

Bezbradica L., Basarić J. (2021) The role of planning regulation in protecting “Prvonek” Basin and accumulation pp. 165-174. In Gastescu, P., Bretcan, P. (edit, 2021), *Water resources and wetlands*, 5th International Hybrid Conference Water resources and wetlands, 8-12 September 2021, Tulcea (Romania), p.235

Available online at <http://www.limnology.ro/wrw2020/proceedings.html> Open access under CC BY-NC-ND license

5th International Hybrid Conference Water resources and wetlands, 8-12 September 2021, Tulcea (Romania)



THE ROLE OF PLANNING REGULATION IN PROTECTING “PRVONEK” BASIN AND ACCUMULATION

Ljubiša BEZBRADICA, Jelena BASARIĆ

Institute for Architecture and Urban & Spatial Planning of Serbia, 73/2 Kralja Aleksandra Blvd., +381113207341, Belgrade, Serbia, Email: ljubisa@iaus.ac.rs, jelenab@iaus.ac.rs

Abstract. Planning documents constitute the basis for area planning and sustainable use of land, water and other resources by taking an integral approach to space organization and protection. Spatial plans for special purpose areas (SPSPAs) for accumulation basins form the basis for basin sanitary protection, basin area protection and organization, infrastructural and communal equipment improvement etc. “Prvonek” accumulation is located in the territory of the City of Vranje as a multi-purpose facility for water supply and/or regulation of large and small watercourses. In the planning, construction and use of “Prvonek”, all its potential implications in the basin area and the accumulation have been considered. This context inevitably includes considering the impact of population on the use and management of land and water resources of the accumulation and/or the exploitation of forests, forest land and agricultural land. The pollution of surface and ground waters penetrating into the accumulation and the accumulation being filled by erosion sediments constitute limitations regarding the protection and conservation of the accumulation and other natural resources of this region. The work analyzes the basin of “Prvonek” accumulation and also presents the planning solutions and/or their impacts on the use and management of the accumulation, and thus the protection and conservation of the basin area land.

Keywords: accumulation, land, protection, population, basin, forests, erosion

1. INTRODUCTION

The impact of water accumulations on the space structure is complex and it is interpreted in different ways. Some authors think that the impact of accumulations enriches the space, thus creating cultural landscapes (Riđanović, 1968), changing cultural and social patterns of existence (Taylor, 1951; Milinčić, 2009), transforming the components of space functioning, land use and economic activities (Mitchel, 1979), up to the geographical transformation of space (Đurić, 1955 and 1960) (Milinčić et al., 2010).

In the territory of Serbia, 60 accumulations with high dams have been built, as well as more than 100 small and micro-accumulations. In the group of accumulations with high dams, 29 of them are large ones, including “Prvonek” accumulation. Separate volumes are over 10 million m³, while total volumes amount to approximately 6 billion m³ (Milinčić, 2009).

“Prvonek” accumulation is located in the territory of the town of Vranje. It was designed on the Banjska River as a multi-purpose facility whose basic role is water supply for the users in the area of the town of Vranje, and potentially of Bujanovac and Preševo. Apart from water supply as a primary role, the regulation of water regime (Kellner et al., 2019) and electrical power production without carbon-dioxide (Jahns et al., 2020) are only some of the secondary roles of the accumulation. The basin area of “Prvonek” accumulation is defined by the conditions and guidelines through several higher-order planning documents, implementation programs, and national and local development strategies. “Prvonek” accumulation is one of the key accumulations within the South Morava river system. Having in mind that “Prvonek” accumulation is an important water facility within the integral water management system of use, organization and protection of the waters of the Republic of Serbia, i.e. Pčinj water supply subsystem, it is necessary to prepare a SPSPA which constitutes the planning basis for realizing the sanitary protection of the accumulation basin with the dam, river dam facilities, water intake, as well as the protection and organization of the basin area. In the process of making the SPSPA, it is obligatory to make a Strategic Impact Assessment of the plan on the environment (SIA). The application of the Strategic Impact Assessment in

planning infrastructural facilities (as well as accumulations as a part of the water management infrastructure) is based on the guidelines for selecting optimal options for the purpose of minimizing or total prevention of potential conflicts in space which may occur in correlation of infrastructure development with environmental elements (Josimović, 2017).

Unplanned use of the basin (water) would lead to the permanent discrepancy between water management interests and developmental interests of other users of the space and environmental protection (Ramírez et al., 2020). The absence of plans for running and managing forest land and agricultural land in the territory of the accumulation basin would result in the forest resources degradation (Muttaqin et al., 2019) and forest and agricultural land devastation (Wohl et al., 2017). The consequence of such approach to management is reflected in the reduced productive capacity, biodiversity destruction, erosion processes, sediment production, pollution of surface and ground waters and so on (Bauda et al., 2019). Erosion sediments enriched by polluting substances, as a result of degradation processes in the basin, are transported into the accumulation, thus reducing the volume of the accumulation area and increasing the risks of pollution and eutrophication of the accumulation (Edwards et al., 2001).

The basic concept of organizing and protecting “Prvonek” accumulation is defining the sanitary protection zones and/or establishing the regime of the area protection and use. It is the definition of the sanitary protection zones and/or use and management measures in the planning document that emphasizes the importance of preparing and adopting SPSPA (Stefanović et al., 2017). The establishment of special regimes of exploiting forests, forest land and agricultural land, construction land and other land, has resulted in an integral approach to the protection of the basin and the accumulation from water pollution as a primary role, and from sediment filling and reduction of the accumulation area volume (Campbell, 2016). The management of such capital facilities requires the consideration of all the elements, factors and impacts in the basin and broader area because the sustainable concept of use can be implemented only through an integral conservation and protection approach (D'Ambrosio, et al., 2020).

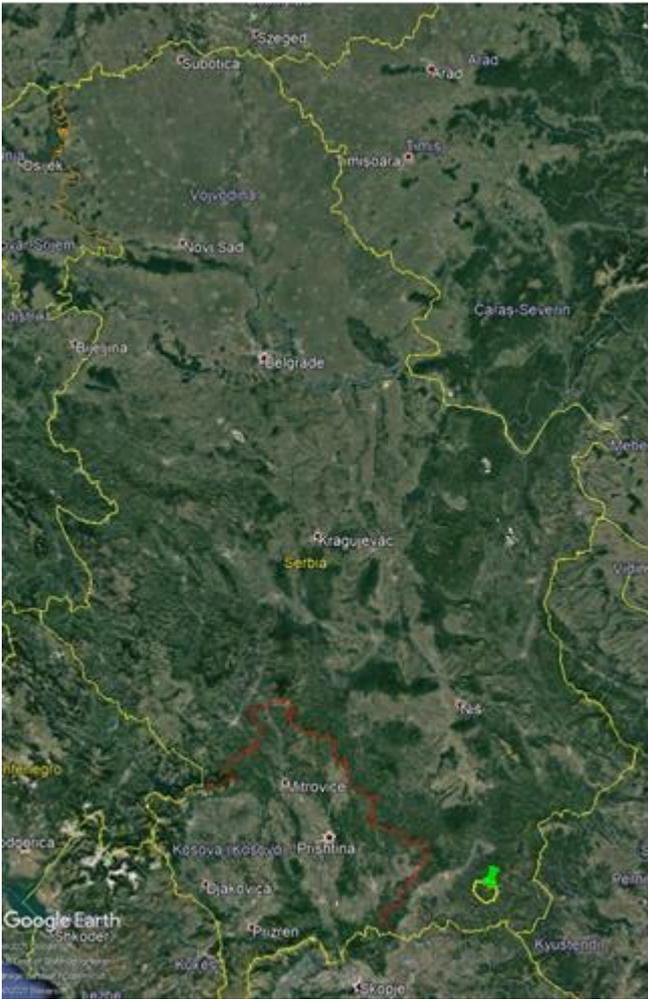
The preparation of the planning document was realized in the period when the facility with the embankment dam and the accumulation filling had been fully completed and taken over in the management and exploitation procedure. The specific characteristics of this area from the aspect of natural and relief features posed a challenge in the process of SPSPA preparation, i.e. in the approach to preventing conflicts in the area between protection and conservation of natural values on one hand, and the users of the accumulation on the other hand (Urbaniec et al., 2017).

2. WORK MATERIAL AND METHOD

2.1. STUDY AREA

The construction of the embankment dam on the Banjska River, nine kilometers upstream from its mouth into the South Morava River, began in 1989 (it was put into trial operation in 2005). The basic construction characteristic of the dam is the riprap construction with the upstream slope of 1:1.75, clay core in the body of the dam, intake and overflow structures, the absorption basin, pipelines and the hydroelectric power plant with two aggregates. The area of “Prvonek” accumulation basin, i.e. of the part of the basin of the Banjska River (mean multi-year flow 1,068m³/s) is 85.38km². In the upper part of the basin there is the spring of the Golema River (another name for the Banjska River) in the mountains of Besna Kobila and Dukat (Figure 1). The basin is of roundish shape, with the main stream and “Prvonek” accumulation situated in the middle. The shape of the basin and the position of the main recipient, i.e. the extensive hydrographic network, are quite important from the aspect of water concentration in the main stream (Spatial Plan for the special purpose area of “Prvonek” accumulation basin).

The basin relief is mountainous, composed of the mountains with altitudes of up to 1,806m above the sea level (the altitude of the Banjska River bed at the dam is 540m above the sea level). The mean altitude of the basin is 1,100m above the sea level, with the mean slope of 35%. More than half of the total territory of the basin is situated at altitudes over 1,000m above the sea level, while the difference in the altitudes between the highest point and the Banjska River level at the dam is more than 1,260m above the sea level. The main stream of the Banjska River to the dam profile is about 9,000m long. The presence of such high mountains leads to the specific climate characteristics, while the slopes of the terrain and/or recipients affect erosion processes in the basin, the methods of running and managing forest land and agricultural land etc. (SPSPA of “Prvonek” accumulation basin).



Source: Google Earth, 2021.



Source: Bezbradica Lj., 2017

2.1.1. CLIMATE

Based on the meteorological observations, the mean annual air temperature in the period since 1961 has been 10.8°C (measured in Vranje, 432m above the sea level) or 6.1°C (measured at Vlasina, 1,190m above the sea level). The warmest month is July, while the coldest month is January. The mean annual temperature value between 1981 and 2010 has a growing trend 11.1°C in comparison to the thirty-year period before 1981 (Vranje measuring station). The mean annual precipitation for Vranje amounts to 614mm of water sediment, or 810mm of water sediment for Vlasina. With the increasing altitude and decreasing temperature, the height of the snow cover and the length of the snow cover season increase (110 days for Vlasina, 45 days for Vranje for the snow cover higher than 1 cm). The decreasing trend of mean annual precipitation and the length of the snow cover season are evident for the period 1981–2010, which is also proved by a slight increase in the mean annual temperatures.

2.1.2. PEDOLOGICAL CHARACTERISTICS

The pedological cover is composed of rankers in more than 60% of the territory. Brown rankers as a dominant subtype of rankers occur in the form of a larger number of pedosequences. Depending on the rock type, altitude and slope of the terrain, they are present in the form of shallow humus-silicate, sandy-loamy soil up to 30cm thick and of light mechanical composition. It is made of a partially developed district cambisol and a poorly developed regosol-ranker. Lithosol-regosols, a combination of skeletal undeveloped and poorly developed soils, which occur on the steep sides of the slopes of valleys and watersheds, are the second largest soil category (SPSPA of “Prvonek” accumulation basin). The degradation of forests and pastures, soil erosion and other processes have had a large impact on the creation of certain types of the soil cover and their productive capacity and/or biodiversity. The percentage of arable farming land and fruit cultivation land, i.e. land of higher rating classes, is low. Livestock breeding is the dominant activity of local

population because the share of meadows and pastures is higher than of other types of land (Nikolić et al., 1997).

2.1.3. LAND

Out of the total accumulation basin area, forests and forest land account for about 85% territory, or about 7,290ha, while 6,300ha or 73% of the accumulation area is covered by forests. The basic role of the forests is soil protection from erosion, water protection and technical timber production. The forests owned by natural persons are of a poorer state and quality than the state-owned ones, mainly of coppice type and covering smaller plots. State-owned forest management is the responsibility of the Public Enterprise "Srbijašume", while the forests in general are run and managed in line with the Law on Forests of the Republic of Serbia. Since "Prvonek" accumulation is primarily used for water supply, protecting the basin from erosion and from accumulation filling is a priority of the forest running and management in basin area (SPSPA of "Prvonek" accumulation basin).

In the basin area of "Prvonek" accumulation, agricultural land accounts for about 14.68% or 12.54km² (Republic geodetic authority), with the tendency of keeping the existing agricultural areas until 2028 in line with the planning documents. Agricultural land is a natural good of general interest so that its protection and use in the basin area of "Prvonek" accumulation is based on the principle of integral natural resources management and the concept of sustainable agricultural and rural development (SPSPA of "Prvonek" accumulation basin). A substantial portion of the area of "Prvonek" accumulation basin, or about 10%, is infertile. The natural characteristics of the terrain account for the fact that the greatest portion of the basin area belongs to the mountain agro-ecological region. The average altitude of over 800m demands limitations to the development of intensive agricultural production (Nikolić et al., 1997). The tendency of decreasing population has significantly affected agricultural production, i.e. the use of agricultural land. Local population migration from Serbia, migration to large cities and local population working in larger economic centers has led to a substantial decrease in arable land and its intensive use (Kupiszewski et al., 2012).

2.1.4. POPULATION AND SETTLEMENT NETWORK

The number of inhabitants and the settlement density have a certain effect on the basin, i.e. the use of the basin, and thus on the protection and conservation of the soil and water quality. The pressures on forest and agricultural resources, unplanned use in the event of a large number of inhabitants, high population density, a wide settlement network etc. may lead to soil degradation, water pollution, erosion processes etc. (Twitch et al., 2016).

In the area of the accumulation basin, the prevalent population density is mostly low, with about 3 inhabitants per km². The highest population density is in the settlement of Prvonek (6 inhabitants per km²), while the lowest is at Crni Vrh (under 1 inhabitant per km²). The trend of the decreasing number of inhabitants has been evident in the past few years, particularly since 1961, while the number of inhabitants has gone down by about 50% since the 2002 census. The main reasons for depopulation are the low population growth as well as population migration.

The settlement network in the basin area of "Prvonek" accumulation includes the fragments of the formed settlement networks within the town municipality of Vranjska Banja and the town of Vranje. The settlements are of a mountainous type and dispersed morphological structure. According to their demographic size, all the settlements in the basin area have fewer than 250 inhabitants. Village settlements functionally gravitate towards the centers outside the accumulation basin area. Most of the settlements have poor traffic and functional connections with the urban centers of Vranje and Vranjska Banja (SPSPA of "Prvonek" accumulation basin).

2.1.5. SOIL EROSION

The planning, designing and construction of "Prvonek" accumulation involved considering the aspects of the impact of erosion processes in the basin, production and transport, as well as accumulation filling with sediments. The deposition of the sediments in the accumulation leads to substantial reduction in the accumulation area and to the increasing risk of pollution of water reserves. Conducting biological, bio-technical and technical works in the basin and the recipients prevents the occurrence of erosion processes and sediment transport (Ristić et al., 2015).

Excessive and strong erosion affects 12% of the basin area; medium erosion affects about 52%, weak erosion affects over 35%, while very weak erosion affects less than 1% of the basin area, whereas the average annual sediment production amounts to about 1,000m³/km². The largest areas threatened by strong and excessive erosion are those with scarce forest or grass vegetation, or those with no vegetation at all, and they are located in the territory of the villages of Babina Poljana, Crni Vrh and Stari Glog (SPSPA of “Prvonek” accumulation basin).

The biological activity in the portions of the accumulation basin is largely determined by the intensity of erosion processes; the more intensive and the longer they are, the poorer is the soil quality and the less fertile it is. The accumulation water quality is good, which indicates a great effect of the forests on the surface runoff and prevention of sediment deposition in the accumulation. Occasionally increased turbidity and increased content of organic matter and phosphorus indicate eutrophication processes, which may indicate to sediment deposition in the accumulation and the need to prevent erosion processes by afforestation and the construction of barriers for preventing sediment deposition in the accumulation (SPSPA of “Prvonek” accumulation basin).

2.1.6. WORK METHODOLOGY

The field work preparations resulted in several analysis stages. The first stage involved the analysis of the current state of the basin and “Prvonek” accumulation, having in mind that the planning document was prepared in the period when the accumulation had already been constructed, i.e. after the dam had been constructed and the accumulation area had been filled. It consisted of the field analysis of the basin, the accumulation, the facility, the pipelines etc. The condition of the forests and forest land, agricultural land, population, settlements, management of forest land and agricultural land, social and economic aspects etc. were analyzed in the basin area. Moreover, other planning and project documentation was obtained and analyzed in order to compare the current state and/or intensity of the implemented planned and projected measures and works. The symbiosis of the data about the terrain recorded in the cartographic, orthophoto and other documentation contributed to the comprehensive overview of this area.

The second stage included analyzing SPSPA of “Prvonek” accumulation basin and SIA. The analysis of the planning documentation put an emphasis on the analysis of the defined measures that have certain impacts on the basin and/or environmental protection and conservation.

The third and final stage sums up the previous two, thus involving the results of the mutual symbiosis of the field and planning analyses resulting in the implementation of planning measures and the definition of their impacts on the conservation and protection of “Prvonek” accumulation and/or the environment of the planning area in general.

The basic hypothesis of the paper is that large capital facilities such as “Prvonek” accumulation, i.e. running a water management facility, requires a comprehensive consideration of all the factors in the basin and the accumulation covered by SPSPA for the purpose of defining the management and conservation measures and methods. It is SPSPA as a strategic document that integrally considers all the factors i.e. that by implementing the planning measures achieves sustainable utilization, as further presented in the paper.

3. RESEARCH RESULTS

The preparation of SPSPA is based on the analysis integrity and processing the challenges of using the factors, environmental resources, which puts it forward as one of the basic principles of the sustainable development concept. Integrating this principle in the planning solutions is founded on the efforts to: harmonize the development of agriculture and forestry with water management, the implementation of the measures for soil protection from degradation, biodiversity conservation, increase in the number of inhabitants, along with the continued growth of communal and infrastructural equipment etc. (Nikolić et al., 1997).

The basic principles of protection, organization and sustainable spatial development of the area of “Prvonek” accumulation are as follows:

- ✓ protection and improvement of the environment and the accumulation waters spring;
- ✓ conservation and adequate valuation of water eco-systems;
- ✓ maintenance of the quality and quantity of water resources;
- ✓ protection from large waters;
- ✓ water regime control;
- ✓ conservation of water and river bank habitats, and

- ✓ water supply for population and economy.

The basis for defining the purpose of the area, the protection regime and/or planning conception is made of the sanitary protection zones. SPSPA determines three sanitary protection zones as a fundamental concept premise in the function of sustainable development. Establishment and implementation of the protection regime within the zones constitutes the primary role of protection and conservation of the spring and the water quality of the Banjska River and its tributaries. Sanitary arrangement of the settlements and control of the space use within the zones are only some of the measures aimed at protection. Within the sanitary zones, water protection is of primary importance for the purpose of maintaining the quality of water intended for supply, i.e. the implementation of the measures serves is aimed at protecting and conserving forests, the basin and agricultural land in order to prevent soil erosion, sediment production and maintenance of the quality of surface waters entering the accumulation.

Zone I of the accumulation (with the area of 90.59ha) consists of the lake at the maximum backwater elevation, and the bank 10 m wide and in the horizontal projection from the maximum backwater elevation, as well as the section of the main tributary. Zone II of the accumulation (with the area of 520.86ha) is composed of the area 500m wide in the horizontal projection from the border of Zone I. Zone III is the area outside the narrow sanitary protection zone to the border of the accumulation basin (with the area of 7,927.43ha). SPSPA establishes the regime of area protection and use for all three zones.

The agricultural land in Zone I must not be used, while in Zone II it is used with the limitations reflected in the following:

- ✓ degree of using chemical preparations in agricultural production;
- ✓ controlled use of watering places for cattle;
- ✓ prohibited storage of agro-technical substances outdoors and prohibited manipulation that might lead to their uncontrolled penetration into watercourses, and
- ✓ prevention of manure fertilizers discharge into the soil and watercourses

In Zone III, agricultural production is carried out by the principles of the rational use of agricultural land. In Sanitary Zones I and II, the emphasis is placed on protecting water from pollution for the sake of achieving and maintaining the quality of water used for supply. For the purpose of better-quality management of agricultural land and protection from occurrence of erosion processes, it is necessary to invest in technology, education and training of the local population.

The planning measures envisage and identify the necessity of supporting the budget funds primarily of government institutions for the development and improvement of rural production with the aim of achieving sustainable development. In order to realize active participation in the market and increased competitiveness, it is necessary to subsidize the acquisition of agricultural machinery and equipment and to introduce standards, as well as to cultivate perennial plantations. That is why the primary activity in the basin area in the future implies investments of budget funds in autochthonous breeds, medicinal herbs, organic food production and forestry development in agricultural land, for the purpose of improving soil quality and preventing erosion processes.

Since the area of “Prvonek” accumulation basin is covered by forests in the largest part of its territory, the measures of the planning document realize the primary role of forest resources in the protection from erosion processes and sediment production and transport. Additionally, the negative trend of decreasing population numbers has resulted in the reduced pressures on forest resources. The absence of anthropogenic factors enables natural renewal of forest plantations and thus the prevention of occurrence of new erosion processes.

Anti-erosion protection in the forest-covered areas and on forest land is achieved, apart from the appropriate measures of cultivating and taking care of the existing forests, by artificially renewing and planting new forests, i.e. by applying various biological and biotechnical anti-erosion works (forest space-filling, afforestation, grassing, putting up wicker hurdles and low walls against drainage etc.). In addition to forestation and other works on the state-owned forest land, privately-owned land is also being afforested, although currently on a minimum scale (SPSPA of “Prvonek” accumulation basin).

Conservation and increasing of the protective forest areas call for the need of reducing any risks that might lead to damage and destruction of these forest plantations. One of great risks are forest fires, after-fire forest clearing and changed purpose of use (Alvarado et al., 2012), particularly in artificially raised coniferous stands, primarily the black pine and the European red pine. Within preventive fire protection it is necessary to implement the measures of control and prohibition of burning weeds and other substances on agricultural and other land, particularly during the spring season characterized by cleaning and preparation for production, as well as during dry summer months, mainly in August. In addition to the measures defined

by the Plan, it is important to emphasize that SPSPA also identifies the measures of after-fire recovery as an important segment of the overall forest protection, in line with the Law on Forests, the Law on Fire Prevention, bylaws and other planning and program documents.

Negative demographic processes, i.e. extremely small population with constantly continuing depopulation, looking from the aspect of environmental protection and/or pressures on natural resources, have positive effects.

Taking into account unfavorable economic situation in this region, endogenous factors can be expected to have a crucial impact on the continuing depopulation in the future as well. Population growth must be supported by the following measures and activities:

- ✓ implementation of government and local demographic policy measures in line with the local socio-economic development;
- ✓ employment of local population as a basis for keeping younger population;
- ✓ incentives to the strengthening of agricultural and catering activities
- ✓ local population education and the use of comparative advantages of sustainable natural resources management;
- ✓ inclusion of older inhabitants into the local community life; and
- ✓ encouraging the development of rural tourism.

One of the main preconditions for tourism development in regions like this, apart from natural features, is the identification of new specific contents. The construction of “Prvonek” dam and other structures in its immediate vicinity and the lake formation constitute exceptionally specific anthropogenic effects on the area and the possibility of attracting tourists. Some of the contents in the basin area and the accumulation defined by SPSPA are explicitly associated to the accumulation itself and the natural resources: summer water recreation, horseback riding, mountain cycling, mountaineering, picnics, outdoor school etc. The proximity of the highway and Besna Kobila and the presence of the panoramic roads along with the development of the local road network, are only some of the main preconditions for completing the year-round offer and successful tourism development. Sanitary Zones I and II are suitable for water sports – swimming, rowing, fishing, diving etc., without using any vessels. Only electric boats and oars are allowed and no motor vehicles have direct access to the water surfaces. Clearly defined and organized fishing trails or cycling paths and access to them specifically exclude the use of motor-driven vehicles.

4. DISCUSSION

The planning solutions for “Prvonek” accumulation are presented through principles, goals and general concepts of spatial development. Since the primary role of the accumulation is water supply, the basic principles and goals of the Plan are directly aimed at protection and organization of the basin, and particularly of the accumulation spring. Within the protection and conservation measures, the emphasis is placed on the environment as one of the basic planning principles. The fundamental and general goals of spatial development define the planning basis for sustainable development of this area. Sustainable development of the special purpose area of “Prvonek” accumulation is realized by using the water resource for supply as the primary role with the permanent conservation of the environment and the water quality. The operational goals of spatial development defined in SPSPA refer to the fields of: water protection and use and development of water management infrastructure, protection of the nature and natural values, use and protection of natural resources, development of economy and tourism, development of traffic, energy, electrical and communal infrastructure, and environmental protection. Some of the operational goals of the Plan ensure:

- ✓ improvement of the condition of forests and forest infrastructure, which is reflected in the protection, conservation and upgrading of forest resources;
- ✓ prevention aimed at protecting forest stands from fires and other adverse phenomena;
- ✓ running and organizing agricultural land, forest land and forests in line with the general concept of the regime and conditions of protecting the spring and the accumulation;
- ✓ incentive and development of agriculture based on traditional production of local products and providing agro-ecological services;
- ✓ implementation of biological and technical measures in the form of afforestation, pasture melioration, the construction of barriers, ground sills, wickers, terraces, contour trenches and other

works aimed at the protection of the basin and the courses from erosion processes and eutrophication of the accumulation;

- ✓ ecological protection of the downstream section of the Banjska River course by implementing controlled management of water balance for the purpose of ensuring season quantities and quality of water;
- ✓ monitoring the environment quality and/or monitoring the quantitative and qualitative parameters of the water in the accumulation, tributaries and springs for local water supply;
- ✓ prohibition and limitation of activities with an adverse effect on the water quality by establishing and implementing the system of measures in the basin;
- ✓ first-class and second-class quality of all watercourses in the basin for the purpose of controlling the water quality in the accumulation;
- ✓ establishment of the sanitary protection zones and definition of the measures of regime, sanitary protection, area organization etc.

The definition of the sanitary protection zones and/or spatial definition of certain special purpose sections in the basin enable the realization of the measures and conditions for the purpose of protecting and conserving the basin and the accumulation, i.e. sustainable management of this large water management facility. Three sanitary protection zones have been defined within the basin. Zone I is defined as the nearest to the water area, and thus it is subject to the most strictly defined conditions and regimes, reflected in prohibited construction and waste disposal and in the establishment of strict sanitary control. In sanitary protection zone II, regimes or controlled area use are formed and it is allowed to keep the existing facilities, along with their reconstruction and maintenance. Within Zone II, controlled agricultural production is performed. The use of chemical and other substances, methods of tillage and production must be in line with the measures of protecting and maintaining the quality of the water and the basin. Moreover, it is forbidden to cut down forest stands, which means that forest resources are run and managed in such a manner as to conserve the basic structure of the forest mass in the function of protecting the basin from erosion processes. Unlike the first two sanitary protection zones, in Zone III it is allowed to construct facilities as well as small industrial and artisan structures which are used in agriculture etc.; it is allowed to expand the settlements, but with limitations in their communal equipment. This zone is also used for sanitary inspections and controls; namely, within these zones it is allowed to develop and expand the community, with all development elements, but under the conditions of implementing measures aimed at the protection of the basin and the water.

5. CONCLUSIONS

Reviewing the measures and conditions within the sanitary protection zones, it may be concluded that SPSPAs in the accumulation basin area have certain effects on the users of this area, but that they positively affect not only the protection and conservation of the broader area, but also ensure population growth and prosperity. The reason for this thesis and/or conclusion is that so far in this area there has been an evident trend of population decrease, unplanned management and use of agricultural land, unplanned management of forest resources, absence of incentives for the development of livestock breeding, tourism, agriculture etc.

In resolving the conflicts between water management and agricultural production development, maintaining the traditional approach to agriculture integrated with tourism has proved to be an adequate planning measure in the sustainable development of the area with the specific water management facilities. In line with the planning measures and conditions, small agricultural holdings would keep the current form of running a household which is reflected in cultivating gardens, vineyards and orchards, tending meadows and pastures, breeding large and small livestock, but observing the limitations and conditions of basin management for the purpose of the protection and conservation of the accumulation. Incentives for the development of organic production, which, according to the overview of working methods, has already been present, communal equipment, construction of sewerage infrastructure and population education will on a large scale positively affect the development of this region, as well as to keeping and increasing the number of inhabitants.

One of the most important planning measures defined for the purpose of protecting the basin is the identification of forest resources as protective forests, and therefore the definition of the method of running and managing in line with the purpose. This particularly refers to the state-owned forests which are in substantially better and more sound production condition. Conservation and improvement of forest structure and health refers to all the forests in the basin area and that is the positive measure defined for protective

forests because it integrates privately-owned forest stands into a unique system of running and management by previously prepared plans, programs and other documents written for this area.

The direct effects of SPSPA implementation, i.e. the implementation of the planning measures, have a certain impact on the prevention of erosion processes and occurrence of torrents. The basin of the accumulation, the primary role of which is water supply, is protected through measures that envisage preventing the accumulation becoming polluted.

The works performed before the completion of SPSPA with the aim of preventing soil erosion and sediment production included: afforestation of the basin, construction of barriers, ground sills, embankments etc. The positive effects of anti-erosion works are reflected in the high percentage of forest areas and in the constructed barriers. During the dam construction, in line with the project of protecting the basin from erosion and from sediment-filling of the accumulation, four anti-erosion barriers were made, two on the Banjska River, one on the Gradašnica and one on the Crna Reka. The exploitation of the accumulation reflected in supplying water to the population and economy, tourism development and traditional agriculture growth among local population would largely improve the economic situation in this region and thus increase the funds for running the accumulation and other facilities in the basin which serve to protect the accumulation.

The economic development of the basin area and of the broader area has certain impacts on the number of inhabitants, i.e. on negative migration and population characteristics. Extremely low average density of population of only three inhabitants per square kilometer is identified as a negative phenomenon in the planning document, although from the aspect of the pressures on forest and agricultural resources, their unplanned or intensive use is a positive phenomenon. A negative trend of decreasing population should be stopped, particularly if all defined and listed measures are applied, the significant ones being incentive measures for the development of rural agriculture and placement of agricultural products in the tourist offer of the broader region.

The presence of tourist complexes in the immediate vicinity of “Prvonek” accumulation implements everything listed above. Besna Kobila Mountain (1922m above the sea level), with the accompanying skiing offer, Vranjska Banja, and the proximity of the completed highway E-75, provides a number of opportunities for tourism development and product placement. SPSPA envisages the development of the summer tourist season, recreation, horseback riding, mounting cycling, mountaineering, picnics etc., along with the fulfillment of the necessary condition of improving the quality of traffic access and integration of village tourism in the accumulation basin area.

The planning solutions for the space whose basic purpose is water management development do not infringe the existing natural state with flora and fauna elements. The measures and conditions defined by the plan fully protect and encourage the development and conservation of the living world, both in the basin and in the accumulation itself. They do not produce negative changes in the state of the nature, geo-heritage, landscape or hydrological and morphological features. The plan implementation affects positively the conflicts in the development of water management and protection, conservation and activities of local population. Traditional forms of the life of local population are encouraged by integration with other branches of economy, tourism, as well as support to rural development. One of important instruments of development and/or conservation of the ecosystem potential for providing water supply and other services is the collection of ecosystem and other services and the formation of the budget for the purpose of unobstructed management and maintenance of the water management facility and the opportunities of financing and encouraging the development of the population community in the basin area. The above-listed planning measures are in an absolute symbiosis with the development of water management, particularly with the protection of the basin and the accumulation and/or environment.

REFERENCES

- Alvarado, C. M., Villar, S. C., Schmook, B., Sandoval, A. F., Christman, Z., Arriola, L. (2012). Land-use decision-making after large-scale forest fires: Analyzing fires as a driver of deforestation in Laguna del Tigre National Park, Guatemala, *Applied Geography*, Volume 35, Issues 1–2, pp. 43–52.
- Bauda, M., Mayer, B. C., Schindewolf, M. (2019). Land use change in an agricultural landscape causing degradation of soil based ecosystem services, *Science of the Total Environment*, Volume 659, pp. 1526–1536.
- Campbell, I. C. (2016). Integrated management of large rivers and their basins, *Ecohydrology & Hydrobiology*, Volume 16, Issue 4, pp. 203–214.

- D'Ambrosio, E., Ricci, G. F., De Girolamo, A. M. (2020). Using water footprint concepts for water security assessment of a basin under anthropogenic pressures, *Science of The Total Environment*, Volume 748.
- Đurić, V. (1960). Changes in the settlements in the Federal People's Republic of Yugoslavia. *Srpski etnografski zbornik*, 74. [In Serbian]
- Đurić, V. (1955). Transformation of the geographical feature of some Serbian landscapes in respect of more rational utilization of water power. *Zbornik radova Geografskog zavoda, PMF*, 2, pp. 71–92. [In Serbian]
- Edwards, K. J., Whittington, G. (2001). Lake sediments, erosion and landscape change during the Holocene in Britain and Ireland, *CATENA*, Volume 42, Issues 2–4, pp. 143–173.
- Google earth, <https://earth.google.com>
- Jahns, C., Podewski, C., Weber, C. (2020). Supply curves for hydro reservoirs – Estimation and usage in large-scale electricity market models, *Energy Economics*, Volume 87, pp. 1–12.
- Josimović, B. (2017). *Spatial impacts of wind farms on the environment*. Beograd: Institut za arhitekturu i urbanizam Srbije. [In Serbian]
- Kellnerab, E., Oberlack, C., Gerberbd, J. (2019). Polycentric governance compensates for incoherence of resource regimes: The case of water uses under climate change in Oberhasli, Switzerland, *Environmental Science & Policy*, Volume 100, pp. 126–135.
- Krunić, N., Josimović, B., Milijić, S., Ristić, V. (2017). Strategic environmental assessment as an instrument for sustainable spatial planning of water accumulation basins, *Fresenius Environmental Bulletin*, Vol. 26, No. 2/2017, PSP-Verlag, Freising. pp. 1281–1290.
- Kupiszewski, M., Kupiszewska, D., Nikitović, V. (2012). The impact of demographic and migration flows on Serbia, Edited by: Dosije Studio, Belgrade.
- Milinčić, A. M. (2009). *Surface water springs in Serbia – ecological limitations and settlement revitalization*. Beograd: Geografski fakultet Univerziteta u Beogradu. [In Serbian]
- Mitchell, B. (1979). *Geography and Resource Analysis*. New York: Longman.
- Muttaqin, M. Z., Alviya, I., Lugina, M., Hamdani, F. A. U., Indartik. (2019). Developing community-based forest ecosystem service management to reduce emissions from deforestation and forest degradation, *Forest Policy and Economics*, Volume 108, pp. 1–9.
- Nikolić, M., Jokić, B., Bakić, O. (1997). A contribution to the research of the soil sustainability factor in Serbia, Chapter in the monograph *The use of resources, sustainable development and space organization*, Special edition No. 35, Beograd: Institut za arhitekturu i urbanizam Srbije, pp. 133–163. [In Serbian]
- Ramírez V. N., Hernandez, J. R., Samaniego, M. G., Burgueño, E. R. (2020). Methodological frameworks to assess sustainable water resources management in industry: A review, *Ecological Indicators*, Volume 119, pp. 1–15.
- Regulation on establishing the Spatial Plan for the special purpose area of “Prvonek” accumulation basin (2018). “Official Gazette of the Republic of Serbia”, No. 89/2018. [In Serbian]
- Ridanović, J. (1968). Geographical aspects of water research. *Collection of works at the VIII Congress of Geographers of SFRY*. [In Serbian]
- Ristić, R., Radić, B., Milčanović, M., Malučević, I., Polovina, S. (2015). Protection from erosion as a precondition for the development of the ski resort at Stara Planina, *Pirot Collection*, No. 40, pp. 1–27. [In Serbian]
- Taylor, G. (1951). *Urban Geography*. London – New York.
- Tritsch, I., Le Tourneau, F. M. (2016). Population densities and deforestation in the Brazilian Amazon: New insights on the current human settlement patterns, *Applied Geography*, Volume 76, pp. 163–172.
- Urbaniec, K., Mikulčić, H., Rosen, M. A., Duić, N. (2017). A holistic approach to sustainable development of energy, water and environment systems, *Journal of Cleaner Production*, Volume 155, Part 1, pp. 1–11.
- Wohl, E., Lininger, K. B., Baron, J. (2017). Land before water: The relative temporal sequence of human alteration of freshwater ecosystems in the conterminous United States, *Anthropocene*, Volume 18, pp. 27–46.