Republic of Serbia
MINISTRY OF AGRICULTURE, FORESTRY,
AND WATER MANAGEMENT
- Republic Water Directorate -
B e l g r a d e

RIVER BASIN MANAGEMENT PLAN ON THE TERRITORY OF THE REPUBLIC OF SERBIA FROM 2021 TO 2027

Extract

INTRODUCTION

Basic carriers of planning and of integrated water management in the Republic of Serbia are Republic Water Directorate within Ministry of Agriculture, Forestry and Water Management, and Public Water Management Companies "Srbijavode" and "Vode Vojvodine". River basin management plan on the territory of the Republic of Serbia from 2021 – 2027 (hereinafter: the Plan) was developed in accordance with applicable laws and regulations of the Republic of Serbia (hereinafter: RS), related to water sector, with applicable international agreements signed by RS related to water sector, with respect to requirements of the European Union Directives, primarily Water Framework Directive (hereinafter: WFD) as the most important legal act of the European Union (hereinafter: EU) in water sector. According to the Law on Water, river basin management plans are developed in compliance with the Danube River Basin Management Plan. Considering that the Danube River Basin in the RS covers about 93% of the territory, it was decided to develop a single water management plan for the entire territory of the RS.

Significant support for the development of the Plan was provided through the implementation of the EU twinning project for capacity building in the water sector "Support to policy planning in the water management sector". This Project was funded by the European Union within IPA 2016, and implemented by Ministry of Agriculture, Forestry and Water Management in cooperation with Ministry for the Environment, Nature Conservation, and Nuclear Safety of Germany, the Environment Agency Austria, and "Deltares" Company from Netherlands.

The Plan is a key document in the water management process, which aims to achieve good status of all waters in accordance with the principles of the WFD. The requirement to develop a Plan is stipulated by Art. 33 and 34 of the Law on Water ("Official Gazette of RS", no. 30/10, 93/12, 101/16, 95/18 and 95/2018 - other law) (hereinafter: the Law on Water). In addition, the development of the Plan is part of the WFD implementation process, as an obligation under the Negotiating Chapter 27.

In water management, according to WFD, biological goals play a central role- in addition to physical and chemical parameters- in environmental protection. Monitoring is inextricably linked to environmental objectives, and where they are not met, WFD requires that the reasons for failure be identified and that a programme of measures (hereinafter: PM) be implemented to re-establish a quality environment. PM contains measures, necessary to achieve environmental goals. Economic analysis conducted during PM development helps to select the combination of measures that are the most effective means to improve water status.

Total area of the RS is approximately 88,499 km^2. The RS consists of two autonomous provinces: AP Vojvodina (area: 21,614 km^2), and AP Kosovo and Metohija (area: 10,910 km^2). Pursuant to United Nations Security Council Resolution 1244 of June 10, 1999, territory of AP Kosovo and Metohija is under the provisional civil and military administration of United Nations. Due to the lack of data, this territory was addressed only in the chapters of the Plan for which data from previous period were available. The territory of RS encompasses parts of the Black, Aegean, and Adriatic Sea Basins.

According to Article 27 of the Law on Water, the following river districts are defined on the territory of the Republic of Serbia: Sava, Danube, Morava, Ibar and Lepenac, and Beli Drim. The Sava River District covers a part of Bosut River Basin, the immediate basin of the Sava River from the village of Jamena to the confluence with the Danube, Kolubara River Basin, and part of Drina River Basin. The Danube River District covers immediate Danube River Basin on the territory of Serbia, parts of Tisa and Tamiš River Basins, and other watercourses in Banat, river basins of Mlava, Pek, Porečka River, and Timok. Morava River District covers Velika Morava River Basin and parts of river basins of Zapadna and Južna Morava. Parts of river basins of Pčinja and Dragovištica are also included in

the Morava River District. Ibar and Lepenac River District covers river basins of Ibar and Lepenac. Beli Drim River District covers the Beli Drim River Basin.
Republic Water Directorate coordinates activities during the development of the Plan. Public Water Management Companies “Srbijavode” and “Vode Vojvodine" are executive bodies, in charge of water management within the assigned territory. Local governments, through public utility companies, implement and coordinate implementation of PM on their territory.

According to the Law on Water, activities on international cooperation in the RS are activities of public interest. International cooperation on the Danube River Basin is based on the Convention on cooperation for the protection and sustainable use of the Danube River (Danube River Protection Convention, signed in Sofia, on 1994, and Convention regarding the Regime of Navigation on the Danube (Belgrade, August 18, 1948). The International Sava River Basin Commission was founded on 2003. The current state of bilateral cooperation in the water sector is not satisfactory. Only bilateral commissions with Romania and Hungary are active.

CHARACTERISTICS OF RIVER BASINS IN SERBIA

Relief characteristics

In the territory of the RS, various types of relief are present, from vast plains in the north, over hilly landscapes, going south, to mountainous areas in the western, southern, and eastern peripheral parts of the territory. North of rivers Sava and Danube, there is the Pannonian Plain through the which rivers Danube, Tisza, and Sava flow. South of rivers Sava and Danube, there is the central part of Serbia and hills of Šumadija. Further south, hills gradually turn to mountains.

Hydrography

All rivers in the territory of the RS gravitate towards three seas: Black Sea, (the Danube), Adriatic Sea (Beli Drim and the Plavska River), and Aegean Sea (Lepenac Pčinja, and Dragovištica). The largest part of the territory of RS (92.6%) belongs to the Black Sea Basin, where three largest tributaries: Tisza, Sava, and Velika Morava. Aegean Sea Basin occupies the smallest part of the territory of the RS – 2.14%. Three rivers belong to this Basin: Dragovištica, Pčinja and Lepenac. Adriatic Sea Basin occupies 5.24% of territory of the RS. Principal river of this Basin is Beli Drim. Significant right tributaries of Beli Drim are Pećka Bistrica, Dečanska Bistrica, Erenik, Plavska River, East River, Klina, Miruša, and Prizrenska Bistrica.

Basic climatic, meteorological, and hydrological characteristics

The largest part of the Danube Basin in the RS belongs to the temperate zone climate. The average annual air temperatures range from 10.8°C to 11.5°C in the north of the Basin, and from 10°C to 12.1°C in the lowlands of its central and southern part. Lower temperatures occur in hilly and mountainous regions. The average precipitation in the Danube Basin in the RS is about 730 mm/ year. In the area of the Pčinja River Basin. The temperate continental climate dominates as the basic climate type. Given the diversity of the relief, there are local differences in the character of climatic conditions, from mild climate in the valleys, to mountain i.e., sub-mountain types of climate on the higher mountain peaks. Since over 90% of the territory of the Dragovištica Basin is above 700 meters above sea level, the climate is mostly mountainous. Two climatic zones confront there: the Mediterranean from the Aegean and the Black Sea and the Euro-Siberian from Siberia and the Carpathians. The Beli Drim Basin is strongly influenced by the warm Adriatic air masses. The average amount of annual precipitation is about 700 mm, and winters are characterized by heavy snowfall.

Geology and pedology

The oldest registered rocks in the Danube basin are related to the Precambrian period and represented by crystalline shales. Paleozoic formations occupy a significant area in the Serbian part of the Danube Basin. Mesozoic deposits are present in Eastern and Western Serbia. Paleogenic deposits are distributed in smaller basins in the area of Southern and Eastern Serbia. The Pannonian Basin, as well as a larger number of smaller basins south of the Sava and Danube, are characterized by Miocene and Pliocene deposits. The basin of the River Pčinja and its tributaries has a complex geological structure. The most represented rocks are from the Paleozoic, Paleogene and slightly less from the Cretaceous.
According to the basic geological affiliation, the Dragovištica Basin is situated in the Rhodope zone, which extends from Western Bulgaria to Southeastern Serbia and Eastern Macedonia. All the mountains are mostly built of old Paleozoic rocks. The area of the Adriatic basin is extremely complex in geological terms. The main highlands are represented by Paleozoic and Mesozoic formations that occur along the periphery of the Metohija Basin and were discovered on the surface of the terrain in the peripheral parts, especially in the northwestern and southeastern part.

Diversity of aquatic ecosystems

An inventory of the flora of higher plants and of large number of algae divisions was made for the territory of the RS. The area of Serbia belongs to the floristically very rich areas. Knowledge of the diversity of micro and meiofauna of aquatic invertebrates in Serbia is not systematized. Precise data on the total number of aqueous macroinvertebrates in Serbia are not available. Of the representatives of herpetofauna, there are three species related to aquatic habitats- the pond turtle (Emys orbicularis), the grass snake (Natrix natrix), and dice snake (Natrix tessellata).

Considerable number of types of aquatic ecosystems are present in the Danube Basin in the RS. The most important are running water ecosystems. There are few natural lakes, but there is a significant number of reservoirs, in which specific ecosystems are often formed. Wetland ecosystems are most widespread in the plains, along large rivers (Danube, Sava and Tisza). Within aquatic habitats, springs, canals, spas, mineral springs, and fishponds, as well as saline waters are also present. Peatlands, as specific habitats for aquatic organisms, are present mainly at higher altitudes. The diversity of aquatic ecosystems in the Aegean Basin in the RS has not been satisfactorily explored. Based on the available data, it is not possible to make a reliable estimate of the number of represented species. There are no available systematized data on the biological diversity of aquatic ecosystems of the Adriatic Basin in the RS.

CHARACTERISTICS OF SURFACE WATER

Basic typology of watercourses

The applied typology principle is based on selected abiotic parameters, using the system B proposed under Annex II to WFD. Mandatory parameters for the typology of system B- geological base, altitude, and basin size is included in consideration. The dominant type of substrate (sedimentation size in the watercourse bed) was also considered as an optional parameter. The territory of the Danube Basin in Serbia includes four regions: ecoregion 5- Dinaric Western Balkans (about 45,000 km), ecoregion 7- Eastern Balkans (about 4,500 km), ecoregion 10- Carpathians (about 2,500 km), and ecoregion 11- Pannonian Plain (about 30,000 km). The territory of Pčinja, Dragovištica, and Lepenac includes two ecoregions: ecoregion 5- Dinaric Western Balkans, and ecoregion 7- Eastern Balkans. The territory of the Beli Drim Basin includes two ecoregions: ecoregion 5- Dinaric Western Balkans, and ecoregion 6- Hellenic Western Balkans.

Classification of watercourse types

Classification was implemented on a basis of the analysis of abiotic and biological criteria.

Following abiotic parameters were selected for classification: water body size, type of dominant mineral substrate, and altitude. Of biological indicators, the parameters which were later prescribed as mandatory in the assessment of ecological status, were analysed, except for microbiological indicators and parameters that take phytobenthos as a basis for an assessment. Six types of watercourses in the Danube River Basin have been defined:

1) Large lowland rivers, dominance of fine sediment,
2) Large rivers, dominance of medium sediment, except for the rivers of the Pannonian Plain,
3) Small and medium watercourses, altitude up to 500 m, dominance of coarse sediment,
4) Small and medium watercourses, altitude over 500 m, dominance of coarse sediment,
5) Watercourses of the Pannonian Plain area, except for watercourses classified in type 1,
6) Small watercourses outside the area of the Pannonian Plain which are not covered by types 3 and 4.

Reference conditions

An important part of the WFD implementation is the definition of reference conditions since ecological status is evaluated according to deviation of selected parameters of ecological status from the values of these parameters in relation to the reference conditions. The parameters for which the reference conditions are defined are prescribed by the RS legislation.

Delineation of surface waters bodies

Delineation of water bodies (hereinafter: WB) is performed in accordance with instructions defined in Guide no. 2: Identification of water bodies, as well as by using available documentation.

Water bodies are defined on the following basis:

1) Classification into a certain category of surface water (river, reservoir),
2) Classification of watercourses into types,
3) Natural physical and morphological characteristics of watercourses (shape of a river valley-gorge, wide valley, etc.),
4) Positions of the mouth of major tributaries,
5) Positions of objects that can represent significant hydromorphological pressure, and
6) Knowledge of the general state of watercourse quality.

Based on the described methodology, and in accordance with the defined typology, WB for watercourses larger than 10 km^2 were delineated. The total number of surface WB is 3,216, and their average length is 8.45 km.

Lakes

Three natural lakes larger than 0.5 km^2 have been identified: Palić (5.45 km^2), Ludoš (3.18 km^2), and Veliko Blato (1.78 km^2). These ecosystems have been significantly modified over time and are proposed as candidates for heavily modified WB.

Preliminary determination of heavily modified and artificial water bodies

According to WFD, “heavily modified water body" (hereinafter: HMWB) is a body of surface water which is substantially changed in character because of human activity.

Before marking WB as heavily modified, all alternatives for its rehabilitation must be considered. If alternative solutions do not exist, WB can be marked as heavily modified. Any WB that can be determined by certainty to have been created exclusively by human activity is defined as artificial WB.

Up to date, only a preliminary delineation of heavily modified and artificial water bodies has been carried out in the RS. Candidates for HMWB were determined on the basis of the impact analysis of hydro morphological changes on the condition of surface WB. Any WB that is created exclusively by human activity in places where there was no water before, is defined as an artificial WB.

Out of a total of 3,216 WB on the territory of RS, 84 WB are located on the territory of the Pešterska Plateau, and 312 on the territory of the AP Kosovo and Metohija. Due to the lack of data, HMWB and artificial WB have not been delineated in these areas. Of the remaining 2,820 WB, 2,454 are natural WB, 218 are candidates for HMWB, and 148 are artificial WB.

CHARACTERISTICS OF GROUNDWATER

The RS is relatively rich in groundwater reserves, which are in different types of aquifers, unevenly distributed throughout the territory of the Republic. The main groundwater reserves are accumulated in thick Quaternary and Neogene aquifers of intergranular porosity and in mountain massifs built of karstified carbonate rocks. Shallow aquifers in the alluvial plains of large rivers are mostly used for public water supply. Confined aquifers within the Neogene basins of Vojvodina and Central Serbia, as well as karst aquifers in the southwestern and eastern parts of Serbia, are also used. Some parts of Serbia have small reserves of groundwaters (Šumadija and Southern Serbia).

Characteristics of hydrogeological regions

Complex geological conditions of the territory of the RS have caused hydrogeological heterogeneity and unequal presence of groundwater within different types of aquifers. In the earlier water management planning documents, 6 hydrogeological areas were singled out: 1. Banat and Bačka, 2. Srem, Mačva and Posavo-Tamnava, 3. Southwestern Serbia, 4. Western Serbia, 5. Central Serbia, and 6. Eastern Serbia.

The area of Bačka and Banat

In hydrogeological terms, the most significant formations of this area are deposits of Quaternary and Neogene age, which have a continuous distribution in the entire basin. Aquifers are recharging by infiltration of precipitation, as well as from rivers along the edge of the Pannonian basin. Drainage of aquifers is primarily done by abstraction of groundwater for public water supply. Slightly less than 55% of the total amount of groundwater is taken from principal aquifer.

*The Area of Srem, Mačva, and Posavo-*Tamnava

There are no aquifers in the northern part of Srem with significant reservoirs of groundwater. In the southern part of Srem, reservoirs of groundwater have been formed within the sandy-gravelly deposits of the Pliocene and late Quaternary. Recharging of aquifers formed within Quaternary deposits is done by infiltration of precipitation, and within Pliocene deposits, by infiltration of precipitation on peripheral parts and partly by inflow from Quaternary deposits.

The area of Southwestern Serbia

From hydrogeological aspect, the most significant formation in the southwestern Serbia is represented by the middle and upper Triassic carbonate deposits. Dominant recharging of aquifers is done by infiltration of precipitation, and discharging is done through numerous springs, the yield of which varies considerably throughout the year. The most important alluvial aquifers are related to the sandy-gravel deposits of Beli Drim and its tributaries.

The area of Western Serbia

Area of the Drina River is the principal aquifer in this territory. The alluvium of Kolubara, Zapadna Morava, Ibar, have generally weaker filtration characteristics and small thickness. The most important aquifer within the rocks with karst type of porosity is related to the carbonate deposits of the Middle and Upper Triassic in the area of Lelić ("Lelić Karst", with an area of about 300 km^2). On the largest part of the terrain of Western Serbia, there are aquifers of the crack type, related to serpentines and peridotites, with low yield.

The area of Central Serbia

In this area, the most important aquifers are formed within the alluvial deposits of the Velika Morava, Danube and Južna Morava, as well as within the Neogene deposits of the Leskovac and Jagodina- Paraćin Neogene basins. These aquifers are recharged by infiltration of surface water and precipitation infiltration.

The area of Eastern Serbia

The area of Eastern Serbia is predominantly characterized by a significant presence of carbonate deposits. The thickness of limestone deposits ranges from 50 m to 500 m. These deposits are intensively cracked and karstified, so that significant amount of atmospheric precipitation infiltrates underground. Formed groundwater reservoirs are discharged through numerous springs, with high variability during the year. Aquifers within the Quaternary deposits are related to the areas of alluvial plains of rivers Beli, Crni, and Veliki Timok, and Nišava.

Delineation of groundwater bodies

Delineation of groundwater bodies (hereinafter: GWB) was performed in accordance with the definition in the Law on Water, according to which GWB represent a volume of groundwater within one or several water-bearing strata. Based on available data and adopted criteria, there are 153 GWB in the RS, out of which 152 belong to the Danube basin (Black Sea Basin), and one belongs to the Aegean Sea basin. GWB on the territory of AP Kosovo and Metohija were not considered. In the process of delineation of GWB, in addition to their distribution, it was also considered the vertical distribution where it was more intensive; hence, there were delineated 12 GWB in deep aquifers and 141 GWB in shallow aquifers. Out of 153 GWB, 131 is identified as national, and 22 are identified as transboundary GWB: 6 each with Hungary and Romania, 3 with Croatia, 2 with Montenegro, 2 with Bosnia and Herzegovina, and 3 with Bulgaria. The areas of delineated GWB range from 35 km^2 to 2,643 km^2. The total area of all GWB in the Danube basin in the RS is 96,217 km^2, and in the Aegean basin 1,156 km^2. Of the total area of all water bodies, approximately 25% (24,051 km^2) are transboundary water bodies, whose harmonization with neighboring countries is expected in the forthcoming period.

SIGNIFICANT PRESSURES, IMPACTS, AND RISKS

The primary objective of WFD is to prevent the deterioration of WB, protect and restore good water status. Pressure and impact analysis is one of the most important analytical phases in the development of a Plan, with the aim of assessing the extent to which anthropogenic activities may pose a risk to achieving good status of water bodies.

In this Plan, all pressures are considered significant, and special attention is paid to identifying significant impacts.

Population

In the RS, 4,722 settlements with population from several to over 200,000 inhabitants have been

recorded, and 10% are connected to some type of wastewater treatment plant. Currently, 56% of the total population is connected to sewage systems (about 3.9 million). Of the total wastewater discharge into the public sewerage network, 69% is from households, about 19% from industry, and about 12% from other sectors.

Industry

Most industrial plants in the RS discharge wastewater into the public sewerage network, and some directly to watercourses through individual sewerage systems. The industry is most developed in the north of Bačka and around big cities: Belgrade, Niš, Kragujevac, Čačak, and Kruševac. In accordance with the Industrial Emissions Directive (2010/75/EU), there are 227 operators on the list of industrial operators that are obliged to obtain an integrated permit in the RS, and 26 permits have been issued so far. In the RS, records are kept on 91 pollutants and data are submitted to the European Pollutant Release and Transfer Register. Serbian Environmental Protection Agency has established national Pollution Release and Transfer Register. In addition to the discharge of industrial wastewater, pollution is emitted into surface and groundwater from the agricultural sector, mining, mining and sanitary landfills.

Agriculture and land use

Agricultural areas occupy the largest part of the area of Serbia (55%) and as such represent significant potential source of diffuse pollution. Regarding livestock, according to the latest data, for the period 2010-2017 there is a decreasing trend in the total number of cattle by 2.3%, pigs by 4.1%, and poultry by 0.7%. Farms that can be classified s potential sources of pollution operate in 82 municipalities with poultry farms (20,000 chicken per shift), in 129 municipalities with cattle farms (200 head of cattle), and in 40 municipalities with pig farms (200 pigs) and are located in the northern and central parts of the country. According to the available data, in the RS in May 2019, slightly less than 1,200 plant protection products were registered, while about 950 various products are available on the market.

Hydromorphological alterations

River regulation works, construction of dams and embankments, are direct drivers of anthropogenic impact on hydro morphological changes of water bodies, while indirect drivers are land use, urbanization, and other industrial activities, which leads to changes in water and sediment regime or surface runoff modification, causing hydro morphological pressures and impacts. In addition to navigation and transport, electricity generation in hydropower plants, surface water intakes, changes in coastal characteristics, inundation, changes in watercourses morphology, climate change, can also be considered significant direct drivers of hydro morphological changes.

POLLUTION PRESSURE ANALYSIS

Identification and analysis of pressures caused by anthropogenic activities and their impact on surface waters was performed according to Article 5 of the WFD and Guide no. 3: Analysis of pressures and impacts. This analysis is the basis for developing an effective program of measures. The main categories of pressures on surface waters are organic and nutrient pollution, pollution by priority and priority hazardous substances, and hydromorphological alterations. However, all other pressures that may not fall into any of these categories should be identified, e.g., using data on land use, black spots so-called “hot spots”, etc.

The assessment of the impact of a particular pressure or combination of pressures is generally based on surface and groundwater monitoring data used to determine the probability that a water body will fail to meet the environmental quality objectives defined in the WFD.

Pressures on surface water can be caused by concentrated or diffuse sources of pollution or

hydromorphological changes in water bodies, while pressures on groundwater are mainly related to diffuse pollution, often from agriculture or through groundwater abstraction, e.g., for water supply or irrigation.

Results of the assessment of pressures on surface WB

Pressure analysis showed that 78% of total emissions are dominant sources of concentrated pollution from settlements and industry, and about 22% are diffuse sources of organic pollution. The analysis also shows that most of the pressures of organic pollution originate from agglomerations (about 80% of the total emission of organic pollution) in which the largest population is concentrated. Relatively high pressures per unit area from organic pollution have been identified in less than 20% of water body basins.

The analysis of pressure from nutrient pollution showed that the concentrated and diffuse sources of this type of pollution are almost identically important, i.e., they amount to approximately 50% of the total emission of pollution. Most of the pressures from nutrient pollution come from urban areas, i.e., from agglomerations (about 57% of the total emission of nutrient pollution), but the dominance of this pollution is not as high as is the case with organic pollution. Relatively high specific pressures from nutrient pollution in the RS have been identified in less than 15% of WB catchments.

Emissions from industry to the environment are the main source of hazardous substances. According to the WFD, the obligation of the body responsible for water management is, among other things, to determine specific and other polluting substances, characteristic for a certain river basin. Locations that can be considered as a potential source of pollution of aquatic environments with priority and priority hazardous substances are mines, tailings, disposals of various types of waste, landfills, and dumps, as well as the application of pesticides on agricultural land. Analysis of pressures from pollution with priority and priority hazardous substances shows that high and medium pressures of such pollution have been identified in 61 WB catchments and are related to the extractive industry (mining) and landfills (tailings, ash, etc.). Although surface water pollution by priority and priority hazardous substances is considered a significant problem in water management, a lack of systematic data collection has been observed.

Results of the assessment of pressures on GWB

As the analysis of pressure shows, the quality of groundwater in the RS is quite uneven, which is partly due to natural factors, i.e., different genesis of aquifers, and ranges from water of exceptional quality, which does not require any type of treatment for human use, to waters that require complex water purification processes.

Pressures on groundwaters are a consequence of pollution from the population (due to the use of septic tanks and dry sewers), industry (due to the use of septic tanks) and infiltration of pollution into groundwater from the surface. Transfer of pollution by infiltration into groundwater includes:

1) diffuse sources of pollution from agriculture (nitrogen, phosphorus, priority and priority hazardous substances) as a result of the application of mineral fertilizers, manures and pesticides, and
2) diffuse sources of pollution from mining and industrial activities (due to land use for landfills, extractive mining activities, industrial areas, etc.).

The analysis of pressure from pollution by priority and priority hazardous substances on groundwater is based on expert assessments. It is concluded that no GWB can be considered under pressure from pollution by priority and priority hazardous substances.

The quality of groundwater in deep aquifers, although protected from human activity by relatively thick impermeable sediments, is heavily burdened by the presence of natural organic matter,

ammonia, and arsenic.

The most significant quantitative pressures on groundwater resources in the RS are groundwater abstractions for public water supply, industrial water supply and irrigation of agricultural areas, as well as drainage in mining works and pressures due to hydro morphological changes of surface waters.
The assessment of the listed pressures on groundwater was performed together with the assessment of the impact, i.e., through the quantification of the impact on the overall sensitivity of GWB.
It is estimated that the total groundwater abstraction for public water supply and other purposes is about 428 million m^3 per year (13.6 m^3/s).
One of major pressures on groundwater is hydromorphological alterations in surface water due to river sediment extraction.

According to the current level of research, it is estimated that the total groundwater reserves on the territory of the RS, excluding the AP Kosovo and Metohija, amount to about 65-70 m^3/s. About 70% of these reserves are alluvial aquifers, and about 16% karst aquifers, almost all of which are located in the territory of Central Serbia.

POLLUTION IMPACT ANALYSIS

The results of the impact assessment on surface WB

The assessment of the impact of pressures on surface WB uses the results of pressure analysis and data on average WB flows.

Analysis of pressures and impacts of organic pollution on 2,816 WB indicates that 40% of surface WB are exposed to significant impacts of organic pollution. 35% WB (971WB) is exposed to significant nutrient exposure. For about 50% WB (1,413 WB) of surface waters, the impact of nutrient pollution pressure is not high enough to cause significant impacts. For about 15% WB (432 WB) of surface waters, the impacts of nutrient pollution are possibly significant and require careful monitoring to determine the necessary measures.

Nutrient pollution as a consequence of concentrated sources of pollution is 50% of the impact, and the remaining 50% comes from diffuse sources of pollution.

Regarding priority and priority hazardous substances, a relatively small number of WB with significant pressures, i.e. impacts, have been identified. Out of 2,816 analyzed surface WB, 61 WB have been identified in which pollution by priority and priority hazardous substances leads to “possible significant” or “significant impacts” and no responsible trigger has been confirmed, indicating the need for improved monitoring. The catchments of these WB are located in an area with significant industrial or mining activities, landfills and tailings.

The results of the impact assessment on GWB

The existence of pressure on GWB is not in itself an indicator of groundwater pollution. Also, the identified pressure does not have to significantly impact the GWB. The results of the analysis of the degree of sensitivity of GWB conducted in the previous period, were used in the analysis of the impact of organic pollution and nutrient pollution due to the existing pressures on GWB.

The final results of the pollution impact analysis on the GWB are expressed through the impact index, which is calculated for both shallow and deep WB. However, practice has shown that only shallow WB are affected by pollution, and there is the impact on deep WB only if a direct connection is established between shallow and deep WB. While developing this plan, it was assumed that deep GWB are not under the pressure of nutrient pollution. It should be emphasized that these results derive from insufficient systematic monitoring of deep GWB.

Assessment of the impact of quantitative pressures on GWB is not possible due to lack of necessary data. Based on expert assessment and analysis of available data, it can be concluded that the identified significant quantitative pressures on groundwater at the same time represent significant quantitative impacts.

ANALYSIS OF PRESSURE AND IMPACT DUE TO HYDROMORPHOLOGICAL ALTERATIONS

The main hydromorphological pressures within hydrological regime are water supply, water abstraction, sudden changes in water levels due to the operation of hydropower plants (hydropeaking), and drainage systems. In regard to the longitudinal continuity of rivers, the main pressures are related to dams that cause interruptions for fish migration, sediment transport, and river sediment extraction. In terms of morphological conditions, the main pressures are correction of river flow, the change of the flow profile, the strengthening of the bank/ riverbed, the embankments together with the changed land use. There are 72 surface water bodies with significant pressure due to reservoirs, which is 2.3%. For 17 water supply intakes, 31 intakes for industrial water supply, 45 intakes for irrigation, and 120 intakes for hydropower plants, significant pressures are recognized in 70 surface water bodies (2.3%). Sudden changes in water levels due to the operation of hydropower plants on rivers occur in 85 natural water bodies (2.8%). Significant pressures from the drainage system were recognized in 77 water bodies (2.3%). Significant pressure due to extraction of river sediment is present on 4 water bodies (0.1%). Significant pressure due to regulation works is present in 36 water bodies (1.2%). Significant embankment pressure is present at 108 WB (3.5%). Significant pressures due to artificial land use in the coastal zone affect 24.5% of all natural water bodies and candidates for heavily modified surface water bodies. Heavily altered meandering is present at 6.3% of natural WB together with candidates for heavily altered surface water bodies (194 out of 3,068).

Based on available data, about 13.3% of all waterbodies in the Republic of Serbia are under high hydro morphological pressure, 28.2% is under moderate pressure, and 58.1% are not under pressure.

For new infrastructure projects, it is important that environmental requirements are considered as an integral part of the planning and implementation process, that stakeholders are involved in all phases of planning, to ensure that the best environmental option is selected.

OTHER PRESSURES AND RELATED ISSUES

Pressures and impacts on sediment quality

Serbian Environmental protection Agency conducted sediment quality testing in the period 20212-2017 which included 143 profiles in 79 watercourses and 41 profile in 17 reservoirs. The highest concentration of nickel (Ni) and chromium (Cr) were recorded in the sediment from the river Čemernica (Trbušani), arsenic (As) in the sediment from the river Jadar (Lešnica), zinc (Zn) and lead (Pb) from the Borska river (Slatina), copper (Cu) in the sediment from the river Veliki Timok (Čokonjar), cadmium (Cd) in the sediment from the river Pek (Blagojev Kamen). In reservoirs, the highest values of nickel (Ni), chromium (Cr), and cadmium (Cd) were recorded in the sediment from the Vrutci reservoir, while the highest value of arsenic (As) were detected in the sediment from the Gruža reservoir.
The results of testing of organic micro-pollutants in river sediments and sediments in reservoirs indicate the presence of organochlorine pesticides.
In HS DTD Vrbas- Bezdan, in 2015, remediation concentrations of copper in about 71% of all analyzed samples, chromium in all layers from second to fifth kilometre of the examined section of watercourses, and zinc in the middle layers of sediment were determined. According to the content of copper, cadmium, and polycyclic aromatic hydrocarbon, class 4 has been determined at the Itbej site, including the content of mineral oils 54, therefore its extraction and disposal without special

protection measures is not allowed.

Invasive species in aquatic ecosystems in Serbia

Out of 26 foreign aquatic macroinvertebrates confirmed for the territory of Serbia, 13 are considered invasive, and of 26 foreign fish species, 10 are considered invasive. Of the reptiles, North American red-eared turtle was most often identified.

Floods, droughts, and climate change

It is estimated that about 18% of the territory of the Republic of Serbia is potentially endangered by floods. The average decrease in precipitation on the territory of Serbia is expected by 20.5%, with significantly higher decrease in the southern regions, f almost 40%.

Microplastic pollution

Due to the lack of adequate data, a detailed analysis of microplastic pressures on surface and GWB was not conducted in this Plan.

RISK OF FAILING TO ACHIEVE A GOOD STATUS OF SURFACE AND GROUNDWATER BODIES BY 2027

The degree of risk that the objectives set out in Article 4 of the WFD will not be achieved must be assessed for each surface and GWB. For WB where such a risk is identified, further characterization is envisaged in accordance with Annex II (1.5) of the WFD to harmonize both the operational, supervisory and research monitoring program (Chapter V) and the program of measures (Chapter IX).

Risk assessment results for surface water

The results of the risk assessment are central to the planning process according to "DPSIR" analytical methodology (drivers-pressures-states-impacts-responses) and provide basic recommendations for the program of measures (Chapter IX). According to the provisions of the WFD and accompanying guides, it is desirable to use the results of water quality monitoring to assess the risk that a particular water body will not have a good status at the end of the planned period.

The results of the risk assessment show that about 50% of the surface WB are "at risk" or "possibly at risk" of failing to achieve good status in the categories of organic and nutrient pollution.

Risk assessment results for groundwater

The extent to which there is a risk of not achieving the WFD objectives must be assessed for each GWB. If GWB does not meet environmental goals or there is a risk that it will not meet goals by 2027, then the cause of this failure must be examined.

Criteria for defining the chemical and quantitative status of groundwater in the RS are defined by the Rulebook on parameters of ecological and chemical status of surface waters and parameters of chemical and quantitative status of ground waters (“Official Gazette of the RS” no. 74/2011) (hereinafter: the Rulebook).

Based on the applied methodology, no GWB in deep aquifer is “at risk”, while some GWB in shallow aquifers are “at risk".

Risk of failing to achieve good quantitative status by 2027

Based on the risk assessment for all GWB, it can be concluded that 135 GWB are "not at risk", and 18 GWB are "at risk" to fail in achieving good quantitative status by the end of the planning cycle. Substantial groundwater abstraction for public water supply is a major reason for risk exposure of 16 GWB.

PROTECTED AREAS

In order to improve the situation in the field of management of protected areas of importance for water management, i.e., which protection depends on status of water, it is necessary to implement first regulatory, then administrative and technical measures, which is envisaged in Water management Strategy of the Republic of Serbia until 2034.

Areas intended for the abstraction of water for human consumption under Article 7 of WFD

In addition to the Law on Water, areas intended for water abstraction for human consumption are currently regulated also by provisions of the Law on Food Safety. Determination and conditions for maintenance of such zones are defined by Rulebook on the method for determination and maintenance of the sanitary protection zones around water supply structures.

Areas intended for the protection of economically important aquatic species

The issue of economically important aquatic species is not specifically regulated by the legislation of the RS. With respect to the above, in the future period it is necessary to prepare and adopt appropriate regulations, in order to prepare a register of this type of protected areas.

Water bodies intended for recreation, including areas designated for bathing under Directive 2006/7/E389

The Law on Water stipulates the use of water for sports, recreation, and bathing. Regulations are currently being harmonized with the EU and this area of water management is being improved.

Nutrient sensitive areas under Directive 91/271/EEC, including areas designated as nitrate vulnerable areas under Directive 91/676/EEC

The Law on Water, Directive 91/271/EEC and Directive 91/676/EEC (hereinafter: the Nitrates Directive) define protected areas sensitive to nutrients, including areas susceptible to eutrophication and areas sensitive to nitrates from agricultural sources. In the following period, in accordance with Art. 96b of the Law on Water, it is necessary to precise criteria for determining these sensitive areas, identify them and determine them spatially, in order to create a register.

Areas intended for protection of habitats or species where an important element of their protection is the maintenance or improvement of water status

According to the Law on Nature Protection, about 470 areas in the RS have been declared protected areas. These areas cover about 677,950 ha or 7.66% of the territory of the RS. There are 125 areas in preliminary register identified as areas where maintaining or improving water status is an important factor in protection of habitats or species. In addition, 11 areas are identified as internationally significant wetland habitats, especially wetland bird habitats, under the Ramsar Convention, with a total area of 130,410 ha.

MONITORING OF SURFACE AND GROUNDWATER

According to WFD, the goal of the monitoring is to achieve a comprehensive overview of water

status by implementing a monitoring program on a sufficient number of WB, to analyse the overall status of surface and underground water.

Requirements for monitoring of surface water, groundwater, and protected areas are stipulated by Article 8 of WFD and Annex V, as well as Art. 107 of the Law on Water.

Surface water monitoring program

Requirements for monitoring of surface water

Monitoring of surface water is implemented through supervisory, operational, and research monitoring programs. The *supervisory* monitoring program should include watercourses of the catchment area larger than 2,500 km^2 and monitoring trends in the assessment of long-term changes in water bodies. The *operational* monitoring program includes water bodies “at risk" of not meeting environmental objectives and focuses on the quality parameters that are most sensitive to existing pressures. The *research* monitoring program is envisaged by additional measures, the results of which should enable a more reliable assessment of status and risk, as well as the selection of appropriate measures for the next planning cycle.

Annual monitoring programs currently implemented in the Republic of Serbia do not fully meet WFD standards, the Environmental Quality Standards Directive and the Nitrates Directive, especially in terms of monitoring scope (number of stations and water body coverage), monitoring frequency, and representation of testing parameters.

Surface water monitoring network

Surface water quality monitoring is implemented by the Environmental Protection Agency (EPA) of the Republic of Serbia, in accordance with the annual monitoring program. Based on the results of the water quality assessment in 2009 and 2010, WB of surface waters for which there is a potential risk of not achieving environmental objectives have been identified.

According to the WFD, monitoring is also established on lakes larger than 0.5 km^2. Reservoirs created by river barriers, which are mainly used for water supply and irrigation, are also subject to surface water monitoring according to the WFD. On reservoirs included in the national monitoring network, operational monitoring is performed if they meet the following criteria: catchment area upstream of the dam > 10 km^2, WB upstream of the dam marked as significantly changed, water renewal period > 30 days, flow length under deceleration > 2 km.

Surveillance monitoring measuring stations are located at catchment areas larger than 2,500 km^2 and/or at border profiles with neighbouring countries.

In the period from 2012-2020, within the research monitoring program, additional research was conducted through contracts with private laboratories and university institutes, as well as for the purpose of submitting data in accordance with international agreements. The monitoring was implemented in accordance with the WFD requirements, and the monitoring results significantly contributed to the overall assessment of the state of environmental quality in the Republic of Serbia.

Current status of surface water monitoring program in the Republic of Serbia

Analytical methods of EPA for the identification of most physicochemical, chemical, and biological quality parameters, as well as priority and priority hazardous substances, are accredited in accordance with the standard EN ISO/IEC-17025.

Groundwater water monitoring program

The EPA of the Republic of Serbia monitors the chemical parameters of groundwater quality.
The Republic Hydrometeorological Institute (RHMI) performs quantitative monitoring of groundwater within the state monitoring network.
The collected monitoring data are processed and published in official annual reports.
To meet WFD requirements, the network needs to be adjusted during the next water management planning cycle.
In addition to the EPA and RHMZ, other institutions in the Republic of Serbia monitor groundwater for various purposes.

Monitoring of quantitative groundwater status

There are two main types of GWB in the Republic of Serbia: shallow (141) and deep (12), and the monitoring of quantitative and qualitative status is primarily focused on GWB of shallow aquifers.
For quantitative status monitoring, the current national monitoring network includes between 400 and 420 monitoring points per year that are under the jurisdiction of RHMI.
The current network of monitoring stations is not sufficient to determine the quantitative status of each WB or group of GWB.

Groundwater quality monitoring

Groundwater quality monitoring is implemented at about 60 to 80 points per year, in the period from 2007 to 2019. During this period, monitoring data are available for 5 or more years for 69 monitoring points. The number of GWB for which water quality data are available for a period longer than 5 years is 32 (2007 to 2019) or 21% of all GWB in the Republic of Serbia. Groundwater quality monitoring is performed on shallow aquifers and one WB of deep aquifer. To monitor the chemical status of groundwater, the current national monitoring network includes 76 stations under the jurisdiction of the EPA, which cover about 20% of GWB. The frequency of groundwater quality monitoring is once a year. The parameters included in the groundwater quality monitoring are almost completely in line with the WFD requirements and with the analysis methods from Directive 2009/90/EC. The integration and further development of WFD-compliant groundwater monitoring is a priority task of the first planning cycle 2021-2027.

Monitoring of protected areas

Monitoring of protected areas is an obligation under the relevant EU Directives and must meet their requirements.

According to the Law on Water, for water bodies from which more than 100 m^3/day can be taken on average, and which are in the water management plan intended for drinking water supply, measuring the amount of water and testing its quality is implemented in accordance with the annual program of the Ministry of Agriculture, Forestry and Water Management. RHMI implements quantity measurement, and quality testing is implemented by EPA, in charge of conducting state monitoring of water quality. Quality and quantity of drinking water is tested on a regular basis by municipal and regional water supply companies, and the hygienic and health safety of drinking water is monitored by the Public Health Institute of the Republic of Serbia.

Monitoring of protected areas of surface water bodies intended for recreation, including areas designated for bathing, is prescribed by the Bathing Water Directive, and within the jurisdiction of Ministry of Health of the Republic of Serbia. still does not fully comply with the requirements of this Directive. There is still no full compliance with the requirements of this Directive.

When it comes to monitoring of protected areas- subject to eutrophication, areas sensitive to

nutrients, and areas sensitive to nitrates from agricultural sources (nitrate vulnerable areas), it is necessary to adjust the existing state monitoring by increasing the volume and network of measuring stations in accordance with the Nitrates Directive, the Municipal Wastewater Treatment Directive and by amending the Law on Water and related bylaws.

Monitoring of areas designated for the protection of habitats or species where maintaining or improving water status is an important factor in their protection, includes monitoring of future Natura 2000 areas, which will be officially determined according to the Birds Directive and the Habitats Directive in the process of EU accession.

SURFACE AND GROUNDWATER STATUS

SURFACE WATER STATUS ASSESSMENT

According to applicable laws, the status of surface WB is determined on the basis of the ecological status of natural WB, i.e. the ecological potential for HMWB and the chemical status of WB, so the worse of the two (ecological status/ potential and chemical status) determines the total status of WB.

Ecological status includes biological quality parameters, together with accompanying physical and chemical parameters, as well as specific parameters and accompanying hydro morphological parameters that affect the biological elements of water quality.

The status of water bodies is assessed by applying the procedure and methodology defined by the Rulebook. The procedure consists of two steps:

1. Assessment of ecological status/ potential, and
2. Assessment of chemical status.

The results of systematic monitoring of WB in the RS are the starting point for assessing the status. The results of the assessment of ecological status/ potential and chemical status are presented in detail in the Plan. Cumulative results are presented on ecological status/ potential maps and chemical status maps.

For the assessment of ecological status, about 2,812 WB were grouped so that the ecological status was assessed at 1,343 WB groups based on the available data of testing biological quality parameters for the period from 2012-2019.

Based on the available monitoring data of biological parameters, the ecological status is estimated at about 800 of surface WB. By grouping WB that belong to the same types and that are subjected to comparable pressures, 1,070 groups of surface WB have been defined. Based on the defined groups, the assessment of the ecological status was performed on another 262 surface WB.

In general, the results of national monitoring and other surveys show that out of a total of 1,062 surface WB, an excellent ecological status is achieved at 273 (26%) WB, and a good one at 220 (21%) surface WB. Moderate status is estimated at 297 surface WB (28%). At 181 assessed WB (17%), the status is assessed as weak, and 91 (8%) WB have poor status.

To assess the chemical status, data from the National Monitoring Program for priority and priority hazardous substances for 185 surface WB in the period from 2012-2018, were used in this Plan. Due to the number of parameters being evaluated (26 out of 45) and the frequency of measurements, which was not monitored at all sampling points in accordance with the WFD requirements, it can be concluded that the chemical status has a medium degree of reliability. In the Republic of Serbia, a list of specific parameters for the assessment of chemical status has not been determined yet.
For many priority and priority hazardous substances in surface waters, pollution is low or non-existent.

GROUNDWATER STATUS ASSESSMENT

In order to determine the status of GWB, monitoring of quantitative and chemical status is implemented.
Criteria for defining the chemical and quantitative status of groundwater in the RS are defined by the Rulebook.

The chemical status of GWB was assessed on the basis of available monitoring data for the period from 2004 to 2018, and analysis of pressures and impacts on GWB, given the insufficient frequency and scope of parameters of existing groundwater monitoring. To assess the chemical status of groundwater in this Plan, a multistage approach based on the concentration of nitrate in GWB was used.
Out of 141 shallow aquifer GWB, based on the monitoring results, 10 GWB were rated in bad and 18 GWB in good chemical status. For other WB, the status was assessed based on the analysis of anthropogenic pressures that were rated as significant, and their impact (impact index > 0.15). Based on this analysis, 27 shallow aquifer GWB were rated with potentially poor status, and 86 GWB have potentially good chemical status.
Of the 12 deep aquifers GWB, based on the monitoring results, it was estimated that 1WB was in poor and 1 WB in good chemical status. For other WB, the status was assessed based on the analysis of anthropogenic pressures that were rated as significant, and their impact (impact index > 0.15). Based on this analysis, 1deep aquifer GWB was rated with potentially poor status, and 9 GWB have potentially good chemical status.

Quantitative status of GWB is determined on a basis of registered quantities of water abstraction and measurement of groundwater level and source yield. Within its network of hydrological stations, the groundwater level is measured by RHMI. Currently, in the Republic of Serbia, only 31 out of 153 GWB are covered by the network of groundwater hydrological stations, i.e. it is covered by monitoring.
The assessment of quantitative status covered all 153 GWB. In total, it is estimated that 18 GWB (which is 12%) is in poor quantitative status.

ENVIRONMENTAL PROTECTION OBJECTIVES AND EXCEPTIONS

The first cycle of water management in the RS covers the period from 2021 to 2027, which is the third cycle of water management for the EU member states. In this period, it is not possible to fully implement measures to achieve good status of all water bodies in the RS by 2027, due to significant deficiencies of data, methodologies, monitoring, which is not fully compliant with WFD, and most importantly, there is a lack of human and financial resources for the implementation of the necessary measures.
Achieving the environmental objectives of the WFD depends to a large extent on the implementation of basic measures, in particular those concerning the Common Wastewater Treatment Directive and the Drinking Water Quality Directive. In order to achieve good status of all water bodies defined by the WFD, a transitional period will be required even after the implementation of the Drinking Water Directive and the Urban Wastewater Treatment Directive. It is planned that both Directives will be fully implemented by 2044, and the implementation of the WFD will require several planned management cycles to achieve the WFD environmental objectives.

Considering that in some cases there are major technical, environmental, and financial challenges for the implementation of these measures, Article 4 of the WFD allows exceptions to environmental objectives in all justified cases where good environmental status/ potential cannot be accomplished for a particular WB. In order to identify particular WB as an exception to environmental objectives, the WFD defines the implementation of clearly defined procedures. Therefore, deviation from the general objectives of the WFD is not allowed, if it is a consequence of inadequate application of the

basic measures listed in the Plan.

Extension of the deadline for achieving good status of WB according to Article 4 (4) of the WFD are provided for the purpose of phased achievement of environmental objectives for the following reasons:

- the improvement can only be achieved in stages due to technical feasibility,
- the measures are technically feasible but economically unjustified (e.g. the costs of measures are unrealistically high which should be justified by an adequate economic analysis),
- if they cannot be implemented during the first cycle due to natural constraints.

In the first planning cycle in the Republic of Serbia, the exemptions under Article 4 (5) of the WFD did not apply to surface water and groundwater. Potential application of these exceptions will be considered for the second planning cycle.

Article 4 (6) of the WFD, which allows for temporary deterioration of WB status if it is the result of natural causes or force majeure, has not been applied to any WB in the Republic of Serbia in this planning cycle.

Article 4 (7) of the WFD determines cases when failure in achieving the environmental objectives of the WFD is allowed- when it comes to planned activities and/ or infrastructure projects to be implemented in the function of sustainable development and resulting in deterioration of the status/ potential of particular water bodies.
This planning cycle envisages the collection of missing data in order to adequately justify the reasons for establishing an exemption for each particular project/ facility for the needs of the next planning cycle.

The Water Framework Directive in Article 4 (1) (c) stipulates the achievement of environmental objectives for protected areas. For WB located at one of the protected areas, environmental objectives may be more stringent than the required good status, if required by other EU directives related to protected areas, such as: Drinking Water Directive, Urban Wastewater Treatment Directive, Nitrates Directive, The Bathing Water Directive, the Birds Directive, and the Habitats Directive. These directives have not been fully transposed into the legislation of the Republic of Serbia. In order to improve the situation in this area, it is necessary to first apply regulatory, and only then administrative and technical measures.

SUMMARY OF ECONOMIC ANALYSIS

Article 5 of the WFD requires an economic analysis of water use, which shows the importance of water for the economy in general and for different sectors of the economy. The analysis helps to understand the share of different sectors of the economy in terms of pressures on the aquatic environment.
Average annual investments in all areas of the water sector in the last documented years amounted to € 120 million, or € 111 million in 2017 and 2018, which is between 1.6% and 2.1% of total investments. The main sources of funding were loans and grants from KfW (more than € 12 million per year) and EU grants (€ 4.7 million per year).
Over the last decade, investment in the water sector has declined significantly, both in terms of maintaining existing infrastructure and building new capacity. The share of investments in water supply and wastewater collection and treatment in total investments is very low and continues to decline. The average annual investment in the water and wastewater sector over the last six years has been € 96 million, well below the level required for sustainable development.
According to the WFD guidelines, water use and water supply services include household and industrial water supply services, wastewater disposal, electricity generation, agriculture, flood protection, fisheries and aquaculture, navigation, tourism and recreation and other purposes.

Most of the available water (70%) is used in agriculture. Industry is the second largest consumer of water (22%), and in some of its sectors, water is an integral part of products (dairy, production of alcoholic and non-alcoholic beverages, pharmaceutical and cosmetic industry). The largest individual consumers of water in industry are power plants, namely thermal power plants in which water is used for cooling. It is important to mention hydroelectric power plants where the amount of abstracted water depends on the purpose of the reservoirs, which can be used for irrigation, public water supply, flood defence, recreation, etc.
Annual water abstraction for public water supply amounted to 659 million m^3 (21 m^3/s) in 2016. Predictions show that the total demand would amount to 827 million m^3 per year without reserves, or 951 million m^3 per year with reserves for greater security of supply. This means that by 2034, about 168 million m^3 per year (5.33 m^3/s) more water is needed than in 2016.

There is no common unit of measurement or common indicator for different pressures on biological, chemical and hydromorphological quality elements of the ecological status of WB. Projections of these pressures are included only qualitatively as trends and described in three possible directions of trend movement: growth, decline or constant.

One of the innovative economic instruments of the WFD is the pricing policy for water supply services, which should provide appropriate incentives for the efficient use of water resources and thus contribute to the established environmental goals. The main principle for achieving this goal is the reimbursement of costs for water supply services, including environmental and resource costs. In addition, the application of the “polluter pays” or “user pays” principles should ensure that different types of water use appropriately contribute to cost recovery.

According to the Decision of the European Court of Justice from 2014, it is up to the member states to decide to which water use activities the principle of reimbursement of costs from Article 9 of the WFD applies, as long as it does not jeopardize the purposes and goals of the WFD.

In this plan, the scope of cost recovery under Article 9 of the WFD is limited to public water supply and public wastewater collection. Moreover, both are a single service for "drinking water supply and wastewater collection", as most public utility companies (hereinafter: PUC) provide a joint service in technical, organizational, and economic terms.

In regard to other types of water use, the costs that enable the accumulation of water in order to protect against floods and navigation, as well as the costs of public irrigation systems should still be paid by the RS budget, because it is public infrastructure of public interest. Private operators pay for the use of water for water supply and wastewater discharge, as well as for hydropower production and irrigation.

The Strategy of Agriculture and Rural Development of the Republic of Serbia 2014 - 2024 envisages support and financing of projects for the improvement of agriculture and rural infrastructure. Priority for irrigation should be areas that can be supplied with sufficient water from local sources. However, the amount of water intended for this purpose is not specified in this strategy.

PROGRAM OF MEASURES (PM)

The Program of Measures (hereinafter: PM), as an integral part of the River Basin Management Plan, has a key role in achieving the objectives defined in Article 4 of the WFD. The term “measure", according to the WFD, refers not only to technical but also legal, administrative, economic measures and other instruments used for the application of the WFD.

PM development is an integrative process that, in accordance with the WFD, takes place in six-year

planning cycles. The process is divided into the following phases: identification of necessary and possible measures, conceptualization of PM, analysis of its implementation as well as monitoring the results of the implementation of implemented measures. The basic structure and content of the PM are set out in Article 11 of the WFD.

Measure planning procedure

The period from 2021 to 2027 is the first planning cycle for which a PM has been established for the territory of the Republic of Serbia in accordance with the requirements of the WFD. For each pressure that puts WB "at risk", an appropriate measure has been selected and included in the PM. In order to standardize the procedure, these measures are defined as key measures (hereinafter: KM) according to the guidelines of Guide no. 35: WFD reporting.
The initial identification of KM is closely aligned with the main pressures and issues listed in the Significant Issues Report.
The scope of previously identified measures far exceeds the financial and other resources available in the six-year planning period. Therefore, some measures have been postponed to later planning cycles.

The most important steps towards meeting the objectives of the WFD are prevention of quality deterioration (quality preservation principle), improvement of the knowledge base (analysis of pressures and impacts, monitoring) and harmonization and implementation of all EU policies and directives related to water (basic measure).

Measures to implement EU legislation in water management and other "basic measures"

The WFD requires the establishment of a program of measures to address significant issues to enable the achievement of environmental objectives in accordance with Article 4 of the WFD. The program of measures in accordance with Article 11 (2) of the WFD should include basic and complementary measures (if the environmental objectives are not achieved only through the application of basic measures). Basic measures include:

1) Measures required to comply with EU legislation related to the environment and the water sector as set out in the WFD (Article 10 and Part A of Annex VI),
2) Measures required for the implementation of EU legislation related to the environment and water as specified in the WFD (Article 10 and Part A of Annex VI),
3) Measures for implementation of Article 9 of the WFD (costs recovery),
4) Measures to promote efficient and sustainable water use
5) Measures to protect the quality of drinking water and reduce the level of treatment of affected waters,
6) Measures to control abstraction from surface and groundwater,
7) Measures for control of groundwater natural recharge,
8) Measures to control discharges from concentrated sources of pollution,
9) Measures to prevent and control the input of diffuse sources of pollution,
10) Measures to address any other pressures that have a significant impact on the status of WB, especially related to hydromorphological pressures,
11) Measures to remove or reduce pollution by priority and priority hazardous substances and
12) Measures to prevent accidental pollution.

Basic measures are identified according to the basic postulate of the WFD, which is that basic measures represent the minimum requirements defined through EU directives.

Measures against pollution by organic matter

Analysis of pressures and impacts indicated that more than half of the estimated organic load comes

from agglomerations with more than 50,000 p.e. In these agglomerations, about 85% of the organic load is due to the small number of sewage systems with municipal wastewater treatment plants (hereinafter: WTP). These loads can be significantly reduced by improving the sewerage infrastructure.
According to the established general principles for determination of PM, measures to reduce organic pollution need to be implemented at 508 WB that are assessed as "possibly at risk" or "at risk" of not achieving good status/potential.
Implementation of the Urban Wastewater Treatment Directive has begun in Serbia, but it is still at an early stage.
A significant reduction in the pressure from organic pollution will be contributed by the full transposition and fulfillment of the relevant EU legislation, especially the Directive on Urban Wastewater Treatment (91/271/EEC) and the Industrial Emissions Directive (2010/75/EU), while providing the necessary institutional and administrative capacities for their implementation.
Water management, capacity building within institutions, and finance are crucial issues in the first planning cycle. Therefore, several cycles will be required until all the requirements of the Urban Wastewater Treatment Directive are met. The specific implementation plan (DSIP) for Urban Wastewater Treatment Directive envisages the construction of 65 WTP in the period 2018-2032.
Although only four WTP have been proposed for more than 150,000 p.e., their load accounts for 42% of total organic pollution in water. The third largest group of WTP (15,000-50,000 p.e.) is expected to reduce the share of about 20% of the total organic load.
Regarding sewage systems, it is estimated that about 10,400 km of new sewage network for wastewater collection (main sewage collectors and secondary sewage network) should be built, which will additionally provide adequate wastewater collection and disposal for about 2 million users.

Nutrient pollution measures

According to the established general principles for determination of PM, measures to reduce nutrient pollution should be implemented at 1,403 (43.6%) WB, which were estimated to be "possibly at risk" or "at risk" of not achieving good status/potential. The draft Code of Good Agricultural Practice and the DREPR project provide guidelines for reducing nutrient pollution and further improving water quality.

With the transposition of the Urban Wastewater Treatment Directive (91/271/EEC) and the Nitrates Directive (91/676/EEC) into national legislation, significant progress is expected in reducing nutrient pollution of surface and GWB. Also, the transposition of the Industrial Emissions Directive (2010/75/EU) is expected to reduce pollution with nutrients originating from the food and chemical industries and farms.

To meet the requirements of the Urban Wastewater Treatment Directive (91/676/EEC), it is necessary to apply a higher degree of treatment in sensitive areas to remove nutrients at plants for more than 10,000 ES. Several planning cycles will be required to achieve an adequate reduction in nutrient pollution.
A key measure to reduce nutrient pollution from concentrated sources is the construction or reconstruction of WTP (KM 1). Measures to reduce nutrient pollution from agriculture as a diffuse source are combined with appropriate advisory services for farmers (KM 2 and KM 12). Where there is no clear boundary for the origin of nutrient pollution (concentrated or diffuse sources), there will be necessary research, improvement of the knowledge base to reduce uncertainty (KM 14) and the involvement of advisory services (KM 12). KM 14 will also apply to all WB "at risk" or that are "possibly at risk".

Measures for priority and priority hazardous substances

Pollution with priority and priority hazardous and other specific substances causes toxic effects on

aquatic organisms and humans. Monitoring of priority and priority hazardous substances in the RS is carried out mainly for the Danube and its main tributaries. Pollution of these substances in water most often originates from industrial sectors with combustion processes, chemical industry, landfills, mines, transport, and energy sector.
The "combined approach for point and diffuse sources" defined in Article 10 of the WFD, involves emission control (based on the application of best available technologies for concentrated sources of pollution, and in the case of diffuse sources the application of best practices and relevant emission limit values) and the establishment of environmental quality standards.
With regard to the remediation of contaminated sites and sediments, measures in accordance with Article 11 (3h) of the WFD are of particular importance, specifying the application of general binding rules for the control of diffuse sources of pollution.
Some of KM must be implemented at the national level, such as KM 15. This measure may include specific measures related to the location (mines, landfills or industrial plants that emit priority and priority hazardous substances) where the drivers of pollution have been identified. Especially important measures are also KM 16 and KM 4, which refer to the construction and reconstruction of existing industrial WTP as well as the remediation of contaminated sites. KM 4 is planned as a supplementary measure for WB "at risk" where mining and/or landfills are the most probable source of pollution, while KM 16 is planned as a supplementary measure if industry is found to be the most probable source of pollution.
KM 14 is one of the main measures related to a significant increase in administrative capacity (i.e. providing the necessary human and financial resources, training and organizational solutions) for monitoring and control of pollution sources of priority and priority hazardous substances.

Measures for hydromorphological alterations

Hydromorphological alterations have the potential to change the natural status of surface and groundwater bodies and their associated aquatic flora and fauna. From the aspect of obtaining appropriate physical characteristics of WB in order to maintain the desired hydromorphological conditions and habitat continuity, they are an integral part of determining the ecological status of WB.
The analysis of hydromorphological pressures estimated that interruptions to river continuity, embankments, reservoirs, water abstraction and regulation of watercourses represent significant hydromorphological pressures on WB. Due to these pressures, as well as additional pressures (e.g. change of land use in the coastal zone, altered flow meandering) 411 WB in the RS are "at risk" of not achieving the objectives of the WFD, and 865 WB are "possibly at risk".
Instruments for the application of basic WFD measures related to hydromorphological alterations already partially exist in RS and they are:

- Application of minimum sustainable flow
- Procedures related to water acts
- Obtaining water permits
- Establishment of water information system (WIS)
- Determination of water fee
- River sediment extraction plans

To achieve the objectives of the WFD, in addition to the basic hydromorphological measures, it is necessary to apply supplementary measures, as well as technical hydromorphological measures on those WB where it is recognized that environmental objectives cannot be achieved due to significant hydromorphological pressures.

Measures to reduce hydromorphological pressures

According to Annex V of the WFD, defined hydromorphological quality elements important for biological elements used to assess ecological status can be associated with various key measures to

reduce hydromorphological alterations: hydromorphological alterations associated with hydrological regime (KM7), hydromorphological alterations associated with river continuity, KM17) and hydromorphological alterations associated with morphological conditions (KM6). KM 23 is associated with both hydrological regime and morphological conditions, while KM17 is relevant for all three hydromorphological quality elements and hydromorphological pressures.

There are two types of hydromorphological measures that are associated with specific key measures:

1) Administrative and research hydromorphological measures- are carried out on all WB
2) Technical hydromorphological measures- are carried out only on WB for which it has been determined that they are "at risk" or "possibly at risk" for achieving environmental goals.

Groundwater abstraction measures

Groundwater abstraction is regulated by the Law on Water, the Law on Mining and Geological Research "Official Gazette of the RS" no. 101/2015, 95/2018- other law, and 40/2021). Water abstraction measurement is mandatory for public water supply, agriculture/ irrigation, industry, and water bottling. Any water abstraction is subject to the issuance of a water permit, except for the needs of one's own household, if the water springs on one's own land but does not flow beyond its borders, as well as in case the groundwater abstracted on one's own land is used for drinking, watering, and sanitation.

The basic measure aimed at reducing water losses is the rehabilitation of water supply networks. Reducing water losses will make it easier to achieve good quantitative groundwater status. Artificial recharge can also be an alternative to sustainable groundwater management; however, the possibilities of its use are still poorly explored. Measures that include conditions for artificial recharge or increase of groundwater volume in accordance with Article 11 (3f) of the WFD have not been sufficiently implemented, but research and improvement of knowledge on the possibilities of artificial recharge is planned.

Measures to reduce the pressure from groundwater abstraction

The risk assessment of the quantitative status of groundwater showed that 18 of GWB (about 12% of the total number of WB) are "at risk" of losing good status, most of which are in AP Vojvodina (12). 135 GWB are "not at risk" of achieving good quantitative status, i.e. about 88% of the total number of WB.

The main reason for low quantitative status is excessive exploitation, ie. lack of balance between groundwater abstraction and restoration. There is a lack of reliable monitoring data that prove significant impacts of water abstraction and that clearly show a declining trend in groundwater levels. Another reason for the failure to achieve good status, especially in the Morava River Basin, is also the significant and permanent lowering of groundwater levels in river alluvium, partly due to the uncontrolled extraction of river sediment.

The basic measures for reducing the pressure from groundwater abstraction in terms of key measures (KM) are improving the groundwater regime and controlling the amount of groundwater abstraction (KM 7), water pricing policy measures for households, industry and agriculture on the principle of full reimbursement of water services (KM 9, KM 10 and KM 11), measures to establish drinking water protection zones (KM 13), measures to encourage efficient and sustainable water use (KM 8), improved monitoring to more reliably assess the quantitative status of groundwater and research to improve knowledge of the conceptual model of GWB at risk in order to reduce uncertainty (K 14).

Measures for other pressures and cross-cutting issues

The Report on Significant Water Management Issues in the Republic of Serbia (SWMI) defines the necessary measures for other "related significant issues" that address: organization of the water

sector and financing of water activities, deterioration of sediment quality, impacts of invasive species, floods, droughts, and climate change.
In this plan, plastic pollution in the aquatic environment and sturgeon have also been recognized as a significant issue.

A cost-effective combination of measures

For the development of economic criteria within the PM, cost-effectiveness was considered. PM is cost-effective if there is no alternative combination of measures to achieve the environmental objectives of the WFD with lower economic costs, which imply costs to whole society, not just the financial costs of the measures. According to Annex III of the WFD, the economic analysis of measures should provide sufficiently detailed information to draw conclusions about the most cost-effective combination of water use measures to be included in the PM based on an assessment of the potential costs of such measures. However, in practice, cost-effectiveness planning is not necessarily the only criterion for selecting measures, as they should also be feasible, affordable, and financially proportionate.

Cost-effectiveness of basic measures

The largest part of PM in the Republic of Serbia consists of basic measures related to the full transposition of EU directives. According to current estimates, about 80% of the total costs for the implementation of the WFD in the Republic of Serbia are attributed to the mandatory basic measures for the three, in terms of investment the most demanding, EU directives: the Urban Wastewater Directive, the Drinking Water Directive and the Nitrates Directive. Measures for the implementation of these directives in the Republic of Serbia have been developed within the framework of specific implementation plans and MIFP. They contain technical measures, legal and administrative instruments for implementation.

The cost estimate for technical measures in specific implementation plans is based on generic cost functions derived from the FEASIBLE tool and is adapted specifically for the Republic of Serbia. Costs for the most important measures were determined on the basis of cost statistics and comparison of costs with similar projects in the Republic of Serbia and neighbouring countries.

The cost-effectiveness ratios for these measures are derived from the relationship between the estimated investment costs and the corresponding physical indicator of the effectiveness of the measures.

Cost-effectiveness of supplementary measures

Unlike the basic measures, supplementary measures in the Republic of Serbia are still not planned in detail. Considering that the basic measures have yet to be implemented, it is difficult to identify and quantify the need for supplementary measures at this stage when the first PM is being prepared. A preliminary assessment of the types of measures that will be needed is based on expert estimates and the use of comparable data from neighbouring countries.

Funding of the measures

The outcome of the accession negotiations of the Republic of Serbia is important for the financing and time frame of the implementation of the PM. Considering that negotiations have not yet been finalized, estimates of necessary investments by 2027 are preliminary. The costs of implementing the WFD are mainly related to basic measures, complementary measures, and measures to strengthen institutional and administrative capacity.
Preliminary cost estimates for implementation of basic measures have been developed in specific implementation plans of the Urban Wastewater Treatment Directive, the Drinking Water Quality

Directive, and the Nitrates Directive. Cost estimates for implementation of supplementary measures as well as for additional institutional and administrative capacity are given in the specific implementation plan for the WFD and in the APCD.
Based on the cost estimates and analysis of funding sources in these four DSIP documents, the MIFP provides a strategy for financing the WFD. Cost and financing analyses in DSIP documents and MIFP are based on two important assumptions:

1) the target year of the accession of the Republic of Serbia to the EU is 2025
2) the transitional period for the Republic of Serbia is set for 2045

Costs of basic measures

The basic measures that require the largest investments are of a technical character and relate to the Urban Wastewater Directive, the Directive on the quality of water intended for human consumption and the Nitrates Directive. This list does not include costs for the IED Directive, which is directly related to achieving the objectives of the WFD.

Costs of supplementary measures

Supplementary measures must be implemented if water bodies cannot achieve WFD objectives only by implementing basic measures. It is difficult to determine which supplementary measures are necessary while most of the basic measures have not yet been implemented. At the current planning stage, cost estimates for supplementary measures by 2027 are not yet possible.

Capacity building costs

Capacity building measures are a necessary precondition for all technical and organizational measures. Administrative costs are defined as administrative costs at the national, provincial, and local levels. The costs of strengthening the institutional capacity to implement the WFD are mainly due to the need for additional staff, training and equipment. Additional operating costs mainly relate to the establishment and operation of monitoring networks under monitoring programs for WB.

Potential sources of funding

The basic planning documents, used to plan the financing of PM in the first planning cycle, are the DSIP documents for directives relevant to the water sector and the MIFP. A combination of potential national and international sources of funding will be used for the implementation of the WFD in the Republic of Serbia. National sources of funding for the water sector are mainly general revenues of the national budget and local government budgets, as well as fees charged to water users. International sources of funding include loans and grants from the EU, international financial organizations, and bilateral donors.
Financing of infrastructure projects as a measure for implementation of WFD is provided from two dedicated funds within the state budget- the Green Fund of Serbia and the Budget Fund for Water Management. The Green Fund was established in 2016 as a state budget fund intended to achieve the goals of environmental protection in the Republic of Serbia. The Law on Environmental Protection defined the system of fees for environmental protection as a source of financing for the Green Fund. The Ministry of Finance is responsible for controlling the distribution of funds. The Budget Fund for Water Management is also part of the state budget. The Ministry of Agriculture, Forestry and Water Management- Republic Water Directorate, co-finances investment projects from the Budget Fund for Water Management in accordance with the Regulations on the Water Management Program adopted by the Government for each calendar year, such as construction and reconstruction of drinking water supply facilities, construction and reconstruction of facilities for collection and treatment of wastewater, development of planning and technical documentation for construction and reconstruction of water facilities, etc.
Local governments and local public utility companies are directly responsible for drinking water

supply and sanitation services to the population and are expected to co-finance these services with their own funds. The Fiscal Council estimates that by reforming local self-government and restructuring public utility companies, savings of up to 0.35% of GDP (€ 100 million) could be achieved that can be invested directly in local utility infrastructure.

REGISTER OF DETAILED PROGRAMS

The Register of detailed programs provides an overview of detailed water management programs and plans related to river basins, sub-basins, sectoral plans, problems, or specific water management issues, and includes strategic and planning documents, documents related to the EU accession process and strengthening of professional capacities, as well as scientific research projects and studies.

PUBLIC PARTICIPATION

Public participation is a principle in EU policies and accordingly is an indispensable part of the WFD, especially in the part related to the development and adoption of Water Management Plans. According to Article 14 of the WFD, all member states and candidates are required to be actively involved in its implementation through three levels of participation: access to information, written consultations, and active participation. The importance of public participation in the development of planning documents in the water sector has been emphasized by several international conventions.

Public access to the documents and information on the basis of which the Plan is prepared in accordance with the WFD primarily includes:

1) the dynamics and work program for the development of the plan, including a statement on what measures should be taken for public consultation, at least three years before the beginning of the period to which the plan refers,
2) current review of significant issues in the field of water management, at least two years before the beginning of the period to which the plan refers and
3) draft Plan, at least one year before the beginning of the period to which the plan refers.

Active involvement of stakeholders is a continuous dialogue and decision-making process, including the institutions of the RS, the AP and local self-governments. Also, organizations, associations, the professionals, and citizens have a significant contribution to the implementation of the WFD.

The public in the RS must, through various programs, workshops, etc., be made interested and actively involved in decision-making process together with representatives of stakeholders and beneficiaries, regardless of whether they are organized or not, because without broad public support in all management activities, solutions cannot be found that will ensure water protection with sustainable development.

Summary of measures implemented to inform and consult the public

Involvement of stakeholders in the process of drafting the River Basin Management Plan of the Republic of Serbia 2021-2027 was conducted through three stakeholder conferences:

1. The first conference was held on December 17, 2019. On that occasion, two documents were presented by the representatives of the Republic Water Directorate: "Proposal of work program and dynamics of drafting the Plan on the territory of the RS 2021-2027", as well as "Proposal of the report on significant issues related to water management in the Republic of Serbia". The public hearing for these two documents was conducted in the period from October 15, 2019, to April 30, 2020, after which the Report on the conducted public hearing was prepared and the documents were revised in accordance with the adopted remarks.

2. The second Stakeholder Conference was held on September 15, 2020. The main goal of the conference was to acquaint the professional public with the progress in drafting the Plan. For this purpose, three presentations were held: on the program of measures, pressure and impact analysis, risk assessment and status of surface and groundwater.

3. The third stakeholder conference to present the Draft River basin Management Plan on the Territory of the RS 2021-2027 with the Draft Report on Strategic Impact Assessment, which is planned for the fall of 2021, was not conducted due to the serious epidemiological situation in the country. Interested parties are entitled to submit their remarks, suggestions, and comments on these documents to the Republic Water Directorate in writing, in the period from November 1 to December 1, 2021.

All documents prepared in the process of drafting the Plan are published on the website of the Republic Water Directorate: http://www.rdvode.gov.rs/dokumenta-primena-okvirne-direktive.php