the fact that the river flow depends not only on climate change, but also on other factors, primarily anthropogenic, in nature. The trend of decrease in the mean annual flow in Central Serbia is about 30%/100 years, but its spatial distribution varies. The least amount of change is expected in the south-western part of Serbia and the worst changes in the east.

A long-term strategy for *the public water supply* and other users of high quality water depends primarily on the quantity and quality of water resources on the territory of Serbia and their spatial layout. Thus, in the areas with sufficient quantities of water of satisfactory quality, it is possible to keep the existing practice of the exploitation of local sources and apply regional arrangements only if local sources prove inadequate. The western and eastern edges of Serbia and the alluvia of major rivers are considered to be water abundant areas, while Šumadija and Pomoravlje are water-scarce, as well as parts of Vojvodina away from the Danube and Sava rivers. However, climate change and human impact can affect the flow regime of water bodies, and thus, the underground water body regime.

Underground water is likely to remain the main source of water supply owing to their lower susceptibility to pollution, while surface waters (rivers, reservoirs) should be used for such purposes when the underground resource is insufficient or of unsuitable quality.

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<sup>45</sup>The data do not include irreversible water losses which are estimated at 20 - 25 m<sup>3</sup>/s in low-water period.

Characteristics of underground water supplies must be taken into account in the course of their exploitation, especially in the case of reserves which replenish slowly (such as those on the territory of Vojvodina). Long-term exploitation of such supplies can be ensured only through rational use, while artificial replenishment is advisable. In addition to deep aquifers, of special importance for supplying drinking water are alluvial aquifers along larger rivers (the Sava, the Danube, the Drina and the river Morava), as potential aquifers for systems of regional significance.

The existing aquifers or those which can be used in the future for human consumption (categories of protected areas under the LOW), both surface or underground, must be protected from accidental or intentional pollution and other influences which can affect the quality and quantity of water. Aquifers of certain capacity are declared to be zones of sanitary protection, in which land use regimes are in the function of protection of the aquifer.

Irrigation in agriculture constitutes by far the largest irrevocable use of water (during the vegetation period from 1,000 m<sup>3</sup>/ha to 3,000 m<sup>3</sup>/ha, depending on the area, that is, 0.3 – 0.5 l/s per ha, depending on the irrigation method applied), so mainly surface water should be used for such purposes, however, if they are not available for rational use, groundwater may also be used, provided that the exploitation does not compromise satisfying water needs of priority users and the environment.

In the lack of comprehensive studies which need to be provided for all significant domestic and international waterways (taking into account possible changes in climate parameters), the Strategy assessed the quantities of surface water available for irrigation as a certain percentage of difference between small water bodies of 80% and 95% provision. In addition to natural characteristics of waterways, the needs of various users and the protection of the environment, the fact that some waterways are international was also given due regard in the Strategy. It has been estimated that in the future about 200 - 250 m<sup>3</sup>/s could be used for irrigation from rivers, most in the northern part (the riparian areas of the Danube, the Sava, the Tisa), and considerably less to the south from the Sava and the Danube.

In the valleys of domestic rivers which do not abound in water which could be used for irrigation (the Velika, Zapadna and Južna Morava, the Mlava), the solution could be in increasing the reservoir area in the basin, as well as in controlled use of dynamic reserves of underground water, and, possibly, in replenishing with water from more abundant basins.

The use of water from international water bodies must be in compliance with international agreements. In order to ensure rational irrigation in these, and other parts, taking into account the needs of downstream users, associations of water users and/or cooperatives may be established.

The development of irrigation mostly depends on the agricultural economy and the water sector will become involved to provide necessary amounts of water for the irrigation of agricultural areas where it is economically justifiable. In any case, irrigation must not be understood as a supplementary measure in struggle with draught and must not serve solely for stabilisation of agricultural production under the existing structure, rather, it should serve as an incentive for the development of the accompanying industries (stockfarming, processing, buying-in, circulation and similar). Educating farmers is also very important.

*Other forms of water use* most often depend on market interests. This is the reason why the dynamics of development and needs for water in various industries will be determined by users themselves, while the task of the water sector will be to provide sufficient amounts of water, taking into account the above-mentioned natural constraints and bringing into balance the requirements of various users, in order to prevent lack of water becoming a limiting factor for the development of economy. This is why

water scarce areas will be supplied with lacking quantities of water to satisfy the needs of various users, in addition to the public, through regional systems, that is, by bringing in water from water-abundant areas.

Sources of supply of water for fish farms and industrial facilities (which do not require high quality water for operation) will be mainly surface water. However, groundwater may also be used for such needs, under previously defined conditions. It should be noted here that fish farms are sizeable users (as well as polluters when legal requirements concerning treatment of water are not complied with).

In the construction of hydropower facilities it is necessary to bring into balance the demands of the energy industry development and other users of space, giving special consideration to the protection of the quality of water and the environment in general. This calls for coordination of respective competent authorities in the sectors of water and energy, from the planning phase through to the phase of exploitation of hydropower plants. Facilities for the exploitation of hydro-potential must be constructed in such a manner that water, after its energy has been used, is returned to the surface waterways so that it can be reused for other purposes, while retention reservoirs must have a section intended for the reduction of high water waves. Retention reservoirs must be adequately protected against being sifted over with sediment through proper regulation of the catchment area.

Special attention needs to be paid to the construction of hydropower plants in lower portions of large waterways (the Velika Morava, the Drina) where newly constructed facilities can considerably affect the water regime and other users of the space.

The use of water in tourism, sport and recreation, including bathing, depends on natural characteristics of the area, while the quality of water must be brought into conformity with applicable standards. Determining places and arrangements for the use of water for such purposes is in the competence of the local government and must be carried out in accordance with with the *Law on Water* and other regulations.

### **Water protection**

The main purpose of the protection of water is the preservation of human health and the environment through the achievement and maintenance of good status of surface and groundwater (ecological status/potential and chemical status), reducing the hydromorphological pressure on natural water bodies, prevention and control of water pollution as well as rational use of resources available.

Water protection is planned and executed under integrated water management, on the basis of agreed strategic and planning documents in the water sector and other relevant sectors, through the use of:

- the principle of reducing pollution at the site of occurrence, or, more specifically, reducing the amount of hazardous substances at the source of pollution through the implementation of necessary water protection measures and the control of the operation of wastewater treatment plants and facilities.
- combined approach which comprises measures for control of release into a receiving water body (emission standard) and measures for control of quality of the environment (immission standard) in accordance with the stricter criterion of the two;
- the principle “polluter pays” which obliges the polluter to bear the costs of measures for offsetting/abatement of pollution;
- the principle of the best available techniques which obliges all operators in the water-related activities to apply the best techniques available.

Protection from concentrated sources of pollution is to be improved through the construction and proper operation of utility infrastructure, the work of inspection services and monitoring.

The construction of sewage systems and wastewater treatment plants - WWTPs in accordance with the EU Urban Wastewater Treatment Directive should apply to all settlements with over 2,000 inhabitants. However, the Republic of Serbia does not have sufficient financial resources to realise this condition within the planning period. In settlements under 2,000 inhabitants which do not have a public sewage system but do have public water supply, adequate treatment of wastewater should be ensured by individual systems, taking into account the drop in the number of inhabitants. However, settlements (mostly suburban) in which the construction of sewage facilities has begun can be connected to the city systems.

The main criteria for the selection of priorities for the construction of sewage systems and WWTOs in settlements over 2,000 inhabitants are: the specific load of the recipient (kg of specific pollution per m<sup>3</sup> of small and medium sized water bodies) and its capacity to receive pollution, in addition to the level of development and connectedness of the public to the wastewater sewage system.

On the basis of the first criterion - the characteristics of the recipient, the plants should first be constructed in settlements within protected zones, then in larger agglomerations along small waterways (those with unfavourable water hydrological regime in terms of small and medium sized water), and only last in settlements near large waterways (the Danube, the Tisa, the Sava). If the level of the development of the sewage network is considered, priority should be given to the construction and completion of the network in settlements with a low level of connectedness, however, if the network is adequately developed, priority should go to wastewater treatment plants. Notwithstanding this, when local government is willing to invest a substantial amount of its own resources in the construction of a WWTP, the government should encourage such initiatives and provide appropriate support.

For full protection of water and protection from water, the construction of an atmospheric sewage system must be in keeping with the overall urbanisation of settlements, and its construction must not considerably lag behind in comparison with wastewater sewage networks. The construction of such systems should make use of a contemporary approach which comprises a number of measures and works on the whole runoff area from the site of occurrence to the recipient, depending on the characteristics of the catchment area and the envisaged objective (protection of the quality of water and land, control of the speed and amount of the runoff and similar). Measures and works for carrying off overland flow should be connected with the activities on the protection from harmful effects of water and protection of water, as well as with urban planning and construction requirements.

In the case of scattered sources of pollution, special attention should be given to dominant scattered sources of pollution on a given territory, or, more specifically, to the public (individual sewage systems), intensive stock-farming, as well as agriculture, through systematic monitoring and control of the use of fertilisers and plant protection products.

The regulation of utility and industrial landfills must comply with contemporary practice and EU standards, while illegal landfills should be eliminated to the largest extent possible, through establishment of particular locations for depositing solid waste. Waste management system, which needs to be established at the level of the state, will certainly contribute to the abatement of the effects generated by such potential scattered polluters.

In the case of protected areas, first it is necessary to set out appropriate criteria and determine categories of protected areas, in accordance with the *Law on Water*, taking into account both social and economic aspects.

The protection of existing sources within zones of sanitary protection and the control and maintenance of quality water bodies used for recreation and bathing shall be implemented by competent local government, while the water sector shall carry out measures of protection in the areas intended for catchment of water for human consumption, as well as those for additional protection of bodies of groundwater which are to be designated as potential sources for regional systems (strategic reserves).

The areas vulnerable in terms of nutrients, the areas designated for the protection of habitats or species in which the element of the condition of water plays an important part, as well as the areas designated for the protection of aquatic species of economic significance which are declared as protected areas, must be under the care and protection of institutions by whose acts they were designated as protected areas.

The monitoring of parameters of ecological and chemical status of surface water and the chemical and quantitative status of groundwater, including water in protected areas, forms the foundation for the improvement of the condition in the area of water protection, and therefore must be performed in a prescribed manner;

An important segment of water protection shall be the reduction of hydromorphological pressure on natural water bodies, which means that new structures which substantially affect the status of water (due to hydromorphological pressure) may be erected only with supporting evidence that there are no more favourable alternatives in a technical and ecological sense.

### **Regulation of waterways and protection against the harmful effects of water**

Regulation of waterways will remain, in the coming period, a necessary activity for the preservation of stability and to prevent the deformation of riverbeds, provision of necessary flow capacity of the river channel, necessary waterway dimensions, as well as the conditions for rational use of water for various purposes (water supply, irrigation, hydropower industry, recreation and similar). The regulation of river channels must be executed with minimal hydromorphological changes to the riverbed and minimal effects on aquatic and riparian ecosystems. This calls for coordinated activity of the water sector, the environmental sector and the river traffic sector, in the case of inland waterways. At that, the exploitation of sediment from riverbeds can be undertaken only in order to improve their flow capacity, in conformance with project dimensions and prescribed dynamics. Exploitation from inundation of medium-sized and smaller waterways must also comply with appropriate technical documentation, and followed by reclamation of the borrowing pit after exploitation is complete.

Taking into account that the risk posed by the harmful effects of water cannot be entirely eliminated, but only reduced to a socially and economically acceptable level, an integrated approach to the management of flood risk is established within the domain of protection from the detrimental effects of water (pluvial and groundwater flooding). This involves defining the strategy at the level of a river basin/sub-basin, within the appropriate Plan for Management of Flood Risk, which envisages an adequate combination of investment works, preventive and operational measures, based on the estimate of costs, technical feasibility, environmental impact assessment and social acceptability of such measures and works.

The attitude toward the protection from harmful effects of water must change in terms of delineating social and individual responsibility. This primarily applies to a change in the long present assumption that protection from the harmful effects of water is exclusively the responsibility of the state, and that it falls on the government to ensure full protection of all users of riparian areas, regardless of the rank of a large body of water and the frequently irresponsible behaviour of users of the area, breach of conditions, limitations or prohibition of construction. The fact must be accepted that constructed water

protection facilities and systems provide protection only up to the standard level of high water, for which they were dimensioned, with regular and adequate maintenance, and that the risk above this is borne by owners and users of property in the coastal zones. Furthermore, the responsibility of each individual who lives and/or operates in areas under threat is to adapt his activities to the risk, without worsening conditions in the area and without compromising the implementation of protective measures.

Planning and execution of protective measures for water demand active and coordinated cooperation between the water sector and other relevant stakeholders. Investment works for protection against fluvial water still remains the primary task of the water sector, while the implementation of numerous non-investment measures, is the responsibility of other institutions in addition to the water sector (protection and rescue services, meteorological services, health services, spatial planning, the environmental sector, local government), together with users and administrators of multipurpose accumulations, the public, non-governmental organisations, companies and entrepreneurs in the areas potentially at risk. In the protection against pluvial floods (drainage), the implementation of hydrotechnical measures must be in accordance with the plans, needs and financial possibilities of the state and agricultural producers and the needs for protection against groundwater in populated areas. Protection against erosion and torrents shall also involve the implementation of regulative and administrative measures and investment works, calling for joint and coordinated action to be taken by the competent administrative bodies and public and other enterprises, users of erosion areas.

Interdisciplinary cooperation at the level of government and local level of administration in the area of protection from water, the environmental sector and spatial planning should ensure the necessary level of coordination in planning measures for protection from water and the use of space (land use, development of traffic and urban centres). Adequate spatial and urban planning will strike a balance between growing demand for further urbanisation and economic use of riparian areas and the need for certain areas to be reserved for regulating the flow and containment of water in the basin, which is a significant measure of prevention and risk abatement.

In international river catchment areas all activities for the reduction of flood risk, including operational defence against flooding and ice, must be performed in active cooperation with other countries in the basin, in compliance with adopted conventions and agreements.

The construction of drainage systems for agricultural land must be done in parallel with land reclamation; otherwise, priorities are set according to the legally established criteria, where the first criterion is ensured protection from fluvial flooding of the area in which the system is being constructed. Adverse effects from high levels of groundwater should be eliminated by the construction of horizontal drainage pipeworks.

Information and education of the public, through a comprehensive plan in the formulation of which the National Conference for Water also plays a part, constitute a significant permanent activity for raising and maintaining awareness of floods and the risk they present. Vulnerability maps provide relevant information on the risk from flooding as they also include data on flooding boundaries at high water of various return periods, including the worst case scenario, as well as the flood risk maps. In the case of fluvial flooding, actual flood zones are determined (areas which would always be flooded in case of high water, mostly in the valleys of smaller waterways without protective systems) as well as potential flood zones (zones protected from flooding with passive or active protective measures, which would be flooded only in such case as a system failure).

Practical directions for settlements and individuals on how to behave during a flood to protect themselves and their property would considerably reduce risk and damage from flooding.

The public needs to be encouraged to take suitable preventive measures for their own and for the protection of their property, while insuring goods in threatened areas can constitute a significant factor for the reduction of financial risk to individuals, operators and the society in general, and should be encouraged as such.

### **4.3.3. GUIDELINES FOR THE IMPROVEMENT OF INTERNATIONAL COOPERATION**

International cooperation is a necessary activity within water management on interstate and international waterways and pertaining groundwater. Such cooperation is based on ratified multilateral and bilateral treaties and conventions governing water management on these waterways.

For the improvement of multilateral and the establishment and improvement of bilateral cooperation the following should be done:

- continued work in existing bodies for the application of international treaties and conventions - working groups attached to the Convention on Water and international commissions (the Danube, the Sava, etc.), and fulfilling undertaken obligations.
- take active part in the work of newly formed commissions and international bodies with relevance to water management.
- intensify international cooperation with neighbouring states on the territory of the former SFRY (Croatia, B&H, MNE and Macedonia), and sign an agreement regulating water management on the portions of waterways of common interest.
- intensify international cooperation with neighbouring states (Romania, Hungary and Bulgaria), together with the signing of a treaty governing water management on the portions of the waterways of common interest;
- ratify the Convention on the Non-navigational Uses of International Waterways (the New York Convention) regulating water management (conditions for the use, development, conservation and protection of international waterways and upgrading their optimal and sustainable use for non-navigational purposes);
- take part in activities connected to planning in water management and planning for flood risk management in the Danube basin, as well as in other planning activities relating to water in international waterways, which calls for the following:
  - ensure compliance of water management plans for water areas on the territory of the Republic of Serbia with the The Danube River Basin Management Plan developed by the international team within ICPDR;
  - ensure compliance of flood risk management plans for water areas on the territory of the Republic of Serbia with the The Danube River Basin Flood Risk Management Plan which is to be adopted in 2015, as the result of the effort of the international team; in line with this, planned is the development of a common plan for the River Sava, to be produced by the Sava Commission;
  - plans for water on international waterways should be developed in agreement with competent authorities in neighbouring states.

### **4.3.4. BASIC ASSUMPTIONS OF THE MONITORING AND INFORMATION SYSTEM**

Systematic and comprehensive monitoring is a prerequisite for reliable determination of the status of surface water and groundwater, as a basis for the planning of water use and efficient integrated water management. The Republic of Serbia has the responsibility to establish and carry out monitoring,

through adoption of the annual monitoring programme and by providing conditions for its implementation.

Monitoring quantity and quality parameters of water and sediment, including the groundwater of deep aquifers, must be performed with the use of standardised methods of measurement in the field, established methods of laboratory analyses and standardised way of processing and presenting results, accompanied with their constant control and improvement; For the assessment and monitoring of the status of water bodies and surface water, monitoring should cover the key parameters of those quality elements (biological, hydromorphological and physicochemical), which, according to previous data, are most sensitive to the pressures to which a particular water body is exposed.

In operational terms, monitoring should be implemented by the federal organisation in charge of hydro-meteorological affairs, in accordance with the Government's annual programme. This organisation collates the findings of the testing which, according to the annual programme, is performed by other authorised legal entities and should, together with its own results, submit those results to the competent ministry. The annual report must contain registered changes in the water quality.

Protected areas need to be monitored, while the subjects who carry out the monitoring, as well as the parameters and frequency of sampling need to correspond to the types of protected areas (in conformity with the recommendations of the WFD). Purposed monitoring must be carried out on certain river sections along which agricultural land lies, where there is significant chemical use, in order to monitor their impact on the quality of water in the waterway.

Relevant monitoring results (primarily those conducted by the federal organisation in charge of hydro-meteorological affairs) must be included in the Water Information System of the Republic of Serbia, in order to allow the monitoring and improvement of the water regime, planning related to water systems development and integrated water management in the Republic of Serbia.

Taking into account the the amount of information and data concerned, the Water Information System constitutes an important segment in the process of monitoring and improvement of the water regime, water infrastructure development planning and operational management of water and water systems. An important part of the information system are water cadastres (water goods, water facilities, use of water and pollutants), and their updating and maintenance greatly affect the effectiveness and quality of water management. A uniform information system for the Republic of Serbia must remain in the competence of the Ministry; however, it must also be the responsibility of water supply companies for the territory under their jurisdiction. An exchange of relevant information with other information systems at the federal and international levels should be undertaken at the level of the competent ministry, unless otherwise provided for in a special act by which a public water supply company is empowered for the territory within its jurisdiction.

Public enterprises and other legal bodies outside the water sector must continuously collect and update all relevant data and information of importance for water management, within the system in their jurisdiction. Such data must be forwarded to the competent public water supply company and other operators specified in the *Law on Water*.

#### 4.4. GENERAL PRIORITIES IN THE PURSUIT OF THE OBJECTIVES OF WATER MANAGEMENT

As the improvement of the situation in certain areas of the water sector requires significant funds and substantial scientific, technical and service capacities, which are at present lacking, activities to improve the water regime and the overall situation in the water sector must be in line with the possibilities of the economy and society, as well as with set priorities.

In terms of priorities, two categories of activities can be set apart:

- activities establishing a foundation for the implementation of water management operations, and
- activities by domains within the water sector, through which improvement is pursued in each area aimed at creating better conditions for the development of the state and society.

*The first category of activities* is the first priority and concerns the completion of regulatory legislation, or, more specifically, the adoption of bylaws in accordance with the *Law on Water* (including its amendments in the process of harmonisation with EU regulations), for the provision of conditions for its implementation. This category also comprises the development and adoption of plans for water management in water areas, as well as the plan for protection of water from pollution, which is adopted by the Government, that is, the competent authority of the AP and Belgrade, together with plans for flood risk management in the Republic of Serbia and water territories.

In addition to bylaws provided for in the *Law on Water*, other regulation pertaining to water or the water sector needs to be completed as well.

Adequate measures of monitoring and control, including penal policy, must be envisaged to ensure effective implementation of regulations.

Cooperation between competent governmental bodies and the mutual cooperation of all stakeholders involved in the process of water management and use of space is both a precondition and a priority for the advancement of the water sector. This especially applies to cooperation of relevant stakeholders in the course of the development of studies for complex uses of particular sub-basins or their portions.

More effective and rational operation of water management also requires building up capacities (institutional, performance, planning, and services, then in the segment of maintenance, as well as monitoring and control) as well as providing a better material foundation for their operation. This activity must unfold continuously, in a planned and coordinated manner, both at the level of government and at the local level, in addition to which educational/scientific-research institutions need to take up a more prominent position.

Another high priority task is ensuring relevant parameters for defining water regimes, which forms the basis for the establishment of adequate water management. This comprises an advancement of monitoring of surface and groundwater, the establishment and regular updating of the Water Information System, the development of water balance for water areas and sub-basins, the development and implementation of programmes of specific research of processes unfolding in surface and groundwater and similar.

In the *second category* of activities, the primary task and a priority for the water management sector is the protection of human health.

In terms of the *healthy drinking water supply* to all settlements which have natural, technical and economic preconditions for said, first it is necessary to extend (upgrade) the network bringing it up-to-date, then to extend existing sources, and when it is impossible to handle the issue of supplying water

in a more cost-effective manner, the issue should be solved by the construction of new regional systems.

The parameter of threat to the consumer (continuous poor quality of water, a health threat, propensity for accidental pollution, and lengthy shortages of water and the like) is the primary criterion for identifying settlements which are a priority issue regarding drinking water supply management. In addition to this parameter, when setting priorities, the social component relating to the consumer group in question may be taken into account, or, more specifically, the degree of improvement in existing conditions in relation to resources invested, the willingness of local administrations to contribute to investments, etc. When the level of threat is similar, slightly higher priority should be given to larger settlements, as the issues of a larger number of users is solved in this manner.

Establishing economic price of water is also a priority activity envisaged for the coming period, and the dynamics of the price increase need to be adjusted to the economic power of the public and the economy.

In the area of *protection of water*, priorities are set in relation to relative contributions of certain categories of pollution, the origin of pollution, as well as to the specific capability of the recipient to receive pollution without undergoing change in the status of surface and groundwater as the following:

- in concentrated sources of pollution - on the basis of a specific load of the recipient in relation to the available quantity of water in it;
- in scattered sources of pollution - on the basis of the relative contribution of individual categories of scattered pollution to overall pollution, and the possibilities of applying efficient and effective measures for the control of release.

Starting from the above, together with the revitalisation of existing and the completed construction of already started facilities, new wastewater treatment plants should primarily be built in:

- zones with a significant impact on water supply sources;
- in larger settlements, in the top sections of their basins, as the capacity of the recipient is smaller there, which can potentially lead to greater pollution;
- in settlements whose recipients have small, specific reception capabilities and self-purification
- near winter tourist resorts, in the top sections of basins.

In settlements with under 2,000 inhabitants without access to public sewage, but which do have a public water supply system in place, priority should be given to individual systems for adequate treatment of wastewater, so as to avoid the construction of central sewage systems, especially in settlements with present demographic stagnation or a drop in the number of inhabitants (most agglomerations in this category).

In this respect, the government and the AP will primarily take part in the construction of main collectors and WWTPs, following the criteria provided in the regulations. The most important criteria are the level of public health risk, as well as the pollution impact level, on the condition of the wastewater recipients as well as the aquatic and riparian ecosystems. The construction of main collectors and WWTPs must be a priority in settlements where they would substantially improve the level of public health protection, drinking water supply source protection and the protection of the recipients, as well as other elements of the environment. This primarily concerns settlements within the catchment areas of the Južna, Velika and Zapadna Morava, the DTD canal network, the Timok river basin, the Tamiš, the Mlava, the Kolubara, the Pek, as well as in the river basins of the Tisa, the Sava, the Drina and the immediate river basin of the Danube.

For industrial wastewater, the priority is the introduction of the obligation of their purification before release into the public sewage network (pre-treatment) or directly into the recipient, especially if it concerns wastewater containing priority substances and priority hazardous substances.

In the case of scattered source of pollution, effective control of the release of pollution must be ensured.

In cooperation with competent institutions for the protection of the environment, illegal landfills must be removed, the existing utility waste and industrial waste dumping grounds need to be reclaimed and the new ones need to be constructed in conformity with standards and priorities laid down in relevant documents.

Revitalisation of the existing *irrigation systems* is a priority activity, with the introduction of a dual-purpose function (drainage and irrigation) where there are needs and possibilities for this. In parallel with this, if there are sufficient interest and resources, new systems should be put up, especially on land with a high level of suitability for irrigation (I and II, and in some areas also IIa class), protected from detrimental effects of fluvial water. Priority should be given to the areas whose irrigation can be supplied with adequate quantities of water from local sources (proximity of surface waterways, of sufficient capacity and quality for such purposes).

Plans for *flood risk management* need to provide a foundation for effective protection of people and goods from pluvial and fluvial flood water. However, it is indisputable that within investment activities reconstruction and extension of existing systems should be given priority, first, for the protection from fluvial water centres of damage (cities and settlements on large waterways, industrial and power plants, traffic infrastructure). On international and interstate waterways an increased level of protection should also be ensured. Also significant is the protection of accumulation areas from being silted over with sediment, in addition to the protection of people and goods, through the regulation of erosion areas and torrential waterways, most notably those running through inhabited areas.

As for *protection against pluvial water* (drainage), improvement should mainly be affected through work on the upkeep of existing systems operations, primarily through adequate regular and investment-related maintenance, then, through reconstruction and extension up to planned performance indicators, while new systems first need to be built on I drainage class land (about 100,000 ha, that is, approx. 20% of areas still at risk). At that, first basic and detailed canal networks need to be constructed, followed by supporting facilities on them.

## **5. PROJECTION OF WATER MANAGEMENT DEVELOPMENT**

### **5.1. SOLUTIONS BY AREA**

#### **5.1.1. PROJECTION OF POPULATION SIZE**

Projections of the Republic of Serbia's population were taken from the documents of the Statistical Office of the Republic of Serbia, which, by applying the analytical method along with the so-called decomposed method<sup>46</sup>, produced projections in five variants: low, medium, high, constant fertility-mortality variant and zero net migration variant.

For the purpose of further analyses, we used data from the high variant of population projection (Figure 37), which also has a trend of population decline, though somewhat slower than other variants.

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<sup>46</sup> The hypotheses have been laid down for the region of Central Serbia and Vojvodina, so that the projected population of the Republic of Serbia is the sum of the projections of the population of its constituting parts, and not the resultant of separate hypotheses.



Figure 37: Projection of population size

Projection of population size  
 Belgrade region  
 Vojvodina region  
 Šumadija and Western Serbia region  
 Southern and Eastern Serbia Region  
 Serbia total

### 5.1.2. WATER USE

Estimation of water requirement is based on the state of water resources and the current situation in the area of water use, as well as the goals and guidelines of development, based on demographic projections and projections of economic and social development in the next twenty years.

**Strategic goal:** Provision of sufficient quantities of water of proper quality for different categories of users, primarily for supplying water to the public, while respecting the environment.

#### Supplying water to the public

Supplying water to the public is a priority over all other forms of water use, and the necessary quantities of drinking water must first be determined for this category of consumers. This also covers specific consumption, i.e. other users supplied with drinking water from the public water supply system (institutions, industry and other economic entities).

#### Required water quantities

The quantities of water required for public water supply in the planning periods of ten and twenty years have been determined on the basis of demographic indicators, the projections of a degree of connection to the system (current and projected) and projected specific consumption.

Demographic projections by the end of the planning period show a negative trend, resulting in a small increase in users of the public water supply system. Based on demographic projections and assumptions that the population connected to the public water supply will increase (Table 46) and that the average specific consumption at the national level will not significantly change during the planning period, the need for water by municipality has been determined and shown collectively by district

(Table 47). The indicators are given for two periods and two variants - needs without reserves and needs with reserves (reserves at source and a higher coefficients of drinking water supply security).

Table 46: Population connected to the public water supply

Region	Population size million			Number of users million			Coverage in %		
	2012	2024	2034	2012	2024	2034	2012	2024	2034
Vojvodina	1,933	1,817	1,771	1,752	1,710	1,700	91	94	96
Belgrade	1,658	1,766	1,879	1,519	1,660	1,805	92	94	96
Central Serbia	3,643	3,332	3,209	2,564	2,730	2,875	71	82	90
<b>Serbia without K&amp;M</b>	<b>7,234</b>	<b>6,915</b>	<b>6,859</b>	<b>5,835</b>	<b>6,100</b>	<b>6,380</b>	<b>81</b>	<b>88</b>	<b>93</b>

Table 47: Water needs by district in millions of m<sup>3</sup>/year

District	2024.		2034.	
	Quantities needed without reserves	Quantities needed with reserves (10%)	Quantities needed without reserves	Quantities needed with reserves (15%)
Northern Bačka	14.20	15.62	15.00	17.25
Central Banat	16.67	18.34	16.50	18.98
Northern Banat	12.62	13.88	12.17	14.00
Southern Banat	27.58	30.34	28.11	32.33
Western Bačka	14.64	16.10	14.56	16.78
Southern Bačka	59.32	65.25	62.62	72.01
Srem	30.97	34.07	33.19	38.17
<b>Vojvodina</b>	<b>10<sup>6</sup>m<sup>3</sup>/yr</b>	<b>176.00</b>	<b>193.60</b>	<b>182.15</b>
	<b>m<sup>3</sup>/s</b>	<b>5.55</b>	<b>6.11</b>	<b>5.74</b>
<b>City of Belgrade</b>	<b>10<sup>6</sup>m<sup>3</sup>/yr</b>	<b>237.56</b>	<b>261.32</b>	<b>247.73</b>
	<b>m<sup>3</sup>/s</b>	<b>7.53</b>	<b>8.29</b>	<b>7.86</b>
Mačva	22.85	25.14	25.45	29.27
Kolubara	17.55	19.31	19.83	22.80
Podunavlje	17.50	19.25	20.50	23.58
Braničevo	15.62	17.18	16.01	18.41
Šumadija	35.51	39.06	39.12	44.99
Pomoravlje	15.38	16.92	18.36	21.11
Bor	17.10	18.81	16.35	18.80
Zaječar	11.65	12.82	12.00	13.80
Zlatibor	28.62	31.48	31.78	36.55
Morava	23.64	26.00	26.39	30.35
Raška	26.81	29.49	33.65	38.70
Rasina	20.49	22.54	24.30	27.95
Niš	41.07	45.18	45.00	51.75
Toplica	8.07	8.88	9.34	10.74
Pirot	9.31	10.24	9.91	11.40
Jablanica	18.54	20.39	22.48	25.85
Pčinja	20.68	22.75	26.54	30.52
<b>Central Serbia</b>	<b>10<sup>6</sup>m<sup>3</sup>/yr</b>	<b>350.39</b>	<b>385.43</b>	<b>397.01</b>
	<b>m<sup>3</sup>/s</b>	<b>11.11</b>	<b>12.22</b>	<b>14.48</b>

District		2024.		2034.	
		Quantities needed		Quantities needed	
		without reserves	with reserves (10%)	without reserves	with reserves (15%)
<b>Serbia without K&amp;M</b>	<b>10<sup>6</sup>m<sup>3</sup>/yr</b>	<b>763.95</b>	<b>840.35</b>	<b>826.89</b>	<b>950.96</b>
	<b>m<sup>3</sup>/s</b>	<b>24.22</b>	<b>26.65</b>	<b>26.22</b>	<b>30.15</b>

The estimates of additional quantities were based on the following:

- The average amount of abstracted water, if we observe a long period, is about 23 m<sup>3</sup>/s;
- The expected gradual increase in the price of water will contribute to more rational consumption;
- The assessed demographic trend for the observed period is negative, with pronounced migration to urban areas, primarily to Belgrade;
- The percentage of inhabitants and households covered by the public water supply will be increased as a result of increased consumption;
- Industries that require water of drinking quality will increase their demand in the planning period;
- The capacity of certain sources will be reduced, while others will be excluded from exploitation;
- It is possible to have increased needs for reasons that are difficult to quantify.

The foregoing indicates that in order to meet the needs of the public water supply, it is necessary to provide approximately 3 m<sup>3</sup>/s more water by the end of the planning period, which means that the total quantity of water required to meet the needs of public water supply would amount to about 827 million m<sup>3</sup>/year, without reserves that would guarantee greater security of the drinking water supply.

#### Water supply orientation

A long-term strategy for supplying water to the public depends primarily on the quantity and quality of water resources on the territory of Serbia and their spatial arrangement. Thus, in the areas with sufficient quantities of water of a satisfactory quality, it is possible to keep the existing practice of the exploitation of local sources and apply regional solutions only if there is a lack of water.

It may be noted that water-abundant areas are in the western and, locally, the eastern perimeters of Serbia and the alluvions of major rivers, while water-scarce areas are Šumadija and Pomoravlje, as well as parts of Vojvodina, away from the Danube and Sava rivers. However, climate change and human impact are likely to result in changes in the waterway flow regime, which would also affect the groundwater regime. That is why, regardless of the general orientation of the priority use of local water sources, it is necessary to reserve space for the construction of reservoirs and protection of certain alluvial areas, as potential sources of future regional systems.

Figure 38 shows the additional amount of water that can be obtained from new sources or by expanding the existing regional systems. The existing regional systems that are not expected to be further expanded, in terms of water source capacity, are not marked in the figure.

In addition to the general orientation for larger territorial units, Table 48 presents orientation towards the sources of drinking water supply by municipality. Orientation towards future sources is given alternatively for some municipalities. The first alternative option involves sources that, at this level of understanding, have better technical and economic indicators and a higher prospect of use in future, which does not exclude the possibility that other option may be given priority if proven to be more favourable on the basis of appropriate research.



Possible new quantity of water from the regional water supply systems (mil m<sup>3</sup>/yr)

Probable regional water sources

Possible alternatives

Potential, insufficiently explored water sources

Table 48: Possible solutions to drinking water supply by municipality

	Current situation	Possible solutions	
		1st alternative	2nd alternative
<b>1. North Bačka District</b>			
1 Subotica	Local, BWBC*	RWSS Western Bačka	
2 Bačka Topola	Local, BWBC	RWSS Western Bačka	Eastern perimeter of Telečka (IOT)
3 Mali Idoš	Local, BWBC	RWSS Western Bačka	IOT
<b>2. Central Banat District</b>			
1 Žitište	Local, BWBC	RWSS Banat	Southeastern Banat (JIB), Danube**
2 Zrenjanin	Local, BWBC	RWSS Banat	Danube, Tisa**
3 Nova Crnja	Local, BWBC	RWSS Banat	JIB, Danube
4 Novi Bečej	Local, BWBC	RWSS Banat	RWSS Banat, RWSS Novi Sad, RWSS Western Bačka, Tisa
5 Sečanj	Local, BWBC	RWSS Banat	JIB, Danube
<b>3. Northern Banat District</b>			
1 Ada	Local, BWBC	RWSS Western Bačka	IOT, RWSS Banat, Tisa
2 Kanjiža	Local, BWBC	RWSS Western Bačka	IOT, RWSS Banat, Tisa
3 Kikinda	Local, BWBC	RWSS Banat	JIB, Tisa
4 Novi Kneževac	Local, BWBC	RWSS Western Bačka	Tisa, RWSS Banat
5 Senta	Local, BWBC	RWSS Western Bačka	IOT, RWSS Banat, Tisa
6 Čoka	Local, BWBC	RWSS Western Bačka	Tisa, RWSS Banat
<b>4. Southern Banat District</b>			
1 Alibunar	Local, BWBC	RWSS Banat	JIB
2 Bela Crkva	Local, BWBC	RWSS Banat	JIB, Danube
3 Vršac	Local, BWBC	RWSS Banat	JIB
4 Kovačica	Local, BWBC	RWSS Banat	Danube
5 Kovin	Local, BWBC	RWSS Banat	
6 Opovo	Local, BWBC	RWSS Banat	Pančevački rit, Danube
7 Pančevo	Local, BWBC	RWSS Banat	Pančevački rit, BWC, Danube
8 Plandište	Local, BWBC	RWSS Banat	JIB
<b>5. Western Bačka District</b>			
1 Apatin	Local, BWBC	RWSS Western Bačka	
2 Kula	Local, BWBC	RWSS Western Bačka	
3 Odžaci	Local, BWBC	RWSS Western Bačka	
4 Sombor	Local, BWBC	RWSS Western Bačka	

	Current situation	Possible solutions		
		1st alternative	2nd alternative	
<b>6. Southern Bačka District</b>				
1	Bač	Local, BWBC	RWSS Western Bačka	Danube
2	Bačka Palanka	Local, BWBC	RWSS Western Bačka	Danube
3	Bački Petrovac	Local, BWBC	RWSS Novi Sad	RWSS West Bačka, Danube
4	Beočin	Local, BWBC	RWSS Novi Sad	Danube
5	Bečej	Local, BWBC	RWSS Bečej	RWSS Banat, RWSS Novi Sad, RWSS Western Bačka, Danube, Tisa
6	Vrbas	Local, BWBC	RWSS Western Bačka	
7	Žabalj	Local, BWBC	RWSS Novi Sad	Danube, RWSS Western Bačka
8	Novi Sad	Local, BWBC, RWSS Novi Sad	RWSS Novi Sad	Danube
9	Srbobran	Local, BWBC	RWSS Western Bačka	RWSS Novi Sad
10	Sr. Karlovci	Local, BWBC, RWSS Novi Sad	RWSS Novi Sad	Danube
11	Temerin	Local, BWBC	RWSS Novi Sad	RWSS Western Bačka, Danube
12	Titel	Local, BWBC	Danube	RWSS Novi Sad, RWSS Banat, Tisa
<b>7. Srem District</b>				
1	Indija	Local, BWBC	BWC, RWSS Eastern Srem	Danube
2	Irig	Local, BWBC, RWSS Ruma-Irig	RWSS Eastern Srem	
3	Pećinci	Local, BWBC	BWC, RWSS Eastern Srem	
4	Ruma	Local, BWBC, RWSS Ruma-Irig	RWSS East Srem	
5	Sr. Mitrovica	Local, BWBC	RWSS Sremska Mitrovica	
6	Stara Pazova	Local, BWBC	BWC, RWSS Eastern Srem	Danube
7	Šid	Local, BWBC	RWSS Sremska Mitrovica	
<b>8. The City of Belgrade</b>				
1	BWC	BWC	Zidine, RWSS Banat	RWSS Eastern Srem, Pančevački rit, Starovlaške vode
2	Barajevo	Local, BWC	Optimisation of local resources, BWC	
3	Grocka	Local	Danube	
4	Lazarevac	Local	Optimisation of local resources	RWSS Kolubara
5	Mladenovac	Local	BWC	Starovlaške vode
6	Obrenovac	Local	The Sava alluvion	
7	Sopot	Local	BWC	Starovlaške vode
<b>9. Mačva District</b>				
1	Bogatić	Local	The Drina alluvion	
2	Vladimirci	Local	The Drina alluvion	
3	Koceljeva	Local	The Drina alluvion	
4	Krupanj	Local	The Drina alluvion	

	Current situation	Possible solutions	
		1st alternative	2nd alternative
5	Loznica	Local	The Drina alluvion
6	Ljubovija	Local	The Drina alluvion
7	Mali Zvornik	Local	The Drina alluvion
8	Šabac	Local	The Drina alluvion
10. Kolubara District			
1	Valjevo	Local	RWSS Kolubara
2	Lajkovac	Local	RWSS Kolubara
3	Ljig	Local	Optimisation of local resources RWSS Rzav
4	Mionica	Local	Optimisation of local resources RWSS Kolubara
5	Osečina	Local	Optimisation of local resources RWSS Kolubara
6	Ub	Local	Optimisation of local resources RWSS Kolubara
11. Podunavlje District			
1	Velika Plana	Local	Optimisation of local resources RWSS Resava
2	Smedrevo	Local, Šalinac	Optimisation of local resources Danube
3	Sm. Palanka	Local	Optimisation of local resources RWSS Resava
12. Braničevo District			
1	Vel. Gradište	Local	Danube
2	Golubac	Local	Danube
3	Žabari	Local	Optimisation of local resources RWSS Resava, Mlava**
4	Žagubica	Local	Optimisation of local resources Mlava
5	Kučevo	Local	Danube
6	Malo Crniće	Local	Optimisation of local resources
7	Petrovac	Local	Optimisation of local resources Mlava
8	Požarevac	Local, Ključ	Optimisation of local resources
13. Šumadija District			
1	Aranđelovac	Local, Bugulja, Kačer	RWSS Rzav RWSS Kragujevac
2	Batočina	Local, Brzan	Brzan (RWSS Kragujevac)
3	Knić	Local	RWSS Kragujevac
4	Kragujevac	Local, Gruža, Grošnica, Brzan	Optimisation of local resources, RWSS Kragujevac RWSS Studenica, RWSS Rzav
5	Lapovo	Local	RWSS Kragujevac
6	Rača	Local	Optimisation of local resources
7	Topola	Local	RWSS Rzav RWSS Kragujevac

	Current situation	Possible solutions		
		1st alternative	2nd alternative	
<b>14. Pomoravlje District</b>				
1	Despotovac	Local	Optimisation of local resources	RWSS Resava
2	Jagodina	Local	Optimisation of local resources, RWSS Crnica	RWSS Kragujevac, RWSS Resava
3	Paraćin	Local, Sv. Petka	Optimisation of local resources, RWSS Crnica	RWSS Kragujevac, RWSS Resava
4	Rekovac	Local	Optimisation of local resources	RWSS Kragujevac
5	Svilajnac	Local	Optimisation of local resources	RWSS Resava
6	Čuprija	Local, Sv. Petka	Optimisation of local resources, RWSS Crnica	RWSS Kragujevac RWSS Resava
<b>15. Bor District</b>				
1	Bor	Local	Optimisation of local resources	RWSS Bogovina
2	Kladovo	Local	Optimisation of local resources	
3	Majdanpek	Local	Optimisation of local resources	
4	Negotin	Local	Optimisation of local resources	RWSS Bogovina
<b>16. Zaječar District</b>				
1	Boljevac	Local	Optimisation of local resources	RWSS Bogovina
2	Zaječar	Local, Grlište	Optimisation of local resources	RWSS Bogovina
3	Knjaževac	Local	Optimisation of local resources	
4	Sokobanja	Local	RWSS Bovan	
<b>17. Zlatibor District</b>				
1	Arilje	Local, RWSS Rzav	RWSS Rzav	
2	Bajina Bašta	Local	Optimisation of local resources	
3	Kosjerić	Local	Optimisation of local resources	
4	Nova Varoš	Local	Optimisation of local resources	Zlatar Lake
5	Požega	Local, RWSS Rzav	Optimisation of local resources, RWSS Rzav	
6	Priboj	Local	Optimisation of local resources	
7	Prijepolje	Local	Optimisation of local resources	
8	Sjenica	Local	Optimisation of local resources	
9	Užice	Local, RWSS Đetinja	Optimisation of local resources	
10	Čajetina	Local, Ribnica	Optimisation of local resources	

		Current situation	Possible solutions	
			1st alternative	2nd alternative
<b>18. Morava District</b>				
1	Gornji Milanovac	Local, RWSS Rzav	RWSS Rzav	
2	Ivanjica	Local	Optimisation of local resources	
3	Lučani	Local, RWSS Rzav	RWSS Rzav	
4	Čačak	Local, RWSS Rzav	RWSS Rzav	
<b>19. Raška District</b>				
1	Vrnjačka Banja	Local	RWSS from the direction of Kraljevo	The Zapadna Morava alluvion
2	Kraljevo	Local, RWSS KG	RWSS Rzav	RWSS Studenica
3	Novi Pazar	Local, the Raška source	Optimisation of local resources	
4	Raška	Local	Optimisation of local resources	
5	Tutin	Local	Optimisation of local resources	
<b>20. Rasina District</b>				
1	Aleksandrovac	Local, Rasina	RWSS Rasina	
2	Brus	Local	Optimisation of local resources	
3	Varvarin	Local	RWSS Rasina	
4	Kruševac	Local, RWSS Rasina (Čelije)	RWSS Rasina (Čelije)	
5	Trstenik	Local	Optimisation of local resources	RWSS Kruševac
6	Čičevac	Local	RWSS Rasina (Čelije)	RWSS Bovan
<b>21. Niš District</b>				
1	Niš	Local, RWSS Niš	RWSS Zavoj	RWSS Selova
2	Niška Banja	Local, RWSS Niš	Optimisation of local resources	
3	Aleksinac	Local, Bovan	RWSS Bovan	
4	Gadžin Han	Local	Optimisation of local resources	
5	Doljevac	Local	RWSS Selova	
6	Merošina	Local	RWSS Selova	
7	Ražanj	Local	RWSS Bovan	
8	Svrljig	Local	Optimisation of local resources	
<b>22. Toplica District</b>				
1	Blace	Local	RWSS Selova	
2	Žitorađa	Local	RWSS Selova	
3	Kuršumlija	Local	RWSS Selova	
4	Prokuplje	Local	RWSS Selova	
<b>23. Pirot District</b>				
1	Babušnica	Local, RWSS Niš	RWSS Niš	
2	Bela Palanka	Local	RWSS Niš	

	Current situation	Possible solutions		
		1st alternative	2nd alternative	
3	Dimitrovgrad	Local	Optimisation of local resources	
4	Pirot	Local	Optimisation of local resources	
24. Jablanica District				
1	Bojnik	Local	Optimisation of local resources	RWSS from the direction of Lebane
2	Vlasotince	Local, Vlasina	Optimisation of local resources	
3	Lebane	Local	RWSS Barje	RWSS Šumanka
4	Leskovac	Local	RWSS Barje	
5	Medveđa	Local	Optimisation of local resources	
6	Crna Trava	Local	Optimisation of local resources	
25. Pčinja District				
1	Bosilegrad	Local	Optimisation of local resources	
2	Bujanovac	Local	Optimisation of local resources	RWSS Prvonek
3	Vladičin Han	Local, Vrla	Optimisation of local resources	
4	Vranje	Local, Prvonek	RWSS Prvonek	
5	Preševo	Local	Optimisation of local resources	RWSS Prvonek
6	Surdulica	Local	Optimisation of local resources	
7	Trgovište	Local	Optimisation of local resources	

\*BWBC-basic water-bearing complex

\*\*river water and alluvion water, as a source

### **Operational goals and measures**

**Operational goal 1:** Increase in the level of coverage by public water supply systems from the current 81% to 93% at the end of the planning period

Measures for achieving the goal:

- Providing a new source capacity of about 7 m<sup>3</sup>/s, including 5-6 m<sup>3</sup>/s by increasing the capacity of regional drinking water supply systems (expansion of existing and opening of new sources), and 1-2 m<sup>3</sup>/s by increasing the capacity of local and regional water sources, for:
  - meeting the future needs of increased water consumption - 3 m<sup>3</sup>/s,
  - reserves (at the source, including compensation for the reduction or exclusion of certain water sources and ensured higher coefficient of drinking water supply security) - 4 m<sup>3</sup>/s;
- Completing the existing public water supply network in settlements, with its extension into suburban areas;
- Building water supply networks and other necessary infrastructure in settlements without access to the public water supply, if justified.

Operational goal 2: Improvement of the public water supply system - ensuring a stable supply of water of required quality, while reducing the risk of water supply disruption under extreme and extraordinary conditions

Measures for achieving the goal:

- Ensuring the quality of water intended for human consumption (water supplied by public water supply systems, water used in the food industry) in line with the prescribed federal standards (and in accordance with the requirements of the EU Directive on the quality of water intended for human consumption) and with the application of best available techniques for drinking water preparation, and conducting systematic controls of water quality;
- Organising water supply, if possible and socially and economically justified, at the level of supply area 47, with one utility company;
- Connecting, wherever justifiable, the existing local water supply systems and local water sources into a system of public/regional water supply systems, thus enabling the full control of the water supply in terms of quantity and quality;
- In cases where the public water supply systems are of insufficient capacity or have an inappropriate natural quality of groundwater or are susceptible to pollution from anthropogenic impacts, the risk of water supply disruption will be reduced through the provision of alternative water sources.

Operational goal 3: Reducing the amounts of non-invoiced sections of water within public water supply systems to approx. a 25% level by the end of the planning period

Measures for achieving the goal:

- Maintaining the existing systems in a functional state, and also replacing worn-out pipes and connections and repairing damaged facilities;
- Controlling individual water consumption on the basis of installing modern water metres with systematic reading capabilities;
- Acquiring and using devices to detect leaks and losses;
- Acquiring and using devices to detect illegal connections.

Operational goal 4: Rational use of water

Measures for achieving the goal:

- Gradually establishing the economic price of water, which will contribute to the reduction of water consumption;
- Educating the public and the industrial sector that use water of drinking quality on the need for rational water consumption.

Operational goal 5: Protection of water sources, exploration, protection and preservation of water resources being used or intended for human consumption in future

Measures for achieving the goal:

- Intensifying the activities of establishing sanitary protection zones and implementing appropriate protective measures on existing water sources;
- On existing and potential surface water and groundwater sources, organising the monitoring of relevant parameters laid down in the rulebook that defines status parameters of surface and groundwater;

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47 One or more areas that can be covered by a common public water supply system and/or areas where the population and economic capacities are sufficiently concentrated to be able to solve the problem of wastewater through a common public sewage system.

- Protecting water sources in order to prevent deterioration of the status of surface water and groundwater bodies through administrative and technical safeguards, in accordance with relevant regulations;
- Ensuring good quantitative status of groundwater through the balance between abstraction and recharge of groundwater;
- Performing appropriate exploration works on the potential sources of surface water and groundwater to assess the quality and quantity of water.

## Supplying water to industry

### Basis for projection

The projected water quantities required by industry are based on elements from the Strategy, the industrial development policy of the Republic of Serbia 2011 - 2020 and macroeconomic projections<sup>48</sup> made after the adoption of said Strategy. Projections from the recent document were adopted, according to which projected annual GDP growth in the ten-year period is about 3% on average, while growth in the processing industry will not exceed 5%. Both values are smaller than those indicated in the Strategy (5.8% and 7.3%, respectively).

### Water demand projections

Based on the revised growth rates in the processing industry sector, and on the basis of data on total and specific water consumption, the amount of water required for industrial production have been estimated (Table 49). It has been assessed that about 20% of the estimated amounts will be provided from the public drinking water supply systems (a part of the required amount of water presented in Table 47), while 80% of the needs will be met from own water intake structures (surface water and groundwater). The industries that do not require water of high quality will use primarily waterways as their source of process water.

Table 49: Estimated water quantities required by industry, by district

No.	District	Quantity (10 <sup>6</sup> m <sup>3</sup> /year)	
		2024	2034
1	Northern Bačka	2.07	4.07
2	Central Banat	3.91	7.68
3	Northern Banat	3.52	6.92
4	Southern Banat	11.18	21.99
5	Western Bačka	3.25	6.38
6	Southern Bačka	9.70	19.07
7	Srem	2.18	4.29
8	The City of Belgrade	19.88	39.11
9	Mačva	5.40	10.62
10	Kolubara	1.54	3.03
11	Podunavlje	20.48	40.28
12	Braničevo	1.07	2.11
13	Šumadija	3.41	6.70
14	Pomoravlje	4.36	8.57
15	Bor	9.98	19.63
16	Zaječar	1.97	3.87
17	Zlatibor	6.68	13.15
18	Morava	5.99	11.78
19	Raška	4.81	9.46
20	Rasina	5.14	10.10
21	Niš	9.03	17.76
22	Toplica	1.60	3.15
23	Pirot	3.86	7.60

<sup>48</sup> 2014 Fiscal Strategy with projections for 2015 and 2016

24	Jablanica	2.96	5.82
25	Pčinja	2.67	5.25
<b>TOTAL Serbia without K&amp;M</b>		<b>146.60</b>	<b>288.40</b>

On the territory of the Republic of Serbia, there are existing, or planned industrial facilities in a total of 250 zones and locations in 81 municipalities and the City of Belgrade. The planned spatial distribution of industry is based on the existing spatial distribution of industry, the potential and limitations of space, and the general strategic orientation of spatial organisation at the regional and local levels.

From the aspect of suitability for spatial distribution and development of industry that requires large amounts of water, the coastal parts of the Danube and Sava rivers and some other zones in the valleys of other major rivers (Morava, Drina and others) have the greatest potential. In selecting locations for industrial zones, we must take into account the different sources used to supply water to the public, as well as the fact that some waterways in Serbia do not have a satisfactory inter-annual flow regime, and therefore cannot provide adequate quantity or quality of water throughout the year. On the other hand, waterways and ecosystem must be protected from the potential adverse impacts of these industrial facilities.

### **Operational goals and measures**

#### Operational goal 1: Provision of water for industrial production

Measures for achieving the goal:

- Abstracting water for technological processes in industrial production primarily from the system of river flows, whose regime should be regulated by applying integral and complex measures, without posing a threat to the ecosystem and users downstream of the water intake;
- In the event that water cannot be provided from the river flow systems, finding a suitable water supply source in cooperation with the water sector.

#### Operational goal 2: Rationalisation of water consumption in industrial production and environmental protection

Measure for achieving the goal:

- In the development of new industrial facilities, applying the best available techniques, which ensure the efficient use of water in technological processes and the reduced pollution of waterways, in accordance with the requirements of the integrated prevention and control of environmental pollution.

#### Operational goal 3: Planned locations for industrial facilities

Measure for achieving the goal:

- Planning the locations of new industrial facilities, in collaboration with the water sector, in areas rich with water resources and in accordance with planning documents for water management.

### **Irrigation**

#### Basis for projection

In order to ensure that the effects of the development of irrigation are full and expected, it is necessary to first change the position of agriculture as a whole, by changing the inappropriate treatment of irrigation as an additional measure for neutralising the adverse effects of drought, which results in its

occasional use, and then by selecting agricultural crops and completing the cycle of production, processing and trade of agricultural products.

The development of irrigation is conditioned by a number of factors, two of which are most important - land and water, unevenly distributed on the territory of Serbia. Land suitable for agricultural production is located mainly in northern Serbia and in the river valleys. There is modest potential of own surface water, which are primarily used for irrigation, which means that for this purpose we must rely on transit water, while complying with all the requirements and conditions for the use of international water.

It is difficult to predict the duration of irrigation development because, in addition to being dependent on natural factors, it is conditioned by the needs of agriculture and must be a function of its development. Therefore, before planning the development of this segment of the water sector, it is necessary to define the status of agriculture as a whole, in terms of giving greater strategic importance to this industrial branch, thus influencing the private sector to invest in agricultural production.

The Strategy for Agriculture and Rural Development of the Republic of Serbia for the period 2014 - 2024, adopted by the government in July 2014, indicates that one of the priorities of agricultural policy is "preservation and improvement of agricultural land fertility, as well as the creation of an effective land resources management system". One of the operational goals is "an increase of ameliorated areas and improvement of soil fertility", due to which "the projects of land reclamation and improvement of land infrastructure will be supported and financed." However, there is no quantitative indicator that would allow for the assessment of the quantity of water needed in the planning period. Therefore, starting from the research and analyses of water and land resources, the level of the completeness and condition of infrastructure, the status of agriculture and the need for its improvement, this Strategy proposes that the development of irrigation and the provision of the necessary amount of water for this purpose should take place on agricultural land classified by several development groups:

Development group I (Table 50) - areas where hydro-melioration systems have been constructed that are either not operational or partly operational, as well as those for which the project documentation has been prepared up to the main project level (for entire systems or for their parts), and also:

- There is a possibility of providing dual-purpose function (drainage and irrigation) by reconstructing and upgrading the system;
- There is a possibility of rehabilitating existing irrigation systems;
- There is a lack of certain facilities and technical equipment in existing systems.

Development group II (Table 50) - areas where there is no irrigation system but which belong to the first and second category of irrigation suitability and for which the provision of water and bringing it to agricultural land require major investments and other activities for:

- construction of new systems and facilities;
- a need for pumping water to areas at higher elevations;
- possible use of dynamic groundwater reserves.

Development group III (Table 51) - areas where there is no irrigation system and which require the use of non-standard resources (artificial infiltration, treated wastewater) to provide water, and also the building of new reservoirs in local water areas, where appropriate, which requires significant investments. Due to this, this development group is not included in the planning period to which the Strategy refers.

Regardless of the development group, the utilisation of local water must be harmonised with other users, and in the case of transit water, it must be in compliance with international agreements.

Table 50: Areas in development groups I and II and water demand ( $10^6 \text{ m}^3/\text{year}$ )

Number.	Water area	Surface area (ha)	Possible	Water demand
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		Develop.	Develop.	water sources	Develop.	Develop.
1	Bačka and Banat	35,000	70,000	Danube - HS DTD	87.5	175.0
		5,000	83,000	Danube - VBK	12.5	207.5
		24,000	21,000	Tisa - HS DTD	60.0	52.5
		14,000	60,500	Tisa	35.0	151.2
2	Srem	6,000	40,000	Sava	15.0	100.0
3	Belgrade	14,000	20,000	Sava, Danube	35.0	50.0
		Sava	12,500	45,000	Sava, Kolubara	31.2
4	Morava	11,200	12,000	Velika, Zapadna and Južna Morava	28.0	30.0
5	Lower Danube	13,500	12,000	Timok, Danube, Mlava,	33.7	30.0
<b>TOTAL</b>		<b>135,200</b>	<b>363,500</b>		<b>338.0</b>	<b>908.7</b>
<b>TOTAL</b>			<b>498,700</b>			<b>1246.7</b>

Table 51: Areas in development group III, by water area

Number	Water area	Possible water sources	Surface area (ha)
1	Bačka and Banat	Danube - HS DTD	148,000
		Danube	258,000
2	Srem	Sava	15,000
3	Belgrade	Sava, Danube	0
4	Sava	Sava, Drina, Kolubara	102,500
5	Morava	Velika, Zapadna and Južna Morava, reservoirs	54,500
6	Lower Danube	Mlava, Pek, reservoirs	5,000
<b>TOTAL</b>			<b>583,000</b>

#### Water demand and water sources

This document envisages the provision of the amounts of water required for irrigation systems in the areas covered by development groups I and II. For these purposes, about 340 million m<sup>3</sup> should be provided annually, i.e. in the vegetation period, for development group I (about 135,000 ha) and about 400 million m<sup>3</sup> for the projected development of irrigation within development group II (about 150,000 - 200,000 ha).

Surface water is a basic source of irrigation (Table 51), while groundwater would be used only in the areas with scarce surface water and such use should be harmonised with other water users.

In general, WA Backa and Banat has the highest water potential, taking into consideration the international waterways of the Danube and Tisa rivers. However, the use of water from the Tisa River is subject to restrictions relating to quantity, while restrictions on the use of water from the HS DTD canal, refer to the quantity and quality of water. The use of water from international waterways is possible only in compliance with the conditions provided under international agreements and conventions.

The areas of Srem and Mačva (WA Sava) are relatively rich with surface water (the Sava and Drina rivers) and groundwater, but their use is limited because of other users and subject to conditions deriving from the international character of these waterways.

In the area of Belgrade, the main water resources are the Danube and Sava rivers, from which about 15 m<sup>3</sup>/s can be abstracted, taking into account waterway status.

The area of Morava has relatively modest water resources, whose quality is significantly compromised, due to the large population size in this area. Šumadija and part of the Južna Morava basin are areas with the poorest water resources. In this region it is necessary to use water very sparingly, while considering the possibilities of accumulating water in the long-term and re-using treated wastewater. Moreover, it is possible to bring water from the water-richer Drina river basin, by transferring water from the Uvac (and Lim) to the Veliki Rzav basin.

The Lower Danube area is relatively rich in water, but due to depopulation, there are no plans for intensive irrigation development.

The use of groundwater for irrigation may be allowed only in areas where there are no other options, and then primarily from alluvial aquifers, with or without artificial infiltration.

### **Operational goals and measures**

Operational goal 1: Provision of sufficient amounts of water to irrigate 250,000 to 350,000 hectares of agricultural land from development groups I and II by the end of the planning period (about 100,000 hectares covered by existing systems and between 150,000 and 250,000 hectares covered by new systems)

Measures for achieving the goal:

- Providing the necessary amounts of water for irrigation by geographical areas;
- Providing water for irrigation within the land reclamation systems and water for individual consumers primarily from river flows, while respecting water and coastal ecosystems and downstream users, and if this is not possible, conducting irrigation from reservoirs or enriched underground aquifers;
- First rehabilitating the existing irrigation systems to reduce system losses;
- Building new systems primarily on the land of first and second irrigation suitability categories and in areas with the highest possibility of rational water provisioning;
- In planning the construction of the system, respecting solutions from water management plans for water areas.

Operational goal 2: Rational use of water and provision of quality and quantity of irrigation

Measure for achieving the goal:

- Determining consumption rates on the basis of technological and economic analyses, according to the yield structure;
- Educating the agricultural population on modern irrigation techniques, the possibilities of protection against drought, the manner of association and product placement.

### **Hydropower**

The development of electricity production will be performed according to the commitments adopted in the strategic documents concerning the development of the energy sector in the Republic of Serbia. In the process related to hydropower, it is necessary to meet the water sector and environmental requirements of minimum sustainable flow, provision of space for reception of flood waves in reservoirs, construction of fish passes, etc.

The available hydro-potential that can be exploited is relatively modest and is far less than what is needed, so that future electricity production will rely on other sources to a large extent. However, hydropower, as the only conventional renewable energy resource, is of great importance, both in the

framework of integrated, multi-purpose water systems, as well as in the overall energy balance of the Republic of Serbia.

### Hydropower potential

Only several waterways (Danube, Drina, Velika Morava, Lim and Ibar) have unused hydropower potential that is approx. or greater than 1,000 GWh/year. However, some of these waterways have international or interstate characteristics and the use of their potential is subject to international agreements. In addition, the hydropower potential of some rivers (Toplica, Crni Timok, Rasina, Studenica, Veliki Rzav, Mlava, etc.) can be used only partially, as these are potential sources of regional water supply systems.

The remaining hydro potential and the possibility of its use must be in accordance with the criteria related to the multi-purpose use of water, taking into account the international characteristics of waterways. In addition, in the use of water as a renewable resource more importance will be given to small hydropower plants, the locations of which should be more precisely determined in future, taking into account their impact on water and the environment in general. Particular attention should be paid to the consideration of cumulative impacts of a large number of small hydropower plants on certain waterways and in certain areas.

Accordingly, the further utilisation of the hydropower potential of waterways can be performed in accordance with the criteria related to the multi-purpose use of water and environmental protection, taking into account the international character of waterways. Since this is a complex issue encountered also by other countries in the Danube basin, the document *Guiding principles for sustainable hydropower development in the Danube Basin* (2013) was adopted within the International Commission for Protection of Danube River. It presents the basic principles that should be followed in the future development of hydropower potential, the rehabilitation of existing facilities, and a strategic planning approach for the development of new hydropower plants.

### Hydropower development

According to the strategic documents of the energy sector, hydropower development will be done through:

- modernisation and revitalisation of existing hydropower plants;
- preparation of investment technical documentation and implementation of joint projects of electric power industry and water sector for existing multi-purpose reservoirs;
- construction of new hydropower plants on interstate waterways;
- construction of reversible hydropower plants;
- construction of medium-size and small hydropower plants.

Specific activities in the field of hydropower will be defined in the programmes and plans for the implementation of energy development strategy. In doing so, it is necessary to bear in mind the current consideration of possible solutions given below.

The section of *Middle Drina*, between the "Bajina Bašta" and "Zvornik" hydropower plants, could be solved by cascading hydropower plants, whereas an optimal solution should be sought between the variants with two or more cascades, taking into account water sector requirements, but also the existing limits of other users.

The section of the *Lower Drina* could be solved with four short cascades, but hydropower solutions largely depends on resolving other issues related to water (protection of coastal areas from high water levels, flood protection, etc.). The necessary condition for the construction of these facilities is the previous river basin management and control of pollution sources.

The potential of the *Lim* on the territory of Serbia can be used through cascades: "Brodarevo-upstream", "Brodarevo-downstream", "Prijepolje" and "Priboj".

The remaining hydro potential of the river *Ibar* can be used primarily on the profile Ribarići, upstream from the existing r "Gazivode" reservoir, and on a series of smaller cascades.

In the future, using the hydropower of *Veliki Rzav* can be done within a complex water system, by transferring the water of the river Uvac (and possibly of the river Lim). The straightened waterways of Uvac and Lim, as well as of Big Rzav, would be used over a number of cascades on the Veliki Rzav, and on the existing hydropower plants on the Zapadna Morava.

One of the possible ways of using the hydropower potential of the *Velika Morava* is to build a series of cascades on the section from Paraćin to Ljubičevo. These cascades would enable navigation on the entire waterway of the Velika Morava, but a number of problems associated with the reservoir in the broad valleys would appear. Solving these problems would require timely and appropriate works and measures in the whole basin of the Morava river and in the system zone (protection of water quality, drift protection, flood protection, protection of coastal area from overflow water, etc.). Possible application of the concept of reversible hydropower steps would allow for the use of Danube water for the irrigation of Velika Morava coastal areas.

The hydropower potential of the Zapadna Morava can be used also through a series of low cascades.

Several small hydropower plants can be built in the *Nišava* basin: on the Nišava, Jerma and Visočica rivers.

Exploiting the larger part of the remaining hydro potential of the Danube could be achieved by building the hydroelectric power plant "Novi Sad". The construction of this facility would enable the gravitational water intake in the hydro-system DTD, but the impact on the coastal area and the environment in general should be thoroughly analysed. The construction of the reversible hydroelectric power plant, "Derdap 3" (*Iron Gate 3*), is also possible.

The increased production in certain hydropower facilities can be ensured by transferring water from the neighbouring basins, i.e. from the Toplodolska reka to Visočica (to be used in the hydroelectric power plant in Pirot) and the Ljubatska river to Vlasina Lake (to be used in the Vrla system).

In addition to hydropower facilities on large waterways, the development of hydropower facilities under 10 MW will gain more importance in the coming period.

Required amounts of cooling water in thermal power plants

The strategic document for the development of an electrical power system of Serbia indicates the following potential new thermal power capacities: TENT B3, TE Kolubara B, TE Kostolac B3, TE Novi Kolin, TE Štavalj and TE TO Novi Sad and construction of a number of gas-based thermal power and heating plants. At the same time, there are plans for the withdrawal of thermal power units with less than 300 MW.

The required amounts of cooling water will be provided in accordance with the dynamics of energy sector development, and from surface water (waterways and reservoirs).

### **Operational goals and measures**

Operational goal 1: Rational use of hydropower potential

Measure for achieving the goal:

- Involving the water sector in the activities related to the use of the hydropower potential of waterways, ranging from the strategic and planning documents of the energy sector to the projects and management of hydropower plants, in order to ensure coordination of various types of water use, water protection and environmental protection and the protection of coastal areas from water.

Operational goal 2: Provided passage for aquatic organisms within the zone of facilities on waterways whose construction has disrupted the natural flow regime

Measure for achieving the goal:

- Providing passage by construction of fish passes or otherwise

## **Navigation**

The strategic document for this type of water use is the Water Transport Development Strategy of the Republic of Serbia from 2015 to 2025, adopted in July 2014. It discusses all segments of importance for the development of water transport, and in particular:

- regulatory framework of the Republic of Serbia and EU policy in this field;
- potential increase in traffic;
- improvement of the national fleet;
- development of ports and harbours;
- development of inland waterways.

Starting from the current situation, vision and mission, strategic goals and measures for their achievement have been defined for each area, while assessment of necessary funds for maintenance and investment in infrastructure has been performed for the development of inland waterways.

Effective implementation, monitoring and improvement of this Strategy will be carried out on the basis of the Action Plan for its implementation, expected to be adopted in 2015. The Action Plan will determine the appropriate activities for each strategic measure, entities responsible for their implementation, participants, implementation method and sources of funding. It will establish the obligations of public authorities and organisations that have responsibilities within the domain of water transport, as well as the obligations of bodies and institutions whose responsibilities may have an impact on the development of this branch of transport. Moreover, the Action Plan will determine the timetable for the implementation of measures and the manner of risk management in the process of achieving the specific and strategic goals of this Strategy.

From the aspect of the water sector, it is significant that all interventions in river basins, which are focused on providing navigability and construction of infrastructural facilities, must be carried out in accordance with the laws, including the *Law on Water*, and adopted conventions and other relevant documents.

## **Operational goal and measures**

Operational goal 1: Preservation of hydromorphological characteristics of and aquatic and riparian ecosystems on navigable rivers

Measures for achieving the goal:

- Involving the water sector (respecting the strategic, planning and water-related acts and with direct contact with competent entities) in all the activities on the reconstruction of the existing national waterway network and planning of its extension;

- Ensuring navigable dimensions and construction of infrastructural facilities intended for navigation in a manner that does not significantly affect a change of hydromorphological parameters or aquatic and riparian ecosystems.

## Fish farming

### Development of carp and trout fish farms

Fish farming is a commercial activity and the development of this branch of industry will depend on the needs of consumers and the possibility of the private sector to invest in the upgrading of existing fish farms and the building of new capacities.

Development of *carp farms* in Serbia implies an increase in production per unit area or volume of water, enhanced areas under fish ponds and reconstruction of facilities or revitalisation of a part of abandoned areas under fish ponds. An important factor for the development of fish farming is the provision of large quantities of water due to an increase in the capacity of fish ponds and frequent water changes during the production season.

If the development of carp farms is achieved within the scope and according to the timetable given in Table 52, the planned production of fish in that area will require, in the ten-year period, approx. 50% more water than presently required, or twice as much as presently required at the end of the planning period (Table 53).

Table 52: Development of carp farms

Period of development	Existing fish ponds (ha)	Activation and reconstruction of aquaculture facilities (ha)	Construction of new fish ponds (ha)	Total (ha)
by 2024	12,000	1,100	1,000	14,100
by 2034	14,100*	550	4,500	19,150

\* situation at the end of the ten-year period

Table 53: Annual water demand for carp farms

Period of development	Existing fish ponds (10 <sup>6</sup> m <sup>3</sup> )	Improvement of technology (10 <sup>6</sup> m <sup>3</sup> )	Activation and reconstruction of aquaculture facilities (10 <sup>6</sup> m <sup>3</sup> )	Construction of new fish ponds (10 <sup>6</sup> m <sup>3</sup> )	Total Annual (10 <sup>6</sup> m <sup>3</sup> )
by 2024	420	105	52	55	632*
by 2034	632*	60	26	97	815

\* situation at the end of the ten-year period

In the case of *trout farms*, in order to increase fish production on the surface areas shown in Table 54, it is necessary to provide, at the end of the ten-year period, nearly double the amount of water than is presently provided, while at the end of the planning period the required amount of water (with the number of water changes increasing to 56 in 24 hours) would be 3.5 times higher than the present amount (Table 55).

Table 54: Development of trout farms

Period of development	Existing fish ponds	Activation and reconstruction of aquaculture	Construction of new fish ponds	Total
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	facilities			
	(ha)	(ha)	(ha)	(ha)
by 2024	9.6	2.4	3	15
by 2034	15*	0	8	23

\* situation at the end of the ten-year period

Table 55: Annual water demand for trout farms

Period of development	Existing fish ponds (10 <sup>6</sup> m <sup>3</sup> )	Activation and reconstruction of aquaculture facilities (10 <sup>6</sup> m <sup>3</sup> )	Construction of new fish ponds (10 <sup>6</sup> m <sup>3</sup> )	Total Annual (10 <sup>6</sup> m <sup>3</sup> )
by 2024	475	119	300	894
by 2034	894*	0	824	1,708

\* situation at the end of the ten-year period

Design, construction and exploitation of fish farms must be in compliance with water-related acts. Surface water must be used for water supply; groundwater may be used only exceptionally, while wastewater must be of prescribed quality.

### **Operational goal and measures**

**Operational goal 1:** Preservation of the quality of water and survival of aquatic ecosystems under conditions of fish farming development

Measures for achieving the goal:

- Designing and exploitation of warm-water and cold-water fish farms must be performed with the participation of the water sector in accordance with the relevant water acts;
- Prohibiting cage fish farming in reservoirs that serve for or are intended to supply drinking water to settlements;
- Performing the stocking of reservoirs and canals in a manner that will not compromise the prescribed water quality and survival of aquatic ecosystems.

### **Sports, recreation and tourism**

The "Tourism Development Strategy of the Republic of Serbia" is a document that defines primary tourist areas, the overall priorities of the spatial development of tourism and development priorities up to 2015.

The development of tourism, sports and recreation on water, as well as increased spa capacities, will be reflected in the water sector, i.e. water demand will increase and the protection of its quality will need to be improved.

The concept of the future water supply of tourist centres and settlements is based primarily on the optimal exploitation of quality local sources, and then on the development of the water supply within the framework of regional systems for the drinking water supply, improvement of reliability and development of basic systems through city water supply systems and improvement of reliability and technical equipment of local systems. This involves complete protection and optimal use of all local sources of groundwater and surface water, with their exploitation only in quantities that do not disturb environmental conditions in the region.

The highest quality water for cities and major tourist destinations will be used from the existing drinking water supply systems because the number of tourists in such places does not significantly affect the increase of water consumption, while the water supply systems in smaller towns and tourist centres have to be designed taking into account the projected number of tourists.

Channelling and treatment of wastewater from tourist centres should be done, as a general rule, within city systems, and exceptionally, for smaller settlements, spas and tourist centres remote from the urban areas, the construction of local sewage systems, in addition to appropriate treatment of wastewater, should be envisaged.

Reservoirs intended for the public water supply can be used also for sports and recreation, but only under the conditions laid down by law and preserving the quality of water in the reservoirs so as not to compromise their primary function.

Since the purpose of recreation on the water is to allow people the chance to enjoy the water near their places of residence, it is necessary to identify surface water locations of interest for recreation and bathing and with satisfactory water regime indicators. Water quality monitoring should be established at these locations, in accordance with Directive 76/160 /EEC.

### **Operational goals and measures**

Operational goal 1: Provision of water for tourist, and sports and recreation centres

Measure for achieving the goal:

- Developing water infrastructure in accordance with the specifics of individual tourist centres and spa and recreational centres, respecting the requirements of the water sector.

Operational goal 2: Preservation of water quality in using reservoirs for multiple purposes at locations suitable for the development of water sports and recreation

Measures for achieving the goal:

- Considering the inclusion of sports and recreation in the multi-purpose use of reservoirs together with relevant authorities and in compliance with the planning documentation of the water sector;
- Using the reservoirs, which are being used or intended for the public water supply, for sports and recreation only under conditions laid down by law;
- Defining the hydrological regime and water quality of waterways and lakes that are of interest for sports and recreation uses, including bathing, and proposing ways of preserving and improving the existing conditions.

## **5.1.3. WATER PROTECTION**

Water protection is a concern and obligation of the Republic of Serbia, autonomous province and local government and all economic entities and individuals, and will be implemented in accordance with the defined general principles.

Water protection and the protection of aquatic ecosystems and terrestrial ecosystems dependent on water will be implemented in accordance with federal regulations, harmonised with the provisions of EU regulations, whose main purpose is the comprehensive protection of all water, whereas a “good” status should be achieved within 15 years of the adoption of the Water Framework Directive (2015).

Strategic goal: Achieving and maintaining the “good” status and good ecological potential of surface water and groundwater bodies, with a view to protect public health, preserve aquatic and riparian ecosystems and meet the needs of water users.

Given the importance and complexity of water protection issues, the achievement of the strategic goal can be expected if the following is ensured:

- protection of surface water and groundwater in the function of satisfying the needs of all water users, primarily the public (current and planned needs);
- protection of surface water and groundwater and protected areas, as well as the preservation of biological diversity within the framework of integrated water management;
- control of the emission of pollutants and their discharge by undertaking measures to reduce the generation of pollution and measures to eliminate pollution at its source, prior to discharge into aquatic ecosystems;
- stimulation and promotion of the rational use of water resources by increasing water productivity<sup>49</sup> in all spheres of human activity.

### **Basics of water protection**

Water protection will be implemented by improving water protection management, through the adoption of the Water Pollution Protection Plan, harmonised with other relevant documents, the gradual implementation of protection measures and systematic monitoring of water status and protected areas and the impact of implemented measures, including (Figure 39):

- pollution prevention through measures for pollution generation reduction, improvement of technological processes of production, water productivity increase and measures for multiple use of water;
- control of point sources of pollution through wastewater treatment and reuse;
- control of non-point sources of pollution by applying best agroecological practices, spatial planning and improving space utilisation, and control of run off from agricultural and other surfaces;
- improvement of ecosystem services within the domain of assimilative capacity, nutrient retention, enhancement of infiltration capacity, etc.

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<sup>49</sup> Water productivity is a measure of rationality in water use and it is expressed in m<sup>3</sup> of water per tonne of product or ratio of consumption by individual activities and/or users and activities, and can also be expressed in m<sup>3</sup> of water per unit of GDP or gross value added per m<sup>3</sup> of water.

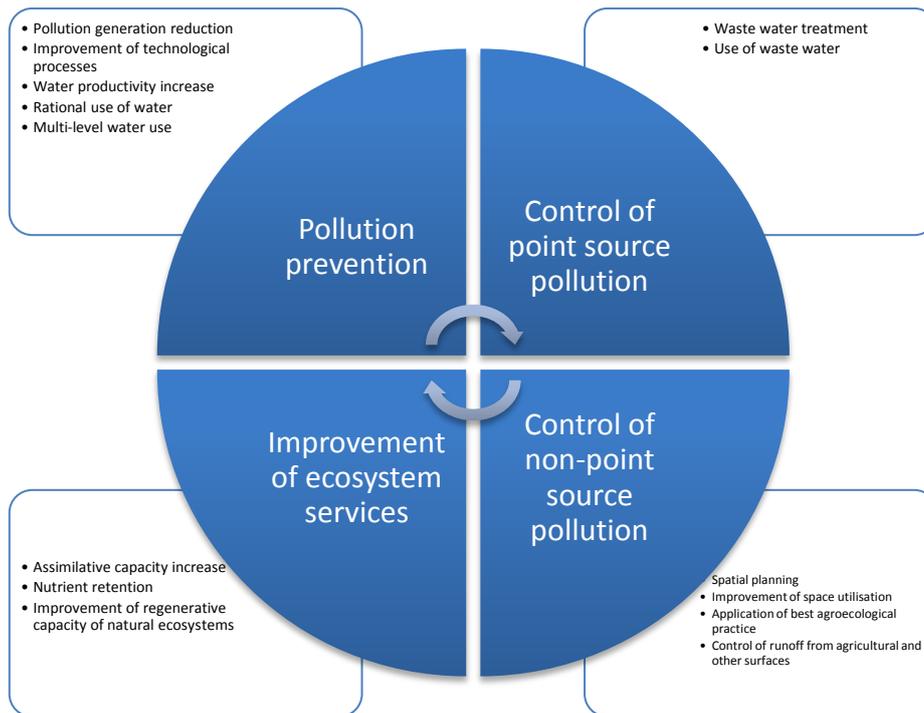


Figure 39: Elements of water protection

## **Prevention and management**

### **Operational goals and measures**

#### Operational goal 1: Prevention of surface water and groundwater pollution

Measures for achieving the goal:

- Establishing and controlling the implementation of statutory provisions prohibiting the discharge of wastewater containing pollutants above the prescribed values;
- Stimulating the re-use of treated wastewater through administrative measures;
- Performing the rehabilitation and remediation of historically polluted sites;
- Improving and intensifying research of insufficiently studied sources of pollution (agricultural lands, industry, mining, roads).

#### Operational goal 2: Management in the field of water protection

Measures for achieving the goal:

- Drafting and adopting bylaws required for the implementation of regulations that govern the field of water protection and the environment;
- Adopting the Water Pollution Protection Plan envisaged under the Law on Water, harmonised with this Strategy, water management plans and relevant plans and programmes in the field of environmental protection, spatial planning, etc. and ensuring control of its implementation;
- Establishing parameters for monitoring the ecological and chemical status of surface water and chemical and quantitative status of groundwater, as defined in relevant rulebooks, and entering monitoring data into the information system.

## **Point sources of pollution**

The public connected to sewage and industrial plants are major point sources of pollution, whose negative impact is eliminated by building sewage systems and wastewater treatment plants. These systems are very closely related to the systems for supplying water to settlements, together constituting a functional whole, and therefore they must be developed in parallel with drinking water supply systems.

The public sewage system, which includes wastewater treatment plants, should be developed in accordance with federal regulations, based on the provisions of the Directive concerning urban wastewater treatment, which determines the obligation of urban wastewater treatment in all agglomerations of more than 2,000 p.e. Given that most of the Serbian territory lies in the Danube Basin (Black Sea Basin), which was declared a sensitive area, upon accession to the EU, the Republic of Serbia will be obliged to provide a degree of urban wastewater treatment applicable to these areas (nutrient removal).

## **Operational goal and measures**

Operational goal 1: Reduction of pollution from point sources, as follows:

- urban wastewater: by constructing sewage systems with adequate capacity (sewage network covers 85% of populations living in settlements with over 2,000 inhabitants) and the degree of treatment established in the Water Pollution Protection Plan,
- industrial wastewater: by reducing pollution from industrial plants, fully implementing the *Law on Integrated Environmental Pollution Prevention and Control* as well as using best available technology (BAT) or best available techniques not entailing excessive costs (BATNEC),
- landfills of urban and industrial waste: by regulating landfills and managing waste at all levels - national, regional and local, in accordance with the *Law on Waste Management*.

Measures for achieving the goal:

- Planning the development of the water sector communal infrastructure and aligning it with the Water Pollution Protection Plan and other planning documents of the water sector;
- Reconstructing the existing WWTPs for settlements and industry and improving their operation so as to reach the standards required by the relevant rulebook, i.e. to reach a level that does not undermine compliance with environmental quality standards;
- Building new WWTPs of industrial facilities by taking into account the standards required by the relevant rulebook and taking care not to undermine compliance with the environmental quality standards;
- Ensuring pre-treatment for industrial wastewater discharged into the public sewage system to reach the level of quality that does not threaten human health, sewage systems and does not interfere with the WWTP processes for urban wastewater;
- Keeping accurately data on water protection facilities in cadastral registers and information systems;
- Removing illegal solid waste landfills, first from the areas (protected areas, coastal waterways with unfavourable hydrological regime, etc.) where their negative impact on surface water and groundwater is prevented;
- Rehabilitating the existing solid waste landfills and constructing new ones in accordance with the applicable European directives and relevant strategic and planning documents related to waste management, giving special attention to the planning of sludge disposal site equipped with a device for the treatment of leachate wastewater;
- Collecting and disposing of mining and industrial waste in a manner that does not pose a threat to the environment and water as its important element.

## **Non-point sources of pollution**

Non-point sources of pollution include all surface water and groundwater pollution originating from settlements with less than 2,000 inhabitants or from the population that is not connected to the sewage system, then from farmed agricultural land, washing away of forest and soil surfaces, and also from livestock, unregulated municipal landfills and other human activities.

Negative impacts of non-point sources of pollution are reduced primarily through regulatory and administrative measures, and then also through technical measures, while the current status indicators are ensured through continuous targeted monitoring.

## **Operational goal and measures**

Operational goal 1: Reduction of pollution from non-point sources, as follows:

- from agricultural land: by applying the provisions of the Nitrates Directive, the Directive concerning discharge of dangerous substances and the principles of good agricultural practice,
- from forest land: by appropriate method of using forest resources in the areas of common interest of water and forest users,
- from roads: by administrative measures that, within the framework of water conditions, determine the method used to solve issues of collection, removal and treatment of polluted water from the roads, and then by the implementation of technical measures,
- from the settlements of less than 2,000 inhabitants: by reducing pollution through the construction of special devices for the treatment of wastewater from small settlements.

Measures for achieving the goal:

- Establishing, particularly in the protected areas, a system of monitoring and controlling the use of fertilisers and plant protection products, for the purpose of quantifying the pollution from agricultural activities;
- Defining nutrient sensitive areas, in accordance with the Nitrates Directive, and ensuring protection measures, in accordance with the principles of good agricultural practice, including the sustainable use of fertilisers and plant protection products;
- Prohibiting the use of fertilisers and plant protection products within a 5m-wide coastal area;
- Establishing a system of multi-disciplinary research, in order to determine the impact of forest management on the water regime, and providing guidance for the sustainable use of forests;
- Fulfilling water requirements in the preparation of project documentation for the construction of roads and meeting the requirements of the water sector and environmental protection in their exploitation;
- Defining technology and procedures for the treatment of wastewater of small settlements.

## **Protected areas**

The categories of protected areas and entities responsible for their determination are defined in the *Law on Water*. In order to improve the situation in this field, it is necessary to first implement regulatory and then administrative and technical measures. Control of the state of protected areas should be provided through continuous targeted monitoring.

## **Operational goal and measures**

Operational goal 1: Establishment and use of protected areas in accordance with the Law on Water, as follows:

- protection of water sources used for the drinking water supply: by establishing sanitary protection zones;
- protection of areas intended for the abstraction of water for human consumption providing more than 10 m<sup>3</sup>/day: by applying administrative and technical safeguards;
- water bodies designated as recreational water, including areas designated for bathing: by applying administrative and technical safeguards, in cooperation with local government;
- nutrient-sensitive areas, including areas subject to eutrophication and areas sensitive to nitrates from agricultural sources: by applying administrative and technical safeguards and implementing the Nitrates Directive;
- protection of habitats or species where the maintenance or improvement of water status is an essential element of their protection: by applying administrative and technical safeguards and inclusion in the ecological network Natura 2000;
- protection of economically important aquatic species: by applying administrative and technical measures.

Measures for achieving the goal:

- Adopting regulations on the manner of determination, maintenance and use of sanitary protection zones of drinking water sources;
- Conducting studies on the establishment, maintenance and use of the zones of sanitary protection of water sources, determining the zones in accordance with regulations and including them in the water management plan, spatial (spatial plan of local government) and urban (general and regulatory) plans, in order to adequately plan the use of such space;
- Identifying water bodies that are used or could be used for human consumption, in an average amount greater than 10 m<sup>3</sup>/day, and ensuring protection measures to preserve their quality and quantity;
- Preparing technical inputs as the basis for determining water bodies for recreation, including bathing;
- Local government, with the professional help of the water sector, must adopt a decision on the designation of areas intended for recreation, including bathing, and ensure measures of protection and control of water quality (monitoring), in accordance with the relevant EU directive;
- Identifying nutrient-sensitive areas, in accordance with the provisions of EU directives;
- Adopting decisions on the designation of nutrient-sensitive areas and carrying out measures to limit the discharge of wastewater from point sources of pollution and the use of fertilisers and plant protection products;
- Analysing the habitats of aquatic and semi-aquatic plant and animal species that depend on the maintenance or improvement of water status and determining priorities for their preservation;
- Adopting decisions on the designation of habitats or species where the maintenance or improvement of the status of water is an essential element of their protection;
- Continuing with the activities for inclusion of endangered species and habitats in the Emerald ecological network, as preparation for the implementation of the Natura 2000 programme;
- Preparing technical inputs and adopting decisions on the designation of areas important for the protection of economically significant aquatic species (fish and shellfish);
- Prescribing and implementing, in a coordinated manner (agriculture, fisheries, the water sector, the health sector, nature protection), measures to protect areas important for growing economically significant aquatic species;
- Organising the monitoring of water status, if prescribed by the act on protected area designation;
- Entering all areas that have been designated as protected areas into the register of protected areas, the summary of which is provided in the Water Management Plan, and updating it in accordance with the results of monitoring.

## **Groundwater - protection of quality and quantity**

Groundwater is a predominant source (about 70%) of the drinking water supply and, as such, requires special attention and appropriate treatment. It is for this reason that here, we have compiled goals and measures for the improvement of the status of this resource, although this resource has been the subject of goals and measures in certain, previously discussed domains of water protection (point and non-point sources of pollution and protected areas). In addition, we have proposed special measures, specific to this resource.

The results of the evaluation of the chemical status of groundwater indicate that 7 water bodies have a poor chemical status, 27 water bodies probably have a poor chemical status, while 119 water bodies (around 77%) are considered to have a good status. Remediation of the chemical status of groundwater can be achieved by applying appropriate measures of protection from urban and other wastewater (landfills, mines, etc.), agriculture (use of chemical agents for plant protection and nutrition) and other sources of pollution.

The evaluation of the quantitative status of groundwater has shown that only 18 water bodies (12% of the total number) have a poor status, most of them being water bodies in Vojvodina (12). The main reason for the poor quantitative status is overexploitation, i.e. the lack of balance between abstraction and recharge of groundwater resources. One of the reasons for the failure to achieve good status, particularly in the Morava water area, is also the significant and permanent lowering of the level of groundwater in the river alluvion, where the uncontrolled exploitation of gravel takes place.

### **Operational goals and measures**

Operational goal 1: Reduction of pressures on the quality of groundwater

Measures for achieving the goal:

- Establishing, monitoring and maintaining the zones of sanitary protection of drinking water sources;
- Establishing and monitoring the situation in the areas intended for the abstraction of water for human consumption, which are characterised as protected areas;
- Controlling the entry of pollutants from agriculture, through a system of monitoring the use of fertilisers and controlled use of pesticides;
- Building sewage systems in settlements, along with the construction of WWTPs;
- Constructing WWTPs for industrial systems, taking into account the imposed standards for the emission of pollutants;
- Carrying out the remediation of identified cases of pollution, if they directly compromise the achievement of environmental objectives;
- Creating groundwater vulnerability maps and applying them in the planning process.

Operational goal 2: Preservation and achievement of good quantitative status of groundwater, in order to provide sufficient quantities of water of satisfactory quality for current and future needs of all legitimate users, taking care of available groundwater resources

Measures for achieving the goal:

- Using groundwater rationally, through the reduction of water supply network losses and the stimulation of using modern "water-saving" technology in households and industry;
- Conducting systematic research, monitoring and evaluation of groundwater resources, in order to maintain a balance between abstraction and recharge of groundwater aquifers;
- Conducting research and evaluation of alternative groundwater sources, in cases where the overexploitation of resources has been recorded;

- Restricting the use of groundwater (ensuring a balance between abstraction and recharge) for the needs of industrial and other users, if there are no alternative sources of water supply;
- Conducting research of the impact of river sediment exploitation on the groundwater regime in order to protect the quantity and quality of groundwater;
- Managing transboundary groundwater in coordination with the neighbouring countries.

**Operational goal 3:** Development of national and regional projects that will consider and determine the following:

- Conditions for sustainable use of groundwater, conditions for survival of aquatic systems dependent on groundwater and effects of irrigation and drainage, as well as measures necessary for the coordination of their mutual effects;
- Impacts of climate change, especially on very sensitive groundwater resources in karst and fractured-rock environments;
- Impacts of large surface coal mines on water resources (Kolubara and Drmno).

Measures for achieving the goal:

- Establishing comprehensive monitoring of the parameters of the chemical and quantitative status of groundwater, as defined in the rulebook regulating this field;
- Through a special programme, beginning with the systematic observation of micro-pollutants in our large rivers (Sava, Danube, Tisa, and Velika Morava) and groundwater sources of coastal type, which are formed in the alluvial aquifers of these rivers.

### **Hydromorphological pressures**

Anthropogenic activities, being the most common cause of hydromorphological changes in the bodies of surface water, often cannot be avoided because they are usually necessary for economic and social development. In order to reduce their adverse effects on the status of water bodies in future, these activities must take place in accordance with the requirements of environmental protection.

### **Operational goals and measures**

**Operational goal 1:** Limitation of hydromorphological pressure on natural water bodies

Measures for achieving the goal:

- In the period of planning the facilities that may cause hydromorphological changes, considering possible adverse environmental impacts and defining mitigation measures;
- In regulating water flow for different types of use or in order to provide protection from the harmful effects of water, applying good practice and best available technology;
- If it is necessary, for the purpose of sustainable development, to construct facilities with significant impact on water status due to hydromorphological pressure, proving that there is no economically, technically and environmentally more favourable alternative and designating the water body as heavily modified.

**Operational goal 2:** Achievement and maintenance of good ecological potential of heavily modified water bodies

Measures for achieving the goal:

- Identifying the values of relevant biological quality elements common for the type of water that, in general terms, is most similar to an artificial or heavily modified water body for which the potential is being determined;
- Identifying deviations of biological parameters caused by changing the hydromorphological characteristics of a water body;

- Identifying the origin of hydromorphological changes (use of water, protection from water, multi-purpose systems) and valorising in technological and economic terms the consequences of bringing the body of water to such conditions that are necessary for ensuring good ecological status;
- Preparing a catalogue of measures for achieving good ecological potential (Figure 40);
- Identifying and implementing measures that do not have negative impacts on water use and protection from water.



Figure 40: Defining good ecological potential of heavily modified water bodies (approach based on the use of possible measures)

Identifying all mitigation measures that do not have significant adverse effects

Defining the maximum ecological potential by assessing the values of biological parameters that are expected in the case of undertaking all mitigation measures

Excluding all mitigation measures that, combined, lead to insignificant ecological improvement

Good ecological potential = values of biological parameters that are expected in the case of undertaking mitigation measures

#### 5.1.4. REGULATION OF WATER FLOW AND PROTECTION AGAINST THE HARMFUL EFFECTS OF WATER

Economically reasonable protection against the harmful effects of water is an obligation of the Republic of Serbia, autonomous province and local government, because its purpose is to protect people, natural and other material goods and resources and provide better conditions for social and economic development.

Strategic goal: Reduced risk of the harmful effects of water

The condition for achieving the strategic goal is to adequately manage the risk of harmful effects of water in which, along with the water sector, other social entities (ministries, local government, economic entities, the public) participate. Management is a cyclic process, which consists of 3 phases: response to the flood event, recovery and preparedness for the next event (Figure 41). The experience of the catastrophic floods in 2014 shows the importance of this approach and the need to define (immediately after the necessary repairs to the protection system) an appropriate set of preventive measures for each basin, which should be implemented within the planned period.

The first priority activities, within the set of preventive measures, must be the improvement of protection of the most important damage centres (cities or settlements near waterways, large commercial complexes, transport infrastructure, etc.), the construction of permanent facilities and mobile protection where possible, and the enhancement of riverbed flow capacity in the waterways with a frequent outflow of high water. This category has to include works and measures on interstate waterways, which should be implemented in accordance with interstate agreements.



Figure 41: River basin flood risk management cycle

Vulnerability reduction  
Damage mitigation

Preparation

- Financing
- Civil defence exercises
- Flood protection exercises
- Insurance

Preventive measures

- Land use planning
- Technical measures
- Biological measures
- Warning
- Information

Event

Intervention

- Alert
- Rescue
- Flood protection
- Information/instruction

#### Repairs

- Provisory repairs
- Communications
- Transportation system

#### Reconstruction

- Final repairs
- Reconstruction of facilities
- Enhancement of resilience
- Financing

#### Preparedness

#### Response

#### Recovery

#### Risk and hazard assessment

The Flood Risk Management Plan, which will be adopted by 2017 for the Republic of Serbia and its water areas, will include all elements of the management cycle. The water sector is primarily responsible for the planning and implementation of preventive measures, which include the regulation of waterways, construction of the system for protection from external and internal water, as well as the regulation of erosive areas and torrents.

#### **Regulation of water flow**

Regulation of water flow, through the construction of water control facilities and the execution of works in the beds of waterways, must be conducted with a high degree of harmonisation of hydrotechnical (ensured riverbed flow capacity for water, ice and sediment) and environmental (preservation and protection of biodiversity) conditions.

#### **Operational goals and measures**

Operational goal 1: Regulation of water flows in accordance with environmental conditions

Measures for achieving the goal:

- Regulating the sections of waterways running through settlements, in order to enhance the riverbed flow capacity and ensure the stability of coasts and navigation conditions, primarily in the Danube and Sava rivers;
- In regulating small waterways outside of settlements, allowing only minimal hydromorphological modifications, while respecting the conditions and criteria for the promotion and protection of the environment and by applying, as much as possible, the principles of "natural regulation";
- Regulating the waterways running through cities and settlements in accordance with local needs and urban plans;
- All new projects of waterway regulation must be proven to comply with economic, technical and environmental conditions and criteria, as well as with the provisions of federal laws and relevant applicable interstate agreements and conventions.

Operational goal 2: Regular maintenance and control of the condition of waterways and water control facilities

Measures for achieving the goal:

- In the period without flooding, organising regular monitoring and control of the condition of riverbeds and water flow regulation facilities, so as to ensure their proper maintenance and execution of necessary repair works;
- Performing regular maintenance of water flow regulation facilities in accordance with standards and norms.

Operational goal 3: Preservation and improvement of the water regime through designated exploitation of river sediment

Measures for achieving the goal:

- Establishing adequate monitoring of river sediment quantity and quality parameters, in order to define the balance of sediment and recognise the impacts of anthropogenic activity on the status of the bodies of surface water and groundwater;
- Performing the exploitation of sediment, including commercial exploitation, only at certain locations within the water area, in order to maintain and/or improve the water regime, in compliance with the conditions for the protection of groundwater and the environment;
- Determining the scope and schedule of sediment exploitation so as to cause minimal hydromorphological modifications, minimal disturbance of the natural balance of aquatic and riparian ecosystems, with the remediation of gravel pits upon completion of exploitation;
- Organising systematic monitoring of the regime of river sediment and morphological modifications of riverbeds where the exploitation of material is pronounced;
- Prohibiting the exploitation of river sediment in the sections of waterways where the water regime has or may deteriorate and the balance of ecosystems has been or may be disturbed;
- Applying an integral approach to the regulation of coastline of medium-size and small rivers, the protection of erosive banks and the exploitation of material in the coastal area, because of the interconnectedness of all aspects of the issue.

### **Protection against fluvial flooding**

#### Required works on the system of protection against fluvial flooding

Solutions for protection against fluvial flooding will be based on contemporary global trends and the current condition of flood protection systems, while their implementation timetable will depend on the economic power of the society.

Reducing the risk of flooding in the whole territory of the Republic of Serbia is a permanent task and goal, while improving the protection of the most important damage centres (cities, settlements, large commercial complexes, transport infrastructure, etc.) and works and measures on interstate waterways are priority activities.

Protection of the coastal area of large and medium-size rivers, or first class water, will continue to be based primarily on water control facilities, and protection will depend on their condition and functionality. For this reason, regular maintenance and investment works on the upgrading and reconstruction of existing water control facilities will be priority activities also in the planning period.

Flood protection for the coastal area of small waterways must be significantly improved in the future, bearing in mind the possible deterioration of the high water regime due to climate change. In this context, it is necessary to promote active flood protection measures as much as possible, i.e. the use of reservoirs and retention ponds, overflow and perimeter channels for the reduction of flood waves. In

addition, timely notification and evacuation of people and goods remain important activities regarding the protection against natural disasters, including floods.

A special type of fluvial flooding is ice flooding, which occurs due to the accumulation of ice and the formation of ice barriers on the riverbed. Special control measures will be applied to prevent ice flooding.

#### Degree of protection against fluvial flooding

The degree of protection against fluvial flooding depends on technological, economic, environmental, social and other criteria, conditions and limitations. It is defined for each system or area (defended zone), based on the number of inhabitants and the level of potential damage caused by flooding.

The recommended degree of protection for new and existing systems being upgraded or reconstructed is shown in Figure 42. The degree of protection provided by facilities is equal to the high water return period designed for their dimensioning. However, in situations of climate change and human impact, the conditions of occurrence and characteristics of high water are also changing, and design flow is no longer a slowly changeable category. Therefore, additional measures and works (mobile systems in cities, reconstruction of facilities) are required to ensure an appropriate degree of protection.

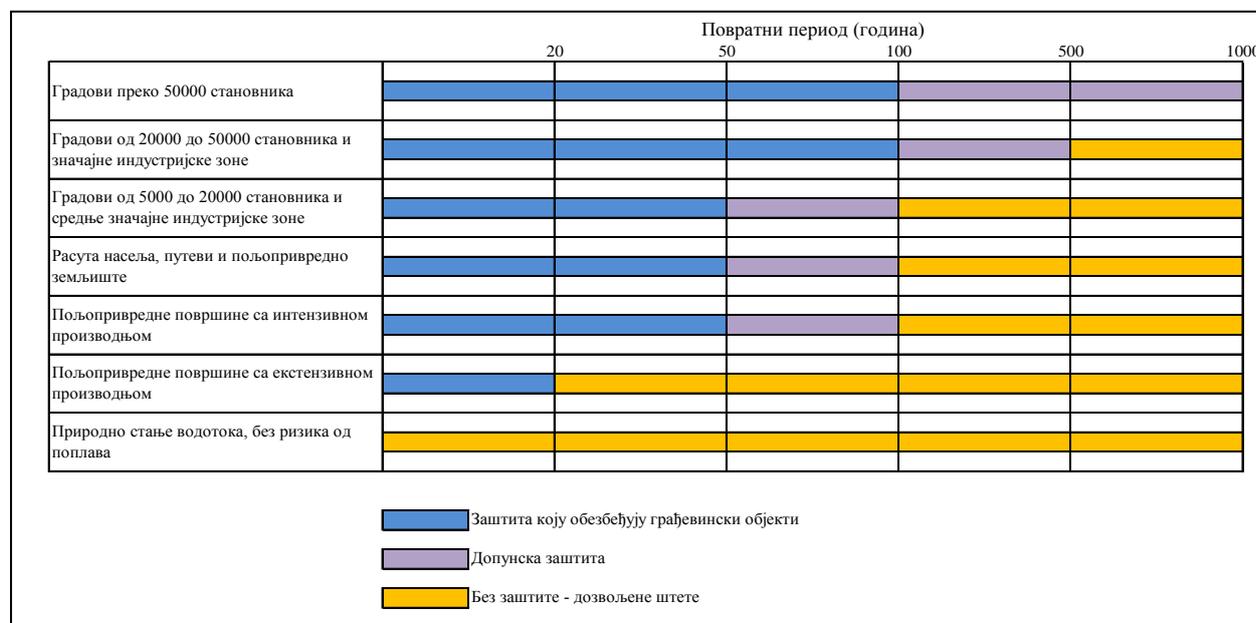


Figure 42: The recommended degree of flood protection

Return period (years)

Cities with over 50,000 inhabitants

Cities with 20,000 - 50,000 inhabitants and important industrial zones

Cities with 5,000 - 20,000 inhabitants and moderately important industrial zones

Scattered settlements, roads and agricultural land

Agricultural areas with intensive production

Agricultural areas with extensive production

Natural state of waterway without flood risk

Protection provided by facilities

Additional protection

Without protection – allowed damage

The water sector is responsible only for the flood damage caused by flood waves with a return period shorter than the one designed for the dimensioning of facilities and systems of defense against fluvial water, provided that they are well maintained. Other risks are borne by owners and users of properties in potentially flooded areas.

### **Operational goals and measures**

Operational goal 1: Development of the defense against fluvial flooding system

Measures for achieving the goal:

- Ensuring flood protection for lowland coastal areas, in particular areas around large rivers (Danube, Sava, Velika Morava) and medium-size rivers, by completion, upgrading, reconstruction and regular maintenance of the system of flood protection facilities;
- Planning fluvial flood defense at the level of the defended area, and adjusting the size of the defended area and the degree of protection to the characteristics of inundation or protected area;
- Creating necessary retention structures, particularly on international transit waterways (Danube, Sava and Tisa) in less valuable areas (forest and agriculture) for the purpose of reducing flood peaks;
- Applying active flood protection measures (existing and future reservoirs, retention structures, overflow and perimeter channels) on small waterways to reduce maximum flow;
- Reducing the risk of flooding also through local protection measures, at the level of individual facilities or clusters of facilities, wherever required and possible.

Operational goal 2: Efficient and coordinated operational flood protection

Measures for achieving the goal:

- Using the constructed water control facilities and systems to ensure flood protection in accordance with the General and Operational Flood Protection Plan, which should be regularly updated to include all the necessary organisational and other relevant information;
- Protecting transboundary waterways at the operational level in cooperation with the competent authorities of neighbouring countries;
- Ensuring increased efficiency of flood protection service, including a sufficient number of qualified personnel, timely prepared technical documentation and adequate machinery, equipment and tools used by the enterprises engaged to provide protection at the operational level, in order to achieve the successful protection of people and goods.

Operational goal 3: Efficient and coordinated protection against ice and ice flooding

Measures for achieving the goal:

- Carrying out protection against ice and ice flooding, as an integral part of flood protection, in accordance with the General and Operational Flood Protection Plan and in cooperation with neighbouring countries in the sectors of common interest;
- Adjusting the technology of ice control and ice flood protection to the conditions of waterways and economic conditions;

- Controlling the implementation of works and measures for ice removal by owners or users of water and other facilities, to protect them from damage.

Operational goal 4: Regular maintenance and control of the condition of facilities used for fluvial flood protection

Measures for achieving the goal:

- Organising regular monitoring and control of the condition of flood protection facilities, so as to ensure their proper maintenance and execution of necessary repair works, and updating data in the cadastral and information systems;
- Carrying out regular maintenance in accordance with standards and norms;
- Establishing an efficient system and appropriate technology for observing the behaviour of protection structures (especially earth embankments and major channels) during flooding, in order to detect any threats, in a timely manner, that may adversely affect the integrity of the facility and its protective function.

Operational goal 5: Efficient and continuous monitoring and forecasting of hydrometeorological events

Measures for achieving the goal:

- Modernising the existing system which monitors and forecasts hydrometeorological events (by using automatic measuring stations, radar, satellite images, modern forecasting models, etc.) as well as the communications system, as an important element of successful operational flood protection;
- Developing and promoting flood forecasting and early warning systems located in basins without flood protection facilities;
- Ensuring efficient and timely communication between hydrometeorological services and those responsible for operational flood protection.

Operational goal 6: Adequate use of wetland areas and potential flooding zones

Measures for achieving the goal:

- Delineating wetland areas, registering wetland areas in the land registry and including it in spatial planning, and then controlling its ownership status and the manner in which it is used as defined by the Law on Water, as a precondition for proper water and wetland areas management;
- Creating vulnerability maps and flood risk maps as a basis for developing flood risk management plans;
- In order to protect human life and property, adopting regulations to prohibit the construction of new facilities in the free-flowing section of a floodplain, and allowing construction in actual flood zone sections, which are not free-flowing but have a retention function, provided that the building owner ensures anti-flood protection or other form of protection against damage;
- Placing the most vulnerable facilities, plants and installations outside the risk zone, which are of particular importance to public safety, defence or maintaining public order, or whose destruction would pose a threat to the public;
- Restricting by law, through special conditions and permits, any further increase of flood risk in potential flood zones;
- In actual and potential flood zones, applying new principles and methods of construction that reduce flood risk and/or damage caused by flooding, gradually eliminating existing sources of pollution.

Operational goal 7: Improvement of water retention in basins

Measures for achieving the goal:

- Increasing retention effects to reduce the peaks of flood waves and prevent rapid run off from rural and urban areas, especially in small and medium-sized basins, through: (1) maintaining and, where possible and economically justified, reconstructing or expanding natural retention areas (swamp and inundation areas); (2) maintaining existing and afforesting new areas, particularly in mountainous regions with high risks of erosion; (3) landscaping parks and green areas in new urban settlements, for better infiltration of precipitation into the soil; (4) implementing other measures to improve retention in the basin.

### Protection against erosion and torrents

Protection against erosion and torrents is a precondition for stable and sustainable land use and defence against frequent and devastating torrential floods.

The situation in this segment of protection against the harmful effects of water will be improved primarily through regulatory and administrative measures, but also through protective biological and technical works, with their continuous maintenance and monitoring. The joint and coordinated action of the competent bodies of administration and public and other enterprises, users of erosion areas, is a prerequisite for the success and efficiency of the execution of these works.

Due to the specificity of this field, the assessed scope of necessary anti-erosion works includes two segments: (1) maintenance of the current state, which involves works required to avoid the reactivation of erosion processes and (2) execution of new works, in order to reduce the intensity of erosion and sediment production.

In order to maintain the current state, it is necessary to carry out technical works covering a total of approx. 350,000 m<sup>3</sup> (about 4 m<sup>3</sup>/km<sup>2</sup>) and biological works covering approx. 34,000 ha (0.4 ha/km<sup>2</sup>), with river basin coverage as shown in Figure 43.

In order to improve the situation in this segment of water protection in future, it is necessary to carry out technical works in the scope of approx. 1,000,000 m<sup>3</sup> (12 m<sup>3</sup>/km<sup>2</sup>) and biological works on the surface area of approx. 100,000 ha (Figure 44).

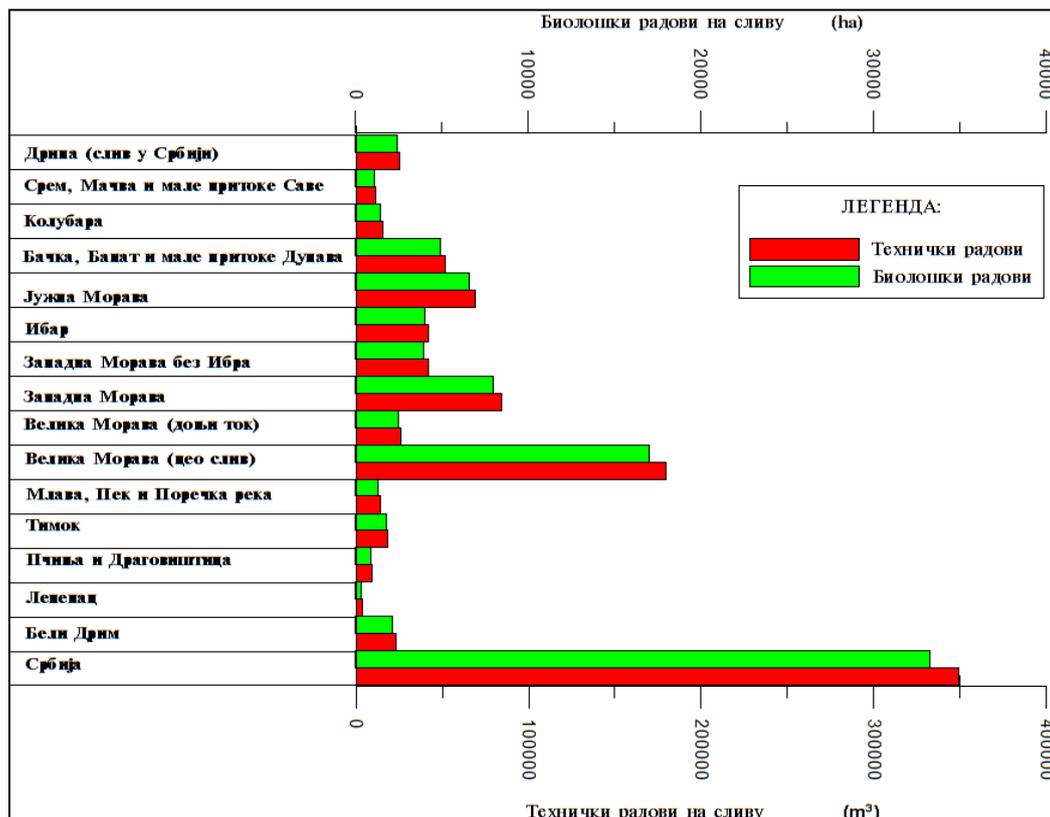


Figure 43: The scope of anti-erosion works for maintenance of the existing state of erosion in Serbia

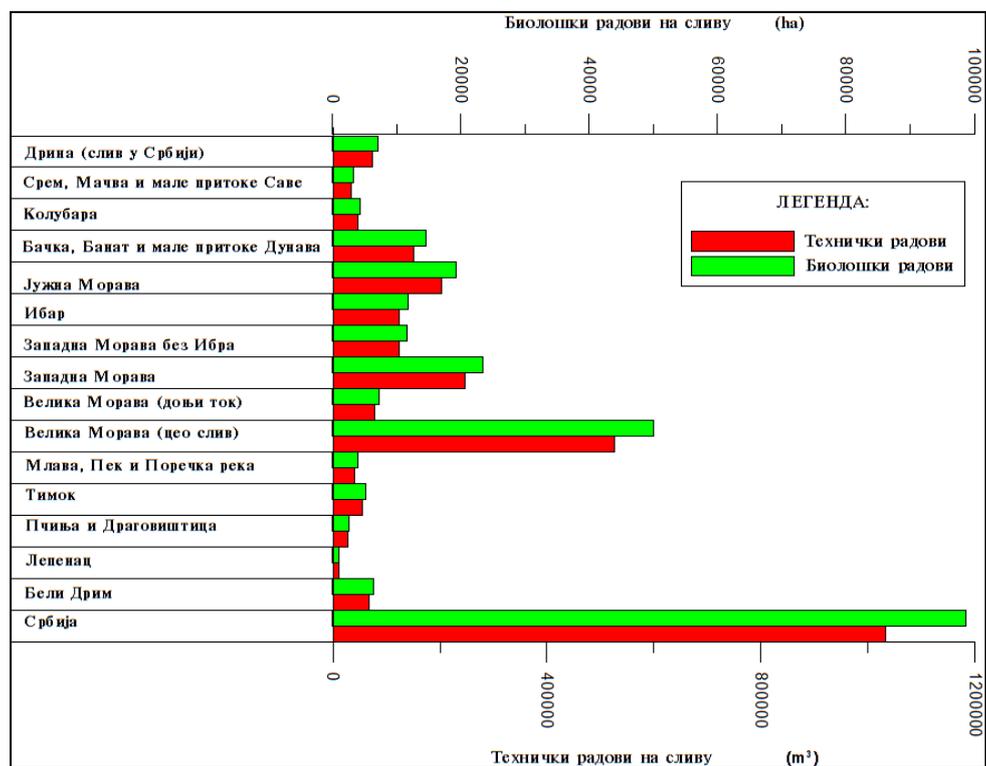


Figure 44: The required scope of new anti-erosion works in the planning period

(isti tekst za obe slike)

Biological works on the basin (ha)

Drina (in Serbia)

Srem, Mačva and small tributaries of the Sava

Kolubara

Bačka, Banat and small tributaries of the Danube

Južna Morava

Ibar

Zapadna Morava without Ibar

Zapadna Morava

Velika Morava (lower course)

Velika Morava (entire basin)

Mlava, Pek and Porečka rivers

Timok

Pčinja and Dragovištica

Lepenac

Beli Drim

Serbia

Technical works on the basin (m3)

LEGEND:

Technical works

Biological works

### **Operational goals and measures**

Operational goal 1: Establishment of legal framework for the improvement of protection against erosion and torrents

Measures for achieving the goal:

- Adopting a bylaw on the criteria for determining erosion-prone areas;
- Developing a new erosion map for the Republic of Serbia in the initial ten-year period, preparing necessary studies and determining erosion-prone areas (obligation of the competent bodies of local government), along with specific conditions for their use and necessary works and measures, while complying with environmental requirements; the studies must be in accordance with the water management plan for the particular water area and must constitute the basis for drafting an Emergency Protection and Rescue Plan - the part relating to the protection from erosion and torrents;
- Ensuring the integration of erosion protection issues in urban planning and forestry and agricultural plans.

Operational goal 2: Improvement of the conditions of protection against erosion and torrents

Measures for achieving the goal:

- Implementing preventive, technical and biological protective works and measures in accordance with studies completed on determining erosion-prone areas;
- Creating and continuously updating the cadastral registers of erosion processes and torrential flows and implemented measures, and entering updated data into the water information system;
- Increasing the efficiency of inspection service and other competent authorities that deal with the state of erosion-prone areas and torrential flows;
- Educating the public on the consequences of improper behaviour in erosion-prone and torrential flow areas.

Operational goal 3: Monitoring the situation and maintenance of facilities and works

Measures for achieving the goal:

- Ensure continuous monitoring of erosion processes and condition of torrential beds and facilities for protection from erosion and torrents;

- Regularly maintaining the constructed facilities and executed biotechnological and biological protection works according to the annual programme and in accordance with relevant standards and norms;
- Repairing facilities and executed biotechnological and biological protection works damaged by natural and anthropogenic influences, in a manner that does not disturb the natural balance of the waterway/torrential flow and its catchment areas.

### **Protection against pluvial and groundwater flooding (drainage)**

The situation in this domain of the water sector will be improved in the immediate future through the implementation of hydrotechnical measures, which include reconstruction and upgrading of existing systems and the construction of new systems in areas at risk of pluvial and groundwater flooding. Hydrotechnical drainage measures will be implemented:

- on the basis of coordinating responsibilities, which obliges the agriculture sector and the water sector to coordinate their plans and implementation of plans for the gradual rehabilitation of existing systems and further drainage development;
- in accordance with the plans, needs and financial possibilities of the state and agricultural producers and the need to protect against groundwater and precipitations in populated areas;
- in coordination with agricultural irrigation works, bearing in mind that the development of irrigation in some areas depends on drainage development;
- by ensuring the dual-purpose function of facilities (irrigation and drainage), wherever possible and necessary.

### **Operational goals and measures**

#### Operational goal 1: Improvement of protection against pluvial and groundwater flooding

Measures for achieving the goal:

- Organising protection against pluvial and groundwater flooding by land reclamation area within the system managed by water management enterprises or other legal entities with appropriate licences;
- Implementing the protection of buildings and land from pluvial and groundwater flooding through the completion, upgrading, reconstruction and regular maintenance of existing facilities for the protection against pluvial and groundwater flooding;
- Building new systems in the affected areas, with a degree of protection depending on the characteristics of a given area.

#### Operational goal 2: Efficient and coordinated operational protection against pluvial and groundwater flooding

Measures for achieving the goal:

- Using the constructed water control facilities and systems to ensure protection against pluvial and groundwater flooding in accordance with the General and Operational Flood Protection Plan;
- Maintaining the regime of pluvial water and groundwater in accordance with the relevant rulebook for each reclamation area and on the basis of criteria determined for the canal network class and the characteristics of the area to be protected.

#### Operational goal 3: Regular maintenance and control of the condition of water control facilities

Measures for achieving the goal:

- Organising regular monitoring and control of the condition of facilities for protection against pluvial and groundwater flooding and entering the updated information in the cadaster and information system;
- Carrying out regular maintenance in accordance with standards and norms.

### **Drought and water scarcity**

As a result of possible changes in the temperature and precipitation regime, we can expect an increase in the number of drought periods in future. In order to neutralise or reduce the adverse effects of drought (the most pronounced and most harmful of which are related to agricultural production) water management in drought periods must be made based on relevant field studies and research.

### **Operational goal and measures**

Operational goal 1: Water management under conditions of drought and water scarcity

Measures for achieving the goal:

- Conducting continuous research of changes in the cycle of precipitation and evapotranspiration and their impact on runoff and water resources;
- Defining environmental requirements for water by waterways and water needs of other users (water supply, energy, irrigation), with the environment treated as equal user;
- Developing drought management plans for water areas, with defined conditions for declaring drought or lack of water and elaborated measures for water management adaptation under these conditions, and including their summary in the water management plan for a given water area;
- Preparing water characterisation under conditions of drought for each water area and, on the basis of historical data and forecasts of climate change, developing a programme of measures for the prevention and mitigation of the consequences of drought;
- Organising and following up on consultations with stakeholders and coordinating the selection and implementation of appropriate measures (preventive, for water retention in the catchment area; operational, in terms of protection and controlled use of water resources during periods of drought; or organisational, related to protocols for coordinated the work of the water sector and other bodies relating to the use of water resources);
- Developing a system of measurements and forecasts on the basis of observation of parameters in the network of meteorological and hydrological stations, satellite imagery and ground examination of vegetation condition, and assessing the impact of water scarcity on the public, economy and environment, on the basis of comparison of the situation under wet and dry conditions.

## **5.1.5. REGIONAL AND MULTI-PURPOSE HYDROSYSTEMS**

The construction of complex regional and/or multi-purpose water control systems, including multi-purpose reservoirs for water use, protection of and against water, will continue to be an activity aimed at the improvement of the water regime on the territory of the Republic of Serbia.

Strategic goal: Improvement of the water regime and elimination of temporal and spatial discrepancies between available water resources and water needs, protection of water and protection from water, development of regional and multi-purpose hydrosystems

### **Reservoirs**

The purpose of dams and reservoirs is to regulate the water regime in a certain area, i.e. to ensure sufficient quantities of water for the needs of users, environmental protection and the elimination of the destructive effects of water, by reducing flood waves. Reservoirs are the only facilities that can be used

to redistribute water in space and time, necessary because of very unevenly distributed water (in terms of quantity and quality) in our region, and possible deterioration of the water regime due to climate change. In respect to this, a particularly important issue is the preservation and improvement of water quality, which is particularly susceptible to degradation at the current stage of social development. Proper water management is a prerequisite also for spatial development (land, settlements, transportation and other infrastructure) and/or for the increase in economic activity on said.

In future, we should improve the use of existing and build a certain number of new reservoirs. Although reservoirs must be designed for multiple purposes, they can be classified into three main groups by priority purpose:

- *Reservoirs whose primary purpose is to supply drinking water*, and where particular attention must be paid to sanitary protection measures of catchment areas (sanitary protection zones), in order to preserve the quality of water in them and reduce the risk to the health of water users.
- *Reservoirs whose primary purpose is to provide water needed by other users (industry, irrigation, etc.) and to protect water*, and in respect to which there are no such strict sanitary protection requirements as for the aforementioned ones, but appropriate measures must be taken to ensure the quality of water within defined parameters, including anti-erosion measures.
- *Reservoirs whose primary purpose is to provide water for the generation of energy*, and whose function must be rationally included into the overall water regime, including prevention (mitigation) of adverse effects, both directly downstream from the facility, and on the downstream sections of waterways. Regarding the protection of accumulated water quality and protection from sediment, the same degree of protection is required as for the previous group.

The multi-purpose character of reservoirs also involves the satisfaction of other needs (fishing, sports, tourism, recreation, etc.). Particularly significant function of reservoirs must be active flood protection which, in addition to solving the issue of destructive effects of water, provides additional usable quantities of water, but also other positive effects. Such effects include the retention of sediment which, although harmful because of the loss of reservoir area, is good for the protection of the downstream area. Therefore, optimum protection from the destructive effects of water must be ensured through the coordinated implementation of active, passive and non-investment measures.

### **Operational goal and measures**

#### **Operational goal 1: Improved use of existing reservoirs**

Measures for achieving the goal:

- Specifying competences and responsibility over the management and maintenance of reservoirs (user, public water management companies, etc.);
- Reviewing the manner of reservoir use;
- Reviewing the existing and/or creating new models of reservoir management, aligned with the water management plan for a given water area in which the individual reservoir is located, if the design conditions have changed;
- Providing support to the implementation of the determined model of reservoir management, through the established monitoring of the water regime, monitoring and updating of water users' demands and requests, completing and updating of the water information system, operationalisation of various models for analysis, forecasting and assistance in decision making, etc.

#### **Operational goal 2: Control of status and maintenance of existing reservoirs**

- Monitoring the status of water in the reservoir and downstream, in accordance with the established programme, including the provision of the minimum sustainable flow in the waterway, downstream of the dam;
- Conducting periodic geodetic surveys of the reservoir and taking the necessary measures to maintain the reservoir area in accordance with relevant technical documentation;
- Establishing an efficient system and appropriate technology for observing dams, in order to detect any threats, in a timely manner that may adversely affect the integrity of the facility and its function.

#### Operational goal 3: Monitoring water storage capacity

- Completing the construction of dams (Stuborovni and Selova, which are in the final stage, and Svrackovo, whose construction began in the previous period), and reviewing and redefining the use of these reservoirs;
- Planning and constructing new reservoirs and supporting infrastructure facilities in accordance with water management plans for a given water area;
- Planning the multi-purpose utilisation of reservoirs, with obligatory provision of the reservoir area for the reduction of flood waves, and the minimum sustainable flow in waterway, downstream of the dam.

Within the framework of Strategy planning period, it is not possible to accurately define the reservoirs that will be built, since their construction depends on many factors, but it is very important to reserve the construction site and prevent any further inappropriate use of the site. Therefore, Table 56 gives an overview of possible dams with reservoirs whose construction would significantly improve the water regime in Serbia, and which are intended for different users (supplying water to the public, irrigation, industry, enrichment of small water bodies, etc.) or which are good for using water power. Protection of downstream areas against the harmful effects of water should be a mandatory function of all potential reservoirs.

Table 56: Potential reservoirs of volume over 10 million m<sup>3</sup>

No	River	Municipality	Indicative dam profile	Area F(km <sup>2</sup> )	Flow Q <sub>sr</sub> (m <sup>3</sup> /s)	Possible purposes
1	Pčinja	Trgovište	Prohor Pčinjski	542	4.6	W, ENR,
2	Vlasina	Crna Trava	Svođe	349	3.9	W, E
3	Šumanka	Lebane	Ključ	110	0.9	W, ENR,
4	V. Kosanica	Kuršumlija	Zebice	92	0.6	ENR, IR
5	Jerma	Dimitrovgrad	Odorovci	665	4.3	W, IR, E
6	Skrpež	Kosjerić	Seča Reka	97	1.0	W, IND
7	Nošnica	Ivanjica	Rokci	180	2.5	W, ENR,
8	Rzav	Arilje	Orlovača	290	4.4	W, IR, E
9	Ibar	Tutin	Ribarići	850	10.3	W, ENR,
10	Ljudska reka	Novi Pazar	Vučiniće	180	2.0	W, ENR,
11	Studnica	Ivanjica	Preprana/Devići*	371	5.5	W, E
12	Lopatnica	Kraljevo	Bela Stena	80	1.4	W
13	Crnica	Paraćin	Zabrege	70	1.0	W, E, IR
14	Resava	Despotovac	Beljanica	120	1.5	W
15	Mlava	Petrovac	Vitman	702	7.2	W, IR,
16	Bukovska r.	Kučevo	Kučevo	67	0.8	W
17	Okoliška r.	Svrljig	Okolište	44	0.3	W
18	Aldinačka r.	Knjaževac	Žukovac	77	0.8	W
19	Crni Timok	Boljevac	Bogovina	359	5.4	W, ENR,
20	Lim	Prijepolje	Brodarevo	2,762	72.0	E

No	River	Municipality	Indicative dam profile	Area F(km <sup>2</sup> )	Flow Q <sub>sr</sub> (m <sup>3</sup> /s)	Possible purposes
21	Uvac	Nova Varoš	Klak	1,420	14.9	E
22	Drina	Bajina Bašta	Tegare**	15,817	362.5	W, ENR,
23	Drina	Ljubovija	Dubravica**	16,192	371.1	E
24	Ljuboviđa	Ljubovija	Gornja Ljuboviđa	72	1.0	W
25	Ribnica	Mionica	Struganik	102	1.2	W, ENR,

\*by transferring Studenica to Lopatnica \*\*large number of low cascades on the Middle Drina  
W – supplying water to the public, IND – supplying water to industry, ENR – enrichment of small water bodies, IR – irrigation, E - energy

The construction of systems for the abstraction and use of domicile water that flow away from our territory, in order to increase their use in our region (for example Pčinja, Lim with Uvac), would certainly contribute to the improvement of the water regime throughout Serbia, but solving these issues requires additional research and harmonisation with the international factor.

Operational goal 4: Appropriate use and control of the state of surrounding area

- Prohibiting by law and preventing the improper use of the area surrounding existing and future reservoirs;
- Removing facilities that threaten the quality of water in existing reservoirs or prescribing compulsory works and measures to eliminate their negative impact;
- Implementing all works and measures, set forth in technical documentation, for anti-erosion regulation of surrounding catchment areas, and ensuring their regular monitoring and maintenance.

### **Regional systems for the drinking water supply**

The task of these systems is to provide quantities of water required to supply the public and other users with drinking water, and to ensure the necessary protection of water and protection from the harmful effects of water. Given the complexity of this issue and primarily bearing in mind the uncertainty of implementing these systems in terms of time, this issue is not treated in the same regard as in other areas (through defined operational goals and measures for their implementation). However, we can point out two basic goals:

- Reviewing and redefining the solutions proposed in earlier strategic and planning documents, including facilities that are operational or whose construction has begun;
- Orientation towards the field research of potential sources designated in the Strategy as possible alternative solutions for the long-term water supply of certain vulnerable areas and preparation of necessary technical documentation.

The need to review this situation is based on the fact that the significantly slower economic development of Serbia has caused the significantly slower construction of initiated water supply projects and regional water supply systems planned in accordance with Serbia's Water Management Basis, thus affecting the need and possibility of their connection. In addition, the population decline over time and reduced water demand by the industry connected to urban water supply systems have led to a reduction in total water needs, so that some municipalities have become oriented to local sources.

Given the relatively low level of exploration (primarily of hydrogeological characteristics) of existing and potential local and regional sources, the Strategy has provided alternative solutions for the development of regional systems for supplying certain municipalities in Serbia with drinking water (Table 50), based on the existing strategic and study documentation. In the coming period, it is necessary to conduct more detailed research and prepare appropriate documentation, in order to include planning documentation for the solutions chosen to the issues of the drinking water supply.

In a large part of Vojvodina, supplied from the main water-bearing complex, it is necessary to adjust water abstraction with the natural recharge of the aquifer in the long-term, and thus enable the achievement of a good quantitative status of the bodies of groundwater.

Since the biggest problems in Vojvodina, in terms of quantity and quality of water, are related to the areas of Central and Northern Banat, Eastern Srem, as well as Central and North-East Bačka, regional water supply systems (RWSS) should be oriented from west to east and from south to north.

The Strategy of Water Supply and Water Protection in AP Vojvodina (2010) defines important potential sources of drinking water. The Danube alluvion from the area of Bezdán-Bogojevo (RWSS Western Bačka) and the Sava alluvion from the Jarak-Klenak area (RWSS Eastern Srem, with possible merging with BWC) will most likely be used as sources for the long-term solution of the water supply issue faced by Central Bačka (WA Backa and Banat) and Eastern Srem (WA Srem). It is not possible to define a long-term method of water supply for other areas in the AP, because in some areas the issue of inadequate water quality must be addressed urgently.

Regarding Central and Northern Banat (WA Bačka and Banat), previous research and prepared project documentation indicate that the water supply issue can be solved by building a RWSS Banat (with source Kovin-Dubovac), which requires substantial resources. On the other hand, the potential sources (designated as the Eastern perimeter of Telečka and Southeastern Banat), have a favourable geographical position, but their level of research is very low. Therefore, further research should be focused primarily on these sites. Favourable research results, in terms of water quantity and quality, could affect orientation to these sources, which would be economically justifiable, while negative results would eliminate them from further consideration. This should be done as soon as possible, as it would significantly speed up the solving of water supply issues for some cities (Zrenjanin, Kikinda, etc.).

In the far north of the AP, in the area of WA Bačka and Banat, small municipalities along the Tisa River can solve their issues with water supply from local sources, and if they do not, RWSS West Bačka becomes the most realistic option.

RWSS Novi Sad (WA Bačka and Banat), presently the largest system in Vojvodina, will continue to expand, covering a certain number of neighbouring municipalities.

The municipalities of the Kolubara District, located in the WA Sava, and Lazarevac, which belongs to the City of Belgrade, will solve the issue with the drinking water supply in the long run through the completion of the Stuborovni dam and the construction of RWSS Kolubara.

In the WA Sava, the powerful alluvion of the Drina and Sava rivers can provide long-term sufficient water for the surrounding area in Mačva (RWSS Drina), for the long-term.

Within the WA Belgrade, the capacity of the existing regional water supply system (BWC) will probably be expanded to some suburban areas. The scopes of coverage of the systems are not sufficiently defined at this point to allow for clear orientation of individual settlements to local sources or the regional system. The following sources may be possible solutions for the overall expansion of the BWC system: Zidine, Pančevački rit, the water of the Stari Vlah Mountains, and also connecting the city or individual settlements in RWSS Banat or RWSS Eastern Srem.

In the WA Morava, the shortage of water in the sources of groundwater in Šumadija has been solved so far by building small (Bukulja, Garaši, Grošnica) and large (Gruža) reservoirs within the RWSS Kragujevac, and by the construction of RWSS Rzav. The current water shortage in some municipalities (Topola, Gornji Milanovac, Arandelovac, Ljig and Kraljevo) can be solved by expanding the RWSS Rzav, after the construction of the Svračkovo dam. The central area of Šumadija can hold additional amounts of water, probably in the somewhat distant future, through the abstraction of water from the Studenica River.

Aleksinac is currently supplied with water from RWSS Bovan, whose expansion can be expected in future, by connecting settlements in the municipalities of Ražanj and Sokobanja.

The central part of Pomoravlje (Rasina District), as part of WA Morava, is already solving the issue of the drinking water supply by expanding RWSS Rasina. It can be expected that RWSS Kragujevac will expand to one of the neighbouring municipalities (for example, through the construction of a water treatment facility that will treat water from the Brzan source, for Batočina and Lapovo).

Jagodina, Čuprija and Paraćin (with about 170,000 inhabitants), also in the WA Morava, may solve the issue of drinking water shortage by building RWSS Crnica, with the Zabregé dam on the river Crnica and a drinking water preparation plant, in future. Optimisation of local sources will be the basis of the drinking water supply for the Despotovac, Svilajnac and neighbouring settlements and downstream municipalities, and if necessary, additional amounts of water can be obtained by building RWSS Resava, whose main facility would be a dam on the Resava River.

RWSS Barje has been used to supply water to the population of Leskovac since 2010 only, when the purification of drinking water facility was built. Lebane is currently supplied from local sources, but its connection to RWSS Barje has been planned, as a first alternative, whereas the second alternative for this municipality's water supply is the reservoir on the River Šumanka (RWSS Šumanka), with the possibility of connecting settlements from the municipality of Bojnik.

The Municipality of Babušnica is currently supplied with drinking water from local sources and RWSS Niš, which is planned to be expanded and to cover settlements from the municipality of Bela Palanka.

The municipalities of lower Pomoravlje (Smederevska Palanka, Velika Plana, Svilajnac, Žabari), also in the WA Morava, may, after the optimal use of local water sources, be connected to one of the existing or potential RWSS (Resava).

The Prvonek Reservoir serves to provide water to the settlements in the municipality of Vranje, while the connection with settlements in the municipalities of Bujanovac and Preševo have been planned.

In some municipalities in Eastern Serbia (WA Lower Danube), water shortages can be overcome by using water from Kučaj-Beljanica Massif. This refers to Bor and Timočka krajina (RWSS Bogovina), Petrovac and neighbouring municipalities, which may abstract water from the Mlava basin, but some municipalities of the Pomoravlje region can permanently solve the issue of drinking water shortage by abstracting water from this area also.

In the WA Lower Danube, the Danube River (Donji Milanovac) or alluvion of this waterway (Veliko Gradište, Kladovo-Negotin) will be used as drinking water supply source.

Some sources (primarily in the Vojvodina and Morava aquifers), as parts of potential regional systems, do not have a balanced inter-annual groundwater regime. Therefore, it is necessary to examine the possibility of transferring water to these locations, from water-abundant seasons to low-water seasons, by pouring water underground. To this end, experimental systems would need to be established and used to monitor the effect of these interventions.

### **Other regional and multi-purpose hydrosystems**

In the coming period, the intended purposes of the existing regional and multi-purpose hydrosystems should first be ensured through appropriate current and investment maintenance. Their condition and the possibility of multi-purpose use will thus be largely improved. This refers primarily to the multi-purpose hydrosystem DTD, which currently and primarily fulfils the function of drainage and irrigation to a small extent, while other forms of water use are well beyond the capabilities of the system.

In upgrading and reconstructing the facilities of this and other hydro-reclamation systems, it is desirable, wherever conditions and needs require, to ensure their dual-purpose function (drainage and irrigation).

In addition to this hydrosystem, the multi-purpose hydrosystems whose dams (Selova, Stuborovni and Svračkovo) are under construction, must be completed and subject to prior review and redefinition of designed functions.

Regarding new multi-purpose hydrosystems, it can be stated that their construction is uncertain at the moment.

The biggest multi-purpose hydrosystem recently considered is the *Danube-Morava-Vardar-Aegean Sea* waterway, whose construction in the proposed form and under these circumstances is almost impossible because it is linked to numerous natural, technical, organisational and financial issues.

A project that also requires significant resources, but is more rational in terms of expected effects, is a multi-purpose system on the Velika Morava, which would allow for the use of hydropower potential, improve water supply conditions (by the additional enrichment of aquifers), allow navigation, agricultural irrigation, the improvement of water quality (the enrichment of small water). The construction of this system requires prior solving of a large number of issues related to different domains of the water sector, so that its construction is unrealistic in the Strategy planning period.

In order to enable the formation of a certain number of regional multi-purpose hydrosystems, with the function of water use and protection, in the planning period it is also necessary to consider the need to improve the regime of waterways that would constitute the backbone of these systems. In this context, we should examine and determine the possibility of transferring water from the waterways richer in water to the areas with less water (from the river Uvac to the river Rzav, from the Stari Vlah mountains, the Mlava and Rasina rivers to the catchment area of the Velika Morava, from the River Drina to the catchment area of the River Kolubara, from the rivers Pčinja and Dragovištica to the river Južna Morava, etc.).

If some dams were constructed in the planning period, the creation of reservoirs would ensure the multi-purpose use of water (public water supply and industry, irrigation, certain forms of sport and recreation), the protection of water and ecosystems (enhancement of low water) and protection against the harmful effects of water (receiving a section of the flood wave). These dams with reservoirs would be the main facilities of future regional multi-purpose systems.

### **5.1.6. OTHER FACTORS WITH RELEVANCE TO WATER MANAGEMENT**

Achieving strategic and operational goals within certain domains of water activity is conditioned by adequate solutions in other fields, primarily within the domain of regulatory legislation and economics.

#### **Legal and institutional framework**

The legal and institutional framework refers to regulations and organisational and institutional support to the water sector.

Strategic goal: Completion of legal reform of the water sector in accordance with the need of adapting to social conditions and EU requirements, and efficient organisation of the water sector

#### **Operational goals and measures**

Operational goal 1: Adoption of all relative legislation and its harmonisation with international law

Measures for achieving the goal:

- Promptly adopting the bylaws prescribed under the Law on Water, including strategic and planning documents, taking into account:
  - Relevant EU directives governing the water sector, including directives relating to environmental protection as a whole (Annex 1);
  - Other EU directives with relevance to water management, the so-called horizontal directives (Annex 1);
- Defining, in a separate bylaw, indicators for monitoring the achievement of the goals set forth in this Strategy;
- Defining the priorities and schedule of achieving the standards prescribed by regulations within the domain of water;
- Adopting relevant acts to improve water statistics, as well as those that regulate the manner of calculating and collecting of water charges;
- Adopting the strategy for restructuring public water management companies and implementing it within the set deadline;
- Adopting the strategy for the restructuring of public utility companies founded by bodies of local government and conducting the restructuring process within the set deadline.

Operational goal 2: Institutional strengthening of the water sector and more intensive cooperation with other sectors related to the water sector

Measures for achieving the goal:

- Ensuring better coordination of activities related to water, among all the ministries in charge of water as a resource;
- Establishing a special financial institution, instead of the current budget fund for water, in order to enable more efficient financing of water sector development;
- Establishing special investment centres at the regional level, for the purpose of more efficient implementation of projects of major importance to the Republic of Serbia, regional and/or local government;
- Strengthening the capacity of public administration within the field of water management at the federal level (within the competent ministry), at the level of the Autonomous Province (within the competent secretariat or other institutional bodies) and at the local level (Water Directorate in Belgrade, and directorates, institutes and other bodies in other local government), while enhancing multidisciplinary representation of qualified staff;
- Establishing better cooperation between relevant bodies of public administration and public water management companies, to promote and implement integrated water management;
- Enhancing inspections and controlling the implementation of the Law on Water.

Operational goal 3: Introduction of the regulatory function in the water sector

Measure for achieving the goal:

- Establishing an independent regulatory body to regulate the operations of companies providing drinking water supply and sanitation services, or expanding the regulatory function of the competent ministry.

Operational goal 4: Publicity of water sector activities

Measures for achieving the goal:

- Ensuring conditions for the work of the National Water Conference as the representative of the public;
- Ensuring the participation of the general public in the phase of the development of water management plans;
- Making available, through the media, information related to the water sector, which is relevant to human life and environmental conditions;

- If necessary, establishing a special body for public participation at the water area level;
- Ensuring education of the public on the importance of water resources, their limitations and the need for their rational use and protection, as well as on the importance of water facilities for the use and protection of water and protection from water.

Operational goal 5: Strengthening of scientific and expert capacities to support the water sector

Measures for achieving the goal:

- Introducing mandatory and continuous education of scientific and qualified staff in the water sector, and introducing modern programmes with a multidisciplinary approach to managing water resource into specialised secondary schools and institutions of higher learning;
- Appointing scientific research organisations authorised to carrying out research activities with particular relevance to water management.

### **Economic policy**

Economic policy in the field of water management includes defined sources and methods of financing in accordance with standards established by federal regulatory bodies, taking into account the experience and practice of European countries in this domain.

Strategic goal: Establishment of a system for sustainable, long-term financing of the water sector based on the principle of self-financing, which involves stable sources of funding, continuous influx of funds and established mechanisms for their collection.

### **Operational goals and measures**

Operational goal 1: Establishment of economic valuation of water and services of water supply and channelling

Measures for achieving the goal:

- Adopting methodology for the calculation of the economic price of water and services in the water sector (based on the principle of full cost recovery and on “user-pays” and “polluter-pays” principles);
- Defining elements of the tariff system for determining the price of water supply and the price of collection, drainage and treatment of wastewater;
- Ensuring measures for poverty alleviation through affordable prices for low-income users or certain discounts.

Operational goal 2: Implementation of regulations and collection of water charges

Measures for achieving the goal:

- Establishing and updating the database of users obliged to pay water charges within the information systems;
- Establishing mechanisms for efficient collection of water charges;
- Monitoring and controlling the use of revenues from water charges.

Operational goal 3: Provision of funds for financing water sector development

Measures for achieving the goal:

- Ensuring the participation of the utility sector in financing water sector development with funds generated from the economic price of water;
- Directing a portion of collected water charges to water sector development;

- Providing conditions for the participation of other funds and private capital in the financing of water sector development;
- Providing co-financing within each field of support from EU funds (technical assistance, investments - infrastructural works and supply of equipment, grant schemes, etc.).

## **5.2. APPROXIMATE WATER BALANCE**

According to the Law on Water, water balance is a qualitative and quantitative ratio between available and required quantities of surface water and groundwater in a particular area and at a particular time. Below is given an approximate water balance, which includes the natural elements of water balance and approximate considerations of the possibility of meeting the demand for water in certain areas. This approach is derived from the lack of detailed insight in the water balance, due to many uncertainties, both in terms of water needs for certain domains of water-related activity and the effects of global climate change in our region.

### **5.2.1. NATURAL ELEMENTS OF WATER BALANCE**

#### **Surface water**

The annual rainfall on the territory of the Republic of Serbia is approx. 63.7 billion m<sup>3</sup>, approx. 16 billion m<sup>3</sup> of it is runoff, while the rest returns to the atmosphere through evapotranspiration. Table 57 presents an overview of the quantity of water on the territory of Serbia by balance unit (Figure 45), and Table 58 shows the quantity of water by water area.

Balance units, as well as areas where water balance is observed, have been proposed on the basis of natural characteristics of the area, possibility to satisfy the water needs of the particular area, the locations of flow control stations, etc. In order to gain more accurate insight into water balance in future, it is necessary to verify, through a dedicated study, the proposed balance units or suggest different ones, and to define the methodology for preparing the water balance in the next planning cycles.

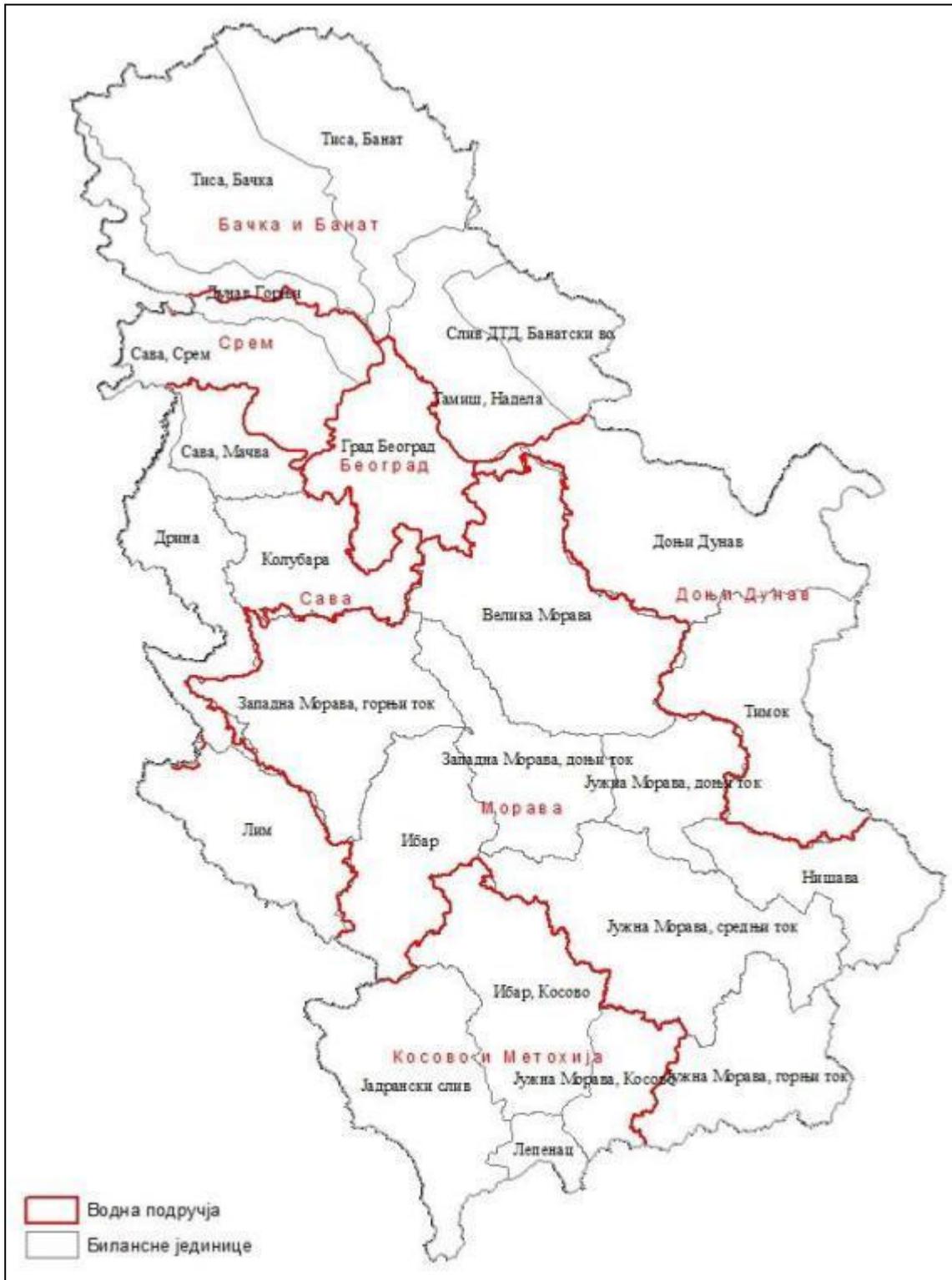


Figure 45: Balance units on the territory of Serbia, with boundaries of water areas

Water areas

Balance units

(nazive prepisati iz tabelle)

Table 57: Overview of average precipitation and runoff on the territory of the Republic of Serbia

Balance units	Basin area		Precipitation			Run off		Evaporation
	F (km <sup>2</sup> )	P (mm)	Q (m <sup>3</sup> /s)	W (10 <sup>6</sup> m <sup>3</sup> )	h (mm)	E (mm)		
Upper Danube	2,475.75	634	5.58	176	71	563		
Tisa, Banat	5,244.63	549	9.35	295	56	493		
Tisa, Bačka	5,611.62	583	8.57	270	48	535		
DTD basin, Banat								
waterways	2,242.56	652	5.16	162	73	580		
Tamiš, Nadela	3,043.43	632	3.40	107	35	597		
Sava, Srem	2,970.02	654	10.79	340	115	539		
Sava, Mačva	1,459.37	700	2.49	79	54	646		
Drina	2,957.14	926	26.24	826	280	646		
Lim	3,150.37	892	36.34	1,145	364	528		
Kolubara	2,728.36	803	19.13	602	221	582		
The City of Belgrade	3,231.23	678	6.27	198	61	617		
Nišava	2,874.75	748	22.83	719	250	498		
Južna Morava - middle course	5,681.62	737	32.71	1,030	182	555		
Južna Morava - lower course	2,109.54	667	7.47	235	112	555		
J. Morava upper c. + Pčinja + Dragovištica	3,494.51	771	26.71	841	241	530		
Ibar	3,490.98	786	31.08	979	281	505		
Zapadna Morava - upper course	4,743.18	871	43.15	1,359	287	584		
Zapadna Morava - lower course	3,034.64	742	14.03	442	146	596		
Velika Morava	6,192.07	680	21.08	664	107	573		
Timok	4,486.71	709	27.90	879	196	513		
Lower Danube	6,245.52	719	36.70	1,156	185	534		
Ibar, Kosovo	4,045.68	772	20.86	657	163	609		
The Adriatic basin	4,654.01	733	62.79	1,978	425	308		
The Aegean Basin - Lepenac	683.89	766	8.93	281	412	354		
Južna Morava, Kosovo	1,555.42	740	8.10	255	164	576		
<b>AP VOJVODINA</b>	<b>21,588.00</b>	<b>605</b>	<b>32.1</b>	<b>1,010</b>	<b>47</b>	<b>558</b>		
<b>CENTRAL SERBIA</b>	<b>55,880.00</b>	<b>759</b>	<b>364.9</b>	<b>11,495</b>	<b>206</b>	<b>553</b>		
<b>AP Kosovo and Metohija</b>	<b>10,939.00</b>	<b>750</b>	<b>100.7</b>	<b>3,171</b>	<b>290</b>	<b>460</b>		
<b>REPUBLIC OF SERBIA</b>	<b>88,407.00</b>	<b>720</b>	<b>497.7</b>	<b>15,676</b>	<b>178</b>	<b>542</b>		

Generally, it can be said that the southern, south-western and western parts of the Republic of Serbia are more water abundant than central and eastern parts. Given the fact that the mountainous regions have more precipitations, specific runoff from these terrains exceeds 15 l/s per km<sup>2</sup>. In the plains and hilly regions, in the northern and central parts of the Republic of Serbia, the specific runoff is usually less than 6 l/s per km<sup>2</sup>. The territory of Vojvodina and the basins of the left tributaries of Velika Morava and Kolubara have the lowest yield (2 - 5 l/s per km<sup>2</sup>). The basins with the highest yield on the territory of Serbia are the basins of Bistrica, Gradac, Lopatnica and Studenica, where it ranges from 15 to 17 l/s per km<sup>2</sup>.

Table 58: Quantity of water on the territory of Serbia, by water area

Waterway / water area	Basin area F (km <sup>2</sup> )	Precipitation P (mm)	Discharge Q (m <sup>3</sup> /s)	Volume W (10 <sup>6</sup> m <sup>3</sup> )	Run off H (mm)	Evapotr. E (mm)
SAVA WATER AREA						
Sava, Mačva	1,459.37	700	2.49	79	54	646
Drina	2,957.14	926	26.24	826	280	646
Lim	3,150.37	892	36.34	1,145	364	528
Kolubara	2,728.36	803	19.13	602	221	582
WA SAVA	10,295.25	851	84.19	2,652	258	593
WATER AREA BELGRADE						
The City of Belgrade Morava Basin	546.07	658	1.47	46	85	573
The City of Belgrade Danube Basin	799.19	645	1.01	32	40	605
The City of Belgrade Sava Basin	986.11	657	1.53	48	49	608
The City of Belgrade Kolubara Basin	899.85	743	2.27	71	79	664
WA BELGRADE	3,231.23	678	6.27	198	61	617
MORAVA WATER AREA						
Zapadna Morava, upper course, Pčinja and Dragovištica	3,494.51	771	26.71	841	241	530
Južna Morava, middle course	5,681.62	737	32.71	1,030	182	555
Južna Morava, lower course	2,109.54	667	7.47	235	112	555
Nišava	2,874.75	748	22.83	719	250	498
Ibar	3,490.98	786	31.08	979	281	505
Z. Morava, upper course	4,743.18	871	43.15	1,359	287	584
Z. Morava, lower course	3,034.64	742	14.03	442	146	596
Velika Morava	6,192.07	680	21.08	664	107	573
WA MORAVA	31,621.30	752	199.07	5,429	172	580
LOWER DANUBE WATER AREA						
Lower Danube	6,245.52	719	36.70	1,156	185	534
Timok	4,486.71	709	27.90	879	196	513
LOWER DANUBE WATER AREA	10,732.22	715	64.60	2035	190	525
SREM WATER AREA						
Upper Danube, Srem	879.27	621	3.81	120	136	485
Sava, Srem	2,970.02	654	10.79	340	115	539
WA SREM	3,849.29	647	14.60	460	119	528
BAČKA AND BANAT WATER AREA						
Upper Danube, Bačka	1,596.48	641	1.77	56	35	606
Tisa, Bačka	5,611.62	583	8.57	270	48	535
Tisa, Banat	5,244.63	549	9.35	295	56	493
Tamiš, Nadela	3,043.43	632	3.40	107	35	597
DTD basin, Banat	2,242.56	652	5.16	162	73	580

Waterway / water area	Basin area	Precipitation	Discharge	Volume	Run off	Evapotr.
	F (km <sup>2</sup> )	P (mm)	Q (m <sup>3</sup> /s)	W (10 <sup>6</sup> m <sup>3</sup> )	H (mm)	E (mm)
waterways						
WA BAČKA AND BANAT	17,738.71	595	28.24	890	50	545
KOSOVO AND METOHIJA WATER AREA						
Ibar, Kosovo	4,045.68	772	20.86	657	163	609
Južna Morava, Kosovo	1,555.42	740	8.10	255	164	576
The Adriatic basin	4,654.01	733	62.79	1,978	425	308
The Aegean Basin - Lepenac	683.89	766	8.93	281	412	354
WA KOSOVO AND METOHIJA	10,939.00	750	100.67	3,171	290	460

Table 59 shows the quantity of water flowing into Serbia from the territories of neighbouring countries, while Table 60 shows the total quantity of water on the territory of the Republic of Serbia, by basin (Aegean, Adriatic and Black Sea).

Table 59: Quantity of water flowing to Serbia from other territories

Basin	Average discharge		Flowing from
	m <sup>3</sup> /s	10 <sup>6</sup> m <sup>3</sup> /yr	
Danube with Drava	2,777	87,575	Hungary and Croatia
Tisa	802	25,288	Hungary
Begej	22.5	713	Romania
Channel Baja-Bezdan and Plazović stream*	2	63	Hungary
Tamiš	38.8	1,224	Romania
Brzavica, Moravica, Karaš, Nera*	35	1,104	Romania
Drina with Lim	301	9,492	Montenegro and Bosnia and Herzegovina
Sava	1,159	36,550	Croatia
Nišava	5.02	162	Bulgaria
<b>TOTAL</b>	<b>5,119</b>	<b>161,415</b>	

\* taken from the Water Management Basis of the Republic of Serbia

Table 60: Total quantity of water on the territory of Serbia

Waterway / Basin	From other areas		From the territory of Serbia			Total	
	Average discharge	Flowing from	Average discharge	Flowing to			
	m <sup>3</sup> /s	10 <sup>6</sup> m <sup>3</sup> /yr	m <sup>3</sup> /s	10 <sup>6</sup> m <sup>3</sup> /yr	m <sup>3</sup> /s	10 <sup>6</sup> m <sup>3</sup> /yr	
The Aegean Basin							
Lepenac			8.92	281	Macedonia	8.92	281
Pčinja			3.29	104	Macedonia	3.29	104
Dragovištica			4.89	154	Bulgaria	4.89	154
The Aegean Basin total						17.10	539
The Adriatic basin							
Beli Drim and Plavska River			62.79	1,978	Albania	62.79	1,978
The Adriatic basin total						62.79	1,978

The Black Sea basin							
Danube with Drava	2,777	87,575	Hungary and Croatia			2,777	87,575
Tisa with Begej*	825	26,001	Hungary and Romania	17.92	564	842.9	26,565
Channel Baja-Bezdan* and Plazović stream*	2.00	63	Hungary			2.00	63
Tamiš	39	1,224	Romania	3.40	107	41.84	1,331
Brzavica, Moravica, Karaš, Nera	35	1,104	Romania	5.16	163	40.16	1,267
Sava before Drina	1,134	35,762	Croatia			1,134	35,762
Lim in Serbia				36.34	1,145	36.34	1,145
Drina in Serbia				26.24	826	26.24	826
Drina with Lim	302	9,523	MNE and B&H	62.58	1,971	364.6	11,494
Kolubara				21.40	674	21.4	674
Direct Sava Basin				14.81	467	14.81	467
Sava before confluence	1,436			98.79	3,112	1,535	3,112
Nišava	5.02		Bulgaria	22.83	719	27.85	719
Južna Morava - direct basin				66.81	2,105	71.83	2,105
Ibar				51.94	1,636	51.94	1,636
Zapadna Morava				57.18	1,801	57.18	1,801
Velika Morava - direct basin				22.55	710	27.57	872
Danube - direct basin				43.29	1,364	43.29	1,364
Timok				27.90	879	27.9	879
Danube after Timok	5,119			417.76	13,159	5,537	174,574
The Black Sea basin total						5,537	174,574
<b>TOTAL</b>	<b>5,119</b>	<b>161,415</b>		<b>497.65</b>	<b>15,676</b>	<b>5,617</b>	<b>177,091</b>

\* taken from the Water Management Basis of the Republic of Serbia

The tables show large spatial heterogeneity of runoff generation on the territory of Serbia. On average, the specific yield of all basins in Serbia is 5.63 l/s/km<sup>2</sup>. Vojvodina has the lowest discharge (1.48 l/s/km<sup>2</sup>), Kosovo and Metohija has the highest discharge (9.21 l/s/km<sup>2</sup>), while Central Serbia has a discharge of 6.53 l/s/km<sup>2</sup>.

It should be noted that all elements of water balance are based on the observed water level time series and the measured/calculated discharge in waterways, which contain elements of human influence on the water regime (losses in various types of water use, the transfer of water from one basin to another, etc.). It is estimated that this impact is not substantial in the case of large waterways, but can be significant for certain small waterways.

## Groundwater

The territory of the Republic of Serbia is characterised by different levels groundwater exploration. The most extensive research has been conducted on the territory of Vojvodina, Belgrade and Mačva,

while the scope of field and study research has been smaller in Central Serbia, and therefore indicators are less reliable.

Designated research was conducted on 157 sources in the period between 2007 and 2011 for the purpose of preparing the balance of groundwater in the Republic of Serbia. Based on the results of the research, the balance of groundwater reserves in Vojvodina, Mačva and in the Belgrade zone, water source was calculated and the following indicators were obtained:

- Bačka, Banat and Srem - reserves in the alluvions are about  $16 \text{ m}^3/\text{s}$ , in the primary water-bearing complex about  $5.5 \text{ m}^3/\text{s}$ , in the Neogene sediments about  $1 \text{ m}^3/\text{s}$ , with the possibility of additional exploitation of about  $10 \text{ m}^3/\text{s}$ ;
- Mačva - reserves in the alluvions are about  $9 \text{ m}^3/\text{s}$ , with the possibility of additional exploitation of up to  $10 \text{ m}^3/\text{s}$ ;
- Belgrade water source (in the Sava coastal area) - reserves are about  $5 \text{ m}^3/\text{s}$ , with the possibility of additional exploitation of up to  $2 \text{ m}^3/\text{s}$ ;

The balance was also calculated for natural renewable groundwater resources in the alluvial and terraced sediments of Južna Morava, Vlasina, Jablanica, Veternica and Sušica, Pusta reka, Toplica, Nišava, Moravica near Aleksinac, Moravica, Đetinja, Skrapež, Ibar, Gruža, Rasina, Pepeljuša, Zapadna Morava, Beli Timok, Crni Timok, Veliki Timok, Lepenica, Resava, Velika Morava, Jasenica, Mlava, Pek, Ralja, right tributaries of the Kolubara, Kolubara, Ub, Beljanica and Turija, Tamnava, Drina (before entering the Mačva river) and Danube (downstream of HPP Đerdap/Iron Gate 1). The obtained average quantity of natural renewable groundwater in the analysed alluvial and terraced sediments is approximately  $16.7 \text{ m}^3/\text{s}$  ( $15 - 18.3 \text{ m}^3/\text{s}$ ). This figure includes approximately 10% of the quantity of natural renewable groundwater resources of small alluvial sediments.

In the coastal area of rivers where the alluvial sediments are in direct hydraulic connection with waterways significantly greater amounts of groundwater can be abstracted, if the sources of coastal infiltration type are formed. The locations of potential regional infiltration-type water sources were thoroughly analysed at the locations of Zidine, Apatin-Mesarske Zidine, Kovin-Dubovac. We also assessed the potentiality of the water bodies in the karst of Western and South-western Serbia (Tara, Vapa and Pešter, Jadovnik, Zarudine, Bučje, Jarut, Lelić, Povlen, Zlatibor and Zlatar), a total area of  $3,276 \text{ km}^2$ . According to the estimates, it is possible to abstract approximately  $8 \text{ m}^3$  in addition to the presently used amount of  $1.2 \text{ m}^3$ .

In the area of Eastern Serbia, pilot water bodies were designated, after which a two-year observation of parameters were conducted and the methodology of calculating the balance of the water bodies in karst was adopted.

According to the current level of exploration, it is estimated that the total groundwater resources in Serbia without Kosovo and Metohija equal about  $65 \text{ m}^3/\text{s}$ , with almost 70% of water from alluvial aquifers (almost half on the territory of Central Serbia and approx. 37% in Vojvodina) and approx. 16% of karst water (all in central Serbia). The water of basic water-bearing complex is fully represented in Vojvodina. The potential amount of groundwater can be increased by approx.  $40 \text{ m}^3/\text{s}$ , through the artificial recharge of existing and new regional water sources. The present level of exploration indicates that certain alluvial sources are most suitable for this, which is the result of artificial infiltration of surface water.

The current exploitation of underground water is almost 30% of the estimated quantity, so that in future we can count on a significant increase in the exploitation of existing sources, which must be verified by necessary detailed research.

In the coming period it is necessary to complete the activities of strategic projects for the purpose of calculating the balance of underground water reserves, in order to obtain reliable values of the total quantity available for the public water supply, and for other types of water use. For the purpose of assessing the level of provision, exploitability and protection of groundwater, it is necessary to carry

out continuous monitoring of groundwater exploitation, the effects of exploitation and the state of quality, including deep aquifers.

### 5.2.2. POTENTIAL IMPACTS OF CLIMATE CHANGE

The studying of climate change and its impact on water resources is a very topical issue, both in our country and worldwide, because of the importance of these resources for the survival and development of society as a whole. Climate itself is variable, and climate change is defined as: "The changes that are directly or indirectly influenced by human activities, and which cause changes in the composition of the global atmosphere and which, superimposed on natural fluctuations in climate, are observed over comparable periods of time." Many recorded climatic phenomena are considered, sometimes more and sometimes less justifiably, to be connected with changes in the climate system of the planet. The certainty of the existence of climate change is reflected in the constant increase in greenhouse gases, primarily carbon dioxide, which is associated with the observed temperature increase on the planet. International research (the Intergovernmental Panel on Climate Change - IPCC) indicates an average temperature increase on planet Earth in the past 100 years of approx.  $0.74^{\circ}\text{C}$ , and its accelerated growth in this century.

The following questions are relevant to the Strategy:

- What type of climate change has been observed in Serbia thus far?
- Has climate change already had an impact on river flow and water resources?
- What can be expected in the near future and what can be expected in the distant future, and what is the degree of (un)certainly in predicting future climate and hydrological conditions?

The answers to the first two questions are sought after through regression and other analyses, while the answers to the third question are also sought after through global (GCM) and regional climate (RCM) and hydrological models. In the last ten or so years, through cooperation between the Faculty of Physics and the Climate Change Research Centre of the Institute for Meteorology, numerous RCM models have been made, with the forecasts of future climate under different scenarios. In the same period, the Jaroslav Černi Institute for the Development of Water Resources conducted numerous studies and analyses of the observed average values of air temperature, precipitations and flow in the rivers in Serbia, and established significant correlation between them. The analysed period was from 1949 to 2006, which, given its duration (58 years), can be considered representative for the identification of trends. There are data for this period from a number of climatic stations (selected 26 temperature and 34 precipitation stations) and hydrological stations (18, and a large number of stations used for specific verification). More detailed analyses of the parameters have been conducted on annual and monthly bases, while additional verification of obtained results were conducted for different time periods.

The average increase in mean annual air temperature in Serbia is about  $0.6^{\circ}\text{C}/100$  years (Figure 46). A higher increase was recorded in the upper (mountainous) regions in the north of the country (over  $1^{\circ}\text{C}/100$  years), while the lowest increase was observed in the south-eastern part of Serbia (slightly higher than  $0^{\circ}\text{C}/100$  years). Within a year, the highest increase in temperature was recorded in spring, then in summer and winter, while a decreasing trend was recorded in autumn.

The forecast of mean annual temperatures is based on the regional climate models, with a wide range of changes, depending on the chosen scenario. According to the Climate Change Research Centre, the results of forecast based on this model show a temperature increase of  $0.5^{\circ}\text{C}$  to  $2^{\circ}\text{C}$  in the next fifty or so years, while further forecasts are more uncertain, due to possible changes in various parameters (Figure 47). It should be noted that RCM forecasts show the maximisation of temperature increase in the summer period.

The trend of the average sum of annual precipitation in Serbia, obtained on the basis of observed data, is slightly negative, but its geographical distribution varies. There is a trend of increase in the (south-)

western part of the country, and a trend of decrease in the eastern part, while in most parts of Serbia it is within the limits of  $\pm 10\%/100$  years. The changing of trend within a year, in terms of increasing, is recorded in the late summer or early autumn, while a decrease is recorded in May and in winter months.

Some of the recent regional climate models predict a precipitation surplus in the summer and early-autumn periods in the near future, which is in line with current trends, and a significant decrease in precipitation in the distant future. The RCM models also suggest a certain average decrease of all precipitation on the annual level in Serbia, ranging from 0% to 25%/ 100 years.

It is also significant for Vojvodina that the unpredictability of all annual precipitation (stochastic component) is increasing. In other parts of the country the stochastic component is stagnant or decreasing.

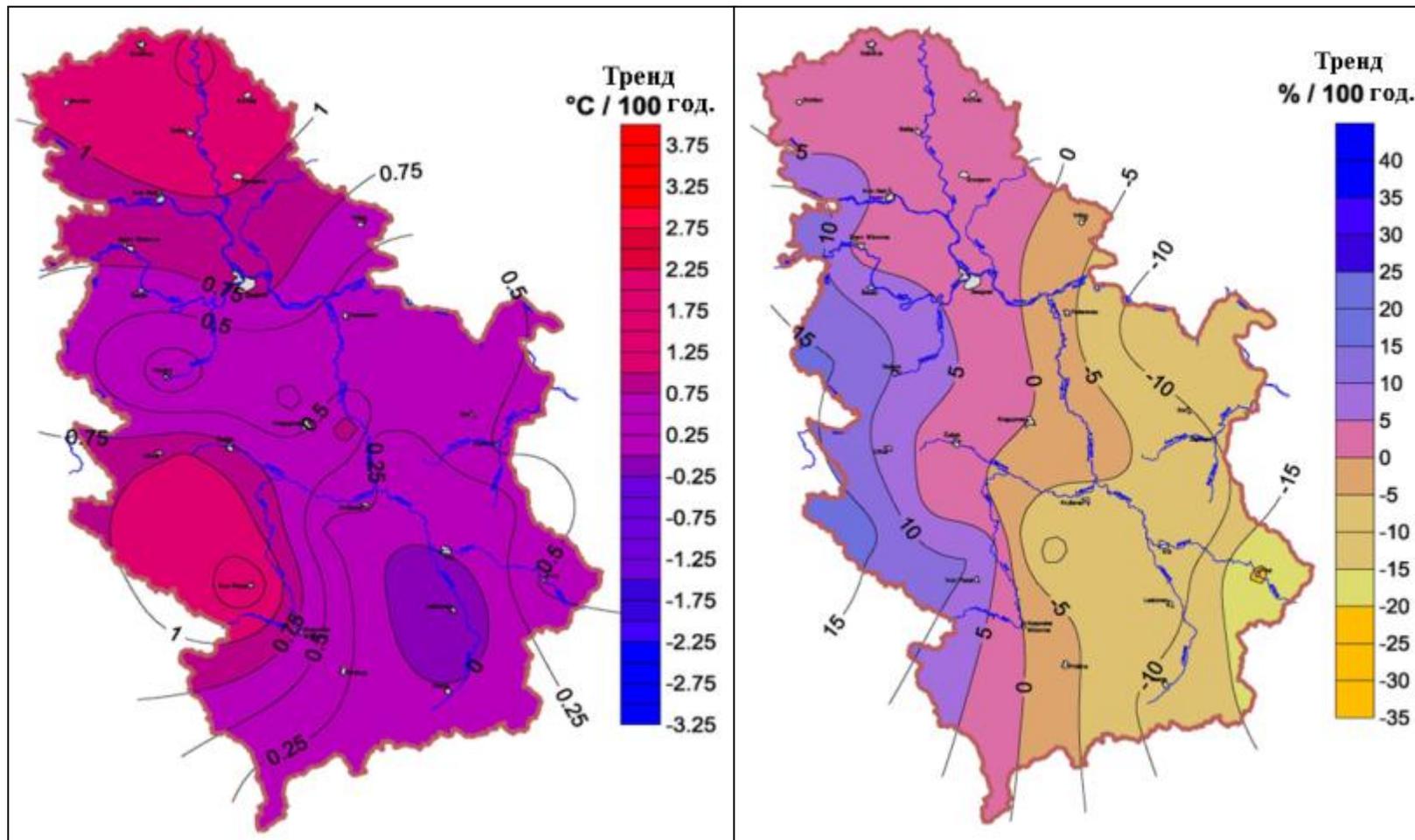


Figure 46: Annual temperature (left) or precipitation (right) trends in Serbia

Trend  $^{\circ}\text{C}/100\text{ yr}$

Trend  $^{\circ}\text{C}/100\text{ yr}$

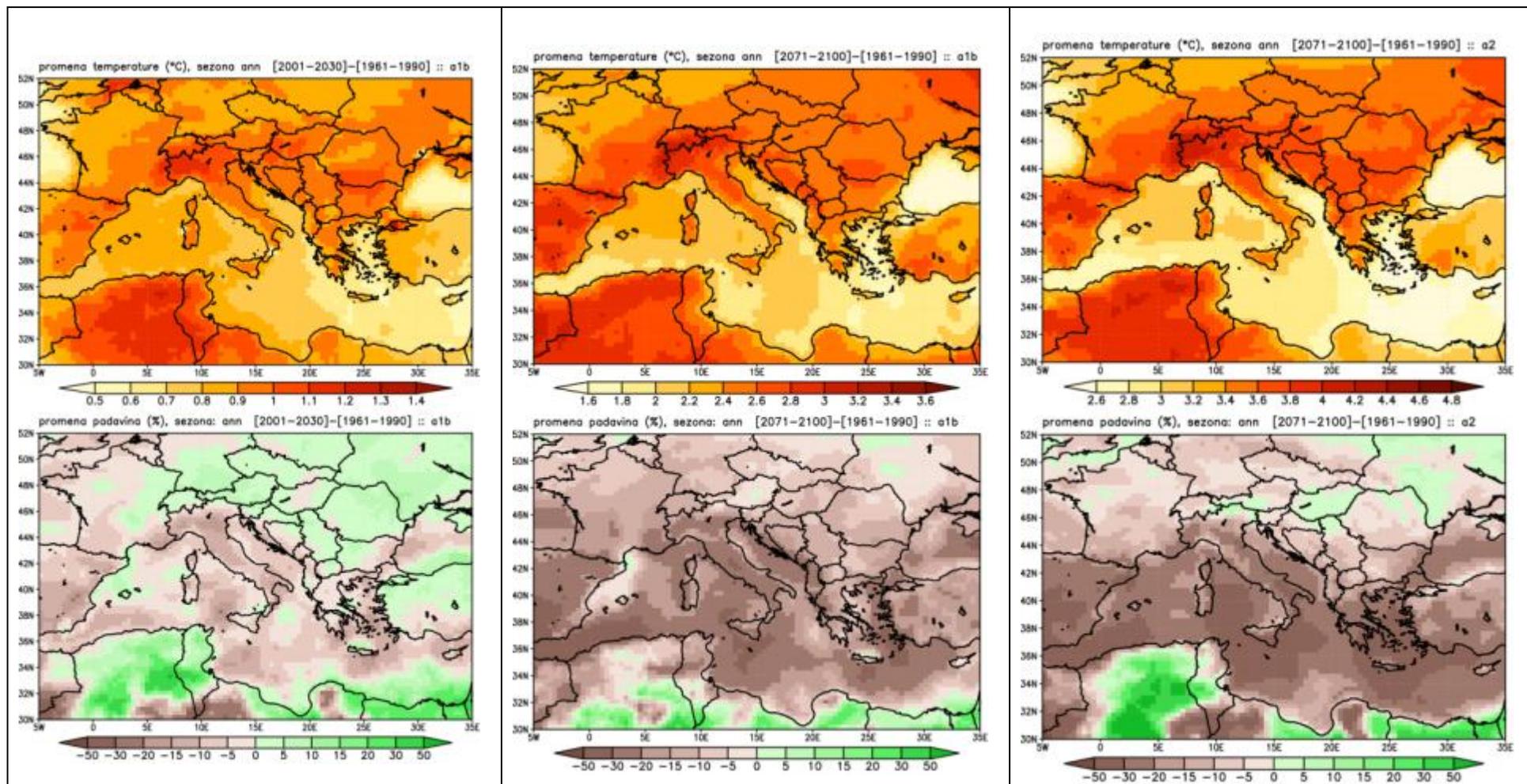


Figure 47: Annual temperature and precipitation change in the near (A1B) and distant future (A1B and A2 scenarios) compared to the period from 1961 to 1990

Temperature change (°C) season ann...

Precipitation change (%) season ann...

Hydrological trends are somehow in line with the observed climate trends, bearing in mind the fact that the river flow depends not only on climate change, but also on other factors, primarily anthropogenic. The trend of decrease in the mean annual flow in Central Serbia is about 30%/100 years, but its spatial distribution varies. The smallest change was recorded in the south-western part of Serbia and the biggest negative trend in the eastern part of Serbia.

It should be noted that a higher increase in temperature could entail a greater negative impact on the rate of flow in waterways on the territory of the Republic of Serbia.

In addition to the aforementioned changes in temperature and precipitation on the annual and seasonal level, it is very likely that significant changes can be expected in terms of intensity and frequency of climatic extremes, such as drought, heavy rain and other. It is certain that Serbia will be faced with an increasing number of dry spells in the future, which does not exclude the possibility of an increased frequency of high water events.

### **5.2.3. WATER REGIME CHANGES**

Changes in the water regime may occur in the Strategy planning period, depending on numerous factors. The most important changes are related to:

- water demand by different users - primarily for irrigation, supplying water to the public, supplying water for industrial purposes, including the cooling of thermal power plants, supplying water for fish farms;
- land use;
- impact of climate change, etc.

The factors that influence these changes are difficult to predict, so that the assessment of water needs for certain domains of water-related activity, expressed as projections, should be treated as conditional and with a great deal of uncertainty.

Below is an overview of the current and expected changes in the water regime of the waterways flowing into our country, and of a number of major domestic waterways.

In the case of the River Sava, the water regime issue should be addressed within the International Sava River Basin Commission, as well as through bilateral agreements with neighbouring countries. Bearing in mind that Slovenia and Croatia are EU countries with deadlines for reaching emission standards and standards of water quality in waterways, the further improvement in the water quality of the River Sava is expected, particularly due to the fact that Bosnia and Herzegovina and Serbia have committed to respecting EU standards concerning the application of the Water Framework Directive. However, although the Sava river basin is rich with water, the territories of upstream countries include large terrains suitable for irrigation, construction of fish farms, construction of thermal power plants and other purposes, which may lead to a reduction in flow, especially in the low-water season, which should be taken into account in bilateral and multilateral negotiations. It should also be borne in mind that the relatively good water quality of the Sava River is partly the result of the fact that the economic situation in the upstream countries is not good and that the industry does not function in line with its earlier capacity. It is therefore important to ensure that the development of industrial facilities in all upstream countries is accompanied by the appropriate construction of wastewater treatment plants. This is particularly important due to the fact that the issues of the quantity and quality of water are closely linked, and because Serbia has important sources of drinking water on the Sava River, whose safety must be a priority.

The smallest change in the water regime of waterways flowing into our country are expected on the River Drina, unless the plans for energy use of the River Tara, by transferring its water to the Morača

river basin, are implemented in Montenegro. It is also necessary to solve certain issues concerning the quality of water flowing from upstream territories, primarily the issue of floating waste.

The Tisa River is very unfavourable in terms of the water regime, due to the fact that the largest part of the basin is located on flat terrain (the Pannonian Plain), where evapotranspiration exceeds precipitation. Bearing in mind that all upstream countries plan to significantly increase water consumption for irrigation, fish farming and other types of agricultural production, the already poor quantitative status of the water of the River Tisa will be further threatened. If the plans of the upstream countries to expand irrigated surfaces were to be implemented, in the summer months the situation could be critical in terms of quantity and quality of water in the Tisa River. Therefore, it is extremely important to ensure integrated planning of water management for the Tisa River, within the framework of international activities in the Danube basin.

Regarding the issues of future water use in the Tisa basin, the possibility of transferring certain amounts of water from the Danube River to the Tisa basin, which is ensured by the construction of the Danube-Tisa-Danube Hydrosystem, is of great importance. However, due to the condition of the canal network, both in terms of quantity and quality of water, this issue must be urgently addressed.

It is clear that the issue of water management for the Tisa River must be considered within the framework of the integrated use of the Danube River. Although at this point, at the international level, the issue of quantitative indicators of water in the Danube basin is not considered important for the basin as a whole, if the trend of reducing the amount of water and increasing of water use (particularly for irrigation) is continued, it may also be necessary to open the issue of proper distribution of water of this important waterway.

On the territory of Serbia, special attention must be paid to the section that is backed up due to construction of HPP Đerdap/Iron Gate 1, where changes have occurred in certain parameters of water quality, sediment accumulation and conditions for the intensive development of plants. It is necessary to continue to carefully monitor this section of the Danube and carry out measures to prevent the negative impact of backwater.

The biggest issues in the balance of water in future can be expected in the basin of our largest local river - Velika Morava. The situation is particularly disadvantageous in the Južna Morava basin, both regarding the current situation and the potential adverse impacts of the factors of climate change. Therefore, the Strategy does not envisage, in the planning period, any significant increase in the irrigation of agricultural land on the territory of the Morava river basin (up to 25,000 ha). In the case of need for larger quantities of water, solutions should be sought after primarily in increasing the storage of water in the basin, and then in considering the possibility of transferring water from the water-richer Drina basin to the Morava basin.

The issue of the water regime of the Banat waterways that flow from neighbouring Romania must be addressed through bilateral cooperation, because most of the measures for the improvement of the situation should be implemented in the neighbouring country.

Regarding groundwater, special attention should be paid to addressing the issue of the quantitative status of the bodies of groundwater that are affected by overexploitation, primarily in Vojvodina. Possible solutions to this problem should be sought after in bringing additional quantities of water for the public water supply from the coastal area of major rivers, and in exploring the possibility of additional recharge of these aquifers with treated surface water.

### **5.3. FUNDS AND SCHEDULE FOR ACHIEVING GOALS, BY DOMAIN**

In order to allow the water sector to function in accordance with the principle of sustainable development and to achieve the aforementioned strategic and operational goals, it is necessary to enhance the capacity, ensure adequate scope and structure of funds and define the schedule for achieving these goals.

#### **5.3.1. PROJECTION OF FUNDS REQUIRED FOR OPERATION AND DEVELOPMENT**

The projection of necessary funds is given for the water sector domains in which the state participates at the federal, AP and the levels of local government (Table 61):

- Current operation and maintenance of existing publicly-owned water facilities and systems, which are used for protection against flooding, erosion and torrents, and for drainage and irrigation;
- Development in the field of water use: supplying water to the public and irrigation;
- Development in the field of water protection: sewage systems, wastewater treatment plants and surface water sewers;
- Development in the field of protection from water: protection from floods, erosion and torrents, and drainage.

In addition, projection also included funds required for the operation of the drinking water supply system and channelling, provided by operators, from the price of water.

Below is the projection of funds required for the operation and development, by areas of the water sector, for the period of twenty years, based on the measures necessary to reach the operational goals referred to in this chapter.

#### **Water regulation and use**

##### Supplying water to the public

The funds for the improvement of the situation within the domain of water supply are required to expand the capacity of water sources, construct plants for the preparation of drinking water, construct the main supply network of regional systems, and to construct new and complete/upgrade existing networks in settlements.

It is necessary to secure EUR 2 billion for activities within this domain: about 60% for water sources, water treatment plants and the main supply network, and about 40% for distribution networks in settlements.

Efficient operation and proper maintenance of the drinking water supply system, including regional systems (dams, reservoirs and main supply structures), require the provision of funds (from the price of water and services) in the annual amount of approx. EUR 362 million.

##### Irrigation

The pace and direction of the development of irrigation in the future will depend primarily on the federal strategy for agricultural production development, which will influence the determination of the private sector to invest in agricultural production, but will also depend on the position of this branch of economy in the macroeconomic plans in the region and beyond.

It is necessary to provide approx. EUR 875 million in the planning period for the rehabilitation of the existing publicly-owned system and the construction of new irrigation systems.

It is necessary to provide approx. EUR 11 million (funds from water charges) annually for the maintenance and operation of publicly-owned irrigation systems.

## **Water protection**

### Sewage systems

Sewage systems and systems for supplying water to settlements constitute a physical and functional entirety and therefore need to be developed in parallel. However, despite the fact that the largest investment has been planned in this domain, having in mind the current situation, it is clear that in the planning period it will not be possible to ensure a level of sewage system coverage, required by the public, including waste treatment, equal to the level of coverage of the drinking water supply system. This is why, in this period, the goal is to meet required EU standards for the sanitation of urban areas larger than 2,000 p.e., in accordance with the aforementioned priorities.

In order to achieve this goal, it is necessary to provide funds in the amount of approx. EUR 3.9 billion (20% for the sewage network, 10% for main collectors and 70% for the WWTP).

The efficient operation of sewage systems (which implies their proper current and investment maintenance) will require the annual amount of approx. EUR 194 million, which must be provided from the price of water and services.

### Surface water sewers

Construction of surface water sewers is the responsibility of local government and therefore it is not discussed in detail in the Strategy. It is estimated that at least EUR 3 billion should be invested in solving the problem of collecting storm water in settlements and its drainage, but it is much more realistic to rely on an investment of approx. EUR 1.5 billion in the considered twenty-year period.

## **Protection against harmful effects of water**

### Regulation of waterways and flood protection

Reducing the risk of flooding in the whole territory of the Republic of Serbia is a permanent task and goal, while improving the protection of the most important damage centres (cities, settlements, large commercial complexes, transport infrastructure, etc.) and works and measures on interstate waterways are priority activities.

Around EUR 260 million should be provided for the implementation of priority works and measures in the next 20 year period. Around 75% of these funds are required for investment works (reconstruction and extension of the existing facilities and construction of new ones) and around 25% of these funds are required for non-investment works.

Given the substantial volume of completed works on the regulation of waterways and the number of facilities built for flood control, the annual investment of approx. EUR 23 million (about 56% on the territory of Central Serbia and about 44% on the territory of AP Vojvodina) will be needed to maintain them in a functional state, including the modernisation of machinery and equipment and protection against flooding. The largest part of the cost (over 50%) is related to the regular annual maintenance of regulation and protection facilities and is covered primarily from fees.

### Protection against erosion and torrents

The construction of new facilities and the execution of necessary protective works require significant resources, because of their complexity and high cost, and the fact that there are still large areas prone to erosive processes. It is estimated that at least EUR 280 /ha should be invested in regulating land with low erosion rates, where no additional afforestation is needed, while in the cases of high erosion rates specific costs reach EUR 2,000 /ha. In order to achieve satisfactory condition, it is necessary to invest approx. EUR 240 million in the anti-erosion regulation of affected areas in the next twenty years, while preserving the operational design of constructed facilities and executed works will require the annual investment of around EUR 7.5 million.

### Protection against pluvial and groundwater flooding - drainage

The construction of modern drainage systems is an expensive activity, as can be seen from the following specific indicators:

- Investment in drainage systems through the canal network only, average coverage 10 to 15 m/ha, amounts to approx. EUR 260 to 330 /ha in the case of gravity drainage systems, and approx. EUR 450 to 800 /ha in the case of pumping systems, depending on the complexity of the system;
- Investment in complex drainage systems (with canal network and pipe drainage) amounts to approx. EUR 800 to 1,150 /ha in the case of gravity drainage systems, or about EUR 1,000 to–1,600 /ha in the case of pumping systems.

The amount of approx. EUR 300 million should be provided for drainage works in the considered period. In accordance with the *Law on Water*, the Republic or the Autonomous Province participates solely in financing the construction of the basic canal network. Such investment to the detailed canal network facilities requires regulatory changes.

It is necessary to provide approx. EUR 34 million annually, from water charge funds, to the maintenance and operation of publicly-owned drainage systems.

### **Summary of required funds**

From all of the above-mentioned, it can be concluded that for the sound operation and development of the water sector over the next twenty years, it is necessary to provide funds in the amount of EUR 21.7 billion, out of which somewhat more than 40% should be invested in development (Table 61 and Figure 48).

Table 61: Projection of funds required in the planning period, in millions of EUR

Ordinal no.	Water sector fields	Funds required for current operation		Funds required for development	Total funds required	% (percentage)
		annual	total in the period			
1	2	3	4	5	6 (4+5)	7
1	Drinking water supply	349,650	6,993,000	850,000	7,843,000	36.14
2	Regional systems	12,350	247,000	1,150,000	1,397,000	6.44
3	Irrigation	11,000	220,000	874,500	1,094,500	5.04
	<b>Water use</b>	<b>373,000</b>	<b>7,460,000</b>	<b>2,874,500</b>	<b>10,334,500</b>	<b>47.62</b>
4	Channelling and water protection	193,800	3,876,000	3,900,000	7,776,000	35.83
5	Surface water sewer			1,500,000	1,500,000	6.91
	<b>Protection of water</b>	<b>193,800</b>	<b>3,876,000</b>	<b>5,400,000</b>	<b>9,276,000</b>	<b>42.74</b>
6	Flood protection	23,000	460,000	260,000	720,000	3.32
7	Protection against erosion and torrents	7,500	150,000	240,000	390,000	1.80

8	Drainage	34,000	680,000	300,000	980,000	4.52
	<b>Protection from water</b>	<b>64,500</b>	<b>1,290,000</b>	<b>800,000</b>	<b>2,090,000</b>	<b>9.64</b>
	<b>TOTAL (1 to 8)</b>	<b>631,300</b>	<b>12,626,000</b>	<b>9,074,500</b>	<b>21,700,500</b>	<b>100.00</b>

The largest amount of funding should be provided in the utility sector (water supply and urban sewage, including surface water sewers), both for current operation (88% of total funds for these purposes) and for development (about 82% of the total funds for development).

Figure 2:



Figure 48: Structure of investment in the development of individual domains of the water sector

Structure of investment in the development of the water sector

- Water supply
- Regional systems
- Channelling
- Surface water sewer
- Drainage
- Irrigation

### 5.3.2. SOURCES OF FUNDING FOR WATER MANAGEMENT

The projected development and efficient water sector management requires, according to estimates, funds in the amount of approx. EUR 21.7 billion over the next twenty years, which can be secured from various sources.

#### Sources of funding for development

*The development of the water sector* can be financed from sources specified in the chapter entitled "Financing of water management".

Capital investment must be extensive over the next twenty year period, because only in this way is it possible to achieve strategic and operational goals within the domain of water sector development. The

proposed structure of financing, i.e. participation of individual sources in the financing of development (total of EUR 9,074.5 million) is shown in Table 62 and Figure 49.

Table 62: Sources of funding for the development of the water sector, in millions of EUR

Purpose of investment	Sources of funding						Total	Share in %
	Budget funds RS and AP	PUC from the price of water	Other sources (credits, etc.)	IPA and other funds	Local self-gov.	Owner resources of investor		
Drinking water supply	200	200		200	200	50	850	<b>9.4</b>
Regional systems	400	100	150	300	100	100	1,150	<b>12.7</b>
Irrigation			200	100	50	524.5	874.5	<b>9.6</b>
<b>Water use</b>	<b>600</b>	<b>300</b>	<b>350</b>	<b>600</b>	<b>350</b>	<b>674.5</b>	<b>2,874.5</b>	<b>31.7</b>
Channelling and water protection	850	300	700	1,150	300	600	3,900	<b>43.0</b>
Surface water sewer	150		700		650		1,500	<b>16.5</b>
<b>Protection of water</b>	<b>1,000</b>	<b>300</b>	<b>1,400</b>	<b>1,150</b>	<b>950</b>	<b>600</b>	<b>5,400</b>	<b>59.5</b>
Flood and anti-erosion protection	300	0	0	100	100	0	500	<b>5.5</b>
Drainage	120	0	0	50	60	70	300	<b>3.3</b>
<b>Protection from water</b>	<b>420</b>			<b>150</b>	<b>160</b>	<b>70</b>	<b>800</b>	<b>8.8</b>
<b>TOTAL</b>	<b>2,020</b>	<b>600</b>	<b>1,750</b>	<b>1,900</b>	<b>1,460</b>	<b>1,344.5</b>	<b>9,074.5</b>	<b>100.0</b>
	<b>22.26%</b>	<b>6.61%</b>	<b>19.28%</b>	<b>20.94%</b>	<b>16.09%</b>	<b>14.82%</b>	<b>100.00%</b>	

The funds from the budget of the Republic of Serbia and the Autonomous Province of Vojvodina, recorded through funds for water, or as appropriations in the budget, as well as funds from water pollution fees will be used for investment in the construction and reconstruction of the following:

- water protection facilities, i.e. wastewater treatment plants and related facilities;
- facilities and systems for the drinking water supply, of regional importance (multi-purpose regional systems), and infrastructure that enhances the capacity of water supply sources;
- facilities for protection from fluvial water (protection against flooding, erosion and torrents);
- facilities for protection from pluvial water and groundwater (basic canal networks for drainage of agricultural land).

Funds generated from the price of water and from the profits of public utility companies will be used to increase utility standards for the public and industry at the local level, i.e. for:

- participation in the construction of multi-purpose regional systems;
- construction of infrastructural network for the supply of drinking water to settlements;
- construction of sewer infrastructure in settlements.

This projection is based on the assumption that the Republic of Serbia will create conditions for obtaining significant amounts of IPA funds. The largest part of financing planned to be obtained from IPA funds will be used for environmental protection, i.e. for building wastewater treatment plants and for the improvement of conditions of the drinking water supply and/or for enhancing the utility infrastructure of local government. It has also been planned to use European pre-accession funds for the development of cross-border cooperation in the field of regulating border or transboundary waterways, while a portion of the funds will be used for the development of irrigation and rural development.

Local government should participate in the development of all fields of the water sector, whereas their greatest interest is to provide citizens and industry with adequate conditions for drinking water supply, and for collection and drainage of wastewater and storm water. Therefore, the funds that local government provide from their own revenues are intended for:

- building a network to supply settlements with water;
- participating in the construction of regional multi-purpose systems;
- constructing a network infrastructure in the settlement for sewage and surface water drainage, and for constructing of appropriate facilities for these purposes;
- repairing, reconstructing and constructing facilities for protection from fluvial flooding (flooding of 2nd class water, erosion and torrents);
- participating in the construction of the canal network for drainage and irrigation of agricultural land.

It is also expected that some interested investors will invest their own resources in facilities and systems whose construction would create more favourable conditions for their business operations. It is assumed that legal entities and/or natural persons will be interested in investing in facilities for their own water supply and treatment of their own wastewater, construction of local facilities for flood protection and construction of the canal network for drainage and irrigation.

The rest of the funds will be provided from other sources, such as loans from banks that finance the projects regarding the construction of infrastructure facilities and systems, loans from equipment suppliers, donations and other sources, to be used for the purposes specified in Table 62.

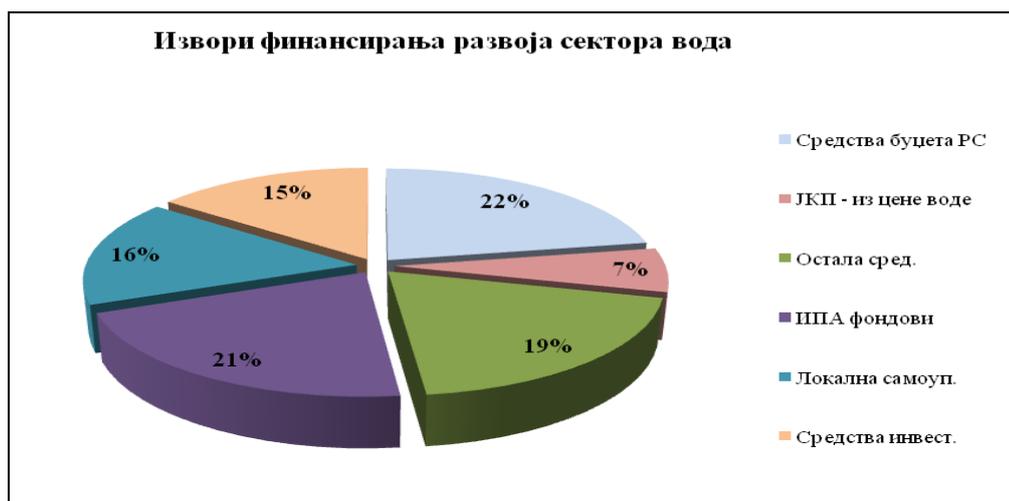


Figure 49: Sources of financing development by water sector domain

Sources of financing the development of the water sector

- RS budget funds
- PUC – from the price of water
- Other funds
- IPA funds
- Local gov.
- Investors

*Current operation*, including maintenance, requires around EUR 630 million per year (average for twenty years), and should be financed from:

- the price of water, in the case of utility activity from the drinking water supply and channelling;
- water charges, in the case of other activities of general interest (drainage and irrigation, protection against the harmful effects of water, etc.);
- own funds of the owners of water facilities and systems.

### **Increase in water price and revenue from fees**

The price of water and services is the most important source of funding for the utility sector. Achieving an economic price (of water supply and urban sewage services) must be adjusted to the economic power of the public and industry. The average projected economic price of water for the twenty-year period is EUR 1.3 /m<sup>3</sup>, without value added tax (Figure 50).

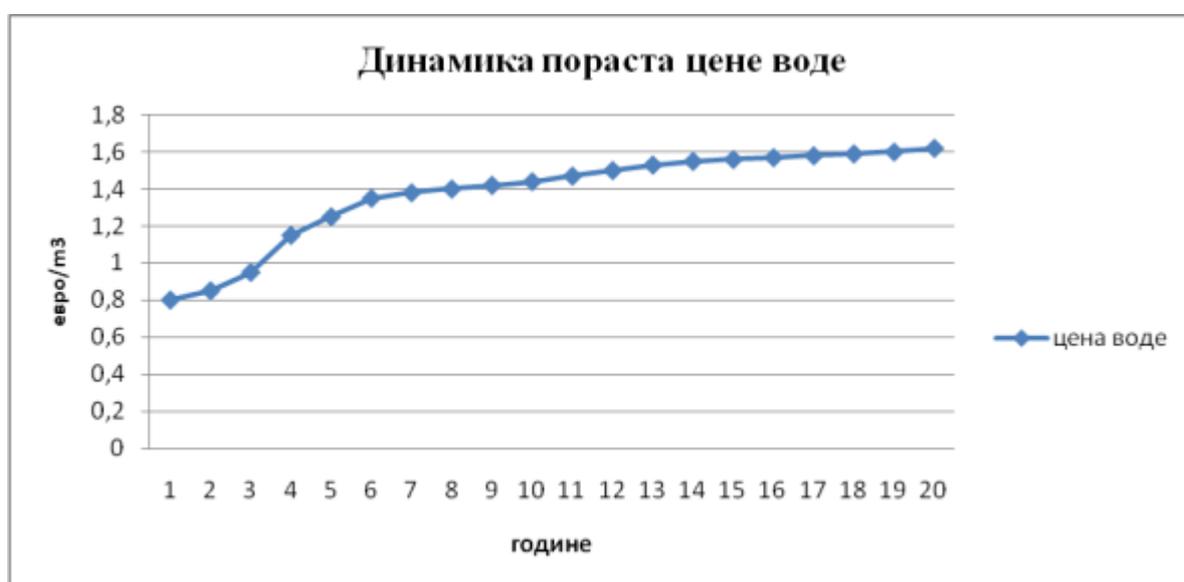


Figure 50: Schedule of achieving the economic price of water

Water-price increase schedule

EUR/m<sup>3</sup>

Price of water

Year

It has been estimated that, by establishing an economic price of water and statutory level of water fees, the total amount of approximately EUR 1,350 million would be provided from the fees for water use and fees for discharged water (paid by utility service operators and payers who abstract water for bottling, i.e. use it as a final product, but also for electricity generation, for plants and other purposes). These are revenues of the budget of the Republic of Serbia (water fund). Also, it has been estimated that these payers will also provide revenue from water pollution fees to the budget of the Republic of Serbia (Table 63). It has been estimated that the share of utility sector in total prospective funds will amount to approx. 60%.

Table 63: Potential revenue from the fees charged for the use and protection of resources, in millions of EUR

Number	Type of fee	Period				Total
		1-5	6-10	11-15	16-20	
1	Fee for the use of water resources	209	231	251	266	957
2	Fee for discharged water	74	92	105	117	388
<b>3</b>	<b>Total (1) + (2)</b>	<b>283</b>	<b>323</b>	<b>356</b>	<b>383</b>	<b>1,345</b>
4	Fee for polluted water*	42	49	36	19	146
	<b>Total (3) + (4)</b>	<b>325</b>	<b>372</b>	<b>392</b>	<b>402</b>	<b>1,491</b>

\* funds estimated only for the industrial sector

The revenue from other water charges (drainage, the use of water control facilities and systems) used primarily for the purpose of financing current operations (Table 64) should double by the end of the observed period. This requires updated databases of payers, an annual increase in the amount of fees by 3 to 4% and a collection rate higher than in the previous period.

Table 64: Total potential revenue from other water charges, in millions of EUR

Type of fee	Purpose of use		Total
	Current operation	Development	
Drainage fee	730	80	810
Fee for the use of facilities and system	270		270
<b>TOTAL</b>	<b>1,000</b>	<b>80</b>	<b>1,080</b>
<b>Share in %</b>	<b>92.6</b>	<b>7.4</b>	<b>100</b>

### 5.3.3. SCHEDULE OF INVESTMENT IN THE CONSTRUCTION AND RECONSTRUCTION OF MAJOR WATER FACILITIES

The pace of development in the water sector will not be the same every year, but investment will depend on the pace of providing appropriate social and economic conditions, including financial and technical capacity (Figure 51).

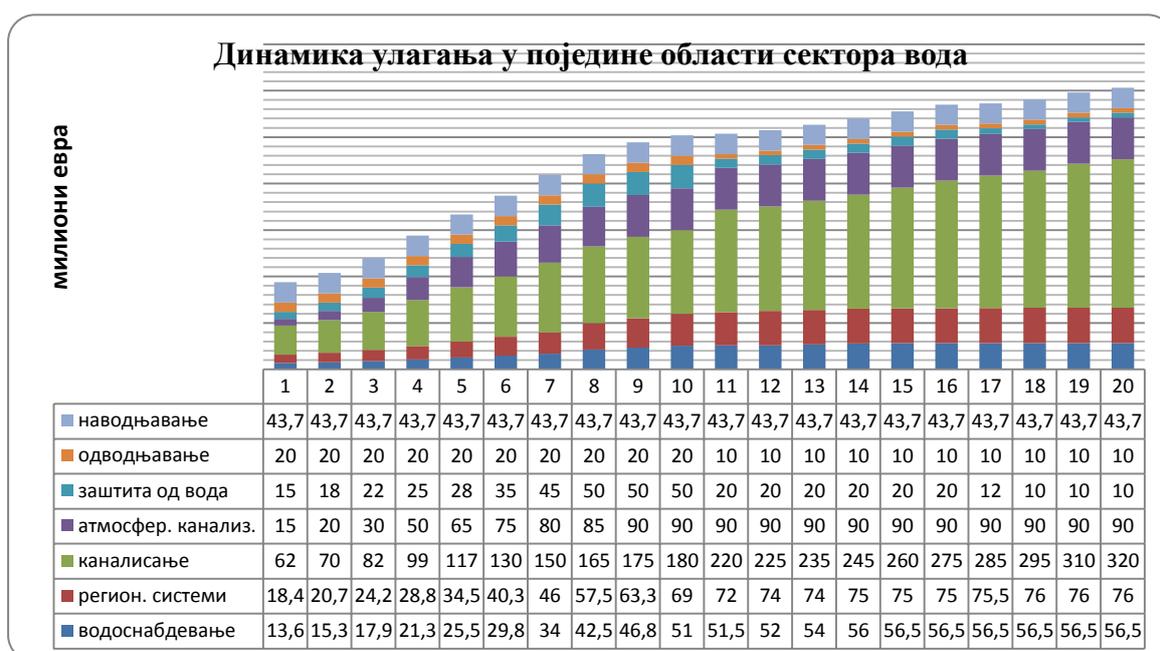


Figure 51: Schedule of investment in the development of the water sector

## Schedule of investment in individual water sector domains

Millions of EUR

Irrigation

Drainage

Protection from water

Surface water sewers

Channelling

Regional systems

Water supply

The observed twenty-year period is a very long period in terms of predicting social, political, economic, fiscal and other operational conditions, for which framework projections at the federal level are non-existent, so that investment priorities constituted the basis for planning the schedule of investment. However, the projection for the ten-year period was prepared by taking into account macroeconomic projections related to the growth of gross domestic product and the growth of investments in the Republic of Serbia in the mentioned period<sup>50</sup> (Table 65) as well.

The scope of investments in water sector development in the first decade or so must ensure the increase of participation of these investments in GDP to 1.07% by 2024, which is twice what it was in 2012. Such an increase would also mean an increase in the share of total investment in the water sector from 4.5% in 2012 to 6.10% in 2023. Previous estimates were based on the average annual real GDP growth of 3%, that is - on the GDP value of approx. EUR 47 billion in 2023 (approx. EUR 6,600 per capita).

Table 65: Water sector share in the country's macroeconomic policy

Indicator (million €)	Years									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Gross National Product	33,737	34,893	36,093	37,328	38,821	40,374	41,989	43,668	45,371	47,232
Investments	4,236.	4,643.	5,056.	5,496.	5,936.	6,393.	6,847.	7,319.	7,795.	8,263.
Invest. in the water sector	188.1	207.9	239.6	287.7	333.7	373.7	418.7	463.7	488.7	503.7
<b>Real growth rates</b>										
Gross National Product	1.0	1.8	2.0	3.0	3.0	3.3	3.5	3.5	3.5	4.0
Investments	4.7	9.6	8.9	8.7	8.0	7.7	7.1	6.9	6.5	6.5
Investment in the water sector	9.4	10.5	15.2	15.2	20.1	16.0	12.0	12.0	10.7	5.4
Share of water sector investment in total investment	4.44	4.48	4.74	5.23	5.62	5.85	6.11	6.33	6.27	6.10
<b>Share in GDP</b>										
Investments	12.56	13.31	14.01	14.73	15.29	15.84	16.31	16.76	17.18	17.49
Investment in the water sector	0.56	0.60	0.66	0.77	0.86	0.93	1.00	1.06	1.08	1.07

The assumption underlying the macroeconomic projections for the ten-year period is that the EU member status will be acquired at the end of the period and that the economic benefits brought by such

<sup>50</sup> The elements for the assessment of given indicators were taken from the 2014 Fiscal Strategy with projections for 2015 and 2016 and other national strategic documents.

political development will be used. Under this scenario, the dominance of consumption growth is replaced by the dominance of investment growth. The backbone of development would be shifted from the service sector to the tradable goods sector, primarily industry. Taking into consideration that this sector is based on water as a raw material or as a source of energy, an increase in the total water consumption is expected in the years to come.

## 6. FUNCTIONS (MEASURES) FOR THE ACHIEVEMENT OF ESTABLISHED OBJECTIVES OF WATER MANAGEMENT

The above established strategic and operational objectives, that is, an efficient and rational water management system in accordance with sustainable development can be achieved only if:

- an appropriate legal environment has been provided, including the regulation of property rights;
- there is an organisational and institutional system established, capable of providing integrated water management on the territory of the Republic of Serbia;
- depopulation has stopped and conditions for the development of industry are provided;
- an ambience for investments and profitable business operation has been provided;
- a system of national priorities has been defined and incentives and more favourable credit lines for financing them have been provided;
- a system of self-financing of the water sector has been established through the application of the “user pays” and “polluter pays” principle and achieving an economic price of water in accordance with the economic and social status of the service users;
- a tariff system has been defined in the field of water supply and channelling in settlements;
- appropriate use of funds has been provided through funds for water or appropriate financial institutions;
- a method of using EU funds has been defined;
- the legal framework has been provided for a public-private partnership,
- a regulatory function has been secured and standards of operations in the water sector have been established;
- there is increased motivation of the public and its involvement in all phases of planning in the water sector;
- there is an increased level of cooperation between public administrative bodies, public companies and institutions, professional, scientific, and financial institutions;
- better relations have been established within the domains of planning, financing, investment in capital infrastructure facilities, between the Republic, the province and local government.

In accordance with the above, reaching defined goals requires that, in addition to an adequate legal and institutional framework, the following basic measures - functions are adequately implemented:

- planning and implementation of plans;
- preparation and implementation of investments;
- providing means and capacities;
- maintenance of facilities and systems;
- supervision and control;
- other measures (functions).

## 6.1. REGULATORY FRAMEWORK

As the Law on Water is the basic legal act for water management, its full implementation calls for the completion of the prescribed bylaws within statutory deadline. This also applies to planning documents (water management plans on water areas, flood risk management plans and a plan to protect water from pollution), which must be passed by the end of 2017, at the latest.

A mandatory element of water management plans must be utility service of drinking water supply through the system of public water management and collection, drainage and wastewater treatment through the system of wastewater in the section related to planning the construction and financing of water facilities, as follows:

- for the water supply: water intake, water treatment plants for drinking water, main pipelines and tanks with accompanying devices,
- for channelling in settlements: main collectors, plants for wastewater treatment, sludge treatment, discharges from the plant into the receiver and other facilities defined in the Law on Water as water facilities for these purposes.

In completing the regulations, relevant EU directives governing the water sector and protection of the environment in general must be taken into account, as well as other EU directives that are of importance to water management, the so-called Horizontal Directives (Appendix 1). These directives establishes standards in certain areas, which should be established and applied in a given period. Given that this activity requires significant funding, the Government, at the proposal of the relevant ministry must issue a special act defining the priorities and a timetable for the establishment of certain standards.

Also, the Government must adopt relevant acts which will define the method of calculating water charges, in order to gradually introduce the application of the principle of “user pays” and “polluter pays” principle. This primarily refers to charges whose amount should be determined based on annual costs of management and maintenance (drainage, the use of water facilities and systems for different purposes).

Strategies for the restructuring of public water and public utility companies should define responsibilities and the necessary capacities of these companies and their effective implementation should provide corporate governance, better business conditions and the provision of quality services in the water sector, as soon as possible.

Bearing in mind the length of the planning period, and the obligation of transposing EU regulations in the domain of water, it is reasonable that the amendments to the Law on Water are adopted, within which:

- water areas should be determined by hydrographic principle, in order to provide preconditions for an efficient water management;
- the number of water management companies should be reduced;
- charges for water discharge and charges for water pollution should be consolidated into a single water charge for water protection;
- activities of drinking water supply through the system of public water management and collection, drainage and wastewater treatment system of public sewers should be separated from public utility companies performing several utility activities and new companies should be formed to perform these tasks; in case that for organisational and economic reasons this separation is not justified, separate record keeping of income and expenditure in these activities should be provided.

If the Law on Water is amended/supplemented in the above-mentioned manner, interventions to other regulations (the utility sector, the local government, the budgetary system, etc.) will be necessary.

## 6.2. INSTITUTIONAL FRAMEWORK

By bringing together under one ministry (the Ministry of Agriculture and Environmental Protection) the state administrative tasks related to water management and environmental protection, certain improvement of the institutional framework has been made. In this way, this ministry has become responsible for water use (with the exception of utility activity which relates to the water supply), protection of water as a resource, as well as protection from the damaging effects of water. Further improvement in institutional and organisational terms could be achieved by extending the jurisdiction of the ministry to utility activities of drinking water supply through the public water supply system and collection, drainage and wastewater treatment system through the public sewage system. This would contribute in the sense that the issues surrounding water use and protection are addressed in a comprehensive and rational way, especially within the sphere of planning and financing the construction of water facilities (within the domain of water supply - water intake, drinking water treatment plants, main pipelines and reservoirs in the area of protection of water - the main collectors, wastewater treatment plants and other facilities for wastewater treatment).

Within this ministry there would still be a government authority responsible for water management, which would carry out all duties prescribed by the applicable regulations pertaining to the strategic planning, development and improvement of the water regime and other activities conducted to improve and rationalise water use and provide a higher level of protection of water and protection from the harmful effects of water. In order for this institution to successfully perform all necessary tasks, it is necessary to continue to manage and promote the Water Information System of the Republic of Serbia. This government authority would have, as it has been the case so far, an established connection with the administration bodies on the Autonomous Province and of the City of Belgrade, whose competence, above all, would be the preparation of plans and programmes for the territory of the Autonomous Province and the City. The plans and programmes would be harmonised and consolidated in a single plan and programme for the Republic of Serbia.

State monitoring of water quality, which includes prescribed and harmonised programmes for the control of quality of surface water and groundwater of the first aquifer and rainfall would be carried out by the national organisation in charge of hydrometeorological affairs.

The proposed solution requires changing legislation in many areas: on the competencies of ministries (if the utility sector is included), water, environment, budgetary system, self government, utility activity, hydrometeorological affairs and others.

The next hierarchical level consists of public water management companies, whose restructuring should be implemented as soon as possible. In the restructuring process, the existing ownership status of these companies should be maintained, together with:

- the improvement of corporate and financial management of companies;
- the establishment of efficiency criteria and mechanisms for the control of operations;
- providing professionalised management of public companies and effective oversight role of the Government.

It is assessed that an increase of efficiency in performance of tasks would be provided if the number of public water management companies in the Republic of Serbia is reduced to one, or two, with several centres organised primarily by the hydrographic principle.

It should be noted that the above mentioned changes in the organisational structure of the water sector, in the part referring to public companies, is not in accordance with current regulations, especially the Law Determining the Jurisdiction of the Autonomous Province, the Law on the Capital City, and the Law on Water. Acceptance of such a solution requires amendments to the above-mentioned laws.

The operational performance of tasks in the water sector is done by water management companies and other legal entities that must be licensed by the relevant ministry, the licence confirming their technical and technological equipment and staff and organisational capacity to carry out these tasks. Companies engaged in the supply of drinking water through the public water supply system, as well as in the collection, removal and treatment of wastewater through the public sewage system must also be in possession of a licence issued by the ministry responsible for water management. In addition to the assessment of the technical and technological equipment and staff and organisational capacities of companies engaged in said utility services, the following aspects should be included in licensing:

- protection of the interests of consumers, by establishing a certain balance between price and quality of services provided, without the more significant participation of state subsidies;
- the provision of security in respect of the tariff system, which creates favourable conditions for attracting private investments.

Bearing in mind the macroeconomic strategy for Serbia and projected relatively modest economic growth in future, it can be concluded that the efficient financing of water sector development could ensure the establishment of special financial institutions (a fund with the status of a legal entity, a specialised development bank for water, etc.), instead of the existing budget fund for water. This institution would be associated with the ministry responsible for water management and would provide funds for the implementation of their programmes and plans, based on established criteria for evaluating development projects. This financial institution would define priorities in the use of resources in cooperation with this ministry. The following activities would be in its jurisdiction, which is of particular importance:

- award of incentive funds,
- granting loans to investors,
- issuance of guarantees,
- purchase of securities, and
- other tasks in accordance with the law.

It is estimated that more effective implementation of the projects of capital importance for the Republic, region and/or local government, as well as better security of funds, especially those that do not originate from public funds (IPA funds, grants, loans), would be achieved through *special centres/agencies*. The required capacity, by number and qualifications, would be conditioned by the scale and pace of investment activities in a particular area, with the necessary preparation and ongoing training of qualified personnel for the performance of investment works.

The proposed modifications to the institutional framework take time and certain funds. However, the strengthening of capacities in the water sector (public administration, public water companies, local authorities, public utility companies and other companies and institutions) should commence immediately, in order to ensure appropriate staff are able to respond to requests of the EU accession process and to implement the upcoming investment projects effectively and in a manner that assures quality.

Particular importance should be given to establishing closer links with research organisations. Under the provisions of the *Law on Water*, the ministry responsible for water management is given the possibility to authorise scientific research organisations that, by conducting a study and research work particularly significant for water management, would be expert support to the state administrative bodies. In this regard, the responsible ministry should implement this provision and ensure the involvement of the Jaroslav Černi Institute for the Development of Water Resources, as a leading research institution in the water area in Serbia, on research, design and supervision tasks in the framework of development projects, as well as activities in the framework of international cooperation.

### 6.3. PLANNING AND IMPLEMENTATION OF PLANS

Appropriate regulatory and institutional frameworks are a prerequisite for other operations in the water sector to be performed in a satisfactory manner.

In this context, one of the first activities includes planning, which is part of the preparatory - pre-investment phase. Planning can be at the national level - strategic and operational, at the level of the Autonomous Province, at the level of local government, as well as by legal entities and natural persons. Different institutions and other legal entities and individuals have the jurisdiction in the implementation of plans and investment activities arising from them, depending on the level of planning.

The ministry responsible for water management is in charge of strategic planning. *The Water Management Strategy on the territory of the Republic of Serbia* represents the basic document which provides integrated and unified water management on the territory of the Republic. Mutual compatibility is required of this and other strategic documents which, at the federal level, deal with natural resources and goods, in order to reduce conflicts of interest in the use of resources, ensure environmental protection and achieve the greatest impact of investments. This ministry is responsible for the preparation of a water management plan on the part of the basin of the Danube River in Serbia, which, like the Strategy itself, has been adopted by the Government of the Republic of Serbia.

Public water management companies prepare, and the Government, i.e., the executive authorities of the Autonomous Province and the City of Belgrade adopt water management plans in water areas, within which the parameters needed for the rational use and protection of water as well as the protection from water in a particular river area, are defined. The plans, in addition to other parameters prescribed by the *Law on Water*, also include water balance, the impact of human activity on the status of water, areas under threat, a list of the environmental objectives in terms of surface and groundwater and protected areas, a programme of works and measures for achieving these objectives, as well as necessary works and measures within certain domains of the water sector. A mandatory content of the plans is also an economic analysis of the use and protection of water (including utility activities of drinking water supply through the public water supply system and collection, drainage and wastewater treatment system through the public sewage system in accordance with the *Law on Water*) and the protection from water, as well as the priorities, dynamics and the manner of providing funds for the implementation of the planned works and measures.

Operational implementation of water management plans in the water area is carried out on the basis of annual programmes of water management, adopted by the same bodies as in the case of water management plans. Public water management companies participate in the preparation and implementation of these programmes, within their scope of work.

Planning of investment activities at the level of local government, which also includes facilities for the public water supply and channelling in settlements, is implemented through programmes of development and urban plans, prepared by the relevant state institutions - directorates, institutes or other organisational forms. It is essential that public utility companies engaged in water supply and channelling in settlements are included in making these plans and programmes, in order to have planning that is based on the relevant parameters. Operational implementation of plans and programmes is carried out through competent utility companies. If these utility activities are consolidated under the jurisdiction of one ministry, the state would be an important factor in the planning of investment activities in this segment of the water sector, primarily in the case of a regional hydro system and the construction of water facilities for the performance of the mentioned utility activities.

Individual legal and natural entities may also plan and implement certain investment activities, to improve their own economic conditions and promotion of the environment. If the construction of the planned facilities affects the water regime, the alignment of these activities with the relevant

documents in the water area is necessary, which is provided by the water acts issued by the competent authority in the water sector.

#### **6.4. PREPATION OF INVESTMENTS AND INVESTING**

##### **6.4.1. Phases and activities**

Successful implementation of the investment project must be based on an efficient and well-organised implementation of all necessary activities within the preparatory (pre-investment) phase, investment phase and operational phase.

Preparatory - pre-investment phase is perhaps the most important in the entire investment cycle, given that the quality of its implementation depends on the efficient implementation of the following phase - the investment phase.

Within this phase the investor, starting from the needs and possibilities, selects priority facilities to be built. The main criterion according to which a water facility, i.e., a system, is classified as potential for implementation should be compatibility of its development with strategic and planning documentation, and especially with the Water Management Strategy of the Republic of Serbia and the water management plan of the water area in which the facility is located. The necessary technical and other documentation for the selected facility are produced based on relevant bases (engineering geological, geodetic, hydrological, etc.), as well as urban, water management, economic, environmental and other conditions. For facilities and works that have an impact on the water regime, water conditions are determined by the administrative authority of the Republic, the Autonomous Province or the City of Belgrade, under the authority given by the *Law on Water*.

The selection of priority projects, i.e., priority facilities whose construction is financed from public funds (Republic of Serbia and the Autonomous Province) must be made on the basis of objective criteria, which include:

- significance of the project/facility,
  - international, national, regional, local,
  - multipurpose character of the facility,
  - the number of direct and indirect facilities,
  - national and security importance of the facility,
  - the degree of influence on the international integration of Serbia;
- economic feasibility of construction
  - cost effectiveness of the implementation of the project/facility, expected effects of the investments and their enlargement,
  - the level of co-financing the project/facility (from other public revenues, own funds or other sources),
  - the possibility of providing funds for the operation and maintenance of the facility by their users,
  - inability to finance construction in another way,
- other criteria,
  - the degree of completion of the facility or the system,
  - supply with planning and project documentation,
  - the quality of the participants in the implementation of the project, and construction of the facility - system,
  - the degree of mobilisation of domestic resources for the completion of the facility - system,
  - impact of the structure on the environmental conditions.

In the case where a larger volume of funds to finance the investments is provided in the budget of local government units, the selection of priority projects must be based on the fulfilment of the following conditions:

- the project is included in the medium-term plan of capital investments of local government;
- its implementation solves the life problems of the public;
- implementation of the project meets the needs of multiple numbers of users;
- planning and project documentation are provided;
- Participation of a larger number of entities is possible in the financing of the project (the state, the Autonomous Province, other local government, interested legal entities and natural persons);
- involvement of major domestic capacities is ensured;
- the effects of the investment are substantial, including the impact on the environment;
- the facility cannot be financed in any other manner.

The documentation made within this phase also includes evaluation of financial, social, economic and environmental justification on the basis of which the decision on the construction of the facility is made (investment decisions). The investor provides financial funds from various sources, and which sources will be represented and in which amount will depend primarily on the importance of the facility and its investment value, but also on the ability of the investor to provide the necessary resources (own funds, co-financing, grants, loans, credit from commercial banks or banks that are financing the construction of infrastructure facilities, the means from earmarked funds, suppliers or manufacturers of equipment, other private partners, funding from public funds, funds pooled with neighbouring government, etc.).

Obtaining a building permit for the implementation of selected facilities is the last step in the preparatory phase. To obtain a building permit for facilities that have an impact on the environment, it is necessary to have a proper study of its influence.

The beginning of the investment phase must be conditioned by closed construction of financing for the project. Tendering and contractor selection are activities that precede the most important part of this stage - construction of the facility. Construction must be carried out in accordance with the technical documentation and building permit, with the required professional supervision (control of quality of works and materials, the application of regulations, standards and technical norms, etc.). Technical inspection and obtaining an occupancy permit for the built facility are the final activities in this phase.

Operational phase includes exploitation of the facility and its maintenance in functional condition. The owner or the user of the facility is required to bear the costs of current and investment maintenance of the facility, and if necessary, to undertake regular, special and specialised examinations of the facility.

#### 6.4.2. HOLDERS OF INVESTMENT

Holders of investment may be from different institutional levels, depending on the significance of the investment project (Table 66).

Table 66: Holders of investment according to the importance of the investment project

Type of facility		Holders of investment				Other entities
		The Republic of Serbia and the Autonomous Province (budget)	Republic (Budget - funds for environmental protection)	LSGU	PUC	
Water supply and regional systems	water facilities	*		*	*	○
	network			*	*	

Type of facility		Holders of investment				Other entities
		The Republic of Serbia and the Autonomous Province (budget)	Republic (Budget - funds for environmental protection)	LSGU	PUC	
Regional and multipurpose systems		**		*		*
Channelling of wastewaters	water facilities	*	*	*	*	○
	network			*	*	
Surface water sewer		Δ <sup>1</sup>		◆		
Regulation and flood protection	first-order	◆				
	second-order			◆		○
Protection against erosion and		*		**		○
Drainage	Main canal	**		*		
	Detailed			Δ		○
Irrigation		■		Δ		○

total financing \* co-financing \*\* majority financing Δ simulative

Δ<sup>1</sup> financing of project documentation ○ financing for own needs ■ the condition is amendment to the Law on Water in the part relating to the financing of works of general interest

*The State, i.e., the Autonomous Province*, assumes the role of holder of investment in facilities that are public property and are of importance for the Republic, or the Autonomous Province, as well as the holder of co-financing for facilities that are of importance to local government. This means that the state, in addition to technical, should also provide material or financial conditions for investment in water facilities and systems. The means for the construction of these facilities originate from public revenue (from appropriations in the budget of the Republic of Serbia, i.e., of the autonomous province and from water charges), and public water management companies should be in charge of implementation, such companies being capable of carrying out investment works in terms of personnel and organisation. This is primarily related to the regulation and protective water facilities in first order water and the basic drainage canal network, but may also span to other facilities (regional and multipurpose hydro system, etc.).

Investor works on the construction of capital facilities the financing of which is provided from the funds or as participation of the *local government unit* are carried out primarily by the competent public and public utility companies. It is particularly important that the local government unit provides its own participation in investment projects financed from the funds of the Republic, i.e., the autonomous province. Facilities of capital importance for the local government unit must be in accordance with the plans and programmes of development of the city/municipality and the planning documents for the area where the construction or reconstruction of the facility is carried out. Forming teams capable of implementing a complete investment process is of primary importance here as well, which can be provided in the framework of regional development agencies.

*Public utility companies* which provide services for water supply and channelling are the holders of investment in the expansion of their own capacities. The means for these purposes are provided from public revenues of the local government units and own sources of public utility companies, with the possible participation of the Republic and the Autonomous Province.

Other companies may also appear as holders of investment, i.e., investors, that from their own funds, or in association with local government funds, or public and public utility companies, build facilities of local importance, to improve their own economic conditions and to improve the condition of the environment. Also, *natural persons* may appear as investors and financiers for certain local facilities for the use of water or protection from the harmful effects of water. Construction of facilities must be in accordance with the planning documents at the water area.

## 6.5. MEANS AND CAPACITIES

To improve the condition in the water sector, both from the aspect of the operation of the existing system, and from the aspect of the planned development, it is necessary to provide adequate resources and capacities (planning, design and other professional capacities).

### 6.5.1. NECESSARY MEANS

It is estimated that funding in the amount of about EUR 22 billion should be provided within the next twenty years and should be provided for the financing of current operations and for the development of the water area (Table 61), of which approx. EUR 13 billion for current operations and around EUR 9 billion for development projects (funds for development are determined, as stated above, based on the measures needed to achieve operating objectives from chapter *Projected development of water management in the Republic of Serbia*). On an annual basis, the average amount of funds required is approx. EUR 1 billion. Water supply and channelling in settlements account for the largest amount in the structure of the funds needed (almost 80%). The largest part of these funds should be provided from the price of water and services, which requires reaching its economic level. The average projected economic price of water for a twenty-year period is approx. EUR 1.3/m<sup>3</sup> (excluding value added tax), and the dynamics of achieving it should be adapted to the economic power of the public and the economy. A limit standard may be adopted, expressed in terms of the share of the costs for these utilities in an average household income, which should be significantly higher than is the case at the moment, but it should not exceed 4%<sup>51</sup> of the average disposable income of households.

Necessary funds may be provided from the sources listed in Table 67.

Table 67: Sources of funding by purpose

Purpose of investment	Sources of funding								
	Funds of the RS and AP		PUC from the price of water		IPA and other funds	Budget of the Republic	Local self-government	Owner resources of investor	
	Current operation	Development	Current operation	Development	Development	Development	Development	Current operation	Development
Water supply		Δ	Δ	Δ	Δ		Δ	Δ	Δ
Regional systems	Δ	Δ		Δ	Δ		●		●
Channelling in settlements		Δ	Δ	Δ	Δ	Δ	Δ	Δ	Δ
Surface water sewer		■					Δ		
Protection from external water	Δ	Δ			Δ		Δ*	Δ	●
Drainage	Δ	Δ			Δ		Δ	Δ	Δ
Irrigation	Δ				Δ	▲	◆	Δ	Δ

incentive funds ● if there is interest Δ\* development and maintenance ▲ from agricultural budget ■ development of project documentation

When it comes to development projects in different areas of the water sector, the means for their funding can be provided from the sources listed in Table 68.

Table 68: Means and sources of financing of water sector development, by area

Purpose of investment	Purpose of funds for investment in capital investments in the water sector in EUR millions							
	Funds of the RS	PUC from	Other sources	IPA and other	Local self-government	Own resources	Total	Share in %

<sup>51</sup> The Strategy for the restructuring and privatisation of public companies (EBRD, EU-SME, KfW, USAID MEGA and the World Bank/LGID).

	and AP	the price of water	Funds	t	of investor			
Water use	600	300	350	600	350	674.5	2,874.5	<b>31.7</b>
Water protection	1,000	300	1,400	1,150	950	600	5,400.0	<b>59.5</b>
Protection from water	420			150	160	70	800.0	<b>8.8</b>
<b>TOTAL</b>	<b>2,020</b>	<b>600</b>	<b>1,750</b>	<b>1,900</b>	<b>1,460</b>	<b>1,344.5</b>	<b>9,074.5</b>	<b>100.0</b>
	<b>22.26%</b>	<b>6.61%</b>	<b>19.28%</b>	<b>20.94%</b>	<b>16.09%</b>	<b>14.82%</b>	<b>100.00%</b>	

Development projects will be implemented at different dynamics (Figure 51), depending on the dynamics of the provision of the necessary social and economic conditions, including financial and technical capacities.

To achieve the proposed dynamics of development, it is necessary, first of all, to establish the economic cost of water in the manner shown in Figure 50, from which a higher income from charges for water use and protection would be collected, which is intended for the development (Table 69).

Table 69: Potential revenue from charges for water, in EUR millions

No.	Type of charge	Total
1	Charge for the use of water resources	957
2	Charge for discharged water	388
4	Charge for pollution of waters*	146
5	Charge for drainage	810
6	Charge for the use of water facilities and system	270
	<b>TOTAL</b>	<b>2,571</b>

\* estimated funds executed only for the industry sector

Potential revenues from charges paid by payers that abstract water for bottling, i.e., use it in the final product, for electricity generation, for plants and other purposes are included in the figures given in Table 69.

Revenue from other water charges (drainage, the use of water facilities and the system), which is used purposefully primarily to finance current operations (more than 90%) should be doubled by the end of the observed period. This requires an annual increase in the amount of these charges by 3 - 4% and a higher rate of collection than in the previous period.

## 6.5.2. REQUIRED PROFESSIONAL CAPACITIES

Available professional capacities are not sufficient for efficient operations in the water sector and for the completion of the planned development, by number or by structure.

As the engineering personnel are the holders of development activity, assessment of required capacities of this professional profile have been made, in accordance with the planned dynamics of development. In making an assessment, it was started from the position that there will be a need for a greater engagement for planning and engineering human resources at the beginning of the investment cycle, while construction capacities will be represented more in the second half of the planning period (Table 70). Of the total number of required engineering staff, civil engineers specialised in hydroengineering represent approx. 35%, while civil engineers, mechanical engineers, electrical engineers, technologists and others make up around 65%, depending on the stage of completion of the investment project.

Table 70: Necessary engineering capacities for the implementation of development projects

Period	Funds in EUR millions/annually	Necessary engineering capacities * (on average annually)		
		planning and	construction	total

	(on average)	engineering		
up to the 5th year	240	1,200	400	1,600
from year 6 to 10	480	1,500	1,000	2,500
after the 11th year	550	1,500	1,700	3,200

\* domestic capacities and international experts on specific projects involved

The required engineering staff, from Table 70 include scientific, technical, educational and other institutions, representing significant potential and providing assistance to state authorities in the planning and implementation of development projects. An important place here belongs to the Jaroslav Černí Institute for the Development of Water Resources as a leading scientific research institution within the domain of water, as well as to other institutes dealing with issues related to water.

In addition, faculties should modernise curricula and methods of teaching, including postgraduate studies that would result in higher quality professional and scientific staff. Apart from the technical disciplines in the curricula, a prominent place should be given to other areas, such as the environment, economy, law, management within the domain of natural resources. A system of ongoing training should be established in the process of work (seminars, courses, study tours, etc.). The successful implementation of development projects in the water sector should contribute to the preservation and improvement of existing local production and service facilities, primarily in the field of construction and industry.

## 6.6 MAINTENANCE

A precondition for the successful and efficient operation of water facilities and systems in line with the projected performance and ensuring long life is their maintenance (regular-current and investment maintenance). Maintenance of facilities, including those facilities that perform their function periodically, must be conducted through the application of standards and norms. The owner or user of the facilities and systems is under obligation to provide maintenance of facilities and systems, and therefore the state, autonomous province or local government, through their departments and competent public companies, are responsible for the maintenance of facilities and systems that are publicly-owned.

To maintain the facilities and perform other tasks within the framework of water activities (repair works, emergency response and protective structures etc.), public companies engage water management or other companies in possession of a licence to perform such tasks.

## 6.7 SUPERVISION AND CONTROL

Supervision and control in the water sector are primarily related to inspection supervision, which is done by inspection services, institutionally established at the federal level, and for certain tasks at the local level as well.

Inspection supervision is performed by water inspectors, sanitary inspectors and inspectors for environmental protection acting within the ministries responsible for water management, environmental protection and health. Inspection supervision of facilities of municipal infrastructure and the performance of public utility services related to water are performed also by national inspectors within the ministry responsible for water management, if these activities are included in the scope of this ministry, and if not, control will be performed by national inspectors within the ministry responsible for utility activities. The supervision over the enforcement of regulations of the local government shall be done through utility inspectors.

In order to have more efficient supervision and control, the number of competent inspectors must be increased and their equipment must be improved and competent judicial institutions must support the work of the inspection services.

## 6.8 OTHER FUNCTIONS - MEASURES

For water management to be in line with the strategic orientations of the state and modern global trends, it is necessary to adequately perform the following functions:

- monitoring;
- water information system;
- regulatory function;
- publicity.

### **6.8.1 MONITORING**

Systematic and comprehensive monitoring is a prerequisite to reliably determine the status of surface water and groundwater, as a basis for the planning of water use and efficient integrated water management. The Republic of Serbia has the responsibility to establish and carry out monitoring, through the adoption of the annual monitoring programme and by providing conditions for its implementation.

Monitoring is an extremely important activity within the exploration of water resources and includes:

- surface water - determining the volume, water level and flow to the extent relevant for ecological and chemical status and ecological potential, as well as the parameters of the ecological and chemical status and ecological potential;
- groundwater - determining the quantitative and chemical status of groundwater, monitoring the effects of the application of measures to achieve good status and management of groundwater resources;
- protected areas - indicators of water status in accordance with the regulations governing this area established as protected area.

The results of monitoring are used to define the condition of the level in rivers from the point of management of waterways and protection from harmful effects of water, including forecasts and works on flood protection.

Improvement in the field of monitoring should be done in terms of:

- national regulations;
- establishing adequate monitoring;
- existing institutional systems and competences.

Improvement of the monitoring system includes:

- harmonisation of federal regulatory legislation with EU regulations;
- engineering and gradual establishment of an optimal network of supervision profiles, which will allow the definition and monitoring of the status of water bodies of surface water and groundwater, with the possibility of supplementing and adapting the network with the monitoring results of the water status;
- completion of the established annual programme of monitoring parameters of quantity and quality of water and sediment, with the use of standardised methods of measurement in the field, established methods of laboratory analysis and standardised way of processing and presenting results, and with their constant control and improvement;
- review and possible revision and amendment of observation network profiles and monitoring programmes within the updating of the water management plan, including deep aquifers in the observation network;
- development of harmonised monitoring of water with neighbouring countries and implementation of joint programmes of testing on shared waterways;
- strengthening human resources, technical and other material capacities of national institutions for the monitoring of water status and its coordination, based on established protocols, with all institutions at regional and local level conducting the monitoring, in order to avoid overlapping

of the workload and to ensure integration at the state level, within the water information system, the results of monitoring of importance to water management;

- quality reporting mechanisms and active public participation in the consultation on the condition and the causes of changes in water quality.

Improving the monitoring must be carried out gradually, according to detailed programmes and projects in accordance with financial capabilities of the state. This means that the required number of measuring points for the performance of supervisory and operational monitoring (if applicable, research monitoring on surface water) and recommended frequency of monitoring (in accordance with the Water Framework Directive and its annexes) will be attained gradually. Also, observation will initially cover the key parameters of those quality elements (for surface water, biological, hydromorphological and physico-chemical water), which, according to previous information, are most sensitive to the pressures that the particular water body is exposed to.

In operational terms, monitoring should be implemented by the national organisation in charge of hydrometeorological affairs, in accordance with the annual programme of the Government. This organisation should incorporate the results of the testing which, according to the annual programme, is performed by other authorised legal entities and should, together with its own results, submit those results to the competent ministry and agency dealing with matters of environmental protection. The annual report must contain registered changes in the water quality.

Monitoring must include protected areas, whereby the entities that carry out monitoring, as well as their parameters and frequency of sampling will depend on the types of protected areas (in accordance with the recommendations of the WFD). Dedicated monitoring must be carried out on certain river sections within the vicinity of agricultural areas where there is a significant use of chemicals, in order to monitor the impact of these chemicals on water quality in the waterway.

Relevant monitoring results (primarily those conducted by the national organisation in charge of hydrometeorological affairs) must be included in the Water Information System of the Republic of Serbia, in order to allow the monitoring and improvement of the water regime, the planning of water systems development and integrated water management in the Republic of Serbia.

## **6.8.2 WATER INFORMATION SYSTEM**

The Water Information System (in the Ministry, for the entire Republic of Serbia, and in the public water management companies on the territory under their jurisdiction) is, given the level of information and data, an important segment in the process of monitoring and improvement of the water regime, planning of water infrastructure development and operational management of water and water systems.

Within the Water Information System, the following is provided: formation, maintenance, presentation and distribution of data on the state of water quality, classes of water bodies of surface water and groundwater, water facilities, water management documentation, regulatory, organisational, strategic and planning measures within the domain of water management, as well as scientific, technical and other information of importance to water management. The Water Information System enables the exchange of relevant information with other information systems at the national and international level.

Given the importance, competent institutions and companies must continuously collect and update (within the systems they use) all relevant data and information of importance for the operation and development of the water sector, and to ensure, through a system of monitoring and control that public companies and other legal entities and entrepreneurs meet the prescribed requirements on the submission of defined data provided by the *Law on Water*.

### **6.8.3. REGULATORY FUNCTION**

The purpose of introducing the regulatory function is to ensure a level of necessary technical and technological equipment and organisational and human resources capacities within companies and other enterprises performing activities in the framework of water activities as well as to achieve the standards in the provision of services in the water sector. In regard to this, it is necessary to effectively carry out the licensing of water management and other companies within the water sector.

Until the establishment of an independent regulatory body responsible for the operations of companies engaged in providing services within the domain of water supply and channelling in settlements, the regulatory function will be fully carried out by the ministry responsible for water management.

### **6.8.4. PUBLICITY**

The Constitution of the Republic of Serbia guarantees the right of every individual to be correctly, fully and timely informed about matters of public concern, including the right to be informed on the state of water and the work of competent bodies in the water sector.

The competent authorities and companies need to ensure active public participation in the creation and updating of a water management plan in the water area, with the aim to achieve the highest quality solutions in the area to which the plan of water management relates. This entails timely notification and public disclosure of documents prescribed by the *Law on Water*, as well as consideration and declaration on the submitted remarks.

Improving the impact of the public in the planning phase, decision-making and control over their implementation should be contributed also by the National Conference for Water, established by the Government of the Republic of Serbia, which should enable the performance of set tasks under the *Law on Water*.

In order for the level of contribution of the public to be appropriate in protecting and conserving water resources (water and wetland areas) and water infrastructure, permanent education should be provided through mass media, debates and educational programmes.

## 7. PRIORITY ACTIVITIES IN THE WATER SECTOR

Given that improvement of the situation in certain areas of the water sector calls for the necessary provision of significant funds and the engagement of extensive scientific, technical and service capabilities, which are currently insufficient in number, activities to improve the water regime and the overall situation in the water sector must take place in accordance with the possibilities of the economy and the society, respecting those priorities which are to be defined by planning documents.

The timely development of appropriate planning and, in accordance with this, technical documentation is of particular importance, bearing in mind that in the past the lack of documentation was sometimes a limiting factor for the allocation of funds and implementation of already agreed-upon investments.

The following are priority activities that should be undertaken in order to establish an adequate system of water management, which refer to the legal, institutional and economic framework, as well as projects which, in the areas of water activities, should be given priority in implementation in the next ten years. It should be noted that this part of the document presents a draft text and that some areas are treated with varying degrees of detail, depending on the level of documentation available.

### 7.1 ESTABLISHING AN APPROPRIATE WATER MANAGEMENT SYSTEM

Priority activities in this area are primarily related to provisions of the legal and institutional framework, thus creating conditions and instruments for the operation of the water sector and establishing the basis for long-term sustainable water management.

Completion of legislation means the adoption of bylaws under the Law on Water and other laws that deal with water, as well as the adoption of the following strategic and planning documents:

- *Water Management Strategy for the period 2014-2034* - the National Water Directorate is responsible for preparing the strategy, while an analysis and research is performed by the Jaroslav Černí Institute (to be adopted in 2015);
- *Water Management Plan for the Danube River Basin* (for a period of 6 years) - the National Water Directorate is responsible for preparing the plan, while a draft version is being prepared by the Jaroslav Černí Institute (to be adopted in 2015);
- *Plan to protect water from pollution* - the National Water Directorate is responsible for preparing the plan, while a draft version is being prepared by the Jaroslav Černí Institute (to be adopted in 2015);
- *Water management plans in water areas* (for a period of 6 years) - public water management companies are responsible for preparing those plans;
- *Plans of flood risk management* (for a period of 6 years) - the National Water Directorate is responsible for preparing the plan, while public water management companies are in charge of plans for water areas.

To monitor the implementation of the objectives set forth in this document, it is necessary to adopt bylaws within which the following should be defined:

- appropriate indicators that, in addition to monitoring the implementation of the Strategy, ensure harmonisation with the activities that, within the EU, are relevant within the domain of environment and water;
- specific indicators to be monitored at the federal level;
- parameters that improve statistics within the domain of water.

A more efficient water management system can be achieved if:

- the existing competence of the water sector and utility companies supplying the public with drinking water and channelling in settlements are consolidated, in the section of planning and implementation of investment activities, including the definition of priorities both by domain, and by space;
- the number of water management companies in the Republic of Serbia is reduced, with more centres organised primarily by the hydrographic principle and with mutual coordination provided;
- a greater capacity of government bodies in the water sector is provided (primarily at the competent ministry);
- the establishment of a special financial institution is enabled - the Water Fund, with the status of a legal entity, which would be connected with the ministry responsible for water management;
- regional centres for implementation of investment projects in the water sector are formed;
- greater power is given to scientific research organisations (primarily to the Jaroslav Černi Institute ) to conduct study and research activities of special importance to water management, as well as expert support to federal administrative bodies;
- conditions are created for strengthening the capacities of construction, design, service provision and others;
- better oversight and control in the field of water management is provided, including control of the use of revenue from water charges;
- the monitoring of surface, groundwater and sediments is improved within the federal organisation in charge of hydrometeorological affairs, as well as the development of complementary systems for monitoring reservoirs, dams, springs, etc.;
- data within the water cadastre are updated regularly and included in the Water Information System;
- the improvement of the education system is ensured at all levels, through a comprehensive plan;
- better provision of information is provided as well as more active participation of the public in procedures relating to the adoption of planning documents within the domain of water;
- activities of the drinking water supply through the system of public water management and collection, drainage and wastewater treatment systems connected to public sewers are separated from public utility companies performing several utility activities and new companies should be formed to perform these tasks; should, for organisational and economic reasons, this separation be unjustifiable, separate record keeping of income and expenditure of these activities should be provided.

In the area of economic policy, priority actions are the following:

- gradual establishment of the economic cost of water and utility services of the water supply and channelling in settlements;
- defining elements of the tariff system for determining the cost of utility services (in the competence of executive bodies of local government);
- introduction of new methodologies in practice for determining water charges and increasing the level of their collection;
- 
- providing conditions for greater participation of other funds and private capital in the financing of water sector development;
- providing conditions for greater use of EU funds and the provision of co-financing within each area of support from these funds.
- consolidating charges for water discharge and charges for water pollution into a single water charge for the protection of water.

## **7.2 MAJOR PROJECTS BY CERTAIN FIELDS**

### **7.2.1. COMPLETION OF CAPITAL PROJECTS (FACILITIES)**

Regarding investment works, the priority is the completion of multi-purpose capital facilities, whose construction has already started in the previous period. This primarily refers to:

- completion of the work on the “Selovo” and “Stuborovni” dams and formation of reservoirs, with possible redefinition of their projected functions;
- continuation of works on “Arilje” dam with reservoirs - profile “Svračkovo”.

### **7.2.2. WATER USE**

#### **Supplying water to the public**

Although water supply is a priority over all other forms of water use, there are still areas where appropriate (in terms of quantity and/or quality) drinking water supply is not provided. Due to this fact, below is a proposal of priority activities within this domain.

Settlements in Vojvodina that are supplied with water from the main water-bearing complex have significant issues in terms of the quality of water supplied to the population, due to naturally high contents of certain harmful substances (organic matter, arsenic, etc.). Therefore, in a number of towns water is not safe for human consumption, but is used only as technical water. Finding solutions for the largest settlements of Zrenjanin and Kikinda are a priority, to be followed by other smaller settlements where the use of water for human consumption is prohibited. Because of the complexity, solving this problem requires the introduction of more advanced techniques in water purification. However, this cannot be a long-term solution, because the application of these methods leads to additional lowering of groundwater levels. Therefore, along with these urgent measures, a study and planning documentation must be developed, within which a long-term, sustainable solution to water issues in a large part of Banat and Bačka should be resolved. Research should first focus on potential water sources, designated as the eastern edge of Telečka and Southeast Banat.

Certain towns/settlements in the valley of the Velika Morava River have significant problems with the quality of drinking water due to the occurrence of nitrate in water. This primarily relates to Požarevac, Lapovo, but also to other settlements. These towns/settlements, which are for the long-term, oriented towards local sources of water supply, must urgently resolve the issues of securing sufficient quantities of water of adequate quality, but along with this they must systematically work on the construction of wastewater treatment plants for the largest settlements in the Morava River basin, in order to improve the water quality of this river. If the solution to the issue of water supply in certain towns is, in future, orienting towards regional navigation systems, actions must be focused on the preparation of appropriate project documentation that would allow the construction of these systems (for example, dams with accumulation Zabrega on the Crnica, from which water for irrigation would be provided).

Bearing in mind that local water sources for the drinking water supply (with the exception of Vojvodina) are mostly directed at the use of groundwater from alluvial sediments through wells, there are two basic problems that need to be appropriately addressed:

- susceptibility to pollution, which affects the quality of water, so it is necessary to protect water sources, in accordance with regulations (sanitary protection zones should be determined);
- aging of the well at the source, which is manifested by reduction of capacities.

The most important examples of declining the water wells' capacities is Belgrade's source of groundwater and springs on the territory of Novi Sad, for which it is necessary to establish a system

of dedicated research (through monitoring of the status and operation of wells, including water quality) and appropriate measures should be taken for the preservation of the capacities (regeneration of wells, injection of new drains in existing wells, construction of new wells, etc.). Preserving or increasing capacities is also needed in the case of other sources in Vojvodina and Central Serbia, which can be achieved by applying methods of artificial infiltration.

The shortage of water in the sources of groundwater in Šumadija has been solved thus far by building small (Bukulja, Garaši, Grošnica) and large (Gruža) reservoirs within the RWSS Kragujevac, and by the construction of RWSS Rzav. The current water shortage in some municipalities (Topola, Gornji Milanovac, Arandjelovac, Ljig and Kraljevo) can be solved by extending the regional system after construction of the Svrackovo dam, whose completion is a priority, but other solutions are also possible, that should be considered within the appropriate study documentation.

For various reasons and primarily because of insufficient investment in protection, most reservoirs, which are intended for the drinking water supply, are now in a relatively poor condition. In some of them, for example, the Vrutci reservoir, which supplies water to Užice, this has already led to the periodic suspension of the drinking water supply. Similar processes occur in other reservoirs (Čelije, Gruža, Bovan, Barje, etc.), which may, sooner or later, lead to a similar situation with the water supply of cities which are sources of this accumulation. To prevent this, it is necessary to conduct a detailed survey of the condition of reservoirs and then suggest measures for rehabilitation and to ensure the long-term and stable supply of water from these sources.

Parallel to the activities related to the protection of existing and the creation of new sources of surface and groundwater, it is necessary to implement measures to reduce losses in water supply systems and increase the efficiency of their work.

## Irrigation

Agricultural areas in public ownership, to be covered by irrigation systems and for which the necessary amounts of water should be provided, are in development group I (Table 71). This group includes areas where there are constructed hydro-melioration systems that are either unoperational or partly operational, as well as those for which the project documentation has been prepared up to the level of development (for entire systems or for their parts), and also:

- there is the possibility of these systems providing dual-purpose function (drainage and irrigation) through reconstruction and upgrading of the system;
- there is a possibility of rehabilitating existing irrigation systems;
- there is a lack of certain facilities and technical equipment in existing systems.

Table 71: Planned irrigation systems

Water area	Subsystem /area	Water source river / canal	Area (ha)
Bačka and Banat*	South Bačka	HS DTD - The Danube	35,000
	Kula - Mali Idoš	The Danube - VBK	5,000
	N. Crnja Žitište	The Tisa - HS DTD	6,000
	The Tisa - Palić	The Tisa	14,000
	Kikinda	The Tisa - HS DTD	18,000
Srem	Eastern Srem down zone **	The Sava	6,000
The Sava	Mačva *	The Sava	11,000
	The Kolubara**	The Kolubara	1,500
Belgrade	Smedrevo and Grocka *	The Danube	2,000
	Obrenovac**	The Sava	3,000
	Pančevački rit - the northern part **	The Danube	9,000

The Morava**	The Velika Morava	The V. Morava	6,000
	The Zapadna Morava	The Z. Morava	2,000
	The Južna Morava	The J. Morava	2,000
	Oplenačko vinogorje (Oplenac vineyards)	local waterways	1,200
The Lower Danube **	Timočka Krajina (Negotin plain, Zaječar basin, The Mlava, The Pek)	The Timok, The Danube, The Mlava	13,500
<b>Total</b>			<b>135,200</b>

\* Finishing the project documentation and construction \*\* development of project documentation and construction

### 7.2.3. WATER PROTECTION

In 2009, the Republic of Serbia while preparing the Water Management Plan for the Danube River Basin (in order to meet obligations under the Convention on the Protection of the Danube River), submitted a list of projects to be implemented by 2015 (Table 72).

Table 72: Projects to be implemented by 2015

	Settlement	Recipient	EC*	Degree of purification	WWTP	Extension of the sewage systems
1	Brus	The Rasina	12,000	tertiary	+	+
2	Blace	The Rasina	19,000	tertiary	+	+
3	Kula	DTD	42,000	tertiary	+	+
4	Vrbas	DTD	50,000	tertiary	+	+
5	Crvenka	DTD	25,000	tertiary	+	+
6	Subotica (cont'd)	Lake Palić	230,000	tertiary	+	+
7	Šabac	The Sava	185,000	secondary	+	+
8	Vranje	The Južna	131,000	secondary	+	+

\* Plant capacity expressed in number of population equivalent

The only completed project is the wastewater treatment plant in Subotica, while other projects are in various stages of implementation.

From the aspect of financing from IPA funds, the situation is as follows:

- WWTP Šabac (IPA 2008) - construction started, halted
- WWTP Vrbas, Kula, Crvenka (IPA 2008) - construction started, delays, problems
- WWTP Leskovac (IPA 2010) - halted, continued
- WWTP Raška (IPA 2013) - start of implementation planned for 2015.

The projects to be financed under the MISP<sup>52</sup>:

- WWTP Čačak - general project
- WWTP Zrenjanin - feasibility study
- WWTP Sokobanja - feasibility study
- WWTP Kraljevo - general project, feasibility study
- WWTP Brus, Blace

The projects that are co-financed by KfW are related to the City of Kruševac, Vranje, Aleksinac and Užice, for which a feasibility study has been completed and the cities of Čačak, Jagodina, Kikinda, Kraljevo, Pirot, Požarevac, Vršac, Zaječar, for which preparation of investments is ongoing.

<sup>52</sup> Municipal Infrastructure Support Programme (MISP).

As it can be seen, little has been done in this area, including undertaken commitments, so work on the priorities should be continued in the upcoming period within the domain of water protection , as defined below.

The general priorities are the following:

- solving the issue of collection and treatment of urban wastewater and industry with the aim of reducing the load of water, primarily domicile water and water in the basins that are most vulnerable and have the highest specific loads;
- improving the water protection system from non-point sources of pollution, primarily from agriculture;
- a significant increase in the volume of investments for water protection;
- strengthening institutional and other capacities for water protection at the national, regional and local level, notably through the implementation of existing legal provisions;
- expansion and modernisation of the network of monitoring water quality and wastewater emissions;
- further harmonisation of the legal and institutional framework for water protection with the existing system of water protection in the EU.

With point sources of pollution in settlements with more than 2,000 inhabitants, the basic criterion for prioritising is the specific load of the receiver in relation to the available amount of water in it (conditions in the receiver), while with non-point sources of pollution, priorities are determined based on the relative contribution of certain categories of the overall pollution and opportunities for purposeful and effective application of control measures of entries. If, as non-point sources, pollutions are observed.

#### **Priorities for point sources**

The level of development of the sewage system is a parameter by which the priority of construction of a network or a wastewater treatment plant is determined. If connections to the public sewer are higher than 60%, priority should be given to the construction of the plant, otherwise priority should be given to the completion of the network.

When building a wastewater treatment plant, larger settlements on smaller streams have an advantage, especially those that have a high level of connection to public sewage systems (all settlements with over 10,000 inhabitants), and the settlements where access to public systems is low (generally settlements with less than 10,000 inhabitants and less than 50% of the population is connected), i.e., the criterion for prioritising is the specific load of the relevant water receiver with wastewater.

Within the construction of the sewage network and the main collector, the priority will be for:

- primary and secondary sewage network:
  - in settlements that have more than 2,000 inhabitants and where the existing individual systems pose a threat to public health;
  - in settlements in which built wastewater treatment plants have excess capacity;
  - if no wastewater treatment plants are built, but the settlements are located close to the powerful recipients;
  - Settlements with less than 2,000 inhabitants in which construction of central sewage systems started (conditionally, more than 30% of the population);
  - in settlements with less than 2,000 inhabitants, without a public sewage system (or sewage systems that cover less than 30% of the population), and with the public water supply, focus should be on the individual systems of wastewater treatment;
- main collectors:

- if their construction is timed with the construction of the wastewater treatment plant of the settlement;
- If their construction is not timed with the construction of wastewater treatment plants, but the collector improves the protection of public health, protection of water supply sources and improves water quality in the waterway which is the recipient.

#### Priorities in the period from 2015 until 2020

1. Continuation of implementation of the initiated projects include the expansion of the sewage network to the required level, the construction of the main supply network and installation of wastewater treatment plants (collectively referred to as WWTPs).
  - WWTP Brus-Blace
  - WWTP Kula-Vrbas-Crvenka
  - WWTP Vranje
  - WWTP Niš
  - WWTP Užice
  - WWTP Mladenovac
2. Work on the preparation of project documentation for the extension of the sewage network and construction of the WWTP for the agglomeration, which, according to the draft plan for water pollution protection for the Republic of Serbia, in which priorities<sup>53</sup> are defined for the planning period 2021 to 2027: Kragujevac (reconstruction and expansion), Kraljevo, Kruševac, Čačak, Novi Sad, Zrenjanin, Valjevo (reconstruction and expansion), Sombor (reconstruction and expansion), Požarevac, Pirot, Zaječar, Jagodina, Kikinda (reconstruction and expansion), Loznica, Vršac (reconstruction and expansion), Bor, Arandelovac (reconstruction and expansion), Ruma, Lazarevac, Surčin, Prokuplje, Paraćin, Gornji Milanovac (reconstruction and expansion), Indija, Smederevska Palanka, Temerin, Bečej (reconstruction and expansion), Vrnjačka Banja, Knjaževac, Požega, Nova Pazova, Negotin, Vlasotince, Ivanjica, Šid, Bačka Topola, Srbobran, Sjenica, Kuršumlija, Odžaci, Novi Bečej, Mali Idoš, Bački Petrovac, Svilajnac, Ugrinovci, Lebane, and Arilje).

#### Priorities in the period from 2021 until 2027

3. Finalisation of project documentation preparation and start of construction of the sewage network and wastewater treatment plant for the agglomeration from point 2.
4. Preparation of the project documentation for agglomerations from 2,000 to 10,000 inhabitants: Kanjiža, Bogatić, Petrovac na Mlavi, Vrčin, Bujanovac, Crvenka, Vladičin Han, Lajkovac, Aleksandrovac, Dobanovci, Banatski Karlovac, Sokobanja, Majdanpek, Svrlijig, Bajmok, Majur, Čantavir, Topola, Ub, Čajetina, Novo Mилошеvo, Osečina, Batočina, Ribare, Kosjerić, Babušnica, Vranjska Banja, Blace, Žitište, Brus, Kusadak, Bojnik, Lučani, Irig, Krupanj, Koceljeva, Despotovac, Azanja, Bukovac, Pukovo, Kučevo, Trgovište, Vučje, Selevac, Žitorađa, Zlot, Ljig, Mionica, Vrdnik, Preševo, Šimanovci, Ralja, Stepovevac, Malošište, Guča, Vinarce, Darosava, Velika Krsna, Mihajlovac, Ropočevo, Bosilegrad, Rača, Pećinci, Maglić, Medveđa, and Veliko Orašje.
5. Start of the construction of the sewage network and wastewater treatment plant for the agglomeration from point 2.
6. Start of the preparation of project documentation for agglomerations in which the water protection is implemented in the period from 2028 to 2034: Belgrade, Novi Sad, Aleksinac, Čuprija, Prijepolje, Priboj, Trstenik, Žabalj, Kač, Surdulica, Ripanj, and Tutin.

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<sup>53</sup> Order by population numbers from 2011.

## **Prevention and management**

The primary prevention measure is implementation of the monitoring and inspection measures. Federal authorities need to ensure strict application of the “polluter pays” principle and measures in the domain of reaching the real price of water and services. Priority activities include prevention and awareness (and capacities) of pollutants, as well as stimulating the application of good agricultural practices. Increased activities of inspection supervision should prevent further pollution (particularly the creation of illegal landfill sites) and eliminate the consequences of previous pollution.

Preventive measures may include remediation of historical pollution, and at selected locations (particularly in protected areas) establishment of a system for monitoring and controlling the use of fertilisers and plant protection products, for the purpose of quantifying the pollution from agricultural activities. Also, in order to determine the status of water bodies of surface water and groundwater, monitoring parameters defined by the relevant rulebook should be systematically established and the monitoring data should be included in the information system.

### **7.2.4. PROTECTION AGAINST THE HARMFUL EFFECTS OF WATER**

#### **Flood protection**

All major floods in the past initiated new cycles of investment in improving the system of flood protection, which lasted for 30 to 40 years, primarily depending on economic conditions in the country.

The flood of May 2014 hit 42 out of 99 major floodplains in Serbia. After necessary repairs of damage to protective structures, a new cycle is launched that will ensure the reduction of the risk of flooding on a large number of waterways in Serbia. It is important that all planned works and measures are flexible and allow adaptation to future conditions that may lead to deterioration in the high water regime, including changes in the use of basins and climate changes.

The basic postulate is that the integral solution - technically feasible, economically and environmentally justified and sustainable in terms of climate change must be defined at the basin level. Given the experience of the flood of 2014, priorities are:

1. Works on completion of a flood protection system along the Sava and Drina rivers, namely:
  - the reconstruction of the embankment in the eastern and western zones of Mačva, with a review of the protection conditions;
  - increase of the level of protection of cities (Belgrade, Sremska Mitrovica, Šabac, etc.) through a combination of fixed facilities and mobile protection;
  - the project and completion of the embankment on the right bank of the Drina River, from Badovinci to Lipnički Šor (28.5 km)
2. Improvement of flood protection in the basin of the Kolubara River, which requires, first and foremost, the development of:
  - A study of flood risk management in the Kolubara River basin, which will define a system of investment and non-investment measures to be implemented in the next 30 years;
  - a study on the threat of the territory of the Obrenovac municipality from flooding from external and internal water;
  - reconstruction projects of individual facilities, especially in the area of Obrenovac and Kolubara coal mine open pits;
3. Improvement of flood protection in the Morava River basin, which includes works to protect:

- Paraćin, in accordance with the expertise and projects of urgent works;
- Svilajnac, in accordance with the expertise and projects of urgent works;
- Smederevska Palanka, in accordance with the expertise and projects of urgent works.

### **Protection against erosion and torrents**

In addition to emergency response and urgent works planned under the Decree on establishing a national programme of reconstruction of damaged water facilities for the regulation of the waterway, water facilities for the protection against floods, erosion and torrents and water drainage facilities (“Official Gazette of the Republic of Serbia”, no. 75/14), in order to eliminate the consequences of flooding in the Republic of Serbia, there are numerous torrential streams that must be regulated in order to protect the public and goods in future.

Priority actions in order to protect from erosion and torrents are the following:

1. Continuation of work on the revision of erosion map of Serbia
2. Start of the formation of a database within the cadastre of torrents and erosion areas and facilities located in them, based on field surveys, existing documents and other relevant information.
3. Regulation of erosive areas and torrents threatened by high water in 2014.

In the last 10 years, general projects have been drafted for some of the areas that were affected during the flood of 2014, but their implementation has not happened. It is necessary to develop appropriate project documentation for these areas and implement works to protect against torrents and erosion.

The torrential flows which also require priority development of project documentation and realisation of protection works are:

- immediate tributaries of the Danube River, from Požarevac to Negotin
  - immediate tributaries of the Drina River, from Bajina Bašta to Loznica
  - small streams in western Serbia (primarily in Krupanj and Osečina)
4. Development of general projects of regulation of erosive areas and torrents in Serbia, for the river basins of the Toplica and Jasenica rivers, Pčinja River, Kolubara River, Timok River.

For these areas of torrential character and with strong erosion processes, the development of general projects is proposed, given that they have not been subject to review in the last 30 years.

5. Improvement of the protection of the city of Belgrade

Belgrade is potentially threatened by a large number of torrents (over 190) which can be activated after extreme rainfall. That is why in 2005, a flood control plan was drafted for the city of Belgrade, where all torrents were listed on the territory of the city and contained proposed priorities for their regulation. Estimated value of the priority works on the regulation of torrents and their basins in Belgrade amounts to EUR 10 million, and the timeframe for implementation of works is 3 years. With certain review, the proposed solutions from this document could be the basis for implementation of priority investment activities in this area.

### **Drainage**

More than 40% of arable land (about 2 million hectares) is covered by drainage. Around 390 drainage systems have been built, with over 24,000 km of canal network, 210 major and several dozen smaller pumping stations (of the total capacity of 543 m<sup>3</sup>/s) and 252 gravity drains. Horizontal pipe drainage has been built on approximately 66,000 ha (mostly in Banat, somewhat less in Bačka, and least of all in the water area of the Morava River).

Due to inadequate maintenance, incompleteness and often improper use, the existing systems of protection of inland water do not provide at all areas corresponding effects and regulatory regimes. Therefore, priority in this segment of the water sector is the revitalisation and reconstruction of facilities and canal networks (including pipe drainage) of the existing system, in order to ensure the effective protection of inland water.

## 7.2.5. PROJECTS OF MULTIPURPOSE CHARACTER

Drinking water supply and protection of water quality are a precondition for the development of economic activities. An example may be the municipality of Veliko Gradište, where a solution to these issues would allow for the development of tourism, adequate supply of water to the population and agriculture, and would ensure the protection of water quality of Srebrno Jezero Lake.

## 7.3 NECESSARY MEANS AND CAPACITIES

### 7.3.1. NECESSARY MEANS

Implementation of development programmes in the first ten years requires the allocation of funds in the amount of about EUR 3.5 billion, or about 40% of the projected total value of investments in a twenty years planning period. Share of different sources in the ten-year period is shown in Table 73. In relation to the structure of financing development in the overall planning period, there is a certain difference, which is in line with the projected development priorities by areas of the water sector and the dynamics of achieving the economic cost of water (average projected price for a twenty years period amounts to EUR 1.3/m<sup>3</sup>).

Table 73: Sources of funding for development until 2024, in EUR million

Area	Sources: Means RS and AP	PUC (from the price of water)	Other sources	IPA and other funds	Local government	Individual means of investor	Total
Water supply	210	105	53	175	105	53	700
Water protection	268	95	221	363	95	189	1,231
Surface water sewer	60		280		260		600
Protection from water	203			68	68		338
Ameliorations	65		108	81	60	322	637
<b>TOTAL</b>	<b>806</b>	<b>200</b>	<b>662</b>	<b>687</b>	<b>587</b>	<b>564</b>	<b>3,506</b>
<b>Share in %</b>	<b>23</b>	<b>6</b>	<b>19</b>	<b>20</b>	<b>17</b>	<b>16</b>	<b>100</b>

In the period until 2024, the plan is to invest the largest amount of funds within the domain of water protection (about 35% of the total amount for this period).

Projected annual investment dynamics by areas of the water sector is given in Figure 52, and the sources from which the necessary funds are expected to be provided in Figure 53.

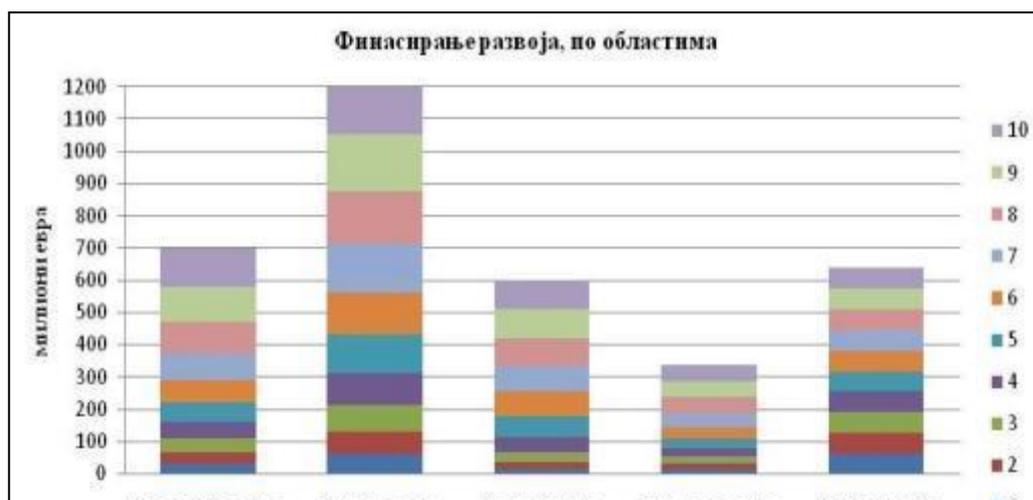


Figure 52: The funds to finance the development of the water sector within a ten year period  
 EUR millions  
 Water supply  
 Water protection  
 Surface water sewer  
 Protection from water  
 Ameliorations



Figure 53: The funds to finance the development of the water sector within a ten year period

Source of funding for development  
 EUR millions  
 Funds of the RS and AP  
 PUC (from the water price)  
 Other sources (loans etc.)  
 IPA funds Local government  
 Own funds

The annual investment volume is gradually increasing (from EUR 190 million in the first, EUR 330 million in the fifth up to EUR 500 million in the last year), in line with the projected economic potential of the state. In the first years of investment activity, the focus should be on the continuation and completion of construction and reconstruction of water facilities and the construction of new facilities should commence, according to the above proposed priorities. For

investment activities, it is of special importance to provide the means for implementation, i.e., a closed financial structure.

### 7.3.2 REQUIRED PROFESSIONAL CAPACITIES

In accordance with the priority activities planned for the ten-year period, an assessment of the necessary engineering capacities was made, given that these personnel will be the carriers of development activities. In assessing, the starting position was that in this period there will be a greater need for engagement of planning and design staff (Table 74). Of the total number of required engineering staff, civil engineers specialised in hydroengineering represent approx. 35%, while civil engineers, mechanical engineers, electrical engineers, technologists and others make up approx. 65%, depending on the stage of completion of the investment project.

Table 74: The required engineering capacity up to 2024

Period	Means in EUR millions/annually (on average)	Necessary engineering capacities * (on average annually)		
		planning and engineering	construction	total
up to the 5th year	240	1,200	400	1,600
from year 6 to 10	480	1,500	1,000	2,500

\* domestic capacities and international experts on specific projects involved

The required engineering staff from Table 74 includes scientific, technical, educational and other institutions, which represent significant potential and provide assistance to civil authorities in the planning and implementation of development projects.

The successful implementation of development projects in the water sector should be contributed to through the preservation and improvement of existing local production and service facilities, primarily in the field of construction and industry.

Directives in the domain of water with which, in addition to the Water Framework Directive, federal regulations are harmonised:

1. Council Directive 75/440/EEC concerning the quality required of surface water intended for the abstraction of drinking water in the Member States
2. Council Directive 91/271/EEC concerning urban waste-water treatment
3. Council Directive 91/676/EEC concerning the Protection of Water against Pollution caused by Nitrates from Agricultural Sources
4. Council Directive 98/83/EC on the quality of water intended for human consumption
5. Council Directive 2006/7/EC concerning the management of bathing water quality and repealing Directive 76/160/EEC
6. Council Directive 2006/11/EC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community
7. Council Directive 2006/44/EC on the quality of fresh water needing protection or improvement in order to support fish life (codified version)
8. Council Directive 2006/113/EC on the quality required of shellfish water
9. Council Directive 2006/118/EC on the protection of groundwater against pollution and deterioration
10. Council Directive 2007/60/EC on the assessment and management of flood risks

Directives in the field of protection of nature and environmental protection with which legislation in the field of water is harmonised:

1. Council Directive 79/409/EEC on the conservation of wild birds
2. Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora
3. Council Directive 96/61/EC concerning integrated pollution prevention and control
4. Council Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
5. Council Directive 91/414/EEC concerning the placing of plant protection products on the market
6. Directive 98/8/EC concerning the placing of biocidal products on the market
7. Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances
8. Directive 2008/1/EC concerning integrated pollution prevention and control
9. Directive 2008/105/EC on environmental quality standards in the field of water policy.

Also relevant for water management are the so-called horizontal directives, which establish general rules to follow when managing water, including:

1. Directive 97/11/EC on the assessment of the effects of certain public and private projects on the environment
2. Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment

3. Directive 2003/4/EC on public access to environmental information and repealing Council Directive 90/313/EEC
4. Directive 2003/35/EC providing for public participation in respect of the drawing up of certain plans and programmes relating to the environment
5. Commission Directive 2009/90/EC establishing technical specifications for chemical analysis and monitoring of water status.

