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INSTITUTE FOR NATURE CONSERVATION OF VOJVODINA PROVINCE

Case Study:

Advocating ESAV in Bosut Forests area - integrating biodiversity and ecosystem services in natural resource uses and management

Content

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Advocating Ecosystem Services Assessment and Valuation (ESAV) in Bosut Forests area - integrating biodiversity and ecosystem services in natural resource uses and management

Implemented by:

Institute for Nature Conservation of Vojvodina Province (INCVP), Novi Sad, Serbia

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1. INTRODUCTION

The Institute for Nature Conservation of Vojvodina Province (INCVP/ПЗЗП) has prepared this case study in partnership and support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Open Regional Fund for South-East Europe – Biodiversity (ORF BD) project, that is funded by the German Federal Ministry of Economic Cooperation and Development (BMZ).

The case study of Bosut Forests deals with four ecosystem services or "benefits from nature" provided by this area that are crucial for flood protection, steady profits, nature conservation, and local population welfare. As part of the activities planned, two panel discussions were held with participation from key sectors and beneficiaries from the area in question. The participants came from the fields of forestry, water management, traditional animal husbandry and nature conservation. The aims of these panel discussions were to recognise beneficiaries' needs and improve cooperation in utilisation and management of Bosut Forests area.

The objective of the project was defined so as to present possibilities for an increase in benefits, both quantitative and qualitative, by introducing integrated planning and multipurpose utilisation of the area.

The case study is based on the management concept defined by conservation study "Bosut Forests Nature Park", prepared by the Institute for Nature Conservation of Vojvodina Province in 2016.

2. MAJOR FINDINGS

If environmental flooding of the forest complex and increase of traditional animal husbandry are implemented along with joint management and establishment of protected area (the Scenario B), the value of four ecosystem services selected as most important for the area (wood production, flood prevention, meat production and biodiversity) is expected to rise:

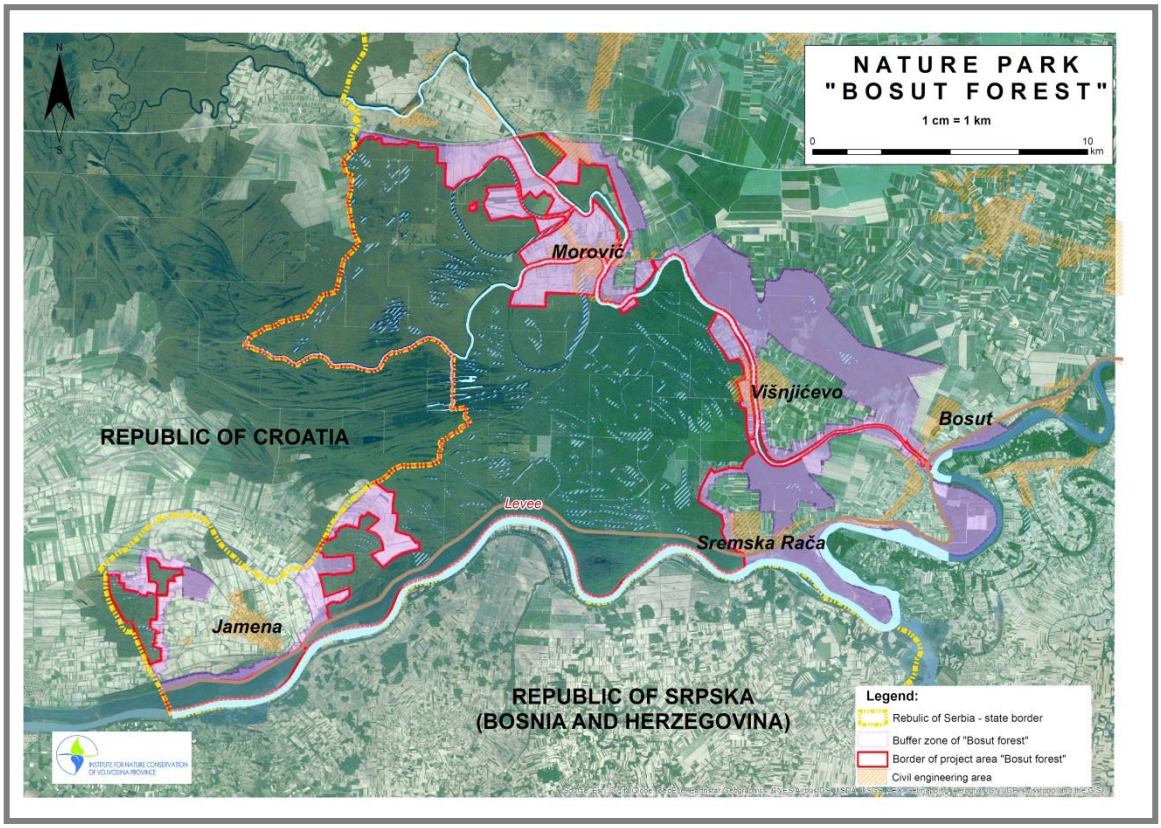
- Wood production would benefit in 30-50% less forest dieback and salvage cuttings related to water depletion, with proportionally higher quality yield in timber.
- Forest retention area will be able to store 100 - 200 million cubic metres of water, with extraordinary importance in flood management.
- Increased number of pigs grazed in Bosut Forests (5-7 times) together with better fodder availability will result in 10 -14 times multiplied income from traditional farming. Moreover, there will be an additional benefit from better meat taste and quality when compared to conventional pig farms production.
- For 6 habitat types, plankton communities and 9 plant and 11 animal species selected as most important, there will be improvements in their ecological status, number, population, and area of occupancy. Since they are indicators and umbrella species, improvements are expected to take place not only for them but for most of other species present in the area as well.

For many other ecosystem services (water and air purification, game management, mitigation of climate extremes, tourism, aesthetics, pollination, pest control), improvements are also expected, but will not be quantified.

Since scenario B predicts general benefits for the area, Study findings led to recommendations addressed to the policy makers, with the aim of supporting further joint development of Bosut Forests area.

3. GENERAL AREA FEATURES

Forests in the alluvial plain of the rivers Sava, Bosut, and Studva, surrounded by the villages of Jamena, Morović, Višnjićevo, Bosut, and Sremska Rača, make the largest complex of common oak forests in Serbia. Together with Spačva Forests in the Republic of Croatia, they comprise the largest spatial and functional zone of common oak forests in Europe and the Pannonian Basin. The Bosut Forests Project area includes the eastern part of the vast complex of lowland forests in the Spačva-Bosut Basin, between the Sava and the lower course of the Bosut river.



Overview map Bosut Forest area

These forests are of enormous economic, environmental, and social importance. They were named after the Bosut, since they are for the most part located in its basin. They played a very significant role in receiving flood waters of the Sava in May 2014, after the salvage breaking of an upstream embankment near the village of Račinovci in Croatia. As the habitat of numerous protected wildlife species, both nationally and internationally (IBA SRB), these forests are part of the National Ecological Network of Serbia and European Ecological Network Natura 2000 in Croatia.

Approximately 90% of these originally flooded forests are separated from rivers by embankments. The embankments along the Sava, the dam on the Bosut, the amelioration system, and other canal networks spreading throughout the area have dramatically changed its habitat features.

Changes in the hydrological system have contributed to an increase in forest dieback, followed by frequent sanitation cutting. Results of business analyses of such forests (Medarević et al., 2009; Letić et al., 2017) indicate far-reaching economic losses. The groundwater level in the woods is much lower than the optimum.

Unfavourable status of wildlife species in lowland forests endangered by dieback, declining profits in forestry industry, and floods threatening settlements and arable land, call for a united approach to solving these problems. At the same time, opportunities for maximising ecosystem services provided by Bosut Forests should be recognised.

3.1. LANDSCAPE FEATURES

Bosut Forests Nature Park belongs to the biggest complex of common oak forests in South-Eastern Europe and the Pannonian Basin, a functional entity comprising forest, wetland, and water habitats. The near-natural condition of the structure of forest and partially of wet habitats, together with the size of the complex, ensures the survival of species that inhabit only spacious and preserved forest habitats. The forest complex is surrounded from three sides by agricultural land with a pronounced fragmentation of natural habitats. Due to the preservation of the Sava river ecological corridor (Bátori et al., 2016; Gallé et al., 1995; Naiman et al., 1993), this area presents the original habitat for species whose meta-populations (Hanski, 2015) have survived in the fragments of forest habitats in Posavina, the Sava river valley (The Institute for Nature Conservation of Vojvodina Provincedatabase). The restoration of degraded ecological corridors of the Danube watercourses and destroyed forest corridors running to Fruška Gora Nature Park may improve the conservation status of sensitive forest species (Bloemenn & Sluis, 2004) in the south-western part of the Pannonian region.

The landscape matrix (Forman, 1995) consists of forest vegetation. The landscape structure is defined by the river terrain: on a comparatively flat area there is a network of effluents and old river meanders in different stages of accretion (Ćurčić et al., 2002) which used to be flooded regularly before the river regulation. The accumulation of river deposits transformed effluents into oxbow lakes, and oxbow lakes into isolated ponds and marshes, which in turn transformed into shallow depressions, forming a system of diverse wet habitats. These wet habitats were connected with each other and the rivers during great floods. Occasionally, during severe flooding, new connections were formed between isolated depressions, while new effluents assumed the role of water corridors. After the embankment construction, wet habitats became isolated from the river courses. Together with flood waves, the groundwater level rises, flooding the lowest parts of terrain. However, the number and interconnection of wet habitats are on the decrease.

The development of amelioration canals and ditches along forest roads throughout the 20th century resulted in a new hydrological network of the area. Increasing the interconnection of wet habitats, it serves as a network of artificial ecological corridors (Foppen et al., 2000; Dragaš et al., 2016; Szabados et al., 2011), and has a short-term positive effect on biodiversity in the area (Herzon & Helenius, 2008). Long-term influence of the canal system is negative since it leads to a decrease in the number of wet habitats and their areas by lowering the groundwater table. In addition, it causes homogenisation of the area and a decrease in landscape and habitat diversity, which will, slowly and gradually, bring about the extinction of species in the wet habitats whose areas are dramatically reduced.

3.2. HISTORY OF RESOURCE UTILISATION

Traces of human settlements around the protected area suggest that humans have always been present here since the Stone Age (Medović 2001). Because of the strategic significance of the confluence of the Studva and Bosut rivers, historical settlements where today's Morović is located were often local administrative or military centres. Inhabitants in the area have used its natural resources, changing its structure and nature in accordance with their technical possibilities.

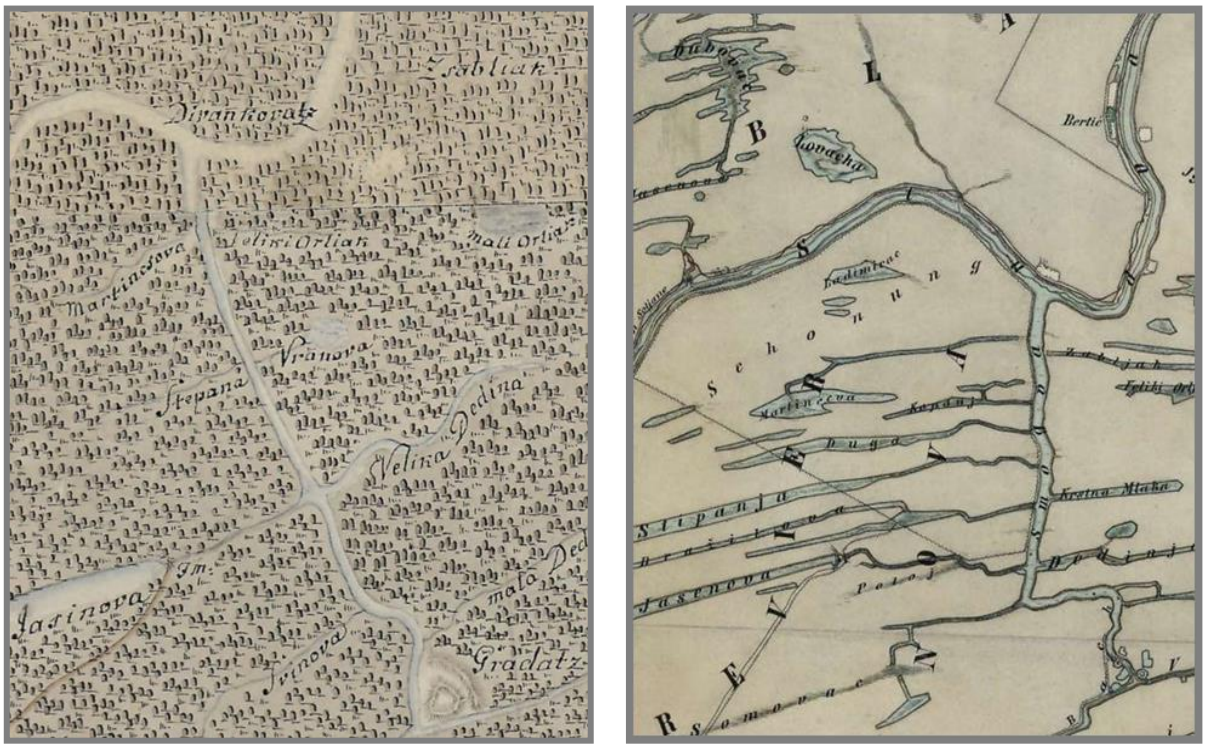
3.2.1. TRADITIONAL (EXTENSIVE) UTILISATION OF THE AREA

The appearance of early agricultural communities during the Palaeolithic caused deforestation with the aim of establishing pastures and agricultural cultures (Gulyás & Sümegi, 2011). This was confirmed by the results of a pollen analysis in the broader area of Ravni Srem (Gajić & Matijević, in Karadžić & Gajić, 1991). Natural resources of the flooded areas provided opportunities for hunting, fishing, and gathering high-quality food of animal (shells, bird eggs) or plant (nuts, forest fruits) origin. The changeability and impenetrability of the flooded area provided protection from enemy attacks (Medović 2001). The cultural and ethnographic heritage of settlers in the flooded areas of the Pannonian Basin preserved the traditional knowledge of utilising a wide range of wild species until the 20th century (Andrásfalvy, 2009).

The first written record on the utilisation of this area dates back to the period of the Roman Empire. At the time, the whole area was called Panonnia glandulifera (Acorn-yielding Pannonia) and "acorn feeding" of pigs was one of the most lucrative professions. The medieval feudal state formed a dense network of small settlements. Cultivated areas, taking only a small piece of the land, were located in close proximity to villages, and a larger portion of the area (including forests) was used for grazing (Szabó, 2004). As the most economical method of using the area, animal husbandry was based on rotational grazing or the seasonal moving of herds between dry and wet areas (Frisnyák, 2004). Flooded areas were the key elements of this system because of the significant production of biomass in the driest period of the year and because of the opportunity for semi-nomadic herds to winter in the safety of flooded forests.

Flooded areas were an economically important region where specific types of fishing and animal husbandry were practiced until rivers became regulated (Andrásfalvy, 2009; Bellon, 1996). Fish catches were the highest in the channels between riverbeds and depressions of flooded areas, which were formed naturally during floods or created artificially and named "fok". In order to ensure good catches, the channels were cleaned from river deposits and often deepened. Shortened periods of flooding and regular pasturing caused a decrease in the swamp area and an increase in the area of wet fields, which contributed to a rise in profits from animal husbandry.

Archival maps of the Bosut Forests area from the 18th and 19th centuries show a network of natural depressions and artificial canals, connecting the Sava, the Bosut, the Studva and most ponds and oxbow lakes into an integral hydrological network. It was considered that the canals, which served for wood transport and provided forest flooding, originated from the Roman period (Déván, 1889). The existence of the described traditional way of fishing is also suggested by a great number of shallow and narrow channels which could not be used for water transport, and a significant number of ponds named after local users of the area such as Martenčeva, Manješeva, and Stipanja.



Ponds and channels south of the confluence of the Smogva and Studva rivers
on the maps from 1782-1785 and 1865-1869.

Channel maintenance slowed down deposition processes, prolonged the duration of ponds and strengthened the interconnectedness of wet habitats. In addition, it increased the area under forests which received additional amounts of water by flooding (Déván, 1889). The channels also increased the area of spawning grounds, providing regular spawning in ponds which had already lost their natural connection with watercourses.

Being situated on the frontier, this area was often exposed to wars (Imerovski, 2011). Its long-standing status of the Military Frontier hindered the area's economic development for two centuries. Although planned management of the forests in Ravni Srem began in 1754 (PE Vojvodinašume, 2008), numerous privileges of the army and its officers impeded the modernisation of management in this territory as opposed to the rest of the country (Erdődi, 1866). Documents from this period imply the existence of

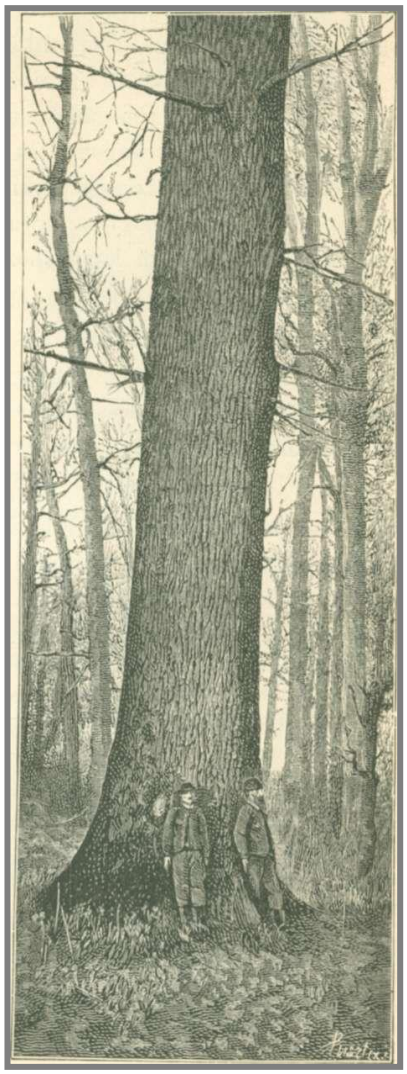
traditional utilisation of forests, applied since the Middle Ages and based on the multifunctionality of forest areas which were used for wood production, pasturing, and acorn feeding.

Traditional pig-herder cottage "Šiljkara". Photo: INCVP

Integral forest management in this area lasted until the second half of the 19th century (Geisinger, 1870), when the profits from charging pasturing (acorn feeding) in Posavina forests were much higher than the profits from gathering gall and oak bark. An article from 1866 (Erdődi, 1866) mentions a comparatively low degree of forest utilisation which was one of the reasons why 64,000 ha of oak forests (the number refers to the whole area of Bosut-Spačva forests which are today located in Serbia and Croatia) was more than 200 years old. The author claims that the livestock population of a forest estate covering 65,650 ha included "97,939 graminivore head (cows and sheep) and at least as many pigs" and that acorn feeding was important even in years with lower acorn yields. According to this article, the area was dominated by common oak stands older than 200 years. Domestic pigs and cattle had their role in preparing forest surfaces (soil) planned for reforestation. They were fenced and pasturing was forbidden five years prior (Petračić, 1931; Klepac, 1981).

3.2.2. MODERN (INTENSIVE) SPACE UTILISATION

Growing population numbers and a higher demand for grains in this area led to the gradual conversion of some forest parts into arable land and pastures (First and Second Military Survey) during the 19th century. During large floods, over 90% of arable land was flooded (Ilić, 2012). Traditional farms ("salaš") were built in the interior of the forest complex, which provided better utilisation of forests and ponds for pasturing. The surroundings of these traditional farms were transformed into arable land and orchards.



A Large Tree –
An illustration in the article about oak forests in Slavonia
(Déván, 1889)

With the emergence of industrialisation, the importance of acorn feeding decreased, and a demand for quality oak assortments (e.g. for wine barrel production) and raw materials for the chemical industry (gall for tannin production) increased (Erdődi, 1866). As a species which satisfied the widest range of the then society's needs, as it does today, the common oak became the most important species in the human-managed selection.

In 1881 the Military Frontier was officially abolished. The forests in this area remained under the rule of public administration, which introduced modern management principles (Déván, 1889). As a result of planned forest management, all lowland primary forests were felled by the 20th century (Metlaš, 1926).

As a precondition for intensive utilisation of natural resources, works on the regulation of the Sava river and its flooded valleys started in 1870. Over the next century an embankment and a dam were built, which stopped flooding in this area. A newly built system of drainage canals decreased the level of groundwater. Following drainage, swamps and fields in the flooded area of the Sava and the Bosut were transformed into cultivated areas with prevailing field crop production. Drainage also enabled settlements to grow on the territories of alluvial areas.

Traditional animal husbandry survived (Prica, 1986), but became ever more restricted due to the modernisation of forestry. In the second half of the 20th century, agricultural areas within the forests were reforested. Only a small number of traditional farms survived in the forest, focusing on pig farming, which is the only extant way of traditional forest pasturing. The number of households engaged in pig farming has decreased sharply in recent decades.

Complex eco-vegetational and production research from 1977 to 1983 defined eco-production units (forest types) and created the preconditions for the modern planning of forest management. The forestation of the area was continued, but water regulation changed the regime of forest flooding by surface waters and groundwater (Letić et al., 2014). Due to drainage, the lower limit of altitude for the development of ligneous vegetation was reduced to temporary ponds and fields, which caused sudden overgrowth of open wet habitats in combination with a decrease in the number of large wild and domestic herbivores.

Even though agriculture is still one of the main occupations in local communities, a decrease in the number of livestock population and greater importance of field crop production are clearly observable. Due to the proximity of groundwater, the maintenance of cultivated areas demands lower levels of groundwater. This is achieved by means of drainage systems, which has a negative effect on the vitality of forests and profitability of forestry. Modernisation of agricultural production causes constant growth of diffusion pollution by nutritional and toxic matter in channels and watercourses. The connectedness of drainage networks in agricultural and forest areas sporadically brings pollution through the canal network to inner parts of the forest complex, threatening the survival of species in wet habitats (Mitić, 2004).

4. METHODOLOGY

The case study focuses on two scenarios, one representing the current "business as usual" situation (A) and the other representing the proposed "integrated management" situation (B). Typical habitats (according to Council Directive 92/43/EEC), indicative wildlife species, wood production, extensive animal husbandry, and flood alleviation are analysed for the proposed scenarios. The aim is to value (in quantitative, qualitative and perceptional terms) the impact of these two different management scenarios on key ecosystem services (wood production, traditional animal husbandry, flood protection, and natural habitats/species).

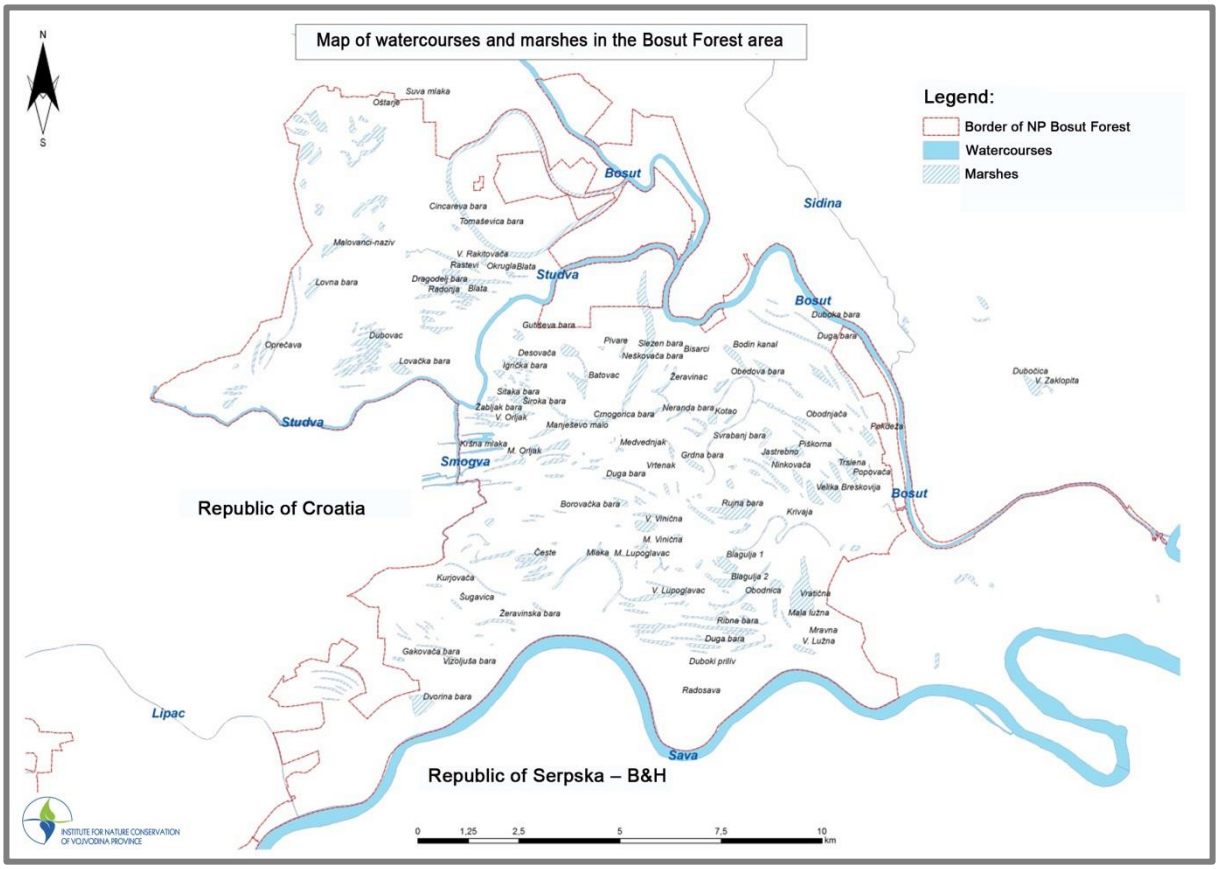
Scenario A: continuation of "business as usual"

Unchanged management (multipurpose significance and potentials of the area are not recognised; the area is not used to receive flood waves; there is a continual drainage of the forest and wet habitat mosaic resulting in forest dieback; extensive animal husbandry and pig farming that shaped the area are dying out, followed by the disappearance of wet habitats and a decrease in natural values; partial loss of yields and profits).

Scenario B: "integrated management" approach

Multipurpose utilisation of the area (the establishment of a protected area with the reception of flood waves in half of the Nature Park; environmental flooding of the forest complex in order to increase forest vitality and maintain the existent habitat mosaic; the application of traditional animal husbandry as the most economical method of habitat maintenance; increasing yields and profits in the area).

Four main levels of data collection and analysis were carried out: ecological and biological, hydrological, economic, and social/stakeholder. A variety of sources, methods and techniques which were used to collect and analyse these data are described respectively in following chapters.



Map of watercourses and marshes in the Bosut Forest area

5. RESULTS OF THE STUDY

5.1. WOOD PRODUCTION

Human influence on the hydrological regime of the observed area is considerable and has great importance for the survival of common oak forests in this area. The availability of moisture from groundwater and surface water is vital for the health (physiological fitness) and biological productivity of species in hygrophilic forests (Galić, 2009, Erdeši, 1971, Rauš, 1975). In 1932, the embankment along this section of Sava River was finished, which caused a very important change in the regime of surface flooding. In addition, drainage canals along forest roads and the forest roads themselves have a great

Common oak forest (Gornji Srem) Photo: INCVP

effect on additional flooding. Several authors have analysed the significance of flooding regime as an important factor of forest dieback in Spačva-Bosut forests (Dekanić, Galić, Letić, etc.).

The area in question can be observed as a set of management units governed by water and forest management authorities. The territory of these management units hosts the most profitable stands of the common oak in the Republic of Serbia.

Methodology

The data used to present the abovementioned analysis come from current management plans. The data about the management records were taken from the article "The problem of forest dieback in Gornji Srem" (Medarević, M. et al., 2009) for the 2004-2007 period, and from the article "The influence of drainage works on the state of common oak forests in Ravni Srem" (Letić, Lj. et al., 2014) for the 2007-2013 period. Apart from the quoted sources, data were also used from "Table 6.5 – Plan and performance of cutting by volume" from Management Basics for MU Vinčina-Žeravinac-Puk 2017-2026. The presented data were used by means of the benefit-transfer method of assessing eco-system services. The starting point of the analysis is the comparison between the structure of wood assortments obtained in seed and thinning cutting, and the structure of wood assortments obtained in sanitation cutting.

Using the data received from PE "Vojvodinašume" about the structure of completed works during the management cycle which started on the 1st of January in 2005, Medarević, M. et al. (2009) concluded that the quantitative ratio between the plan structures had been changed due to forest dieback. They claim that "due to forest dieback, the quantitative ratio of plan structures changed and is characterised by: finalisation of 13% of the main cutting (regeneration cutting) plan compared to the planned 33%; production of salvage yield 1.5 times higher in quantity than the sanitation cutting plan; assortment structure of yield which is much more unfavourable in finalised sanitation cutting than in regeneration cutting; the share of timber compared to firewood, which makes 5-20% in certain units in sanitation

cutting, and 55% in regeneration cutting (in MU Vinčina-Žeravac-Puk); economic effect of the same volume of production within salvage yield which is lower by 95-64% compared to regeneration cutting." According to the available data, it is concluded that sanitation cutting in certain parts of MU Neprečava-Varoš-Lazaric in the first four years of the plan produced 2.5 times higher yield, initially projected in the management plan (Medarević, M. et al., 2009). It is also important to note that this article registers sanitation cutting recorded before the severe drought in 2012 and the flood in 2014.

Since the drought and floods caused additional dieback, the government of the AP of Vojvodina reached the Decision on the establishment of a committee to solve the problem of dieback on the territory of the Autonomous Province of Vojvodina ("The Official Gazette of the Republic of Serbia," No. 10/2014). The efforts of this committee influenced the government of the AP of Vojvodina to reach conclusions concerning dieback. Based on these conclusions, the PE "Vojvodinašume" was appointed to write amendments and annexes to plans for the areas affected by an increased dieback, in accordance with the Forestry Law ("The Official Gazette of the Republic of Serbia," No. 30/2010, 93/2012 and 89/2015). Amendments and annexes were required for MU "Rašikovica – Smogvica," "Rađenovci – Novi," and "Draganovci – Lopadin – Dubrave – Kablarovac."

Oak timber yard in Morović. Photo: Forest manager PE Vojvodinašume

Economically speaking, losses resulting from more frequent sanitation cutting are presented by comparing the assortment structure formed by thinning and the assortment structure formed by sanitation cutting between 2007 and 2013.

Timber yield from sanitation cutting is 29%, whereas 73% from seed tree cutting. It is important to take into account a higher percentage of the most valuable veneer logs in seed tree cutting.

Apart from financial losses, obviously resulting from unfavourable assortment structure, an additional burden is the production costs, which are equal for assortments in seed tree cutting and assortments in sanitation cutting.

Table 1. Logging plans and unplanned (sanitation) cutting share (2007 – 2013) (Source: Letić et al., 2014)

MU	Marked Area	Common oak	ds	Dieback degree "3"(trees)	Dieback degree "4" (trees)	m³/ha	Narrow-leafed ash	ds	Dieback degree "3"(trees)	Dieback degree "4"(trees)	m³/ha
2701	441.44	3382.36	**30**	1015	1372	7.66	8.03	**27**	5	14	0.02
2702	587.11	9099.18	**28**	1160	6603	15.50	962.80	**29**	425	941	1.64
2703	1118.73	41862.14	**37**	1821	23591	37.42	1687.61	**31**	292	1538	1.51
2704	985.91	14528.37	**40**	1246	5731	14.74	2237.27	**30**	641	2089	2.27
2705	1481.47	24267.43	**41**	2871	6794	16.38	3492.45	**32**	932	1798	2.36
2706	233.56	6000.29	**34**	204	2702	25.69	427.23	**35**	26	234	1.83
2725	18.45	71.72	**32**	25	27	3.89	29.5	**23**	31	21	1.60
∑	4866.67	99211.59	**35**	8342	46820	20.39	8844.89	**30**	2352	6635	1.82

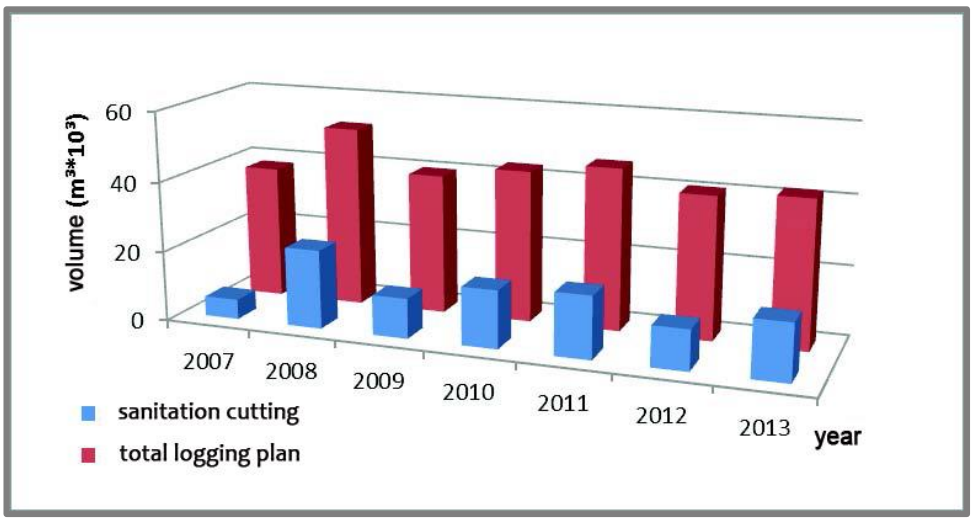


Figure 1. Share of sanitation cutting in Morović Forest Administration from 2007 to 2013 compared to the logging plan (Source: Letić et al., 2014).

The ratio of sanitation cutting to regular cutting ranges from 14.9% (2007) to 43.5% (2008), with the average of 32.57% for the analysed period (2007 – 2013). Letić et al. (2014) conclude: "Based on the data from Table 1 and Chart 1, the conclusion is that a bigger share of sanitation (unplanned) cutting (only trees with dieback degrees "3" and "4") in the annual plans for the analysed period (2007 – 2013) represents more difficult circumstances for implementing the planned activities in this management half-period, considering the limited time and employment of workforce needed for additional (unplanned) tree cutting". In addition, trees marked for sanitation cutting mostly have a low percentage of timber compared to trees of the same age and diameter marked for seed cutting, which causes considerable financial losses in management".

The previously analysed situation is related to the current state of the affairs in the area, which corresponds to Scenario A of the project goal.

The establishment of an optimum watering regime (Scenario B), which implies a near-natural state, would contribute to a decrease in forest dieback in the observed area. A lack or surplus of water is a stress factor causing decay (dieback) of ecologically significant and economically valuable common oak forests in Serbia (Nikolić, 2016).

Based on the measuring in the area of Gornji Srem (the observed area of Bosut Forests) from 2010 to 2012, it was concluded that Gornji Srem had an unfavourable watering regime because of the embankment for prevention of periodic flooding.

In accordance with the primary reason causing devitalisation of hygrophilous forests, and based on referential research conducted in the given area (Medarević et al., 2009; Letić et al., 2014), it is estimated that establishing an optimal watering regime will reduce forest dieback by 30-50%. In the particular case of Vinčina-Žeravinac-Puk management unit, it means that salvage yield (sanitation cutting because of dieback) of 60,771.1 m^3 is reduced by the estimated value (30-50%), which is from 18,213.33 m^3 to 30,385.55 m^3 in terms of volume. Financially, profits depend on a different (more favourable) assortment structure (Table 2). Medarević et al. (2009) conclude: "The economic effect of the same production volume, within a salvage yield, is reduced by 95-64% when compared to regeneration cutting."

Table 2. Assortment structure of the common oak in sanitation and seed cutting (2007-2013) (Source: Letić et al.).

Common oak	F	K	I	II	III	Timber	Cordwood	Sum
Seed (m^3)	7954.02	3352.12	6250.39	6600.83	9664.71	33830.48	12795.65	46626.13
Sanitation (m^3)	1124.01	1126.13	2341.52	3900.68	8914.16	17406.5	43515.95	60922.45
Seed %	24	10	18	20	29	73	27	100
Sanitation %	6	6	13	22	51	29	71	100

According to Letić et al. (2014) "the separately analysed Vinčina-Žeravinac-Puk management unit" (16.38 m^3/ha; mid-diameter dg=41 cm; dieback area approx. 1,480 ha) is similar to area average in terms of common oak dieback intensity (Table 1). This points to the economic and environmental significance of forest dieback problem in the whole area.

5.2. TRADITIONAL PIG HERDING

5.2.1. INTRODUCTION

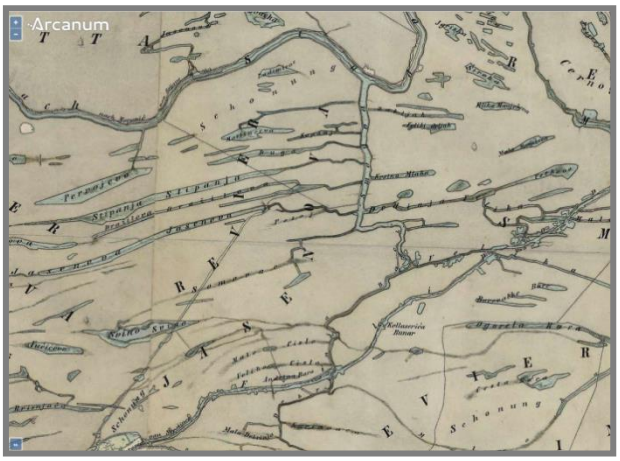
Traditional pig herding in hardwood floodplain forests of Central-Europe has a long history. Feeding pigs on acorn, fruits, forest grasses, worms and roots was institutionalised in the practice of '*pennage*' in the Middle Ages. Grazing, trampling and uprooting by pigs might have had a significant effect on the forest. However, we have only little knowledge about how these disturbances may drive the development of stand structure and forest dynamics. Pigs feed not only in forests but in wetlands and small forest openings too. Disturbances caused by pigs pasturing in the wetlands were rarely studied in Europe.

Traditional pig herding in lowland oak forests was abandoned in the rest of Europe. Therefore, Bosut Forests area represents a unique socio-ecological system where pennage and pig grazing in forests and wetlands are still alive. The aim of this report is to present the results of our research in order to assess the effects of pig activity in the hardwood floodplain forests and wetlands of Bosut Forests area.

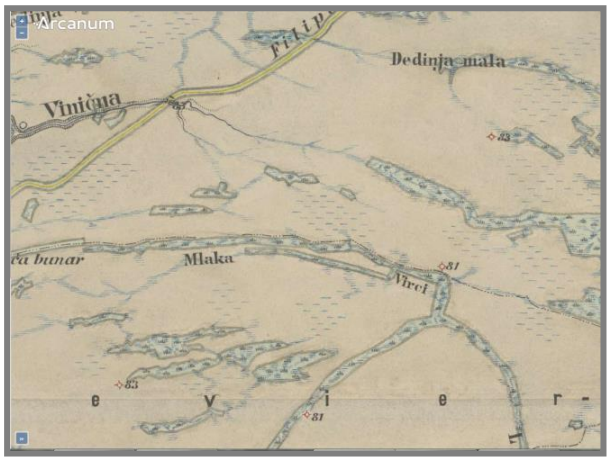
Traditional extensive pig herding on the floodplain of Sava River has had a long history in Bosut Forests, at least 2000 years. In 1977 all the pig herders, together with their pigs, were forced to leave the forest. Before that there had been no less than 50,000 pigs herded within the forest, and another 50,000 heads of cattle and sheep. At that time hardwood floodplain forests had a more open forest structure. Wetlands were also more open in the past. As a result of abandonment and other environmental factors the canopy of the forest started to fill in with *Carpinus betulus, Acer campestre* and other shrub species. Abandoned wetlands had become overgrown by tall sedge communities and reed beds. In 1989 local pig herders were allowed to return and continue their activity.

Recently this type of traditional forest management has almost become non-existent due to absence of knowledge transmission. It is a tough and demanding job, no longer appealing to the younger generation. There are 17 active pig herders in the area at this moment, and only about 1000 pigs. To this day just several patches have remained open and almost all of the forest has been overgrown by the second canopy and shrub layer. Of all the previously used wetland area, only a few remain grazed.

Before the river regulations the forests were interspersed by wetlands (see maps: Second and Third Military Survey). In 20th century only fragments of former wetlands remained in the forest, located within the forest management units.



Before the river regulations, the forests were interspersed by wet depressions, regularly flooded. Source: Second Military Survey (1806-1869). HM HIM, Arcanum Adatbázis Kft. See map in detail:



Wetlands i.g. 'mlakas' and 'baras' in the Third Military Survey (1869-1887). Source: HM HIM, Arcanum Adatbázis Kft. See map in detail:

Temporary wet depressions in the forests were formed during the Holocene by the river activity. In addition to the current oxbow lakes, there are several former oxbow-lakes in different stages of sedimentation. A larger wetland area in the forest is called 'bara' by the local inhabitants, and a small wetland area as well as a very small muddy place is known as 'mlaka'. 'Baras' are generally wet for longer periods than 'mlakas' and are more open and less affected by canopy shading.

Wetlands of floodplain hardwood forest areas are very rare in Europe. Wetlands in the forest, called 'bara', generally dry out during the summer. Photos: Á. Molnár, Zs. Molnár

Methods

In the autumn of 2017 field work (vegetation surveys and interviews with pig herders) was conducted to document the effect of pig herding on structural attributes of hardwood floodplain forests and wetlands of the forest area.

Surveys of forests was focussed on the most representative forest types: ash-oak and ash-oak-hornbeam forests (*F. angustifoliae – Quercetum robur s.l.* and *Carpino-Fraxino-Quercetum roboris s.l.*). The aim of field work was to:

1. Define what kind of disturbances are visible in the vegetation and on the soil surfaces in the forest;
2. Document the spatial distribution of disturbance intensity and pig habitat preference within the closed canopy forest;
3. Reveal how pigs affect different attributes related to herbaceous, shrub and canopy layers.

Surveys of wetlands was done by in-detail mapping of wetland habitats on diverse distance from pig stables (wodden shelters), populated by different number of pigs.

More than 20 wetland sites were surveyed with 120 relevées in total. Comparing vegetation structure and other attributes on 5 different categories regarding pigs' influence (disturbance) on the forest and wetland habitats, the key findings addressing scenarios A and B were revealed.

5.2.2. CAPACITIES AND CONSERVATION VALUES OF TRADITIONAL PIG HERDING

Pig presence impact on the forests

Types of disturbances related to pig activity

Pigs may influence the development of a different layer in the forest (herb, shrub and canopy) by several different activities: grazing, trampling, uprooting, or manuring. The most visible were uprooting and trampling. According to our observation, grazing alone seems to be a less important factor on the development of the shrub layer. However, as one of the pig herders stated, *pigs can damage shrubs below 50 cm in height. They graze mostly in spring*. Differentiating the effects of the above mentioned activities is almost impossible due to several structural attributes.

Spatial pattern and intensity of uprooting, and factors influencing 'walking' preference of pigs in the forest

There is no evidence of declining disturbance intensity along the distance gradient moving away from the centre of the farming place in the forest. The surroundings closest to the pens are certainly overtrampled and uprooted. The area of disturbed surface is quite large, up to 200 m from the centre, but it becomes homogenised or random when moving away.

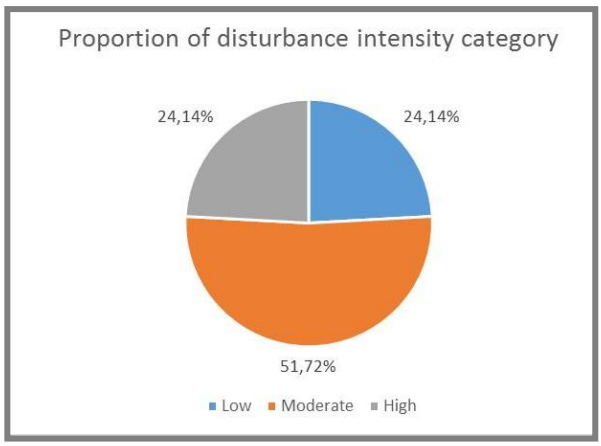


Figure 2. Proportion of uprooting intensity category, measured in the vicinity of an active pen near the village of Morović.

Low disturbance intensity in the forest not far from the herding place. Dense Carpinus betulus second canopy layer as a results of grazing and flooding abandonment in 1978. Photo: Zs. Molnár

However, there are sites within the forest where the ratio of disturbed surfaces is much higher, showing signs of being preferred by pigs. These sites are: forest marshes, muddy ponds, forest dirt roads and paths, and certain patches of shrub layer (see photographs). So it is not only the distance from farming places but position of marshes, forestry roads and fences that affects the walking preference of pigs.

Uprooted forest edge, next to the fence and the road. Photo: Zs. Molnár

Diverse habitat with pioneer muddy surface and patchy shrub layer, created by rooting activity of pigs. Photo: L. Demeter

Effects of pig presence on the herb layer

We have not found clear evidence of the degradation of herbaceous layer. However, lack of forest specialist species is obvious, and it cannot be connected directly to the grazing history. Floodplain

forests of Bosut area generally lack forest species, which could also be a consequence of the historical flooding regime of this landscape.

However, although intensively grazed forest are often believed to be invaded by nitrophilous plant species (e.g. *Sambucus nigra, Urtica dioica* or *Chelidonium majus*) due to nutrition accumulation, we have not found evidence of it in these forests. They are missing even at the most intensively disturbed sites. Their presence is proven only in the surroundings closest to the farming places, and even there they are not abundant.

Pigs can create small muddy ponds within the forest stand, where water cover, open canopy and open soil surface can provide a habitat to different groups of organisms (see the following photograph).

Very small wetlands in the forest, puddles and 'mlakas', maintain specific habitat types in the forests as they are affected by canopy shading in many cases. Photo: Á. Molnár

With floodplain forests deprived of regular floods (a crucial disturbance of these habitats), pig pasturing has been the only semi-natural disturbance type which can control the structure of the forest and create fine-scale mosaics of shrub layer with diverse morphology of individual shrubby species. Physiognomy of the shrub layer and the shape of individual shrubs differ between sites with different disturbance intensity history. Abandoned sites and sites with low disturbance intensity have a dense shrub layer with individual shrubs having a straight form. At sites with high disturbance intensity, individual shrubs are not uniform, and have diverse shapes (e.g. tree-like, low-spreading). The recent number of pigs can prevent the shrub layer encroachment only in the closest vicinity of herding places. Where the close tall shrub layer developed, due to the water table dropping down and the decreasing number of pigs 20 years ago, it is impossible for pigs to open up it. Only the cover and shape of low shrub layer can be affected by this pig density. According to a local pig herder: '*Where there are pigs, shrubs need 10 years to grow up. But without pigs 3 years are enough*.'

Pig presence impact on the wetlands

Pig activity in the wetlands

Wetlands, especially open, muddy ponds and wet areas have special importance in pig pasturing as they are preferred by pigs for daily walking. Pigs visit these sites not only for wallowing and bathing but for feeding as well. Searching for pieces of plants (e.g. roots, bulbs) and animals (e.g. snails, worms, insects and other invertebrates) in the water or in the mud are typical feeding activities of pigs.

The most visible activities of pigs influencing the wetlands are the uprooting, grouting, wallowing, grazing, and trampling. Trampling was visible dominantly in the heavily grazed wetlands (C4-C5), where uprooting and other disturbances caused by pigs keep the wet mud surfaces and the wetland habitat open.

Maintaining water supply of the wetlands is very important in Bosut Forests area. Oxbow-lakes, baras and mlakas are generally filled with water after the vegetation periods. Photos: Á. Molnár

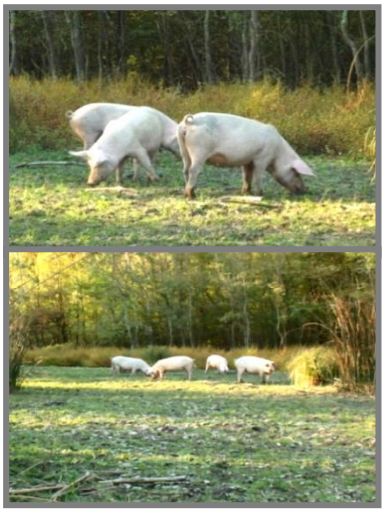
Most of the wetlands dry out during the summer. Pigs graze on the wet mud surface of the temporarily dried out lakes. *Carex elata* tussocks in a grazed oxbow-lake near a herding place (G4, see in the map). Photo: Zs. Molnár

Slightly grazed wetlands are also preferred during the daily walking of pigs. Pigs form a network of pathways in the slight or medium level grazed marshes (C2-C3). These wetlands have higher vegetation (*Carex riparia* dominated tall sedge communities, *Iris pseudacorus, Glyceria maxima, Phragmites australis* beds), and so the pathways and uprooted muddy surfaces were visible only during the vegetation sampling works. Open surfaces of these sites are in the shade of the tall vegetation cover, that is why they are less suitable for Nanocyperion species.

In the intensively grazed sites (C4-C5), open water surfaces, typical in the spring, change to wet mud surfaces later in the year.

According to our observation, pigs rooting and grouting keep open the wet mud surfaces which are preferred by Nanocyperion species, such as *Ludwigia palustris, Marsilea quadrifolia, Lindernia procumbens, Heliotropium supinum, Gnaphalium uliginosum* and *Eleocharis acicularis*. These mud surfaces with stands of rare and protected species increase the nature conservation value and the habitat diversity of the whole Bosut Forests area.

All of the most valuable bara sites are in the neighbourhood of the pig herding places (*szállás*).



Pigs grazing and uprooting in a temporarily dry wetland. Photos: Zs. Molnár

Wet mud surfaces are preferred by Nanocyperion species as well. Photo: V. Ulicsni

Diverse marshland communities with *Schoenoplectus lacustris* and *Carex elata* tussocks. Photo: Zs. Molnár

Small muddy pond near a pig herding place. Unique microhabitats such as muddy ponds, puddles and 'mlakas' are maintained by the pig rooting. Many of them are home to valuable plant species (e.g. *Hottonia palustris, Marsilea quadrifolia, Callitriche palustris*). Photo: Zs. Molnár

Effects of pigs on wetlands flora and composition of species

We found that 'baras', having a greater grazing pressure and often situated closer to the farming places, are more valuable floristically (more open and having more muddy surfaces suitable for Nanocyperion species). We found those Nanocyperion species mostly in the wetlands of Bosut Forests area; they are not eaten by pigs and are well-adapted to medium or higher level disturbances caused by larger numbers of pigs (e.g. *Marsilea quadrifolia, Ludwigia palustris*).

Pigs can diversify the wetland habitats. Heavily grazed sites are often totally overgrown by Nanocyperion species, e.g. *Ludwigia palustris, Marsilea quadrifolia, Hottonia palustris, Callitriche palustris*. Other mud species such as *Lindernia procumbens, Cyperus fuscus, Heliotropinum supinum, Gnaphalium uliginosum, Eleocharis acicularis* are also typical in several wetland areas with very intensive grazing pressure (C5).

One of the very heavily grazed *bara* sites (C5) with *Hottonia palustris, Ludwigia palustris* and *Lindernia procumbens*. Photos: Zs. Molnár

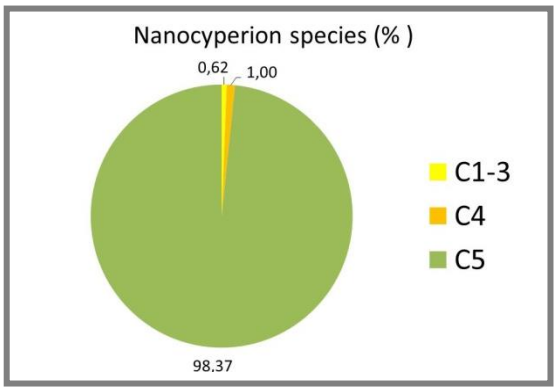


Figure 3. More than 98% of Nanocyperion species occur in the very heavily grazed wetland sites (C5).

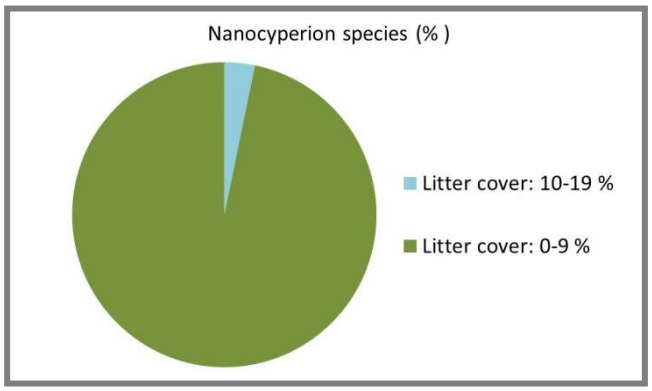


Figure 4. Most occurrences (96.7%) of Nanocyperion species are in sample localities with very low litter accumulation (below 9% litter). Mud species do not occur in sample localities above 20% of litter accumulation.

Hottonia palustris only occurs in wetlands that have a better water supply and are very heavily grazed (C5). A good example for this is the bara near to szállás G3 (see in the map) with *Hottonia palustris*, *Ludwigia palustris* and *Marsilea quadrifolia*, see next photographs). We have found *Hottonia palustris* in the total of five bara sites.

Marsilea quadrifolia prefers only wetlands which are heavily or very heavily grazed (C4-C5), thus also rooted, grouted or trampled, and usually not very far from the herding place or from the pathways often used as daily walking routes of pigs. We could not find *Marsilea quadrifolia* in wetland areas with low or medium intensity grazing, or abandoned ones (C3-C1).

Abandoned wetlands (C1) are rather species-poor and often have monodominant and repeating species composition. In most of the cases, *Carex riparia, Glyceria maxima* and *Iris pseudacorus* dominate these marshlands, forming high and dense vegetation cover. Reed beds also occur in some low intensity grazed sites. These habitats are rather species-poor, with monodominant *Pharagmites australis* stands.

Best expert opinion and recommendations

Recent studies show that flooding and pasturing have been key disturbance factors in floodplain forest ecosystems for millennia. However, such disturbance types have almost disappeared from this habitat. As a consequence, European most endangered forest habitat types are facing unknown developmental pathways. Therefore, restoration of these ancient disturbance types is critically important for maintaining natural forest dynamics that can create a diverse forest structure that contributes to local well-being.

Wetlands are also very important habitats for pig herding, as pigs need wet, muddy places to meet their daily grazing habits more than other livestock. A very dense system of wetlands in Bosut Forests makes this area optimal for pig herding.

Pig pasturing in Bosut Forests area is a unique type of land use, although it was common in the past throughout Central Europe. During this complex socio-ecological study we collected field data, information and wisdom of pig herders about how this dynamic floodplain forest-marshland system functioned in the recent periods. We described how forest and marshland communities have been changing due to continuous elimination of floods and pig pasturing.

Our thoughts on ecological processes can be summarised as follows:

1) Hydrological regime, available light and pig grazing have formed and developed the structure and dynamics of forest communities of Bosut Forests area;
2) Extensive farming in the former floodplain areas is a surrogate ecological factor to the natural, millennia old, disturbance pattern in floodplains;
3) Forest and marshland structure are highly sensitive to the changes in the number of grazing animals and flooding regime;
4) High disturbance intensity by pigs is limited only to small forest areas, where unique microhabitats were formed and maintained (e.g. muddy ponds, puddles, *baras*, *mlakas*, wetlands or small openings near the herding places). Some of these microhabitats are home to valuable plant species such as *Hottonia palustris, Ludwigia palustris*, not registered in overgrown marshes;
5) The present number of pigs (approx. 1000) does not damage the herbaceous and shrub layers of forest communities;
6) Grazing, trampling and uprooting activity of pigs can contribute to the development of a diverse shrub layer structure in the forest;
7) Nutrition cycle was not altered by the manuring activity of pigs. Based on vegetation surveys in forests and wetlands, no evidence of nitrogen accumulation was found;
8) Preventing shrub encroachment, the total closure of forest canopy in small patches requires higher density of pigs;
9) Maintaining and restoring open marshes also require a much higher number of pigs;
10) Alongside with restoration of grazing regime, forest communities would benefit from the restoration of natural disturbance regime. The dominance of *Carpinus betulus* might be reduced by these measures;

11) Pigs can create small muddy ponds within the forest stand where water cover, open canopy and open soil surface can provide habitat to different groups of organism;

12) Pigs can diversify wetland habitats. Uprooting caused by pigs keep the wet mud surfaces and the wetland habitats open;

13) Maintaining water supply of the wetlands would be very important in the future;

14) Abandoned wetlands are very species poor and often have monodominant and repeating species composition;

15) The most valuable *bara* sites are in the neighbourhood of the pig herding places (*szállás*);

16) Most of the wetlands dry out during the summer. Pigs graze on the wet mud surface of the temporary dried out lakes. Heavily grazed sites are often totally overgrown by Nanocyperion species.

17) Increasing grazing intensity suppresses tall marshy vegetation, like tall sedge communities and reed, and Typha beds. Without pigs wetlands would be overgrown by tall marshland vegetation;

18) The abandoned wetlands are threatened by shrub encroachment, mostly with *Amorpha fruticose, Fraxinus angustifolia, Pyrus pypyraster, Malus sylvestris, Salix cinerea, Salix alba, S. fragilis, Carpinus betulus.*

Possible scenarios for ecological processes in forest communities

Scenario A

Our field and 'oral history' interview survey shows the evidence that without traditional pig farming activity and natural flooding regime, shade-tolerant and flood-intolerant tree species (*Carpinus betulus, Acer campestre*) would take the dominant role in the canopy and the shrub layer (Janik et al. 2011).

Alternatives for the future. Scenario A. Abandoned '*szállás*' (pig herding place) and overgrown '*bara*' (wetland). Photos: Zs. Molnár

Creating a dense under-canopy layer, they would prevent the establishment of light demanding species, such as *Quercus robur*. The natural regeneration of these species would thus be hindered. In abandoned wetlands, protected mud species will disappear, and tall marshland vegetation, like the reed and Typha beds and tall sedge communities, will overgrow the muddy surfaces. Shrub encroachment also threatens the abandoned wetlands in the near future. This process has already started and is apparent mostly in the forest edges. In the future, abandonment of grazing will decrease not only the floristic diversity but the habitat diversity as well. Small muddy ponds overgrown by shrubs and trees are yet another consequence of the abandonment of pig pasturing. Disappearance of these ponds would homogenize the microhabitat-diversity of the woodlands and threaten the habitat of protected plant species like *Hottonia palustris*.

Scenario B

Keeping alive and enhancing the traditional farming activity of the area would be a cost-efficient tool for habitat maintenance. According to our field experience, a minimum of 5000-7000 heads of pigs (1 adult pig/ha) would be an ecologically reasonable stock for the whole project area (Bosut Forests), benefiting the forest and marsh communities. However, it should be kept in mind that the impact of pigs depends not only on pig density but also on the vicinity and size of marshes, roads, young or old forests, weather in a given year, quantity of acorns. New '*szállás*' should only be established in place of former (disused, abandoned) *szállás* places. Localities of these would be selected based on knowledge and memory of local inhabitants.

Alternatives for the future. Scenario B. Pasturing in forests and wetlands of Bosut Forests area. Photos: Á. Molnár

5.2.3. EXPECTED BENEFITS FOR TRADITIONAL ANIMAL HUSBANDRY ACCORDING TO SCENARIO B

Flood water washes out tannins from acorns so that they become easily digestible for animals which need to use its high nutritional value. This is why pigs stay near the ponds surrounded by common oak trees. Acorns which fall into water stay nutritious much longer, compared to acorns that lie on the ground or forest litter until the next spring. Most acorns that stay on dry ground are food to weevils and

rodents, and later decomposed by fungi. On the other hand, acorns that fall into water or mud are preserved in a way and pigs readily eat them until the next year's yield.

Another benefit of environmental flooding under Scenario B would be a greater vitality of common oak trees and higher production of acorns, since the soil would contain enough humidity during summer months for unhindered physiological processes and ripening of acorns. On average in the last two decades, full yields of acorn occurred once or twice in a ten year period. Increasing the volume and frequency of acorn yield would ensure steadier production of acorns as natural feed for pigs.

Pigs prefer feeding in marshes. Acorn in water loose bitterness (leached tannins). Photo: A. Molnar

In addition to acorns, pigs also readily eat high-protein food such as freshwater shells and snails, other invertebrates and fish, which abound in all ponds with enough water. Restoration of 20-60% of surfaces that are potentially important for spawning of fish species (former ponds) would enhance the diversity of natural food supply suitable for pigs.

In accordance with the presented findings, flooding under Scenario B would heavily contribute to an increase of the capacity for extensive pig farming. Taking all the parameters into consideration (yield frequency, acorn production, digestibility of acorn, invertebrates, fish, etc.), capacity for pig farming in the parts of forest area nearer to villages would considerably increase. For the purposes of this study, based on the mentioned parameters, a conservative estimate is that an optimal capacity for extensive pig farming would be in the range of 5,000 to 7,000 domestic pigs, in the area not larger than a half of Bosut Forests area.

The essential economic contribution of a natural flooding regime is related to the possibility of supplemental feeding for pigs. They can feed on acorns from September to May, and their diet can include invertebrates and fish from permanent ponds. Therefore, the costs of (supplemental) corn feeding are lowered by 50% (the average amount was determined by surveying different breeders in the area).

Altogether, it is estimated that the predicted increase in the intensity of pig farming is 500-700% (5-7 times; from 1,000 to 5,000-7,000 heads), which enhances profitability by 100% compared to farming with regular supplemental feeding (profitability is doubled). The conclusion is that the contribution of this ecosystem service can be increased 10-14 times in ideal environmental, water management, and social circumstances.

CONTRIBUTION OF TRADITIONAL ANIMAL HUSBANDRY

Scenario A

Pig farming area: approx. 2,200 ha. Number of heads: 500-1,000, different ages.

Capacity exploitation per area unit: 1/3 regarding optimal density.

Meat production worth: € 50,000 to 100,000 per year.

Financial resources saved by cancelling alternative costs of pond habitat maintenance (by mulch grinding): 100 ha x 100 €/ha (mulch) = € 10,000 per year.

Scenario B

Pig farming area: approx. 6,500 ha. Number of heads: 5,000-7,000 adult pigs.

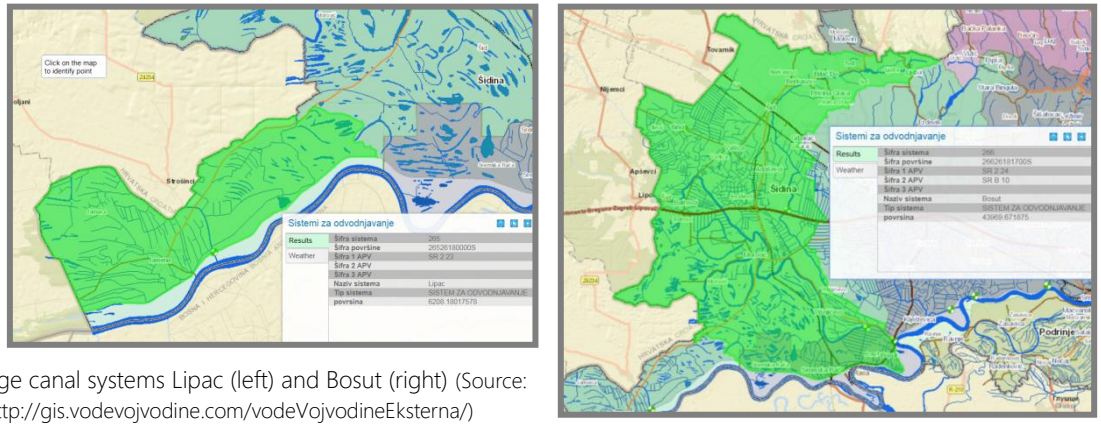
Capacity exploitation per area unit: 1 head per 1 ha of area.

Meat production worth: € 500,000 to 700,000 per year.

Financial resources saved by cancelling alternative costs of pond habitat maintenance (by mulch grinding): 500 (700) ha x 100 €/ha (mulch) = € 50,000 – 70,000 per year.

5.3. FLOOD MITIGATION

Between 1928 and 1938, the area of Bosut Forests in Serbia and Spačva Forest in Croatia, as a former flood zone of the Sava River, was made narrower by building an embankment near the Sava, from the settlement of Gunja in Croatia to Sremska Mitrovica in Serbia. In addition, drainage canal systems were built for the purpose of more efficient drainage (for the needs of forestry, agriculture, etc.). In the Republic of Serbia, these drainage systems were named Lipac and Bosut. The systems include a network of canals for draining agricultural land with pumping stations, and also a network of canals for draining swamps within the forest areas, connected to canals dug by forest roads. These anthropogenic impacts, along with climate change, have led to lower levels of groundwater.



Drainage canal systems Lipac (left) and Bosut (right) (Source: http://gis.vodevojvodine.com/vodeVojvodineEksterna/)

Flood mitigation

The ecosystem service, flood mitigation, has been selected as a relevant one in relation to the Sava River, as it primarily affects the populated areas downstream of this area. The area of Bosut Forests can provide this service because, as a former flood area with an area predominantly under the common (pedunculate) oak, it has the capacity to retain water, and after a certain period of time, slowly release it. At the beginning of rainy season or during the peak river flow, large areas of Bosut Forests area can absorb water in most of the surfaces, taking into account morphological and pedological characteristics of the area, groundwater level, volume of water retained by forests, etc.

Flood mitigation by ecological flooding (Source: INCVP archive)

Water supplies can also be more easily maintained in a dry period, as water is kept longer and thus "stored". In favour of this is the fact that this area is part of the Regional Hydrosystem "Srem", providing for the use of the Sava waters for irrigation through Bosut. The establishment of forest retention area will also allow for a potential reduction in the amount of water needed for irrigation of agricultural land in the surrounding parts.

The importance of this ecosystem service, flood mitigation, is on the rise especially due to the impact of climate change. Ecosystems and living organisms reduce or mitigate flood damage. In Bosut Forests area natural ecosystem changes occurred primarily due to the narrowing of the flood area by the construction of embankments, and also the by the construction of a drainage canal network. Restoring ecosystems, designing and implementing man-made alternative solutions require substantial investments. People usually recognize their dependence on functional ecosystems only when natural disasters have already struck and when the loss of this service becomes apparent (http://www.aboutvalues.net). Although in 2012 the Sava and Bosut rivers, according to the preliminary assessment of flood risk in 2012, were designated as significant flood areas for the Republic of Serbia (www.rdvode.gov.rs), floods still occurred. And there were catastrophic floods in 2014, causing enormous material damage, loss of human lives, destruction of livestock and environmental degradation in large parts of the Republic of Serbia, Bosnia and Herzegovina, Republic of Srpska, as well as eastern Croatia.

Based on the data from the Republic Hydrometeorological Institute, maximum water levels are recorded at almost all hydrological stations along the Sava River in Serbia (Table 3).

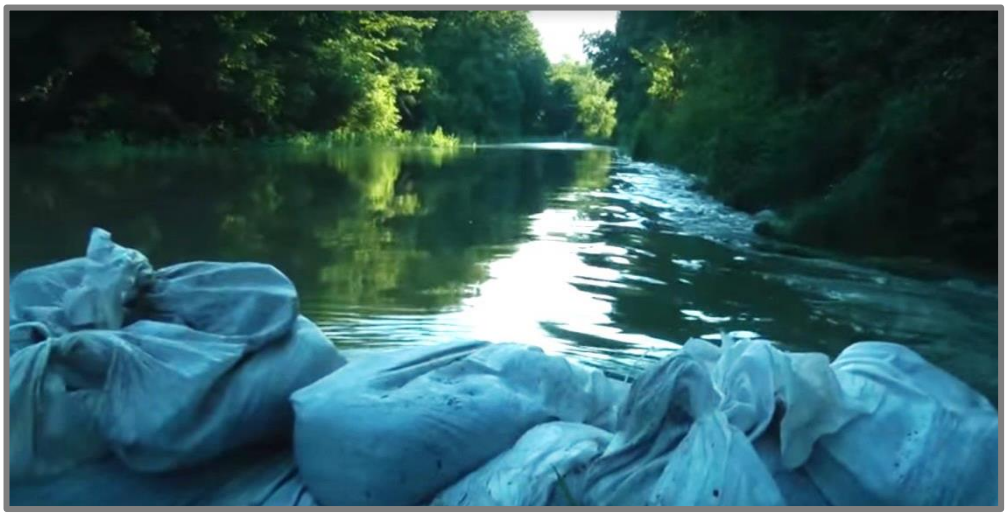
Table 3. Maximum inspected water levels at hydrological stations along the Sava River

Hyd. station	River	May 2014		Historical maximums	
		H_{max} (cm)	датум	H_{max} (cm)	date
Županja	Sava	**1168**	17.05.	1064	19/01/1970
Jamena	Sava	**1268**	17.05.	1104	12/01/2010
Sremska Mitrovica	Sava	**869**	17.05.	800	26/10/1974
Šabac	Sava	**664**	17.05.	590	25/03/1981
Beljin	Sava	755	18.05.	**764**	25/03/1981
Belgrade	Sava	538	18.05.	**738**	16/04/2006

Based on the data taken from the Annual Report on business operations of a state-owned water management company, JVP "Vode Vojvodine" for 2014 (Novi Sad, 2015), catastrophically high water levels of the Sava river and the breakdown of the first line of flood defence in the Republic of Croatia resulted in the flooding of a part of western Srem with water from the hinterland, and in Srem over 5,000 ha of agricultural land and over 20,000 ha of land were overflowed.

Jamena village during 2014 flood, an air photo
(Source: https://www.youtube.com/watch?v=QfC61Px8tzE)

During the above mentioned floods, water management estimates are that water quantity was about 80 million cubic meters. Using this data, it can be estimated that, if the stated quantity of water is calculated for an area of 10,000 ha, as the area of a potential retention basin, average water depth will be about 80 cm (80,000,000 m^3 / 100,000,000 m^2 = 0.8 m).



The "passage" of water through Bosut Forests and sandbags set up for flood protection of Morović village (Source: https://www.youtube.com/watch?v=WewJNccOg-8)

The maximum water level height within tolerance limits of the forest hardwoods is in the interval of 1 - 2 m, depending on the age of the forest and the season when the flood occurs, which would amount to 100 -200 million m^3 of water in an area of about 10,000 hectares. The maximum length of water retention period depends also on the temperature, season, and development phase of the flooded forest. In the reference year 2014, even in the absence of additional infrastructure for timely discharge of water from the forest after the flood wave passed (canal network, one-way drains, pumps, etc.), less than 1% of the area of submerged forest collapsed.

Evaluation of this ecosystem service, flood mitigation, was carried out in line with the global project (http://www.aboutvalues.net/) that provides support when selecting methods for integrating ecosystem services into legislation, planning and practice. The chosen method is the cost-based method, which estimates the amount of money saved due to availability of ecosystem services. In this case an estimate was made of how much the water management company (since it manages the area) would save if there was no flood damage. Of the two available methods, the "damage costs avoided" method has been selected here, taking into consideration the available data, e.g. flood damage reports and data from bilateral meetings. This method was more acceptable than the one outlining investment costs in the retention basin, which are unknown at this stage. It includes the increased costs of the water management company, incurred during 2014 flood defence at the first line embankment along the Sava, from Croatian border to the town of Sremska Mitrovica, and its repairs afterwards.

In addition to the above mentioned costs, since September 2017, according to the data from the web page of JVP "Vode Vojvodine" (www.vodevojvodine.com/Strane/Strana/37-Izgradnja_nasipa_Hrtkovci_-_Jarak), the three kilometre long embankment along the left bank of the Sava river, downstream section of Bosut Forests area, was built, at the cost of RSD 130,000,000.00. The embankment protects from floods a specific locality of the Gomolava archaeological site (earthen dam and concrete wall).

In addition, in 2015, project technical documentation for two projects was prepared: "Preliminary feasibility study with the General design for flood defence facilities - embankments on the left bank of the Sava, from Progar to Hrtkovci" where the JVP "Vode Vojvodine is an investor, and "General design for improving protection of Sremska Mitrovica and Mačvanska Mitrovica from large floods", with the City of Sremska Mitrovica as an investor (http://www.hidrozavoddtd.rs/userfiles/files/Regulacije%20i%20odbrana%20od%20poplava.pdf), but the cost data was not officially available to the public due to the project phase.

Cost information is shown in Table no 4.

Table 4. Costs in the existing flood protection regime

Costs	Amounts (in RSD / EUR)
Implementation of flood defence at line I of defence	300,000,000 / 2,542,372
Rehabilitation after flood defence in 2014	131,000,000 / 1,110,169
TOTAL	**431,000,000 / 3,652,542**

Statements from regulations

Legislation related to the area and future activities:

- Negotiations on the Agreement between the Republic of Serbia and the Government of the Republic of Croatia on Cooperation in the Sustainable Management of Transboundary Waters have not been conducted in the previous period, but interest has been expressed by both countries for the drafting of the Agreement (www.rdvode.gov.rs). Cooperation with the Republic of Croatia at the multilateral level takes place as part of the activities of the bodies of The Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention), the International Commission for the Protection of the Danube River (ICPDR), and the International Sava River Basin Commission.
- The Water Management Strategy in the territory of the Republic of Serbia until 2034 ("Official Gazette of RS", No 3/2017) states that the current state of flood protection in the Republic of Serbia is not satisfactory despite the fact that embankments and other types of "linear" protection were built, that watercourses are regulated, water deposits and ice flow conditions improved, as well as that a certain number of existing reservoirs and retention basins play a role to a greater or lesser extent in flood defence. A large part of the territory is still in real danger of floods, while a potential flooding risk exists where the protective systems were built. As a confirmation of what was mentioned in the Strategy, the floods affecting Obrenovac and other cities and settlements in May 2014 are listed. The same document indicates that in the forthcoming period, bearing in mind a possible worsening of water regime due to climate change, active flood protection measures should be promoted as well, that is, the use of reservoirs and retransmissions, reservoir and peripheral canals for the reduction of flood waves.

One of the above mentioned operational measures for achieving this goal is to form, primarily with regard to international transit watercourses (the Danube, the Sava and the Tisa), necessary retention basins in less valuable areas (forest and agricultural), in order to reduce the flood wave peaks.

Conclusion

From the aspect of water management, a retention basin would reduce the risk of flooding downstream towns (Sremska Mitrovica, Šabac), and there would also be savings against the costs incurred in implementation of flood defence and repairs of the damage.

Sremska Mitrovica just before the breakdown of the embankment upstream in Croatia
(Source: www.helivideo.rs)

5.4. BIODIVERSITY

5.4.1. HABITATS

3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Isoëto-Nanojuncetea order*

The *Isoëto-Nanojuncetea* order appears in low, muddy, and flooded habitats developing in the contact zone between water and land or under a strong influence of groundwater. This type of vegetation is very sensitive to any disruption of water regime and water pollution. The main preconditions for the survival

of this habitat type are the existence of regular flooding, and regular treading and upturning of soil (usually due to wild and domestic animals grazing).

Oligotrophic to mesotrophic standing waters with vegetation of the order *Isoeto-Nanojuncetea.* Photo: INCVP

Scenario A

Amphibious vegetation of low muddy banks in Bosut Forests area is relatively well preserved in comparison with similar kinds of vegetation in Serbia (the biggest areas of this habitat type in the country are located here). In the territory of seven mapped ponds, this habitat type is developed in its typical form, with all or almost all of the characteristic communities and species. The wetlands are moderately or strongly affected by grazing and take up around 19-25% of the total area. Since the existence of this vegetation type is conditioned by flooding and grazing, it has a significant share only in bigger ponds in the whole area of Bosut Forests (the ones in the zone of influence of groundwater from the rivers Bosut, Studva, Smogva, and Sava). The existence of domestic pigs around pig farming places and a greater number of wild boars enhances the maintenance of bare furrowed areas. **The estimated area under this habitat type in Bosut Forests is under 30 ha.** Considering the tendency of abandoning traditional ways of space utilisation – a decrease in the number of pigs and pig farmers, drainage and forestation of the remaining ponds – **predictions for the survival of this habitat type in the next 25 years are grim. It is expected that this habitat is going to diminish and disappear in at least 50% of the areas**.

Scenario B

The potential for optimal grazing around mapped ponds, i.e. pasturing in combination with flooding, will decrease areas under closed-canopy vegetation such as tall helophytes, tall reeds, and bank canes. In turn, amphibious vegetation will flourish. The estimated increase of the area in the habitat 3130 is 10-20% of the mapped ponds area. On the other hand, flooding without any pasturing influence will not contribute significantly to favourable conditions for expansion of areas under habitat type 3130 since the absence of grazing will benefit the expansion of other closed types of vegetation. Therefore, a significant expansion of areas under habitat type 3130 is expected only in parts of ponds where pasturing and pasturing combined with flooding will exist. It is estimated that very favourable conditions for the emergence and maintenance of habitat type 3130 will be created in the area of approximately 65-200 ha.

3150 Natural eutrophic lakes with *Magnopotamnion* or *Hydrocharition* vegetation type

This group comprises eutrophic shallow (up to 2 m depth) standing or slowly flowing waters in lowland zones which are rich in organic matter and have developed vegetation of floating and rooted underwater plants that often form underwater meadows. The main precondition for revitalisation of this habitat type is to establish regular flooding.

Natural eutrophic lakes with vegetation type *Magnopotamnion - Hydrocharition*. Photo: INCVP

Scenario A

After the construction of defensive embankment along the Sava, a bigger part of Bosut Forests area was cut off from regular flooding. As a consequence, this habitat type has mostly disappeared or has been reduced to smaller fragments in the riverbeds (the Bosut, the Studva, the Smogva, the Sava) and to several larger ponds during one part of the year (Slezen, Dubovac). The estimated area under this habitat type in Bosut Forests is under 10 ha. Current conditions for the survival of habitat type 3150 in the area of Bosut Forests are unfavourable. Taking into account the tendency of drainage and forestation of ponds, this habitat type could completely disappear from all the ponds within Bosut Forests.

Scenario B

Seasonal flooding of ponds, slow draining and formation of connections between ponds could lead to the revitalisation of this habitat type in most large and midsize ponds of the flooded part of Bosut Forests. Based on the connection between ponds and the share of marsh habitats (formed by

succession and clogging of habitat 3150 after termination of regular flooding), it is estimated that establishment of flooding anew could start the revitalisation of habitat type 3150 on approximately 200-600 ha of the flooded areas. A significant limitation factor in revitalising this habitat type is the duration of flooding (ideally, there is water during most of the vegetation season, which can be expected only in bigger, deeper and connected ponds, and ponds closer to the rivers). Another important factor is unpolluted water..

3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

Typically, this habitat involves clear, moderately warm and flowing waters at lower montane levels. Due to eutrophication and pollution, this habitat type is comparatively rare today and confined to smaller areas.

Scenario A

Within seven mapped ponds, this habitat type was found in only two micro localities with areas smaller than 2 m2. A significant limiting factor in the expansion of this habitat is a lack of regular flooding. Vegetation typical of this habitat type usually develops in pools and pits filled with remaining water after flood water withdraws. Pools formed in holes and furrows made by domestic pigs and wild boars are suitable habitats. Drainage canals and pools on forest dirt roads are secondary habitats where the abovementioned vegetation develops. The estimated area of this habitat type in Bosut Forests is under 1% of their total area. The survival odds for this habitat type are unfavourable in the long term because of the current tendency of drainage and forestation of the ponds, and climate changes (drying).

Scenario B

Establishing a regime of regular seasonal flooding would facilitate the creation of natural conditions necessary for the emergence and maintenance of this habitat type in the coastal zone and around all the flooded ponds and pools. An expansion of the areas under this habitat type is likely to be expected in the coastal zone of all flooded ponds where there is no excessive grazing. However, grazing is necessary to prevent the expansion of invading species. Approximately 6-30 ha is the estimated area of Bosut Forests where very favourable conditions for the emergence and maintenance of this habitat type may appear.

*91E0 Marsh forests of the narrow-leafed ash (*Fraxinus angustifolia*)

Communities in this type of habitat appear in valleys of lowland rivers, in the zones of common oak forests in depressions, and in the areas with regular flooding. According to the EU Habitats Directive, this forest type belongs to priority habitat types, which involves more obligations with respect to its maintenance and to the establishment of a favourable conservation status. In the territory of Bosut Forests, the 91E0 habitat has a lower share compared to the other two forest habitat types: 5.73% of the total forest cover.

Marsh forests of the narrow-leafed ash (*Fraxinus angustifolia*). Photo: Victor Ulicsni

Scenario A

Both of the flora species typical for this kind of habitat, the summer snowflake and the narrow-leafed ash, are indicators of flooded, seasonally waterlogged habitats. Its sparse distribution mostly results from being cut off from flooded areas (inundation) by the embankment. On the whole, the conservation status of this habitat type is unfavourable ("C") because it is sparsely distributed and endangered by invasive species, parasites, and pathogens.

Scenario B

It is possible to improve the status of this habitat type by means of controlled flooding and pasturing as a biological measure for the suppression of invasive flora species. A slight increase in its area is expected in the parts bordering habitat type *91F0 during natural reforestation or anthropogenic reforestation (by cutting). Flooding would reduce the negative effect of ash parasites. Planned grazing would lower the degree of invasive species overgrowth (false indigo, in particular). Considering the limited possibility for an increase in its area to the detriment of habitat type 91F0, which has a higher economic value in forestry, and the endangered status due to invasive flora species, it is estimated that the conservation status of this habitat could improve to the average status ("B").

91F0 Riparian mixed forests of the narrow-leafed ash and common oak *Fraxinetum angustifoliae – Quercetum robur*

Communities of this type of habitat appear in different parts of alluvial plains under a strong or weak influence of groundwater and/or flood waters, in a hydrographic position above habitat type *91E0. This is the most widespread habitat in Bosut Forests, with a share of 81.98% in the total forest cover. It includes a wide ecological range of habitats, from regularly flooded ones to those only sporadically watered by groundwater.

Scenario A

Functionality of ash and common oak forests cannot be established in the long term due to the unfavourable status of the ash ("C") and the average conservation status of the common oak ("B"), with a tendency for the habitat conditions to deteriorate. Both types of forests are endangered by numerous parasites and pathogens, whose impact becomes more evident with frequent droughts. The current structure of the forests is still at a high level when compared to average values in Serbia. Soil moisture deficit and frequent hydrological extremes may soon create a state in which environmental and production circumstances could become almost irreparable. Thus, the overall conservation status is assessed as unfavourable ("C").

Scenario B

It is possible to significantly improve the status of this habitat type by means of controlled flooding and pasturing. Since it incorporates a wide ecological valence, with a greater number of trees, certain changes are possible in the coenological relations among its species. At the lower limit of the hydrological position of this habitat type, it is expected that the ash will have a bigger share than the common oak. Flooding would reduce the populations of rodents and parasites which dwell or hibernate in the ground, and the near-natural dynamics of the watering regime would increase the vitality of the main species. A decrease in the acute dieback of old trees would add to the significance of these forests, whose life cycle is connected to old oak forests. Overall, the conservation status could gradually improve to favourable ("A").

9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*

The common oak and oak-hornbeam forests are cultivated on higher grounds which are beyond the reach of flood waters. This habitat has a 9.14% share in the total forest cover of Bosut Forests. The oak-hornbeam is the best indicator of this community. Since it is located on the border of groundwater reach, it appears on terrestrial and semi-terrestrial grounds. This habitat type is less endangered by invasive flora species (unflooded parts of river terrace, deeper shade of the lower storey).

Scenario A

Since these kinds of forests develop in mostly terrestrial conditions, they are less dependent on additional watering than the previous two habitat types, located in the lower hydrographic positions. However, frequent droughts, the fragmentation of plain forests and the influx of new parasites have a

negative effect on both key tree species. Regarding the preserved structure of this habitat, its current conservation status is assessed as average, with a tendency to deteriorate.

Scenario B

These forests had formed in conditions which provided groundwater by means of capillary rise, decades before there was a significant drop of groundwater levels. Periodical watering of rhizosphere parts would have a positive effect on the vitality and stability of the forest community, as well as other species of plants, animals and fungi which form a biocenosis with it. The conservation status could improve to favourable ("A").

Oak-hornbeam forests (habitat type 9160) Photo: INCVP

5.4.2. PLANTS/FLORA

Three-stamen waterwort (*Elatine triandra*)

It is an exceptionally rare species in Serbian and regional flora, now found only in three Serbian localities. Obodnjača Pond in Bosut Forests is the only locality in Vojvodina. The plant grows in wetlands overgrown with amphibious annual plants.

Scenario A

Ten to twenty specimens were found in the floodplain of Obodnjača Pond in an area of around 2 m^2. Status assessment of the species according to scenario A indicates extremely unfavourable outcomes as the plant grows in an endangered habitat type (3130), in a very small area and in a limited number of specimens.

Scenario B

Regular grazing and the establishment of seasonal flooding are vital for the creation and maintenance of habitats suitable for this species. A combination of flooding and pasturing in one part of Bosut Forests will contribute to the revitalisation of the habitat type 3130 in the area of around 65 to 200 ha. Considering the species' affinity for semiaquatic, contact conditions, it is estimated that at least 5 ha will provide suitable conditions for the development and spreading of the existing population in Bosut Forests.

Creeping false pimpernel (*Lindernia palustris*)

This plant is typical of wetlands which are heavily influenced by pasturing. Revitalising the habitats of *L. palustris* requires the creation of a regime of moderate to intense grazing combined with flooding.

Scenario A

This species is currently found in five localities in Bosut Forests, which is more than a half of the localities in Serbia known to support it. The largest population is in Crnogorica Ponds, where several hundred specimens occur in an area of around 100 m^2. In the other localities of Bosut Forests the species is found in areas of several square meters, with several to several dozen specimens in each. If the number of specimens of the estimated population in Bosut Forests is taken into consideration, they comprise around 80% of the national population. However, it is estimated that the species' numbers will eventually decline, considering a small number of the species' known localities, their relatively small area, a small number of specimens comparing to the size of Bosut Forests, the area of potential habitats (under 30 ha), as well as the existing negative influences resulting in the degradation and loss of habitats 3130 (drainage, decrease of pasture, spreading of invasive species).

Scenario B

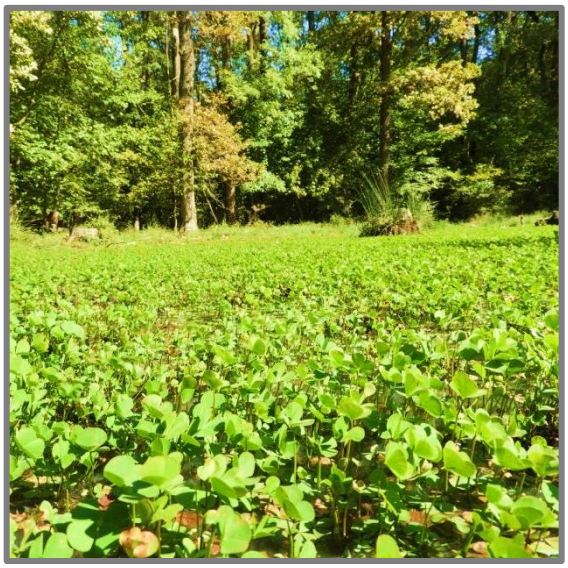
Increasing the areas influenced by flooding and pasturing will have a positive effect on maintaining and spreading suitable habitats for this species in Bosut Forests. In contrast with other representatives of amphibious vegetation sensitive to intense grazing, this species is fairly resistant to grazing and trampling, so its numbers will significantly increase in marshes within a few hundred meters from pig farming places. In the area of Crnogorica Ponds suitable habitats are found in up to 90% of the area of the pond bed, within the perimeter of several hundred meters from pig farming places. The introduction of grazing in approximately 650 ha of the marshes is estimated to create conditions suitable for the survival of this species in an area of at least 60 ha.

Four-leaf clover (*Marsilea quadrifolia*)

This species grows in wetlands in conditions of regular flooding and moderate grazing. It is found in around ten localities in Serbia.

Scenario A

In the area of Bosut Forests, the species is found in four ponds, in areas ranging from several to several dozen square metres, as well as in forest pools in dirt roads. The abovementioned (sub)populations are estimated to comprise around 40% of the national populations. The maintenance of the abovementioned habitats depends on the regular inflow of groundwater and the presence of pigs and game. However, considering the current trend of habitat drainage, the overgrowth and forestation of ponds, and the decrease in the number of pigs, the prognoses for the species' survival in the next 25 years are extremely unfavourable.



Four-leaf clover (*Marsilea quadrifolia*)
Фото: Маријана Биро

Scenario B

Moderate pasturing and regular flooding in the area of Bosut Forest ponds will enable the creation of gradational zones of grazing and trampling influence in the vicinity of pig farming places. This will condition maintenance of wetland habitats with different levels of grazing and trampling. It will also be suitable for the development of different species of amphibian vegetation. It is estimated that regular pasturing in the pond areas which are not within the perimeter of 0.5 km from pig farming places will enable the creation of suitable conditions for the spreading of *Marsilea quadrifolia* in an area of at least 50 ha.

Water violet (*Hottonia palustris*)

This is an endangered species in Serbia and is found in a limited number of localities. Its presence is contingent upon the existence of clean, calm, slow-flowing waters (habitat type 3150).

Scenario A

The only recent locality is in the vicinity of Obodnjača Pond, where only a few specimens of the species are found in an area of up to 2 m^2. The basic factors impeding the revitalisation of this species populations in Bosut Forests are: pond drainage and converting ponds to forest areas, the process of succession and overgrowth after the separation of large areas of Bosut Forests from the natural flooding regime, invasive species spreading, and water contamination. Taking the long view, they lead to the species' inevitable extinction in this area.

Water violet (*Hottonia palustris*) Photo: Marianna Biró:

Scenario B

Developing a system of regular flooding and establishing links between pond complexes in the area of Bosut Forests, especially to the effect of containing waters and enabling slow flow through systems of large and middle-sized ponds, could have a positive effect on the area increase of habitats available for the development of this species. This implies that around 80% of the projected 200-600 ha, i.e. 160-480 ha of the flooded ponds can be expected to provide a highly suitable habitat for this species. The potentially limiting factors are contaminants and invasive species, so the probability for a complete recovery of the habitat type 3150 is likely to be lower in the ponds near the lower reaches of the Bosut River and along the Sava.

Water soldiers (*Stratiotes aloides*)

This plant grows in habitats similar to those suitable for the previously mentioned species (3150). However, it prefers more open areas of water and somewhat deeper waters.

Scenario A

In the area of Bosut Forests, this species is found only in the waters that remained after the flooding of Lupoglavac Pond, with only a couple of relatively devitalised specimens. Current conditions do not ensure the species' long-term survival, even in the case of individual specimens accidentally brought by surrounding streams and drains, due to a lack of sufficiently large areas of relatively clean eutrophic waters (3150). This considerably reduces the species' chances of survival, and hinders any kind of its accidental or deliberate reintroduction.

Scenario B

Regular flooding and the establishment of communication between ponds would significantly contribute to the expansion of potentially available habitats suitable for this species. This species is expected to grow in the area of large ponds and flooded grounds where water remains during most of the vegetation period. The estimated area where the species could grow after the introduction of regular flooding is 200-600 ha.

Debreceni horseradish (*Armoracia macrocarpa*)

This species inhabits wet meadows in floodplains and aits. Today, the species is on the verge of extinction in Serbia since it is found in only two localities, one of which is in the area of Bosut Forests, while the existence of the other has not been confirmed for 25 years.

Scenario A

The total area of the species' habitat, wet meadows, does not exceed 2% of the area of Bosut Forests. Considering that the entire known population, which constitutes almost the entire national population, is in the area of Bosut Forests, concentrated in an area of around 1 ha, the slightest disturbance is enough to wipe out the species. Despite the population's vitality and relatively large numbers, its survival chances in the area of Bosut Forests are slim.

Scenario B

The species' survival chances in flooding conditions are slim due to the spreading of invasive species. They are equally low if grazing is introduced, so in both these cases the species could become extinct. On a more positive side, flooding in a wider area of Bosut Forests, combined with moderate pasturing, would contribute to a greater diversification of the habitat, so the population would probably be more widespread, and divided into a number of microlocalities with a smaller number of specimens in each. Since the area of flooded ponds is around 1,300 ha, it is assumed that conditions suitable for the species' survival could be created in an area of up to 10 ha.

Debreceni horseradish (*Armoracia macrocarpa*) Photo: INCVP

Summer snowflake (*Leucojum aestivum*)

In the area of Bosut Forests, this species is tied to the locally specific forest community of ash and another species of summer snowflake (*Leucoio-Fraxinetum angustifoliae*).

Scenario A

The area where this species grows is also the area covered by the ash forests of the floodplain. Although this species is endangered by the spreading of invasive ones, its survival chances under scenario A are high.

Summer snowflake (*Leucojum aestivum*) Photo: INCVP

Scenario B

As this is a poisonous species avoided by cattle, its spreading is expected in all ash forests with the projected regime of flooding combined with grazing in Bosut Forests and in some areas of the ponds. The area presumed to be potentially suitable for the survival and spreading of this species virtually corresponds to the area of flooded stands and ash forests, along with large nearby ponds. Considering the approximate projected scope of flooding, the potentially suitable area is at least 3 times bigger than the area of the species' existing habitats.

Narrow-leafed ash (*Fraxinus angustifolia*)

Scenario A

In recent years, intense dieback of ashes was recorded in several localities, which led to sanitation cutting. Frequent droughts (in 2012 and 2013), followed by extreme flooding (in 2014), significantly deviate from optimum habitat conditions for this species, so the projection of its future condition is unfavourable. These circumstances indicate that the species conservation status ("C") is unfavourable, as is also the case with forest communities dominated by ashes.

Scenario B

Optimised flooding that involves technical solutions would adjust flooding to the altitudinal, climate, and seasonal dynamics of the water regime, which created this type of stands. This would result in far more favourable habitat conditions for ash in the area of Bosut Forests. Flooding would reduce the number of over-reproducing insects and rodent populations. Unobstructed physiological processes, which serve as the basis for the production of biomass and for a species' resistance to diseases and pathogens, would help this species regain a status that would enable its biological functionality and functionality in terms of economic production. The species' conservation status, an indicator of additional soil moisturisation, would certainly be more favourable. Yet, due to uncertain effects of introducing a new pathogen (*Chalara fraxinea*), the estimated change in status can only be from reduced ("C") to average ("B").

Common oak (*Quercus robur*)

Scenario A

The basic processes which could describe the current state of the common oak, particularly the old, environmentally and economically most valuable forests and trees, are devitalisation and dieback caused by disturbances to original habitat conditions. The species' level of endangerment can best be deduced from records of sanitation cutting that mostly involved the harvest of common oak trees. The species' current condition is significantly affected by weakness parasites and pathogens, of the principaly alluvial forests which thrive in an unnaturally dry and warm microclimate. A majority of important parasites and abiotic factors of common oak devitalisation are associated with a lack of flooding and rainfall shortage in summer. For reasons mentioned above, the common oak's overall conservation status as the economically most valuable species which serves as an "umbrella" for specialised wild species of old oak forests is unfavourable ("C").

Scenario B

Occasional, environmentally optimised flooding of forests that host this species would compensate for a deficit in soil moisture during vegetation and, at the same time, regulate the number of parasites and other species which reduce the vitality of the common oak. Developmental phases and a decades-long moisture deficit in summer reduce the possibility for a complete revitalisation of the now old (mature) oak stands. Taking the long view, the mentioned changes and the functionality of environmental processes would alter the conservation status from unfavourable ("C") to excellent ("A").

5.4.3. PLANKTON

A qualitative analysis of the composition of the plankton community in the area of Bosut Forests reveals species of phytoplankton that belong to the following phyla: Bacillariophyta (*Asterionella formosa, Amphora ovalis, Amphora pediculus, Aulacoseira granulata, Caloneis amphisbaena, Cocconeis placentula, Cyclotella meneghiniana, Cymatopleura solea, Cymbella affinis, Cymbella minuta, Cymbella prostrata, Cymbella tumida, Diatoma tenue, Diatoma vulgare, Fragilaria acus, Fragilaria capucina, Fragilaria crotonensis, Fragilaria dilatata, Fragilaria ulna, Gomphonema olivaceum, Gomphonema parvulum, Gomphonema truncatum, Gyrosigma acuminatum, Melosira varians, Meridion circulare, Navicula cryptocephala, Navicula cuspidata, Navicula gracilis, Navicula lanceolata, Navicula viridula, Nitzschia acicularis, Nitzschia linearis, Nitzschia palea, Nitzschia sigmoidea, Nitzschia vermicularis, Pinnularia nobilis, Pinnularia viridis, Stephanodiscus hantzschii, Surirella minuta, Surirella tenera*), Chlorophyta (*Eudorina elegans, Carteria ovata, Chlamydomonas sp., Gonium pectorale, Pandorina morum, Actinastrum hantzschii, Ankistrodesmus falcatus, Coelastrum microporum, Coelstrum reticulatum, Micractinium pusillum, Pediastrum boryanum, Pediastrum duplex, Pediastrum simplex, Pediastrum tetras, Scenedesmus acuminatus, Scenedesmus arcuatus, Scenedesmus disciformis, Scenedesmus opoliensis, Oocystis lacustris, Scenedesmus quadricauda, Closterium reticulatum, Closterium limneticum, Closterium parvulum, Closterium strigosum, Spirogyra sp.*), Cyanobacteria (*Anabena constricta*, *Anabena solitaria, Aphanizomenon flos-aquae, Clavariopsis aquatica, Merismopedia tenuissima, Microcystis aeruginosa, Oscillatoria chalybea, Oscillatoria limnetica, Oscillatoria limosa, Oscillatoria princeps, Oscillatoria rubescens, Oscillatoria tenius),* Euglenophyta (*Euglena acus, Eugl ena oxyuris, Euglena viridis, Lepocinclis ovum, Phacus longicauda, Phacus acuminatus, Strombomonas sp., Trachelomonas hispida, Trachelomonas volvocina),* Pirrophyta (*Ceratium hirudinella, Gymnodinium sp., Peridinium cinctum*), and Chrysophyta (*Dinobryon divergens, Synura uvella*).

Silicate algae (Bacillariophyta) are present because the water is shallow and transparent, especially in spring. Silicate algae's significance lies primarily in their position in the food chain – they are basic primary producers, or the first link in the chain. Green algae phyla (Chlorophyta) are typical of slow and stagnant waters rich in organic matter, and are adequate food for fish spawn and zooplankton. Prevalent among blue-green algae (Cyanobacteria) and euglenoids (Euglenophyta) are species that indicate pollution and eutrophication. As far as zooplankton is concerned, qualitatively speaking, the dominant group is Rotatoria (*Anuraeopsis fissa, Kellicottia longispina, Keratella cochlearis, Keratella cochlearis tecta, Lecane bulla, Trichocerca rattu*). Among the small crustaceans of the Cladocera order, the species *Bosmina longirostris* and *Bosmina coregoni* are present, while the order Copepoda is represented only by the larva stadium *Nauplius*.

The advantage of scenario A over scenario B lies in the fact that the ponds which are revitalised under the optimum flooding regime in spring will have water during most of the year. In this way, with respect to plankton organisms, the ponds will have a better feeding capacity, primarily for ichtyo- and herpetofauna that live there and feed on plankton species. Changes in pond water level result in changes in the composition of phytoplankton. Integral management, which involves optimum flooding and prevention or slowing down of overgrowth, increases from 625.05 ha to around 1,304.85 ha, i.e. by around 100%. During flooding, the pond phytoplankton will be "rinsed" by river species brought by the flood wave. In such unstable conditions, tiny, fast-growing forms of green algae dominate. The flood wave brings a number of suspensions that transform abiotic conditions. In murky waters, where the available light necessary for photosynthesis is reduced, algae productivity is also reduced. However, it increases in the flooded area, where the slow flow of water causes sediments to accumulate. Early spring floods can stimulate the development of phytoplankton – due to the available light and higher temperatures, algae growth is greater during spring/summer floods than during winter ones. On the

other hand, the flood wave in May/June changes the concentration of available nutrients, diluting it and thus causing an increase in phytoplankton mass. The positive effects of scenario B are the establishment of water retention, an increase in groundwater levels, and the revitalisation of ponds. However, this scenario could have negative effects which would manifest in the case of traditional animal husbandry intensification. Namely, inadequate management of livestock population that would involve excessive and uncontrolled grazing could have numerous negative effects on pond habitats in Bosut Forests. They are manifest in temperature rises, an increase in nutrients (eutrophication) in water, changes in shoreline vegetation, defecation and urination near or in the water.

5.4.4. FAUNA

5.4.4.1. INSECTS

For the purpose of this study, two insect species were selected as umbrella species, the great capricorn beetle (*Cerambyx cerdo*) and the large copper (*Lycaena dispar*). These species indicate the existence of interrelated, yet different habitat types.

Great capricorn beetle (*Cerambyx cerdo*)

The great capricorn beetle (Coleoptera, Cerambycidae) is a widespread species in Central Europe. Despite that, as its development is closely connected with different species of managed oak, and the larva development lasts three to four years, this species is included in the Annexes II and IV of the EU Habitats Directive. It is also mentioned in the Appendix II of the Bern Convention. The urgent need for the protection of the great capricorn beetle results from over a hundred years of monitoring its shrinking habitats (Buse et al., 2007). It inhabits semiopen insolated forests, primarily oak forests (Quercus) in plains and hills. Furthermore, the larvae make wide galleries that other species later inhabit. In Serbia, the species is strictly protected under the Regulations on the designation and protection of strictly protected and protected wild species of plants, animals, and fungi ("Official Gazette of the Republic of Serbia," No. 5/2010, 32/2016, 98/2016)).

Great capricorn beetle (*Cerambyx cerdo*)
Photo: Dragiša Savić

The area of Bosut Forests is dominated by the common oak (*Quercus robur*). Tree vitality, insolation and the openness of habitat represent the basic parameters for estimating the species' presence (Redolfi De Zan et al., 2017). Bark thickness, tree diameter, insolation (primarily from the

south and west sides (Albert et al., 2012)), as well as the distance to the next suitable tree are vital for the great capricorn beetle (Buse et al., 2007), which is why it is essential to open up habitats. A suitable tree is the one exposed to the sun with the diameter of at least 40 cm (Platek et Čižek, 2010), or 60 cm (Buse et al., 2007, Kadej et al., 2017). It is also worth mentioning that the females lay eggs in the crevices and damaged parts of the bark of previously colonised living oak trees that are over 100 years old, mostly in the current year's snag (90,9%) and weakened trees (34,8%) (Matsiakh et al., 2017).

Scenario A

An unfavourable flooding regime, caused by embankment construction, has resulted in lower groundwater levels. This in turn has a negative impact on the forest complexes of the common oak. In the examined parts of the area, according to the current working plan, the area populated by oak forests older than 100 years (the oldest are 381 years old) amounts to 9,486.54 ha, i.e. 53%.

Scenario B

In the period of around 50 years following the establishment of flooding, the area covered by forests older than 100 years can include the area covered by forests older than 60 years (60-99 years according to the current working plan). This is an area of 2,753.63 ha, i.e. 17%, which means that habitats suitable for the development of larvae of the great capricorn beetle will expand. This will allow the females to lay eggs in around 70% of the oak forest of suitable age, or tree diameter. If water is maintained at the level of up to 0.5 m from the ground in the flood period, this will not severely affect the larvae since they congregate in largest numbers at 0 to 4 m (half of the population), and as many as a third of them congregate at 2 m (Albert et al., 2012). The total estimated expansion of the area of habitats populated by this species is 29% (absolute expansion) i.e. from 9,486.54 ha to 12,240.17 ha; and 17% (relative expansion), in proportion to the total area of Bosut Forests from 53% to 70%.

Large copper (*Lycaena dispar*)

The large copper is a hygrophilous species of butterfly that inhabits wetlands (Strausz, 2010) along rivers, canals, and ponds (Bloemmen et van der Sluis, 2004, Bąkowski et al., 2010). It is found at altitudes up to 400 m. The adults fly in July and August (Barnett et Warren, 1995). They can migrate 5 km, so a direct presence of plants on whose nectar the females feed is not vital for laying eggs. Habitat size is not vital for laying eggs either (Strausz, 2010). In nature, the female lays around 60 eggs (Duffey, 1993). The selection of the plant on whose leaves the female will lay its eggs depends on microclimatic conditions, vegetation structure, and the feeding plant's quality (Strausz, 2010). The females select insolated wide-leaved plants whose leaves are furthest away from the ground (Webb et Pullin, 2000), in areas with smaller numbers of herbivores, far from anthropogenic influences (agricultural land, garbage dumps, etc.). It is essential for the leaves to be far from the ground so that egg destruction is avoided in case of a flood wave (Barnett et Warren, 1995). According to Duffey (1977), pasturing in June and July has a positive impact on oviposition by opening up the habitat and making the larvae-feeding plants more accessible to the females.

Scenario A

Based on the abovementioned information on the presence of larvae feeding plants around the ponds, an area of 4,515.2 m^2 where *Rumex hydrolapathum* grows is obtained from the total area. Pig pasturing around some ponds prevents overgrowth by bushy and arboreous vegetation, as well as the inflow of water in spring and autumn. This has a positive impact on this species of *Rumex*, which is another hydrophilic species.

Large copper (*Lycaena dispar*) Photo: INCVP

Scenario B

Based on the data concerning the presence of the larvae feeding plant around the ponds, an area of 15,033.44 m^2 is obtained from the total area for the growth of *Rumex hydrolapathum.* This would expand the suitable habitat **3 times**, i.e. by 10,518.24 m^2. This is highly significant for the conservation of large copper populations in Bosut Forests.

5.4.4.2. FISH

Two indicator species were selected and monitored in relation to the current state of Bosut Forests, based on the following criteria: literature overview (expert and scientific articles, a study on the protection of the "Bosut Forests" nature park by Kiš et al. (2016)), the species' national status (protection and fishing status), biomass data, fish species' production, and the qualitative and quantitative composition of ichtyofauna in the part of the Sava between 207 rkm and 123 rkm, as well as between 96 rkm and 49 rkm (Fish management plan for parts of the areas Srem, Banat, and Bačka for the period 2016–2025). An analysis of future tendencies according to Scenarios A and B was carried out, and the species' conservation status was determined.

The carp (*Cyprinus carpio*) is a benthopelagic fish that lives in moderate climates and inhabits the middle and lower areas of cyprinid regions (Ristić, 1977), which include lowland stagnant and running waters (at altitudes below 200 m) with water vegetation and sludgy bottoms (canals, moderately and slow-flowing rivers, inlets, oxbow lakes, ponds, and lakes). The breeding season is between April and June, and breeding occurs in water temperatures above 18-20^{o}C, in floodplains where the depth of water usually does not exceed 0.5 m (ponds, canals, oxbow lakes overgrown with vegetation, and flooded wet meadows and sludgy banks). The species has great economic significance and is therefore under considerable pressure from fishing (both recreational and commercial).

Carp (*Cyprinus carpio*) Photo: INCVP

The European bitterling (*Rhodeus amarus*) is a benthopelagic fish that lives in moderate climates, in clean stagnant and slow-flowing waters, with water vegetation and sandy-sludgy bottoms (canals, slow-flowing rivers, and inlets). The European bitterling was designated as strictly protected in AP of Vojvodina by the Regulations on the designation and protection of strictly protected and protected wild species of plants, animals, and fungi ("Official Gazette of the Republic of Serbia", No. 5/10, 47/11, 32/16 and 98/16). By Order on measures for the conservation and protection of the fish ("Official Gazette of the Republic of

Serbia," No. 56/2015), there is a permanent closed season for this species. The European bitterling is also listed in Appendix II of the Directive for the conservation of natural habitats and of wild fauna and flora (Council Directive - 92/43/EEC), and in Appendix III of the Bern Convention (Law on the confirmation of the Convention for the Conservation of European Wildlife and Natural Habitats ("Official Gazette of the Republic of Serbia – International contracts," No. 102/2007)).

European bitterling (*Rhodeus amarus*) Photo: INCVP

Scenario A

Due to the works on the Sava river flow regulation, former floodplains within the proposed borders of the Nature Park Bosut Forests have been cut off from the main current. This caused the area to cease functioning as a spawning ground and mating site.

The most important grounds for fish spawning in a part of the Sava, within the proposed borders of the protected area, is the undefended section. The total area of open waters (5 ponds) is around 21.5 ha. The largest of these ponds is Radosava Pond (around 18 ha).

In the absence of shallow parts of the river beds of the Bosut, the Studva, and the Smogva, which fill with water up to 1 m in spring, only some sections of the river bed serve as spawning grounds. Shaded areas with reed belts and dry branches and trees in the water represent suitable grounds for the spawning of local fish populations. The size of these areas, based on estimates, amounts to approximately 20 ha.

Due to fish kill caused by the floods being exceptionally rare and the females and spawn not being able to return to the watercourse, ponds and wet habitats within the embanked sections have no significance for ichtyoproduction and make no contribution to the conservation and improvement of fish populations in the Sava, the Bosut, and the Studva.

According to existing data on the qualitative and quantitative composition of fish fauna in the rivers Sava and Studva (Fish management plan for parts of the areas Srem, Banat, and Bačka for the period 2016–2025), the carp makes up 20% and 32% of biomass, while the European bitterling stands for less than 1%.

Scenario B

In case the natural flooding regime is re-established in the area of Bosut Forests (i.e. in case of environmental flooding), conditions would be created for the formation of a mosaic of wet and water habitats important for the feeding, spawning, development, and growth of fish spawn.

According to estimates, conditions suitable for the existence and maintenance of habitat type 3130 would be created in around 65-200 ha of the area. Re-established flooding would also result in the creation of habitat type 3150 in an area of around 200-600 ha of Bosut Forests. According to the data, areas important for fish species can ideally cover between 265 and 800 ha, if we presume that the occurrence of the flood wave will coincide with the spawning period. However, considering abiotic conditions, a more realistic estimate suggests that around 20-60% of the areas potentially important for fish species (14-480 ha) will function as grounds for spawning, development, and growth.

In case of environmental flooding in Bosut Forests, the area's ichtyoproductivity is estimated to be at least 30-60 kg/ha. Multiplying productivity values with potential areas important for fish shows the minimum potential productivity of Bosut Forests, which is between 420–28,800 kg of fish per year. If the carp retains the existing share in biomass (20-32%), the expected annual production of carp can increase by 82-9,216 kg. The annual production of European bitterling with regard to its current share in biomass of around 1% can reach additional 4-288 kg.

Species' conservation status

Enabling environmental flooding in the area of Bosut Forests can result in an expansion of areas significant for fish spawning from around 40 ha to a maximum of 800 ha (20 times). The carp and European bitterling can use around 60% of the newly-formed floodplains for reproduction, which can significantly improve their conservation status in the future protected area NP Bosut Forests (Tables 5 and 6), if suitable conditions are created for spawning and the survival of both adult specimens and spawn.

Table 5. Overview of the population size and conservation status of the carp (*Cyprinus carpio*) under Scenario A and Scenario B.

Cyprinus carpio	Population size	Conservation status
Scenario A	C	C
Scenario B	C	A

Table 6. Overview of the population size and conservation status of the European bitterling (*Rhodeus amarus*) under Scenario A and Scenario B.

Rhodeus amarus	Population size	Conservation status
Scenario A	C	C
Scenario B	C	A

5.4.4.3. AMPHIBIANS AND REPTILES

Two species of amphibians were chosen for the current conservation status assessment (Scenario A), and for the expert assessment of the conservation status change under Scenario B, which involves water retention in the forest and an increased scope of traditional animal husbandry. These are the Danube crested newt (*Triturus dobrogicus*) and the European fire-bellied toad (*Bombina bombina*). The Danube crested newt is very sensitive to the degradation and loss of habitat caused by the drainage of surface waters (Ajtić, R. et al., 2015). The Danube crested newt inhabits small ponds, inlets, canals, oxbow lakes, ditches, flooded grounds, and ponds in open habitats with mixed forests and bushy vegetation. The European fire-bellied toad's current conservation status in the area of Bosut Forests is assessed as satisfactory, but deteriorating towards unsatisfactory, primarily because of the ever greater loss of habitat caused by water deficiency and decreasing pond areas. The assessment of the current conservation status, and the expert assessment of the conservation status change under Scenario B, which involves water retention in the forest and an increased scope of traditional animal husbandry, presupposed the selection of an amphibian species that spends its whole life cycle (except when laying eggs) in water and water habitats. The species in question is the European pond turtle (*Emys orbicularis*).

Danube crested newt (*Triturus dobrogicus*)

The currently unsatisfactory conservation status of the Danube crested newt will continue to deteriorate under scenario A due to further overgrowth of water and pond habitats. Estimates indicate that the species currently inhabits up to 100 ha of wetlands instead of 1,304.85 ha which it inhabited in the past. Under scenario A, the area would continue to shrink. Under scenario B, flooding would expand the area up to 340-400 ha.

European fire-bellied toad (*Bombina bombina*)

Of the three selected species, only this one currently has a satisfactory conservation status. The European fire-bellied toad inhabits various types of water and wet habitats, ranging from open bodies of water to canals and ruts in forest tracks. It is estimated that, under scenario A, the species inhabits 700–900 ha of 1,304.85 ha of former ponds, or depressions that were once flooded. Under scenario B, flooding is estimated to expand the species' habitat up to 1,000-1,200 ha.

European fire-bellied toad (*Bombina bombina*) Photo:

European pond turtle (*Emys orbicularis*)

Based on the available data and terrain surveys, it is estimated that this species currently inhabits only 1/5 of the former 1,304.85 ha of wet habitats, i.e. up to 300 ha. Regular seasonal flooding could almost triple the area of the species' habitat to around 800 ha. The species benefits from the constant presence of water, which is not a necessary condition for the previous two species.

European pond turtle (*Bombina bombina*) Photo: INCVP

5.4.4.4. BIRDS

Scenarios A and B have been developed for all three species, in view of improving the management of unique oak forests and water regimes, in order to create better habitat conditions and prevent flooding more effectively through forest retention. Other interests that have to be considered are development of traditional pig farming to benefit the local population, and the need to integrate conservation of biodiversity with valorisation of ecosystem services, aiming to manage space, processes, and resources.

White-tailed eagle (*Haliaeetus albicilla*)

Scenario A

If the situation remains the same with regard to all the monitored parameters, the population of around 6-7 couples is expected to stagnate at best, with a relatively low birth rate and high mortality rate in the project area and its surroundings.

Scenario B

If the situation significantly improves, feeding habitats will also improve, as well as the quantity and availability of food, especially during the reproduction period. The situation could improve primarily by means of establishing regular flooding of forests and depressions in the periods of importance for eagles, and by increasing the number of pigs in forests, ponds, and clearings. In that case, stabilisation can be expected within a period of 10 years, followed by a slight increase in numbers from around 10, currently, to a maximum of 15 couples in the entire area of Bosut Forests.

White-tailed eagle (*Haliaeetus albicilla*) Photo. Farkas Géza

Black stork (*Ciconia nigra*)

Population and distribution of this species in Bosut Forests and the vicinity largely depends on the presence of old forest stands and lonely old trees for reproduction, as well as on mosaics of open ponds and feeding clearings.

Scenario A

If the situation in the area of Bosut Forests remains the same or similar, the population is expected to decline gently after a period of stagnation. The current number of reproductive couples of around 12-16 will probably gradually decrease, as will the number of areas where adult specimens can stay during reproduction. In the long term, the number of active couples can decrease by half, to only 6-8 couples.

Scenario B

If the situation significantly improves, primarily through establishing regular flooding of forests and depressions, and through an increase in the number of pigs, feeding habitats and food quantities will significantly improve as well, especially in the reproduction period. The numbers are expected to slightly increase within a period of 10 years, from the current number of 12-16 to maximum 20-25 couples in the entire area of Bosut Forests.

Collared flycatcher (*Ficedula albicollis*)

The population and distribution of this species in Bosut Forests and their surroundings significantly depends on the presence of old deciduous forest stands (Lundberg, 1997), with enough old trees, suitable nesting holes and crevices, and lonely old trees with broad, thinned out crowns and little undergrowth, so that the open space would allow the birds unobstructed flight, catching insects, and access to the ground.

Scenario A

If the situation in the area of Bosut Forests remains the same or similar with regard to all the monitored parameters, the population is expected to gently decline in the long term. Due to intense forest dieback, old trees wilting and depression drainage, the choice of reproduction holes will inevitably become limited, as will the quantity of available insects and suitable grounds for catching them. The number of reproductive couples, estimated to be 60-80 in 2009 and 1,500-2,500 in 2015, was calibrated to 1,000-1,400 after the research conducted in 2017. In the long term, this population will decline to 700-1,100 couples.

Scenario B

If the situation significantly improves, habitats necessary for the collared flycatcher's reproduction and feeding are certain to significantly improve as well. The situation could improve primarily through the establishment of regular flooding of forests and increase in vitality and resistance to dieback, in an area of 6,000-8,000 ha, as well as through an increase in the number of pigs in forests, ponds and clearings to 2,000-2,800 couples, evenly distributed among pond and forest habitats.

5.4.4.5. MAMMALS

Eurasian otter (*Lutra lutra*)

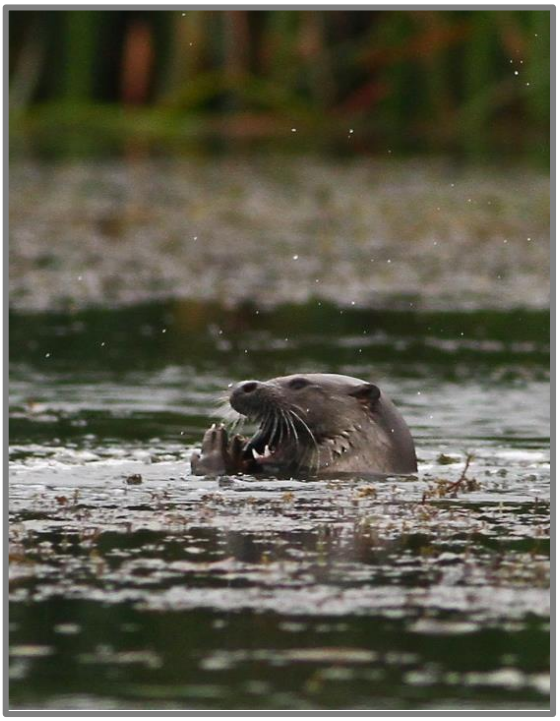
The Eurasian otter (*Lutra lutra*) is a semiaquatic mammal that inhabits a wide spectrum of wetlands and largely depends on water availability. The daily radius of the otter's movements is 1-40 km, and less than 20 km on average (Chanin, 1985, retrieved from *www.swlakestrust.org.uk*). Its habitats are running or stagnant waters whose banks are overgrown with forest vegetation and small bushes, as well as rocky banks overgrown with vegetation. In the Republic of Serbia, the otter is a strictly protected species, and is listed in Appendixes II and IV of the Habitats Directive, Appendix II of the Bern Convention and Appendix I of the CITES Convention. In the IUCN list it is designated as NT (Near Threatened – reserved for species which are not critically endangered but can become so in the future) (Temple and Terry, 2007). The otter mainly feeds on fish, and the daily intake is around 15% of its weight. In summer, apart from fish as the main food, the otter also largely feeds on crayfish, amphibians, and sometimes insects and small birds.

In the area of Bosut Forests, steady numbers of the otter population are regularly present in the rivers Bosut, Studva, and Smogva, and in Slezen Pond, which always has water.

The data collected was used to analyse predictions for the state of the otter population under two possible scenarios, A and B.

Scenario A

The current situation, which involves an unfavourable flooding regime caused by embankment construction, prevents the natural flooding regime, water retention, drainage, and overgrowth in most ponds and depressions. Of the total 1,304.85 ha of pond area, only 300 ha contain wet/pond habitats with ponds where otters have been seen. Otters inhabit only bigger watercourses and permanent ponds. The otter population numbers in this area are neither large nor increasing, and the species' conservation status has stagnated for 10 years (Table 6). If the current trend continues, fish spawning is expected to decrease, and otters will retreat in time and inhabit only bigger watercourses.



Eurasian otter (*Lutra lutra*) Photo. Farkas Géza

Scenario B

In case of re-establishing the natural flooding regime through retention, whereby all 1,304.85 ha of ponds, filled with water in spring, would receive optimum flooding, half of the area (around 650 ha) could be covered by pond vegetation. With regard to the otter conservation and protection, this scenario would be doubly beneficial. It is safe to assume that a rise in the otter population would follow a rise in the percentage of total fish population. Improved hydrological situation would provide the conditions necessary for the otters to stay permanently. An improved conservation status would undoubtedly lead to the otter population growing and stabilising (Table 7). Rise in the otter population in ponds only would be dramatic (200-300%). However, with respect to their total population in the whole complex of Bosut Forests, now primarily inhabiting watercourses instead of ponds, the rise would be by around 30% under this scenario.

Table 7. State of the otter population (*Lutra lutra*) in the area of Bosut Forests

Lutra lutra	Population size	Conservation status			Isolation
		A	B	C	
Pre-existing condition	C		X		C
Scenario A	C		X		C
Scenario B	C	X			C

5.5. BENEFICIARIES' ATTITUDES ABOUT THE BENEFITS OF INTEGRAL MANAGEMENT OF BOSUT FORESTS

The stakeholder analysis is based on two panel discussions, of which the first one was held in Jamena on 20th December 2018 and the second in Morovic on 1st May 2018.

The first panel discussion was conducted using the World Café method. There were 40 participants, including the representatives of four target sectors (forestry, water management, traditional animal husbandry, and nature protection), representatives of local governments and civil society organisations (associations of women, hunters, and fishermen), and other participants whose activities may directly or indirectly affect ecosystem services in the area. The shares of participants from different fields are given below (Figure 5). Members of the local population had the highest share among the participants (about 30%), since they are crucial stakeholders for the long-term utilisation of ecosystem services in the area.

Discussion on the interconnectedness of different activities in the area of Bosut Forests included: forest management (priority being the production of timber and firewood); traditional animal husbandry (forest pig farming, sheep pasturing on embankments and/or poplar plantations); water management with related activities; nature protection (maintenance of favourable conditions of ponds, forests, and meadows as wildlife habitats). The conclusions drawn were a result of different perspectives of stakeholders and their common understanding of the situation.

Following the present situation and identified conflicts among the sectors, as well as analysis of the questionnaires filled on the discussion, proposals for potential improvements in stakeholder collaboration and sustainable land use.

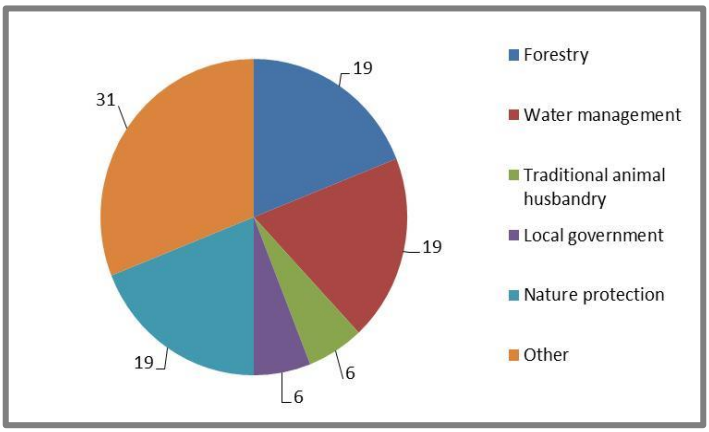


Figure 5. Percentage representation among participants

Panel discussion in Jamena village. Photo INCVP

Forest management and other activities

The participants recognised forest services related to water regulation (quantity and quality), preservation of air quality, provision of habitats to forest and meadow species. In addition, it was acknowledged that recreational, spiritual, and aesthetic values form a basis for development of ecological tourism, which creates new possibilities for employment. As direct benefits for the local community, the participants mentioned potential use of branchwood as firewood, use of acorns as animal food, and utilisation of fungi and other primary and secondary forest products. Furthermore, their opinion was that animal husbandry has a positive effect on mature forests (older than 10-20 years) by cleaning undergrowth, maintaining routes and clearings through pastures, etc. Forest area management can have a twofold effect on preservation of biodiversity as a basis of numerous ecosystem services. The effect can be positive if the area mosaic is kept as it is by maintaining and preserving forest habitats. However, biodiversity is affected significantly if the forest habitat diversity is diminished and if the disappearance of non-forest habitats is accelerated for wood production priorities.

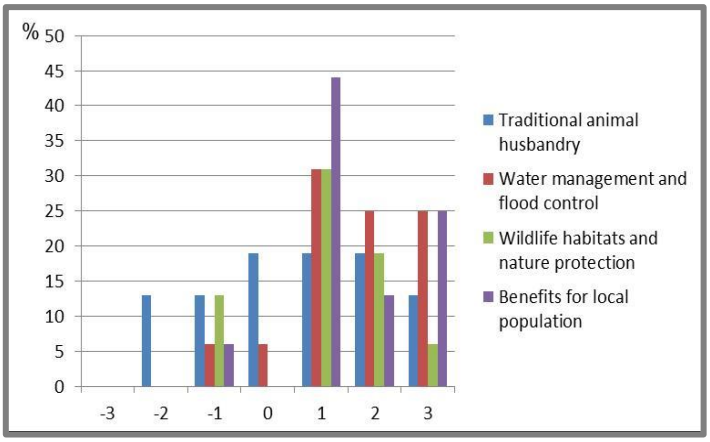


Figure 6. Relation of the forest management to other shakeholders

Stakeholders' discussion (World Café) in Jamena. Photo INCVP

Livestock farmers represent a serious challenge when it comes to forest management in this area. Share of negative marks (Figure 6), referencing influence of forestry on traditional farming, is equal to sum of all other negative marks regarding to other sectors. Participants consider actual forest management to have significant positive effects on the welfare of local people. The majority (45 %) graded the positive influence with the mark "1" (modest positive influence) and 25% gave the highest mark ("3"). Main objections raised were related to the effects of forest management on the local population and included limited possibilities for the use of branchwood, need for an integrated offer of forest products, and insufficient control of truffle harvesters. Besides, a large part of participants consider forest management to be more suitable for flood regulation than for wildlife habitats protection – the highest mark for the flood regulation issue was given by 25% of them, whereas for nature protection only by 5%. Suggestions for improving wood quality and prevention of tree or stand dieback involved the need for changes in water management. In other words, it was deemed necessary to establish a proper water regime which would include periodical retention of water in the forests. Other recommended measures were forest certification, better organisation of labour, law-abidance, etc.

Traditional animal husbandry and other activities

The participants stressed producing highly valuable food with minimum investment, manufacturing and marketing traditional livestock products, increasing household income, and raising standards of healthy and preserved environment as direct benefits of ecosystem services provided by traditional animal husbandry. Livestock dwelling in this area (feeding, pigs furrowing, etc.) reduces the costs of poplar plantation maintenance, eliminates forest undergrowth and invasive species; in addition, the soil is fertilised, the soil air regime is maintained, matter exchange is stimulated, wet depressions are retained, and water flow is ensured. Traditional animal husbandry prevents ponds and meadows from

overgrowing. It also prevents the spreading of invasive species and is the most economical method of open habitat maintenance. Pond maintenance increases the capacity of water reception.

Inadequate animal guarding can raise the costs of reforestation (investing into fences), lower vegetation density, and cause a lack of oak acorns needed for reforestation. A major problem is negative influence of the uncontrolled livestock on the maintenance of embankments, canals, and forest roads.

According to participants' statements, biodiversity maintenance is tightly dependent on traditional farming, together with the conservation of local/traditional breeds. Grazing is a tool for vegetation maintenance and natural habitat revitalisation, without additional costs. Traditional husbandry prevents marshes and meadows to overgrow in shrubs and invasive species, so it is the most cost-effective manner for open wetland habitats maintenance.

However, pigs (and pulling dogs) can prey on smaller wild animals on the ground.

From the perspective of influence of traditional farming on forest and nature conservation, opinions are different: half of them considered the farming to be a threatening factor, while the other half considered it to have a positive effect. The participants thought it was necessary to estimate the number of livestock heads with regard to space capacity in order to improve the maintenance of wet habitats, to simplify access to subsidies for farmers, and to apply a better control system. Furthermore, it was suggested that areas available for traditional animal husbandry should expand in accordance with regulations. About 45% of them considered traditional pig farming to be the key threat for timber production, whereas more than 10% gave the highest negative mark (-3). The strongest arguments were related to insufficient cattle guarding and breaking rules in general. Other recommendations included encouraging the activities of local farming associations, improvement of cooperation between farmers and other parties, education regarding the application of laws concerning animal husbandry and sanctions for offenders, promotion of sustainable animal husbandry, development of appropriate strategies and locally adjusted programmes, assistance in choosing partners for international projects, providing easier access to financial help and donations, etc.

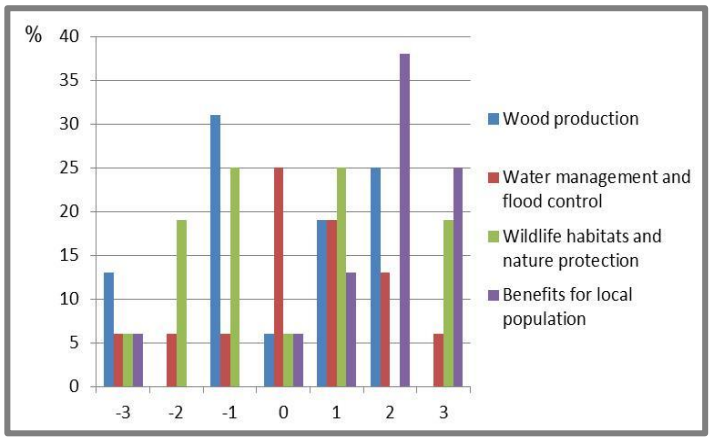


Figure 7. Relation of the traditional farming to other stakeholders

Water management and other activities

Importance of multifunctional water management was acknowledged among the participants. The appropriate water management has a positive effect on the habitat quality and a number of species. Multifunctional water management can form a basis for the provision of many ecosystem services. Keeping water within the appropriate range during one year, with periodical flooding, creates

appropriate conditions for pasturing or watering of animals, higher crop yields, forest cultivation, and conservation of wet habitats. Adequate defence against floods is important for preservation of human lives and property, cultivars, and other species of flora and fauna. On the other hand, urbanised regulation of water courses in combination with damming riverbeds by building embankments has a negative effect on all the considered activities. The absence of flooding in forest or meadow habitats adversely affects biodiversity. Excessive and monofunctional drainage has a negative effect on habitats and species. For instance, Bosut River is pumped out during Mart and April for arable land drainage, with consequential water depletion in forest, marshes and grasslands. On the other hand, excessive flooding followed by extended water retention also has a negative effect on all those activities.

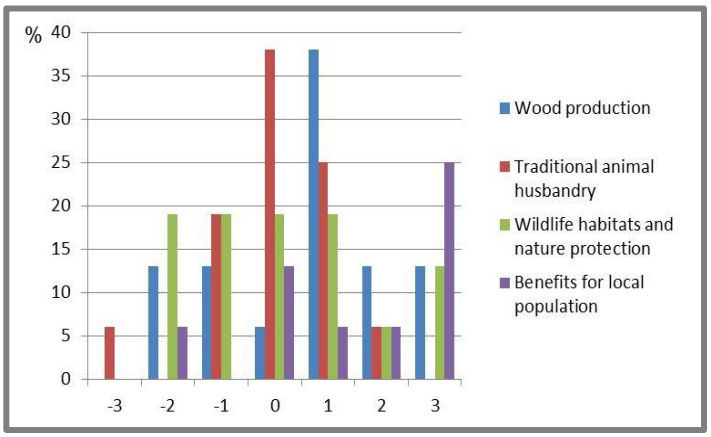


Figure 8. Relation of the water management to other stakeholders

Comparing the statement of 80% of the participants that forest management has a positive effect on flood control (25% gave the highest mark), lesser part (about 60%) consider water management positive in timber production (Figure 8), while about 30% gave the negative mark. Insufficient knowledge about influence of water management on traditional farming was proved by the fact that related statements were very divergent: more than 30% considered the influence positive, about 25% negative, while a significant share of them (about 40%) consider the influence to be indifferent.

Panel discussion in Morović. Photo INCVP

Farmers objected to the banned/restricted access to the canals and embankment which prevents the use of hay potential for livestock. On the other hand, even with many objections to the activities of the water management enterprise, its influence on the local population was mostly perceived as positive, where 25% of participants gave the highest positive mark. Key suggestions about the activities of the water management enterprise involved integrated management of the water regime, synchronised with other sectors and requirements of the local population. The participants proposed that a beneficiaries' board should be elected (representatives of

sectors and the local population), and subsidies should be introduced for farmers maintaining the wetlands by pasturing in accordance with the regulations. The water regime needs to be adjusted to the types of forest and meadow habitats. In order to secure the multifunctionality of the canal network, the canals should play a dual role, involving the draining and replenishing of water, depending on what is needed. Another proposal involved building a multifunctional retention basin followed by lowering or abolishing drainage compensations. According to the information given in the completed questionnaires, a retention construction project is under way.

Nature conservation and other activities

The participants noticed some positive effects of establishing a protected area on rural households, primarily seen in potentials for developing sustainable tourism, promotion of local products, preservation of traditional pig breeds, encouraging sustainable space utilisation and extended use of resources, improved population health due to environment preservation, recreational potentials, etc. In the opinion of the participants, nature protection tends to maintain the natural dynamics of waters, and biodiversity preservation results in cleaner water, prevention of soil erosion, better defence against floods, etc. Voiced objections mostly called for limiting intensive agriculture and hunting, restricting the livestock numbers, regulating time and method of habitat utilisation in animal husbandry, and delaying/preventing certain investments. Although it is evident that nature protection mostly supports animal husbandry, and that animal husbandry can develop better in cooperation with nature protection, it was noted that the local population did not recognise all the benefits of such protection.

Sectors of forestry and water management recognized the harmonisation with nature protection as an improvement of ecosystem services by financial benefits, however through narrowed-sectorial utilisation of natural resources. They objected to spatial and temporal limitations in the management of forest and water areas, the requirement for obtaining a permit related to nature protection rulings, as well as increased costs and decreased financial profit from forests. It was stated that „a strict protection negatively influences the forest stability", as well as that „nature protection forbids ditches' maintenance, which consequently causes water logging on agricultural lands", „limits response due to procedures", „insists on integrated solutions", and that „any nature protection ruling which affects the water bodies is negative, because it threats the flood management". Such statements implicate that natural resource managers do not recognize the fact that sustainable utilisation of natural resources is based on necessary limitations as prerequisite for sustainable development.

Following the findings from the discussion, results of the survey were prepared. The most impressive result is the fact that about 70% of the participants consider nature protection as a limitation in timber production (Figure 9).

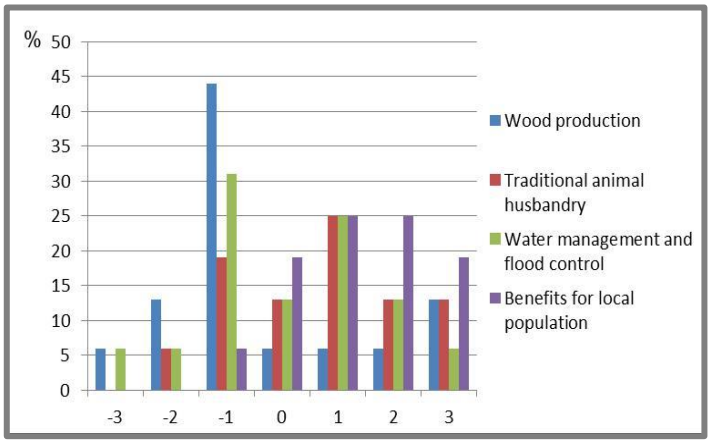


Figure 9. Relation of the nature protection to other stakeholders

The result of the survey indicating that more than 40% of participants believe that the protection of the area has negative effects on water control and flood management, can be traced back to long-standing disputes among different sectors. They disagree about the establishment of a proper water regime in the protected areas and lack understanding of the role of wetland areas as retention basins that receive flood waves. On the other hand, about 70% of actors consider the significant role of nature protection to be in local population benefits, whereas half of the total participants recognize the benefits of nature protection in traditional farming. Regarding the improvement of goods and services, the participants suggested educating the local population and more frequent communication between the nature protection sector and other stakeholders. They also demanded a better promotion of services and goods provided by the protected area, transparency of activities, and faster and simplified procedures.

Ecosystem services regulations

Regarding regulations, plans, and programmes, the participants thought it was necessary to harmonise regulations in the sectors, implement and improve the existing laws, plan a participatory approach, introduce a better subsidy system, employ agri-environmental measures, provide subsidies for traditional animal husbandry, impose sanctions on those who break the law, etc. The stakeholders' statements implicate needs for harmonisation among sectoral policies and implementation of relevant EU legislation which were arranged to solve the conflicts in an integrated manner.

Significance of goods and services nature provides for people in this area

Among the many ecosystem services that this area provides, the participants singled out those which they considered to be the most important to the parties involved in the survey (Figure 10).

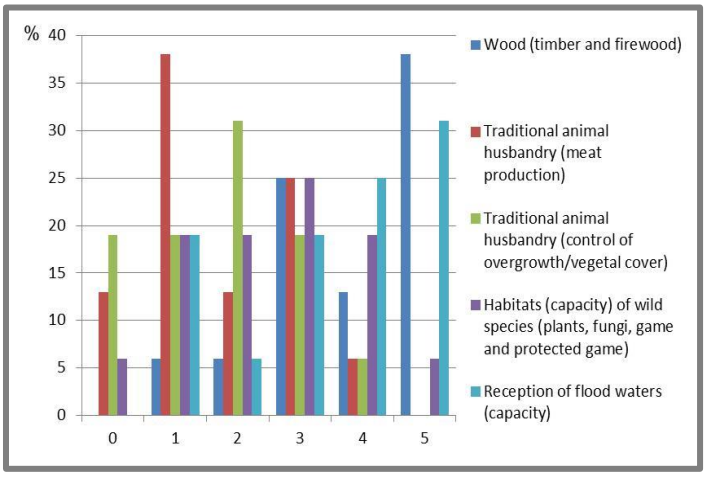


Figure 10. Importance of goods and services provided from nature to people

According to the answers given in the questionnaire, more than 35% among questionees do not consider traditional farming and wildlife habitats important for ecosystem services in the frame of sustainable development. Average significance was recognized in wildlife habitat provision, meat production in traditional farming, and wood production (25%), as well as significance of traditional farming in preventing overgrowing in marshes and flood waves retention (about 20%). About 40% of the participants gave the lowest significance to traditional farming.

More than 35% of the participants gave the highest mark to the ecosystem service of wood production, more than 30% of the participants gave the highest mark to the area's role in receiving flood waters, while a little more than 5% of the participants gave the highest mark to wild species' habitats, with additional 20% giving a slightly lower mark (mark 4). This result is not surprising, considering the fact that

forestry and water management have exploited the area for years as dominant industries, and the establishment of the protection area is in its initial phase.

The second discussion panel gathered a smaller number of participants, which were engaged, informed and motivated to consider future Bosut area management in a long term.

The panel was organized in the form of a round table or open debate, where the preliminary results of the report on the goods and services for the two scenarios were considered.

Representatives of local government, entrepreneurs and institutions engaged in water, forests and nature management, consulting and communal services, civil societies participated in constructive consultations how to implement the findings in resource management and development initiatives.

In the first part of the discussion representatives of Institute for Nature Conservation of Vojvodina Province introduced the preliminary results and compared the effects of the foreseen water retention with increased traditional farming (Scenario B) with the business as usual (Scenario "A"). Afterwards, participants exchanged their opinions on whether the changes recognized in the scenario "B" are realistic, and if there were any consequences which were not adequately anticipated. The plenary discussion which followed was about further steps and stipulated changes for sectors whose representatives participated.

The key risks related to the foreseen flood retention and the multipurpose utilization were recognized: flood-driven spread of invasive species, pollutants and garbage, water-logging on forest habitats within the retention and surrounding arable plots, wildlife loss due to sudden and excessive flooding, the transfer of diseases from domestic to wild animals and vice versa.

Respectively, the key benefits were acknowledged: increased safety with extended capacities for defense against floods, mitigation of drought-caused income loss in forestry, more frequent and increased acorn production benefiting forestry, game management and traditional farming, increased overall benefits from the same area.

As following steps, the participants implicated common platform on joint aims and activities for their implementation, including precisely defined technical solutions for introducing the multipurpose utilization. The results from the ecosystem services valuation were observed to be useful in spatial planning too.

Panel discussion in Morović. Discussion about preliminary results

General impression of the process:

Although the inter-sectorial discussion was found to be challenging in advance, firstly for conflicting interests and diverse stakeholders, participants were open for cooperation, listening arguments different from their own and considering the common approach. A different institutional level in decision making, the participants' positions and roles outputted the positive results. The need to follow up the process in continuum was stressed, id est to develop mechanisms for capacity building among all the partners toward the integrated management with readiness for implementation.

Table 8. Summary of estimated quantitative changes

	Scenario A	Advantage of Scenario B	Advantage with regard to:
Wood production		30-50%	– less damage caused by forest dieback
Traditional animal husbandry – pig farming		10-14 times	– control of expenditures for supplemental feeding and expansion of suitable area
	50,000-100,000 €/ p.a.	500,000-700,000 €/ p.a.	– meat value
Traditional animal husbandry – habitat maintenance	100 ha	500-700 ha	– pond area maintained by pigs
	10,000 €/ p.a.	50,000-100,000 €/ p.a.	– alternative maintenance expenditure (by mulch grinding)
Flood mitigation		3,652,542 €	– avoided cost of the flood defence
Habitat 3130	C	B	– conservation status
	< 30 ha	65-200 ha	– habitat area enlargement
Habitat 3150	C	B	– conservation status
	< 10 ha	200-600 ha	– habitat area
Habitat 3260	C	A	– conservation status
	< 2 m^2	6-30 ha	– habitat area enlargement
Habitat *91E0	C	B	– conservation status
Habitat 91F0	C	A	– conservation status
Habitat 9160	B	A	– conservation status
Three-stamen waterwort *(Elatine triandra)*		25,000 X	– habitat area enlargement
	C	B	– conservation status
Creeping false pimpernel *(Lindernia palustris)*		6,000 X	– habitat area enlargement
	C	B	– conservation status
Four-leaf clover *(Marsilea quadrifolia)*		1,000 X	– habitat area enlargement
	C	B	– conservation status
Water violet *(Hottonia palustris)*		1,600,000 X	– habitat area enlargement
	C	B	– conservation status
Water soldiers *(Stratiotes aloides)*	C	B	– conservation status

	Scenario A	Advantage of Scenario B	Advantage with regard to:
Debreceni horseradish (*Armoracia macrocarpa*)		10X	– habitat area enlargement
	C	B	– conservation status
Summer snowflake (*Leucoium aestivum)*		3X	– habitat area enlargement
	B	A	– conservation status
Narrow-leafed ash (*Fraxinus angustifolia*)	C	B	– conservation status
Common oak (*Quercus robur*)	C	A	– conservation status
Plankton		1	– increase of area/volume
Great capricorn beetle (*Cerambyxcerdo*)		29 %	– habitat area enlargement
	B	A	– conservation status
Large copper (*Lycaena dispar*)		3 X	– habitat area enlargement
	B	B	– conservation status
Carp (*Cyprinus carpio*)		420– 28,800 kg	– annual production increment
	C	A	– conservation status
European bitterling (*Rhodeus amarus*)	C	4 - 288 kg	– annual production increment
		A	– conservation status
Danube crested newt (*Triturus dobrogicus*)		3.4-4X	– habitat area enlargement
	C	B	– conservation status
European fire-bellied toad (*Bombina bombina*)		25-30%	– habitat area enlargement
	C	B	– conservation status
European pond turtle (*Emys orbicularis*):		62.5%	– habitat area enlargement
	C	B	– conservation status
White-tailed eagle (*Haliaeetus albicilla*)	6 -7	10 - 15	– more nesting pairs
Black stork (*Ciconia nigra*)	6 - 8	20 - 25	– more nesting pairs
Collard flycatcher (*Ficedula albicollis*)	700 – 1,100	2,000 – 28,000	– more nesting pairs
Eurasian otter (*Lutra lutra*)		30 %	– habitat area enlargement
	B	B	– conservation status

Legend for conservation status:
A – excellent conservation status
B – average conservation status
C – unfavourable conservation status

6. FINAL CONCLUSIONS AND RECOMMENDATIONS

6.1. CONCLUSIONS

There are clear estimated benefits for Bosut Forests area in case of environmental flooding of the forest complex and increase of traditional animal husbandry (the above mentioned Scenario B). With these two major physical changes and integrated management of the area, the following general ecological improvements are expected: in up to a half of the area of Bosut Forests, the area under permanent and temporary ponds will increase and forests will get sufficient water for tree growth. An important finding is that without increase in pig-herding, the benefits of environmental flooding will be far fewer, since flood water will bring nutrients and seeds of invasive plant species as well. Therefore, habitat maintenance by pig pasturing on flooded areas is important to prevent overgrowth of ponds and canals and ensure better water storage and fluctuation. According to the Study results, changes related to Scenario B will increase the value of four ecosystem services selected as most important for the area (wood production, flood prevention, meat production and biodiversity, as shown in the Table 8). The benefit for wood production was calculated as reduction of loss actually present, caused by inappropriate water regime. The approximation of water volume that forest retention will storage was used for quantification of flood mitigation benefit. The estimate of higher incomes from traditional farming was directly calculated through changes in the number of livestock: however, the benefit from better meat taste and quality, compared to meat production from pig farms, was recognised, but not quantified, The prediction of biodiversity component change was shown for certain habitats and species selected as most representative in relation to the studied area and proposed Scenarios. For six selected habitat types the Study estimates improvement of conservation status, and for three of them, according to the calculations, the occupied area would be a number of times larger. The estimation of change was done for 9 plant and 11 animal species, as well as for plankton communities. For 7 plant species, which are herbaceous, joint benefits of natural flooding combined with more pasturing was predicted, interpreted as change in an area of occupancy. For the most representative tree species, ash and oak, the Study estimates improvement of their conservation statuses due to better vitality and functionality within the biotic community. Evidently, restoring seasonal flooding to the floodplain forest is also essential for a sustainable supply of high quality timber products. Benefits for selected animal species were calculated both directly, through favourable habitat increase, and indirectly, through increase in their food/prey. All in all, since according to predictions all indicators would increase, the Study findings should be used by policy makers, mainly from forestry, water management, agriculture and nature conservation sectors, to support such changes not only within Bosut Forests area, but in similar areas in the region as well. One of the crucial findings is that the most important ecosystem services are not competitive, but compatible to a great deal.

In addition to these quantified results, there are other ecosystem services for which improvements are also expected, but in this phase of field work and stakeholder analysis, they can be discussed only in qualitative terms:

Pollination: Habitat improvement will result in better nesting habitats for wild pollinators (hoverflies, wild bees, bumble-bees, butterflies…). Therefore, service from pollination of crops (alfalfa, oil-seed rape, sunflower, orchards…) adjacent to Bosut Forests area will increase;

Game management: Like for the described species, habitat improvement will ensure better conditions for game species as well. Main game species within the area are wild boar and reed deer, both related to a mixture of forest, grassland and water habitats. Change in these habitats gives good base for increase in their population;

Tourism: Although weekly developed, the tourist offer in Bosut Forests area is based on natural conditions, mainly hunting, fishing, traditional products and eco-tourism. Under a proposed scenario, the improvements will ensure a good basis for tourism development. And not only for tourists, the aesthetic service will be improved for even more local people, since Bosut Forests are ever-present backdrop of their daily yard and field activities;

Water purification: Depending on flood prevention activities, the water received in Bosut Forests area will be in contact with vegetation, and therefore to some extent naturally purified from nutrients. Better ecological state of forests and ponds will improve their air purification and local climate extremes mitigation services;

Pest control: Improved ecological conditions will result in higher numbers of predator animals in forests (polecats, weasels, martens, owls, and buzzards) which are highly important in control of pests (voles and mice) in nearby agricultural fields.

6.2. RECOMMENDATIONS

The main two recommendations of this study is that Bosut Forests should be used for water retention in up to 10,000 ha of their area, and that number of pigs traditionally pasturing there should increase from 1,000 up to 5,000-7,000 heads. Both of the changes have to be carried out in a well planned manner, with prior consultations with main stakeholders (forestry, water management, traditional pasturing, and nature conservation), but with other stakeholders as well (hunting and fishing management, agriculture, infrastructure...).

Main Recommendations:

1. Establish forest water retention;
2. Increase the number of pigs grazing in forests;
3. Establish a protected area (Nature park "Bosutske Šume")

Further recommendations:

1.1. Throughout the process of planning for forest water retention, in addition to the main purpose of flood prevention other purposes, should be taken into consideration (forestry and biodiversity, but traditional pasturing, game management and agriculture as well). Target: Water management sector;

1.2. Funding the forest retention project and works is essential, mainly aimed at flood prevention, which is a critical issue in the Sava river basin, but providing multiple benefits for other sectors. Target: National and international funds;

2.1. Ensure proper funds for subsiding traditional pig pasturing in Bosut Forests and other areas of importance for nature conservation. Target: Ministry of Agriculture;

2.2. Ensure good control of pig grazing in the area in order to avoid damage to young forests, dykes and biodiversity. This means that pigs cannot move without the control of a pig-keeper. Target: Pig owners, PE „Vojvodinašume", forestry inspectors. When a protected area is established, control will be enhanced due to the obligation to obtain environmental permits for grazing, and additional checks by environmental inspectors;

3.1. Although stakeholder engagement in establishing the protected area is provided for by the Serbian Law on Nature Protection Law, additional harmonization effort is needed in the process of issuing an appropriate bylaw concerning the establishment of the Nature Park "Bosut Forests". Target: Provincial Secretariat in charge of nature protection.

3.2. Establish a stakeholder council; ensuring its proper function will warrant continuation of joint management.

In addition to Bosut Forests area, the results stemming from integrated management can be implemented within similar areas in Serbia and the region. The areas recognised for potential implementation of water management related recommendations, with minor modifications, are Spačva Forest area in Croatia and Gornje Podunavlje/Upper Danube (part of the Danube valley) in Serbia. Both of these areas are former floodplains isolated form river courses by dykes, with marshes and ponds in an appropriate condition to retain water and serve as habitats. The areas seen as having potential for implementing the traditional pasturing related recommendations are Obedska Bara in Serbia and Lonjsko Polje in Croatia. Pig grazing is present in both of these areas, but in different forms and numbers.

Recommendations for strengthening the legal basis

Project results indicate a need for strengthening the legal basis for nature preservation, both within the nature conservation sector and in the related sectors.

Recommendations for the Nature Conservation Law:

- Include conservation as well as improvement of ecosystem services among the nature conservation goals;
- In defining conservation measures, emphasize the importance and necessity of activities that provide favourable habitat and species conditions for fragmented, partly or fully modified habitats.
- Conservation studies, as well as conservation acts derived from these studies, should clearly define traditional resource uses which contributed to conservation of natural resources, while conservation measures should enable and encourage these activities;
- The duties of protected area manager should clearly include the obligation of maintaining favourable habitat conditions, with a special emphasis on traditional resource uses of importance for maintaining and preserving biodiversity;

- Ensure continuation of the ecological network concept, harmonised with prior experiences. The ecological network concept, applied in Serbia since 2010, aims to integrate areas important for biodiversity conservation, encourages all stakeholders, and opens possibilities for defining multi-functional elements of the network.
- During the creation of Serbian agri-environmental program as a main EU document for financing biodiversity of rural areas, subsidies for all traditional production systems important for agro-biodiversity conservation and ensuring biodiversity at landscape or habitat level, should be implemented.

Strengthening cooperation in harmonising legislation, both among the sectors using natural resources and between them and the nature conservation sector, is a precondition for lasting ecological processes which are regenerating the resources. New obligations for water and forest management sectors, stemming from multilateral treaties, enhance intersectoral cooperation, which is, in this phase of our transitional society, quite limited.

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Legislations

Директива о заштити природних станишта и дивље фауне и флоре (Council Directive - 92/43/EEC);

Закон о потврђивању Конвенције о очувању европске дивље флоре и фауне и природних станишта („Сл. гласник РС - Међународни уговори“, бр. 102/2007);

Програм управљања деловима рибарских подручја „Срем“, „Банат“ и „Бачка“ - риболовне воде реке Дунав од 1433 rkm до 1297 rkm, Дунав од 1112 rkm до 1075 rkm, Дунав од 1233 rkm до 1187 rkm, Сава од 207 rkm до 123 rkm, Сава од 96 rkm do 49 rkm и Студва, осим риболовних вода у оквиру граница заштићених подручја за период 2016-2025. године;

Правилник о проглашењу и заштити строго заштићених и заштићених дивљих врста биљака, животиња и гљива („Службени гласник РС“, бр. 5/10, 47/11, 32/16 и 98/16);

Правилник оутврђивању методологије за израду прелиминарне процене ризика од поплава („Службени гласник Републике Србије”, број 30/10)

Наредба о мерама за очување и заштиту рибљег фонда („Сл. гласник РС“, бр. 56/2015);

СтратегијауправљањаводаманатериторијиРепубликеСрбиједо 2034.године ("Сл. гласникРС", бр. 3/2017)

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Case Study: Advocating Ecosystem Services Assessment and Valuation (ESAV) in Bosut Forests area - integrating biodiversity and ecosystem services in natural resource uses and management, was supported by Open Regional Fund for South-East Europe – Biodiversity project (ORF BD), implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), funded by the German Fedeal Ministry of Economic Cooperation and Development (BMZ).