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DEMAND FOR BUILDING WATER RESERVOIRS AS A BASIS FOR SUSTAINABLE SPACE MANAGEMENT IN THE REPUBLIC OF SERBIA

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Abstract. The purpose of planning space for water reservoirs is to produce a plan as a final product of dynamic activities focused on realizing the idea of purposeful space. In a wider context, the process of spatial planning of multipurpose systems intended for water supply is a controlling structure of events directed towards producing changes in space in a certain time horizon as a precondition for progress of a community. Water supply to the population and economy, intensive erosion, and torrential floods in mountainous regions in the Republic of Serbia stress the significance of managing the existing water reservoirs and call for the need for planning and building the new ones. These key infrastructure facilities enable the integral use and protection of drainage basins and prevent degradation of certain natural resources. One of the basic characteristics of water reservoirs is their multipurpose role in the social and economic development. Apart from their major role in water supply and power production, reservoirs directly impact hydrological regimes, sediment transport, biodiversity in aquatic and terrestrial ecosystems, microclimatic characteristics, river basins management, population, economy, etc. The paper will stress the needs for planning and building water reservoirs as multipurpose systems intended to respond to the challenge of progress of the society, as well as the change in climate conditions, which result in the periods of drought and water shortage, on the one hand, and excessive rains producing floods, on the other. The focus will be on the sustainable management of water reservoirs, but also on remediating the impact on water sources, land and forests.
Keywords: water reservoir, space, land, regimes of protection, population, river basin, erosion.

1 INTRODUCTION

Planning and development of water reservoirs involves the preparation of spatial and urban-planning-related documents, as well as the Strategic Environmental Assessment (SEA), drafted in accordance with the principles of area planning and by applying a continuous and integral approach, along with rational, optimal and sustainable use of natural resources (Perišić, 1985; Maričić, Josimović, 2005; Josimović, 2008; Krunić et al., 2016; Josimović et al., 2021). The key reason for the preparation and the adoption of the planning documents for water reservoirs is creating conditions for acting in national interests in the area of water management infrastructure, based on the principles of sustainable development. The conditions and guidelines defined in planning documents and development strategies enable regional water supply to rely not just on local water springs but on the key facilities, such as multi-purpose water reservoirs, which provide long-term and reliable water supply to the settlements and industry (Dašić,Đorđević, 2013). The vision of an environmental area realized by a planning document promotes the activities on preservation and prevention of soil degradation, i.e. soil erosion and sediment production (Ristić,Nikić, 2007). The finalization of spatial planning documents ensures, among other things: the protection and regulation of the area, improvement of infrastructural and communal equipment, improvement of the quality of life of the population, meeting socio-economic needs of the population and guidelines for the institutional, organizational and administrative support to the sustainable use and protection of natural resources (Đorđević,Daboviċ, 2014; Nenković-Riznić et al., 2014; Dobričić et al., 2016; Dobričić et al., 2017; Dobričić, Josimović, 2018; Josimović, 2020; Dobričić et al., 2022).

In the process of planning, with a focus on the spatial aspect of development, sectorial documents in the field of forests, forest land, forestry and agriculture play an important role, particularly those related to forests protecting water reservoirs, mitigation of the impact of erosion and torrential floods, etc., with an action feasibility plan for project financing. This aspect of spatial planning is becoming increasingly relevant in the context of climate change, and in the efforts to reduce conflicts concerning the purpose and use of space in the area of nationally and regionally significant water reservoir basins (Krunić et al., 2017; Josimović et al., 2019; Bezbradica et al., 2023; Josimović et al., 2022; Josimović et al., 2020).

Urbanization, mining activities, construction of infrastructure facilities (reservoirs, roads, transmission lines, gas pipelines, ski centres, etc.) as well as other facilities, have a strong impact on the characteristics of space use (Abdullah et al., 2019). The management of forest and agricultural land has a significant impact on the production of soil sediment. A reduction in the forest stock and unplanned agricultural production are some of the phenomena that intensify erosion and increase the quantities of eroded material. Unplanned mining and infrastructure construction activities increase the risks of soil devastation. Soil, as a natural resource, has its own dependence process, which is reflected in the correlation between annual losses and the productive ability to renew the land cover. These anthropogenic factors significantly influence the acceleration of loss of the natural surface soil layers (Spasić, 1988).

Climate change that has been gaining momentum in the past two decades has produced large oscillations in the quantities, distribution and intensity of precipitation, oscillations in air temperature, wind strength, etc. both in the territory of the Republic of Serbia (RS) and globally (Belchikhina et al., 2016, Josimović, 2020; Josimović, Crnčević, 2009). The mayor loss of vegetation in unfavourable terrains makes the soil susceptible to erosion (Zarei et al., 2020) and reduces the existing or planned uses of the space. The compromised soil structure has unfavourable infiltration characteristics, which results in surface runoff, torrential flows and floods. Sediment production, transport and sedimentation reflect the scale of soil resource losses over time (Goharrokhi et al., 2021). Analysis of the extent of soil degradation consequences in annual life cycles show that the process of natural renewal takes centuries (EEA, 1999). The greatest impact on the problems of soil loss and sedimentation of erosive material, i.e. a reduction in the water bodies reservoir space (lakes and rivers), with an increased risk of water pollution, in addition to the unchanging input parameters of the relief and climate, comes from land use planning of in the area (Meng, et al., 2021). Numerous water reservoirs, i.e. wider drainage basin areas of reservoirs in the RS, have attempted in recent years to harmonize the management and use of the area with the developed and adopted planning regulations. It is precisely the periods of adoption of plans that can be conditionally marked as zero states in future observations, analyses and measurements of the process of erosion and sediment production, the maturity of sediment in reservoirs, water pollution, the condition of forests and agricultural soil, etc. (Sedláček et al., 2022). However, this condition depends on compliance with technical documentation and the degree of performed works on bio-technical protection of water reservoirs and tributaries, which will be analyzed below.

Water demand by the entire society, climate change and frequent occurrences of floods, as well as the soil degradation and sediment production in the mountainous areas of the RS place a focus on the existing water reservoirs and indicate the necessity of planning and constructing the new ones. The needs and challenges also stem from the conditions and guidelines stipulated in the Water Management Plan in the Republic of Serbia until 2027. It sums up all the elements of the national legislation and current international agreements from the area of water management signed by the Republic of Serbia (Water Management Plan in the Republic of Serbia until 2027; Đorđević et al., 2020). It takes into account the requirements of the EU directives in the water management sector, primarily the Water Framework Directive, from characterisation of waters and the analysis of the current state, to defining the programme of measures for a 6-year planning period, which will in the future enable the attainment of the environment goals set for all groundwater and surface water bodies. By constructing and using water reservoirs, positive impacts are achieved on wider areas, enabling the protection of drainage basin areas, i.e. the environment in general. Realisation of hydro-technical infrastructure, as well as completing facilities that serve the purpose will contribute to the economic development, meeting the needs of local population for drinking water supply, and the development of other social activities. Developing, equipping, and managing water reservoirs and regional water supply systems indirectly contributes to strengthening the functioning of cities, municipalities, and a large number of smaller-scale settlements, and also to achieving the goals of the planning documents and the complete development strategy of Serbia, as well as the recommendations of the European Union in the area of water directives. The most important document in the area of waters if the Water Framework Directive, which is both the strategic and the operative framework for meeting key targets of the European water policy. The role of water reservoirs as multipurpose systems in the RS is the basic characteristic of these important key facilities (Dašić et al., 2021; Đorđević et al., 2012; Kostadinov et al. 2008). The basic concept of the existence of water reservoirs is

water supply and electricity generation (Đorđević et al., 2004). However, in addition to the presented basic roles of water reservoirs, they influence the occurrence of flood waves on the one hand and the dry periods on the other (Đorđević et al., 2012). Large water bodies enable micro-climatic influences, which additionally affects the entire flora and fauna in these areas. During the construction of reservoirs, it is necessary to regulate the drainage basins integrally, which has certain impacts on the production and transport of sediment, i.e. the construction of water reservoirs has a strong impact on all users, both of the basins and the wider social and economic community. Planning documents of all hierarchical levels strive to achieve positive impacts of the exploitation of water reservoir basins in the RS. Reduced reserves of fresh water, the impacts of demographic characteristics on the reduction in natural resources of forests and agricultural land, degradation of natural resources, a permanently increased need for food and water, changes in climate features, temperature and precipitation regimes in the world make water reservoirs one of the main elements in the fight against the stated facts. Some of the mentioned features have been present in the RS for a long time, while some have gained in prominence in recent years. Given that some water reservoirs are used for a certain period of time, the filling of the reservoir space and water pollution have been increasingly present as a direct problem in Serbia. Among other things, the mentioned problems brought about the need to create planning documents for individual water reservoirs in the Serbian territory, particularly in relation to Južno Pomoravlje as one of the most endangered areas. The purpose of the Study is to set the guidelines for the long-term development, use and management of water reservoirs, and defining the elements for integral water management and protection, as well as providing conditions for more beneficial functioning of water management system.

2 WORK MATERIAL AND METHOD

2.1 Study area

Serbian waters gravitate towards three seas: the Black Sea (rivers of the Danube basin, covering 98% of the RS territory), the Adriatic Sea (the Drim and the Plavska rivers; these two basins account for around 4,283 km^2) and the Aegean Sea (the Lepenac, the Pčinja and the Dragovištica; these three basins account for around 2,000 km^2). The share of natural and artificial lakes in Serbia is rather minor – Palić and Ludaško lakes in the territory of the Autonomous Province (AP) of Vojvodina and Vlasina, Srebrno and Sava lakes in the remaining territory (Water Management Strategy in the Territory of the Republic of Serbia until 2034, Fig. 1).

The total territory of the RS with AP Vojvodina and AP Kosovo and Metohija (88,499 km^2) has the following structure of land cover: agricultural land covers 43,113 km^2, forests and shrubs take up 38,240 km^2, wetlands and water bodies account for 2,377 km^2, anthropogenically modified (artificial) and barren surfaces amount to 4,757 km^2, while 11 km^2 is undistributed. In terms of erosion, the RS territory can be divided into two parts: the northern aeolian and southern pluvial, i.e. plains in the territory of Vojvodina with frequent processes of aeolian erosion and the mountainous part south of the Sava and the Danube rivers, with more intensive water erosion processes (Ristić et al., 2016). Such division does not exclude fragmentary occurrence of water erosion processes and floods in the territory of AP Vojvodina – the hilly part, and the effects of wind in the plains – valley parts of rivers and basins in the rest of the country, with AP Kosovo and Metohija. Degradation processes led to different types of erosion in around 80% of the Serbian territory, according to the 1983 erosion map (Lazarević, 1983), of which about a half of these surfaces are under the influence of very weak erosion processes, while the rest are exposed to weak, medium, strong and excessive (1.16%) erosion. Using modern models, i.e. the modified Erosion Potential Method (MPE) from 2020, the following was established: around 3% of the state territory is exposed to excessive erosion, 7% to strong erosion, 12% to medium erosion, 25% to weak erosion, and 52% to very weak erosion (Ristić et al., 2022). Large quantities of sediment, millions of cubic meters in Serbian rivers and water reservoirs reflect the intensity of this negative phenomenon of production, i.e. transport of soil material (Dragićević et al., 2011). Over 10,000 of registered torrential flows encourage the transport of sediment and entail comprehensive measures and works on the regulation of drainage basins and recipients (Ristić et al., 2016). The data of the Serbian Statistical Office on the erosion in Serbia for the 2012–2017 period indicate that, on average, around 600 km^2 are being eroded annually. The basin of the Vlasina river, the valleys of the Pčinja and Lim rivers, the upper parts of the Vranje basin and the basin of the river Ibar are just some of the areas with frequent occurrences of torrential flows and progressive erosion.

Water restrictions in certain cities and areas of the RS are a product of water shortages in summer periods and water pollution in reservoirs intended for water supply to the population (Gorguner,Kavvas, 2020). The inflow of erosive sediment in a reservoir negatively affects the volumetric space, increasing the risks of eutrophication of the lake (Kumar et al., 2019). Activities in drainage basins contribute to these negative

phenomena, which, as a result, has a significant impact on the socio-economic conditions of individual regions, as well as the country as a whole. Some cities and other places in AP Vojvodina have problems with drinking water supply throughout the year. The reason behind it is the pollution of water sources, damaged water supply system and large losses during water transport. The consequences of intensive agricultural production in this lowland region of Serbia contribute to the pollution of water sources.

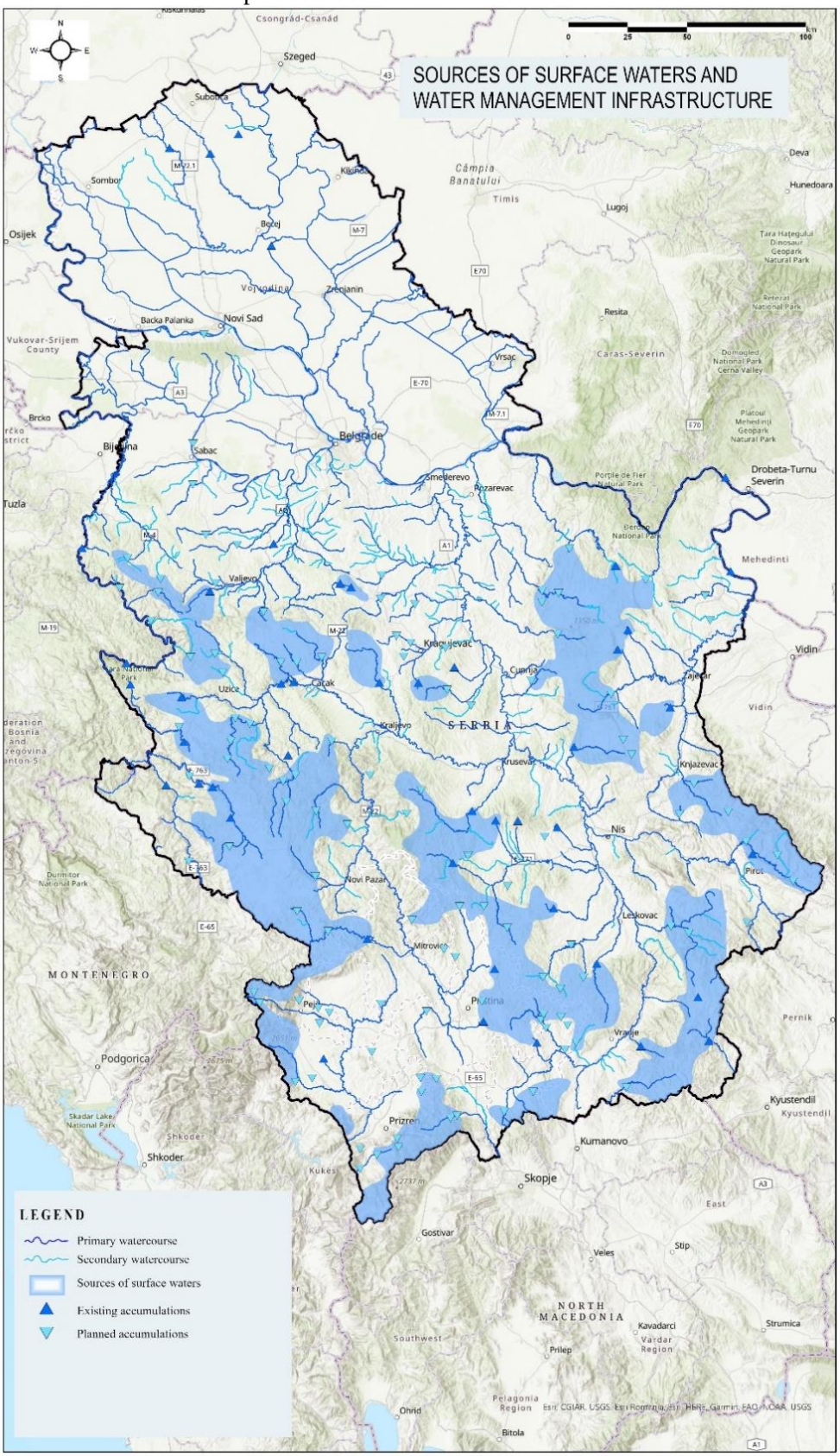

Figure 1. Water management infrastructure in the research area. Source: Spatial Plan of the Republic of Serbia until 2035

2.1.1 CLIMATE, PEDOLOGICAL CHARACTERISTICS, POPULATION AND ECONOMY

The RS territory belongs to the category of continental climate. The southwestern part is actually somewhere in between the Mediterranean and continental climate zones, while the mountain ranges surrounding the area are intersected by river valleys, thus modifying the climate, both Mediterranean (from the west) and continental (from the north and east). In the northern and central lowland region, the climate is moderately continental,with warm summers and cold winters, while the central and high mountains belong to the mountain climate zone. In the north of the country, annual air temperatures range from 10.8°C to 11.5°C, and in the lowland areas of the central and southern parts from 10.0°C to 12.1°C. The hilly and mountainous regions feature lower temperatures, decreasing linearly as altitude goes up, with a vertical gradient of 0.6°C/100 m. Precipitation in the RS territory is very heterogeneous, with yearly precipitation ranging from around 500 mm in the north to over 1,000 mm in mountainous regions (annual precipitation averages around 730 mm) (Water Management Strategy in the Territory of the Republic of Serbia until 2034).

The RS consists of a highly diverse land cover, as a consequence of diverse conditions of origin and development. Depending on the mentioned factors, there is a fertile plain in the north, calcareous and base soils in the east, clay soils in the mountains and hills in the southeast, up to humus-clay, sandy, humus-silicate soils etc. In the area of AP Vojvodina, the soils feature carbonates and readily available phosphorus, while readily available potassium content ranges from optimal to high. Weakly alkaline, as well as weakly humus to humus soils are dominant. In the south of Serbia, slightly acidic to acidic reactions, carbonate-free to slightly carbonated, slightly humus to humus, with low and very low content of readily available phosphorus are dominant, as well as soils with optimal and high content of readily available potassium (Strategic Environmental Impact Assessment, Spatial Plan of the Republic of Serbia).

Depending on the character of natural soil wetting, i.e. the water-physical properties of the soil, a general division of the soil was carried out, which is not only an appropriate, but also a purposeful approach in regulating the water regime from the aspect of applying hydro and agromelioration measures, as well as assessing the suitability of the soil for irrigation. Soil in the RS territory can be classified into three large groups (the mentioned areas do not include the territory of AP Kosovo and Metohija): automorphic soils 80%; hydromorphic soils 19%; and halomorphic soils 1% (Water Management Strategy in the Territory of the Republic of Serbia until 2034).

The number of users covered by the public water supply system increased over time, and thus the specific water consumption grew from around 100 l per user in 1950, to 390 l/user/day in 1981, up to 460 l/user/day in 1991, mainly due to the industrial development. The percentage of the population connected to public water supply systems is around 81%, namely around 71% in central Serbia, around 92% in Belgrade, and around 91% in AP Vojvodina, i.e. around 70% of the RS population uses water from groundwater resources.

In the early 21st century, water abstraction for public water supply systems in the RS amounted to around 23 m^3/s of water (around 730 million m^3/year).

Water use is directly correlated with the physical volume of industrial production. Thus, in 2008, around 136 million m^3 of water was used for industrial purposes. At the same time, more than 16% of the total amount of extracted water was from the public water supply system, while own water abstraction was mainly oriented towards surface waters. Later, the quantity of water extracted for the industry decreased, and in 2012 it amounted to around 90 million m^3 in the RS territory. For these purposes, more than 80% of water from own water intakes is used, with a higher share of surface waters.

The areas suitable for unrestricted irrigation and for irrigation with caution cover an area of around 1.9 million ha. Hydrosystems for irrigation in public ownership were built on an area of around 105,500 ha, which is less than 6% of the soil with favorable features for irrigation. It is estimated that less than 40% of these areas are covered by irrigation. According to data of the irrigation equipment distributor, in addition to the mentioned areas, another 45,000 ha are irrigated by individual privately-owned systems.

The largest hydropower plants were built on the rivers with great hydro potential, the Danube and the Drina, as well as smaller but hydropower-friendly watercourses such as the Vlasina, the Uvac, the Visočica and others. The hydroelectric power plants built so far produce an average of around 10,500 GWh/year (Water Management Strategy in the Territory of the Republic of Serbia until 2034).

2.1.2 FLOODING AND WATER RESERVOIRS IN THE REPUBLIC OF SERBIA

In our country, around 18% of the territory is potentially threatened by floods, mainly along the banks of the Danube, the Tisa and the Sava rivers, followed by the Morava, the Drina, the Kolubara, the Timok, etc. The problem of flood protection is quite relevant given the frequent occurrences of high waters on numerous watercourses, as shown by the events of 2006 and 2013 on the Danube, of 2006 on the Tisa, of 2010 in the Timok, the South Morava, the Drina and the Kolubara basins, particularly the catastrophically high waters in the spring of 2014. Direct and indirect damage in 24 municipalities affected by the floods in 2014 amounted to around EUR 1.5 billion.

Although torrential floods cover smaller areas, they pose a significant threat and sometimes lead to human casualties. In the RS, there are a large number of smaller watercourses with a torrential character, i.e. specific genesis, rapid concentration and short duration of high waters.

Numerous anthropogenic causes, such as damage to water facilities, deforestation, unplanned urbanization, construction of facilities on rivers, climate change, improper management of water facilities (reservoirs, retentions, relief channels) caused the deterioration of flood protection system. Around 3,550 km of embankments and other types of "line" protection on first-order waters participate in flood defence, i.e. around 400 km of regulated riverbeds on all watercourses.

To mitigate flood waves of high waters, 58 existing reservoirs and retentions (with a secondary role in flood defence) are used as active flood protection measures, in the form of a reserved space for receiving large water waves of a certain probability of occurrence (Water Management Strategy in the Territory of the Republic of Serbia until 2034).

Pioneering works in the field of building water reservoirs were carried out for energy needs (the so-called Great Dam on the Đetinja, 1930), and then for water supply purposes (Grošnica near Kragujevac, 1937). Due to electrification, high dams were built and the first large reservoirs were formed, with a volume of over 10 million m^3 (Vlasina lake, Međuvršje, Zvornik). In the RS, there are 28 reservoirs of individual volumes greater than 10 million m^3 with a total reservoir capacity of around 6 billion m^3. In addition to the large ones, a number of smaller reservoirs with different functions were also built. The unplanned management of these key facilities has led to unregulated drainage areas, resulting in soil erosion, production of silt and significant backfilling and loss of reservoir capacity (Sokolovica, Ovčar Banja, Parmenac, Zvornik, etc.). The quality of water in some reservoirs intended for water supply (Vrutci, Gruža, Ćelije, Bovan, etc.) is generally not satisfactory, therefore it is necessary to urgently identify the causes of deterioration and take measures to eliminate them. A certain number of reservoirs built for energy needs are also used in water supply.

2.2 WORK METHODOLOGY

In striving towards an integral way of planning, the rational, optimal and sustainable use of water resources and the use, regulation and protection of drainage basins, it is necessary to adapt the methodological approach to the content of the work, the sources and the materials used. Defining the subject matter and the area of the research, setting the working hypotheses, scientific goals and tasks of the research, all belong to the introductory stages of the work, i.e. the basic gradation level of the research problem.

The collection and systematization of professional and scientific literature, as well as the national, regional and local planning documentation from the subject area, are aimed at creating the information basis of the research. This part of the research is done by description, systematization and classification methods. In addition to these, the comparative-historical and inductive methods will be applied. These methods should include the following: subject areas related to the researched areas of the priority drainage basins of Serbian water reservoirs, vector and raster bases, meteorological and climatic characteristics, as well as the experiences of countries with a higher degree of drainage basin protection in terms of preventing erosion processes.

The analytical method as the second phase of the research is concerned with the systematic study and classification of relevant facts, processing the results and making proper conclusions. The analysis will cover natural, physical, relief, topographic, geological-pedological, hydrological, demographic and social characteristics. The implementation of the planning measures and rules of use, and the regulation of agricultural, forest, water and construction land, as well as their mutual conditionality and dependence, represent the basic activities in this research phase.

The method of synthesis of theoretical results through data processing and interpretation of the research results, and concluding considerations constitute the final phase (Diagram 1).

The basic hypothesis of the research is that the planning documents enable the sustainable use of natural and created resources, through integral management and spatial dispersion of activities in water reservoir basins, which results in the prevention of soil erosion and torrential floods, leading to the protection and preservation of water reservoirs, surrounding settlements and the infrastructure.

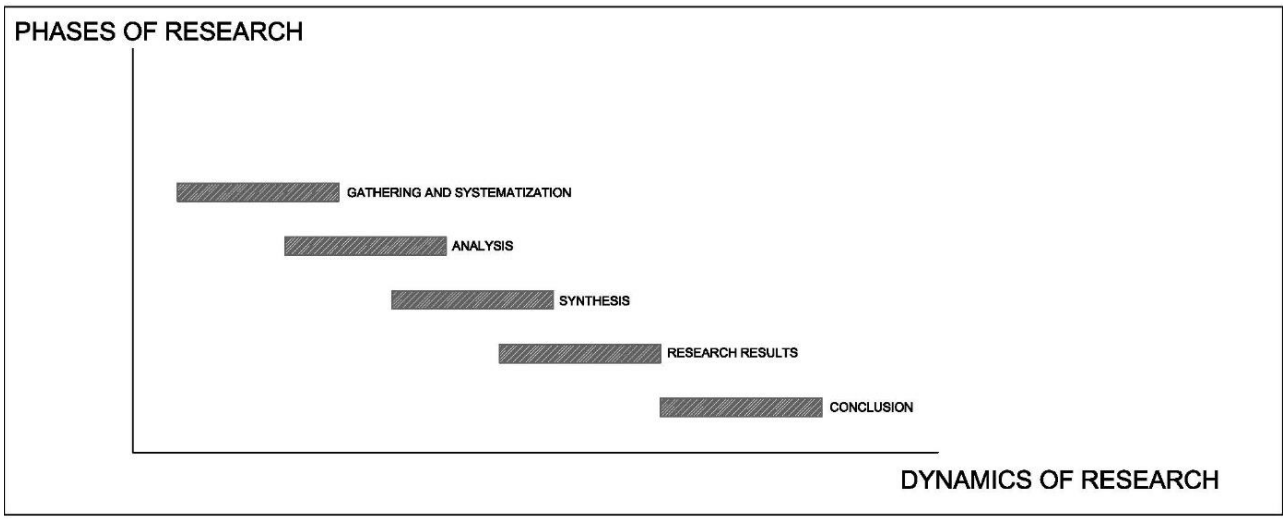

Diagram 1. Research phases

3 RESULTS

Recent decades are marked by population growth and increased needs for water and food to sustain the ever growing population. The main characteristic of this process is non-linearity, i.e. unevenness. On the one hand, in some developed countries, agricultural and forest land areas are decreasing, while the population and their need for the basic natural resource – water are growing. On the other hand, some countries have experienced a significant population decline, i.e. migration, most often from poor countries to developed, rich countries of the world. These major social and political changes significantly impact the environment and all its factors.

Global trends of the population fluctuation and migration can also be perceived in Serbia. According to the latest population census, there is a noticeable shrinkage of population, and migrations are evident both to developed EU countries and from less developed areas of the RS to more developed ones, i.e. from smaller settlements to larger cities. The population decline has not reduced the pressure on natural resources though. This is explained by the fact that in the territory of AP Vojvodina, agricultural production has significantly intensified, while the mountainous areas of the country have seen an expansion in forest exploitation, mining activities, tourism development, construction of infrastructure facilities, etc.

Global climate features display large amplitudes and significant changes in the relationship between rainy and dry periods. These changes also affect the territory of the RS. Prolonged periods without precipitation cause changes in the way water resources are managed. On the other hand, in rainy periods, we witness frequent occurrences of floods, which cause great material damage and jeopardize the population. Deficits in water supply at some locations in the summer and the occurrence of floods in rainy periods necessitate new, more modern ways of planning and using the water management facilities and systems of the RS.

Spatial plans for the special-purpose areas including water reservoir Stuborovni and the Regional Kolubara Water Supply System near Valjevo enabled the meeting of basic goals in modern planning, and/or the provision of spatial conditions for the construction and use of water reservoirs and the sustainable development of special-purpose areas. The implementation of this project would enable: the provision of the necessary amount of water and its distribution (beside the use of water in water supply to the population, the water is planned to be used by the electric power company Elektroprivreda Serbije as well), the protection against floods (caused by climate changes), and the improvement, i.e. the sustainable development of the wider area of the regional system. The protection of the public interest, public goods and goods in general use, the preservation and adequate valuation of water ecosystem services of the basin are only some of the principles achieved by the construction and use of the Stuborovni water reservoir. The long-term task of the development of this water management system is the maximum possible exploitation of the planning potential and purposes of water resources, along the mandatory protection and improvement of the quality of surface waters and

groundwaters, through complex, rational and integral water management. The basis for planning the construction and protection of the Stuborovni water reservoir is the protection of the existing and planned sources of water supply. In this regard, the most important measures are: rational water abstraction, taking into account the preservation of downstream ecosystems and the needs of other users, preservation of water quality, implementation of monitoring and timely undertaking of proactive and preventive measures aimed at the sanitary protection of water sources from existing and potential sources of pollution, application of modern technical and technological solutions for extracting and processing raw water, etc.

Water reservoirs as multipurpose systems are primarily used for water supply and electricity generation. The impact on water regimes downstream of the dam is a very important segment of the use of these facilities. Floods in recent decades have caused great material damage, and in some cases they exceed the value of the water reservoirs themselves, i.e. their construction, on all rivers where these facilities existed. On the downstream parts of the dam, there were no flood effects or they were insignificant, because during the design of the reservoirs, space is reserved for the reception of the flood wave. Also, the water mirror, i.e. the accumulation, has a positive effect on the entire biodiversity, particularly because water is the basis for the development of all living plant and animal species. The relativisation of conflicts concerning the use of water reservoirs and sustainable development of local communities, particularly the services of regulation and control (maintenance of the quality and quantity of water resources, protection from high waters, control of water regimes, preservation of aquatic and coastal habitats), i.e. water supply for the population and the economy, is the basic task in the process of planning and use. Numerous water reservoirs in the RS, as part of regional water supply systems, are the basis for harmonizing water use interests with the long-term interests in the economic and social development of local communities. Excluding necessary large investments, supplying the population with drinking water from regional systems has multiple advantages, with the security of water supply from different sources (or even different types of sources) being particularly important. The Water Resources Master Plan of the Republic of Serbia envisages that water supply to the population in Serbia will be ensured by expanding public water supply systems, linked to larger and more consistent units, completing regional systems, with these connections eventually forming a coherent water supply system of the RS. The basic characteristics of the regional water supply systems, which were intended to include all local sources (groundwater and surface water), are also given. Solutions from the Water Resources Master Plan were incorporated into the Spatial Plan of the Republic of Serbia and have since served as the basis for planning in the water sector. However, due to numerous reasons, notably the economic crisis, a reduction in industrial production, a demographic decline, adherence to international standards, etc., the expected increase in the water supply demand have not taken place, nor has there been the need for a significant increase in the number of regional water supply systems compared to the situation in the mid-1990s. Moreover, the poor financial situation made it impossible to complete certain regional systems that had been planned (Water Management Strategy in the Territory of the Republic of Serbia until 2034).

Bearing in mind the EU recommendations and standards regarding the sustainable development in the field of water policy and protected areas, it is necessary to permanently solve the problems of using reservoirs for water supply with measures of organization, regulation and regimes of space use. Such sustainable use of water resources will be ensured by permanent and integrated protection and improvement of water quality, and establishment of water monitoring and control systems, as well as the provision of space for the functioning, reconstruction and construction of water management infrastructure and facilities.

In cases where reservoirs are used for electricity generation, they ensure sufficient, safe, high-quality and economical supply of electricity to all consumers, as well as the conditions for connecting renewable energy sources to the distribution and transmission power grid. In the era of the reduction in fossil fuels and the increasing production of batteries and the use of electricity, water reservoirs represent the basis for the green production of this important energy source. The production of electricity implies the permanent harmonization of the interests of energy and water management with the development interests of other space users, environmental protection and the protection of natural and immovable cultural heritage.

The integral regulation of a reservoir basin and the sustainable use of all its elements and facilities built in it play a key role in a space and society. These impacts are mainly related to measures and works on the basin itself, in order to ensure water quality and fill the reservoir with sediment. The measures are reflected in the stipulation and implementation of particular activities of using forest and agricultural land, the prohibition of construction of some types of facilities, as well as anti-erosion technical, biotechnical and biological works. Restrictions must be compensated to the local population in accordance with the restrictions of the water protection regime, through the development of infrastructure and facilities, activities and functions of public importance, support for agrarian restructuring and diversification of economic activities in the countryside, particularly in the area of environmentally friendly tourism and other complementary activities.

Some of the compensatory measures can be the creation of conditions for rest, recreation and education of visitors about the natural and cultural values of the area, by organizing a content-rich tourist-recreational offer adjusted with the source protection regimes and integrated into the offer of the primary tourist destination.

Biological measures and works in the basin include the protection, preservation and improvement of the condition of forests and forest infrastructure in the area of the basin, preventive protection of forests and protected plant species from various threatening factors, particularly fires, plant diseases, excessive exploitation and pests. In addition, it is necessary to preserve the quality of agricultural land and its sustainable use according to the regimes and conditions for the protection of water supply sources. It is also necessary to support the development of multifunctional agriculture based on the traditional production of high-value local products and the provision of agro-ecological services. Technical anti-erosion works include the construction of landfill barriers on recipients, in order to prevent the transport of sediments, and to mitigate the effects of torrents, which would increase the risk of filling the reservoir area and impair the quality of water. The effects of these measures and activities, i.e. the use of drainage basins and water reservoirs are the reduction in the quantity of erosion sediment downstream from the dam and the reduction in the occurrence of floods and torrential floods.

Measures and works in the basin that affect a reduction in the risk of water pollution and significantly contribute to the overall state of society are the following: establishment of a system for monitoring the quality of the environment, especially the following and systematic monitoring of the quantitative and qualitative characteristics of water in the reservoir, tributaries and at the sources of local water supply; determination of the system of measures to manage the risk of accidents involving dangerous substances; establishment of a system of controlled and sanitary safe collection and purification of waste (municipal, stable and atmospheric) waters, storage and application of manure, use of mineral fertilizers and chemical agents in agriculture; development of an integral register of pollutants in the territory of the basin; improving information and primary education of the population and visitors about the protection of the reservoir and the environment.

In the RS, this year there are plans to carry out the works on the construction and reconstruction of water facilities for the supply of drinking and sanitary water, building tap water facilities, building main pipelines and reservoirs with appertaining devices in public ownership, maintaining water facilities for the regulation of watercourses and water facilities for flood protection in public ownership, and the maintenance of watercourses and irrigation and drainage facilities in public ownership, and rehabilitation of water facilities for the regulation of watercourses and the protection against floods, erosion and torrents in public ownership. Works will also be carried out on flood defences against external and internal waters and ice accumulation, water quality testing, elimination of accidental water pollution, preparation of technical documents and urban-planning related documents for water facilities in public ownership, as well as tasks of their professional revision, including the development of studies, projects and planning documents, as well as investor tasks on behalf of the RS, tasks arising from international cooperation in the field of waters, activities to improve the regulation and utilization of waters, protecting waters from pollution, and improving the regulation of watercourses and protection from harmful effects of waters (Decree on Establishing the Water Management Program in 2023).

The impact of climate change with the construction of water reservoirs is reflected in the preservation and maintenance of the diversity of wild flora and fauna and its increase through the reintroduction of extinct indigenous species of animals and plants. Habitat preservation and increasing the number and the spatial dispersion of the population of rare, endangered and critically endangered (on the verge of survival) plant and animal species represent the positive effects of using these water management facilities. In addition, they show the sustainable use of places, natural objects and phenomena that, with their features, represent prominent, rare and attractive values of geo-heritage and preservation of the beauty and diversity of the landscape.

The research of the said water management area significantly contributes to finding the solutions to the modern challenges in the era of significant social and natural changes. Extensive research material contributes to broadening the existing principles of planning and development of water reservoirs and the related infrastructure, which should adjust to and include the said social and natural changes in the Republic of Serbia.

The research results serve as the basis for future activities and research focused on integrating all the individual regional water management systems into a single national and wider regional system. The goal of future research should be the protection of the existing and the improvement and development of the new water reservoirs that would belong to the integral system, which would provide the necessary amounts of water to the population and the economy and the protection from flooding with the implementation of the required national legislature and EU directives in the area of waters and the environment in general.

4 CONCLUSION

Given all the above, it can be concluded that the construction and use of water reservoirs is the basis for the sustainable development in the RS. The problem of water shortage and population growth globally is not a dominant problem of Serbia. The shortage of water in some parts is a local phenomenon from the aspect of water balance and the pollution of groundwater sources. Economic activities are stagnating or declining compared to previous periods, which can be justified by the crisis and difficult times that the RS has faced. This does not mean that such economic trend will continue. Coal resources, from which most electricity is generated, are not inexhaustible, which calls for the need to generate electricity from renewable sources such as water reservoirs. This is an urgent need, notably in terms of responding to climate change and changes in precipitation regimes, i.e. the occurrence of cycles of rainy and dry periods. This is particularly important in light of possible irrigation, which is not sufficiently developed in agricultural production. Frequent occurrences of floods have been causing great material damage in the last decade, almost every year. With their reservoir space, they significantly contribute to the reception of the flood wave, preventing large-scale floods. Also, the development of mining in the RS requires significant quantities of water resources with constant water supplies. The diversity of flora and fauna in water reservoir zones proves their positive influence on the entire living world in and around the water body. The development of other branches of the economy, such as tourism, enables the development of local environments and the improvement of the economic status of both the local population and the wider community.

In terms of the planning regulation of multipurpose water supply systems, i.e. the area of water reservoir basins, soil erosion represents a functional and ecological problem, which increases the risks of the reduction in reservoir space and the reduction in water quality. The filling of the reservoir with sediment and erosion processes in the basin represent limitations regarding the use, protection, preservation of the reservoir and other natural potentials of the wider area. In this context, it is indispensable to consider the influence of the population on the use and management of soil and water resources of the reservoir, i.e. the exploitation of forests, forest and agricultural land. Negative anthropogenic influences, i.e. inadequate use of soil and water resources intensify soil erosion and sediment production. Unplanned use of a basin would lead to a permanent mismatch of the interests of the water management industry with the development interests of other users of the space and the protection of the environment. Spatial plans of special-purpose areas for reservoir basins provide the basis for the protection and regulation of basin areas, implementation of regional water supply systems, regulation of river systems, where the prevention of soil erosion, sediment production and transport has an important function. Potential population growth and the increasing needs for clean water, and a reduction in the living space, forest and agricultural resources call for new, innovative ways of using and managing drainage basins of water reservoirs.

Integrity in the use and management of these key facilities is the main goal in the planning of water reservoirs. The management of forest and agricultural resources and the area of drainage basins as a whole, in a way that protects soil from erosion and pollution, is the only way of protection and preservation. The construction of water reservoirs has a significant impact on basins and wider areas, as well as on the economic and social development of society. The integration of these facilities into regional water supply systems has been recognized in numerous planning and development documents. By drafting planning documents for existing and future water reservoirs, the importance of these facilities for the sustainable development of the RS is realized and proven.

Observing the RS in a global context, particularly in relation to some advanced countries and their experiences in the development of society, we can conclude that in this transition period utmost attention should be paid to the provision of water resources, both for water supply and renewable energy sources. This can only be achieved by preserving the existing water reservoirs and building new, significant water facilities.

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