SAVA. RESTORE

Connecting the Floodplains for a Healthy Alluvial Forest.

Feasibility Study for Spačva - Bosut Forests Restoration.

supported by

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SAVA PARKS NETWORK

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Feasibility Study for Spačva - Bosut Forests Restoration

The EuroNatur Foundation is campaigning together with its partners for a Europe with free-flowing rivers, ancient forests and a rich variety of cultural landscapes. In the framework of the project "Freedom for Sava" EuroNatur Foundation and its partners want to boost the implementation of river and floodplain restoration projects in the Sava River Basin triggered by successfully conducted feasibility studies at selected pilot sites and to further strengthen the SavaParks Network – a network of GOs and NGOs committed for the protection of Sava River Basin and its transnational cooperation, name recognition and reputation in the region. Both purposes are interlinked and have a mutually reinforcing effect.

This brochure reflects the comprehensive results of the feasibility study conducted by the Austrian E.C.O. – Institute for Ecology for the pilot area around Spačva (Croatia) and Bosut (Serbia) forests. The study area lays between the Sava-Bosut irrigation canal near Jaruge village in Croatia, Bosut river in the north and Sava River until the Bosut mouth in the south.

The aim of the feasibility study was to assess and to analyse the possible options for an ecological floodplain restoration plan for those alluvial forests, which are disconnected from Sava River due to hydro meliorative measures in the past.

The project team would like to thank EuroNatur Foundation and all local project partners for their engaged and open project support. The input and information received are very rich, the discussions were fruitful, and the resulting information encompasses a wealth of data.

Especially we would like to mention the technical contributions from the Croatian Society for Birds and Nature Protection and the Serbian Institute for Nature Conservation of Vojvodina Province who contributed local ecological information and organized Lidar data from other institutions. We want to mention Radenko Ponjarac who did the hydrostatic modelling. We also want to thank partners of the International Sava River Basin Commission and all the stakeholders in this project who provided the necessary data like Water, Forest and Environmental Departments of Croatia and Serbia among others.

More detailed information on base data, methods and results is presented in the technical report (Glatz-Jorde et al., 2021).

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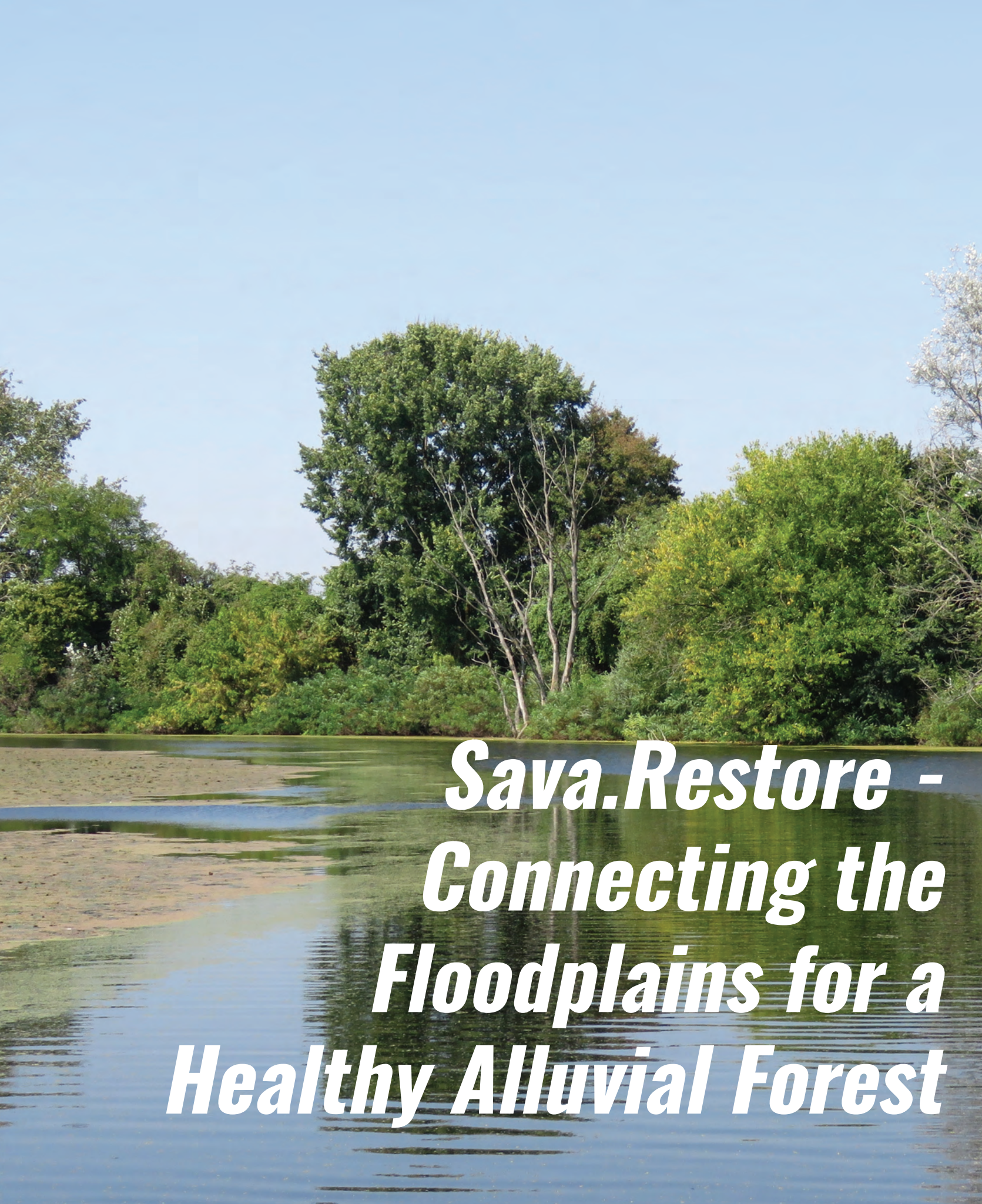
PHOTO BY: TIBOR MIKUSKA



Sava.Restore - Connecting the Floodplains for a Healthy Alluvial Forest

Project Description and Methodology

The base for the study was a literature review, hydrostatic modelling, GIS analysis and ecosystem service calculation. Various studies and data of prior projects were screened, and the findings were summarized. A qualitative comparison with historic maps was done. Relevant GIS data of those studies were provided by EuroNatur, partners and institutions of the study area. For the hydrological analysis gauging data from different stations along the Sava River and the Bosut River were used. Lidar data were provided as base for the digital elevation model and for scenario development.

The first task of the project was to provide a pros and cons analysis of floodplain restoration - considering forestry operation activities, nature protection objectives and flood alleviation needs.

The second task was to elaborate scenarios of optimal ecological and highest acceptable alleviation potential which would not destabilize the business sector and environmental objectives. Setting up optimum spatial-temporal flooding for the habitat mosaic and defining pessimism thresholds in height, length and season of flooding for the key species and habitats.

The third task of this project was to define how the integrated solutions for the floodplain restoration is bringing added values in business and environmental issues (nature-based solutions, climate buffer etc.).

The last task of this project was the assessment of restoration costs and a cost-benefit analysis.

PHOTO BY: NAME LASTNAME

photo by: E.C.O.
Sava River impression in the study area

Analyses of Status Quo

Land use

The centre of the study area in Croatia consists of a forest area with representative floodplain hardwood forests. In total, 45% of the project area is covered by forests. Part of it is covered by shrubland, which reflects abandoned meadows and clear-cuts. The forest area is surrounded by intensively used arable land and several settlements with adjacent orchards. The Zagreb Highway passes trough the forest.
The study area in Serbia is situated in the lowland between Sava and Bosut river. It is a mosaic-like landscape dominated by a mixture of old lowland hardwood forests, with mosaics of softwood forest, marshes and waterlogged areas. Small grassland patches lay within different stages of succession. There are also some settlements and roads, as well as the abandoned railway line.

Forest

The study area is covered by a large area of oak forest. In Croatia 48.648 ha is covered by forest while on the Serbian site 19.407 ha of forest exist. The dominant tree species is the pedunculate oak of different age, intersected by large clear cuts, which reflect intensive use. In Serbia, there is moderate forestry use. Part of the forest is covered by ash forest and poplar plantations.
The soil types reflect the alluvial character of the forests. In Croatia (Spačva Basin) there is mainly eugley, humogley and alluvium (fluvisol). There is great variation in the horizontal and vertical soil profiles, expressed in modified lay-

Photo by: Mario Zilek
Ancient Hardwood forest

PHOTO BY: MARIO ŽILEC
THERE IS A HIGH POTENTIAL FOR ECOTOURISM IN THE AREA

ers of different grain sizes.
Prior studies reflect on forest dieback in Serbia due to drought and groundwater depletion. The former alluvial hardwood forest is changing to a dryer variation with Field maple *Acer campestre* and Hornbeam *Carpinus betulus*.

Agriculture

Thanks to the fertile soils, the favourable climate and the abundance of water, along the Sava, Bosut and Studva developed an intensive agricultural production with a long tradition. The biggest share of the total study area in Croatia (116,589 ha) outside the forest is composed by small sectioned agriculture (30%). This agricultural land is located mainly close to villages. There are smaller sections of intensive large scaled agriculture in areas, were hydro meliorative activities in the past were conducted.
The Bosut area in Serbia is particularly sensitive to intensive agricultural production (diffuse source of pollution). Here it is especially important to establish a balance between nature and human activities. Agrochemicals, nitrates, and phosphates from fertilizers contaminate rivers and groundwater. Contrary to Croatia traditional pig pastoring is still ongoing in Bosut forest.

Game management / Hunting

Hunting and Game management are another economic factor in Croatia and in Serbia. Red deer *Cervus elaphus*, wild boar *Sus scrofa* or roe deer *Capreolus capreolus* are hunted the most. High game populations in both the Spačva and Bosut forests are preventing natural rejuvenation. In case of clear cuts these areas must be fenced to protect the new plantings from being grazed or destroyed by game.

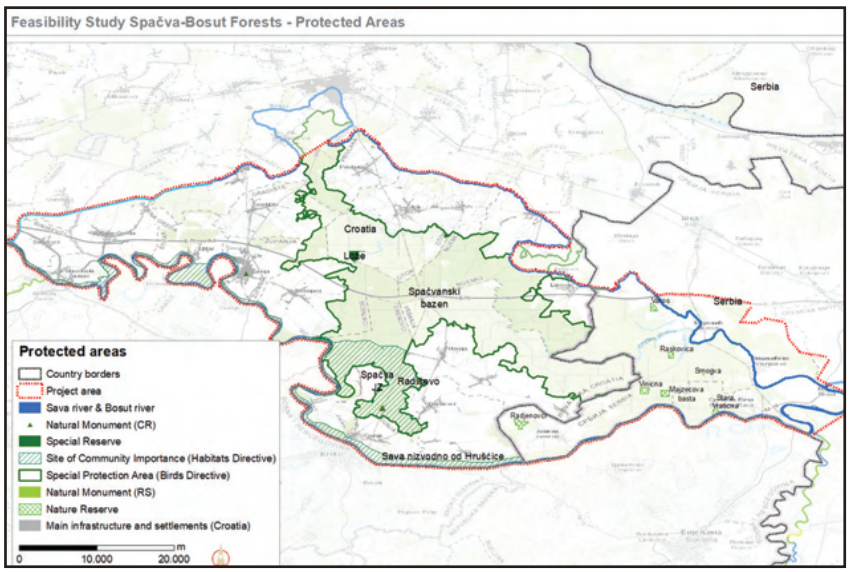
Fishery

Commercial fishing is allowed on Sava River downstream Jasenovac to the Croatian/Serbian border with very few licenses at the moment, but there is a potential for development. However, with the implementation of the project flooding can be improved and dramatically enlarge the spawning area for fish species that would enter from Sava River. With more fish in the system importance of fishing in the Spačva and Bosut area would grow. In the area of the Bosut forests, next to the Morović settlement, there is a "Slezen" pond, used for breeding carp, silver carp and grass carp.

Tourism

At the moment, the tourism sector is not of high importance, but the Spačva and Bosut forests have the potential to develop and sustain transboundary eco-tourism areas, especially for bird watching. The Ramsar Convention held in Bucharest in July 2012 enacted the Resolution XI.7: Tourism, recreation and wetlands, which confirms that "sustainable tourism and recreation can bring economic opportunities for securing wetland conservation and wise use and the maintenance of key socio-economic wetland values and functions".

PHOTO BY: ALEN KIŠ
430 YEARS OLD UPROOTED OAK



Croatia

Four Natura 2000 areas are situated in the Croatian part of the study area, all of them are of immense international importance for the European natura 2000 network:

- HR2001311 Sava nizvodno od Hrušćice (SCI)

- HR2001414 Spačvanski bazen (SCI)

- HR2001415 Spačva JZ (SCI)

- HR100006 Spačvanski bazen (covers the whole area 43.549 ha) SPA

Additionally, there are the forest protected areas Lože Special forest reserve and Radiševo Special forest reserve.

Habitats and Species

The Spačva - Bosut Forests with its alluvial forest habitats, old pedunculate oak forest stands, lowland rivers and streams (tributaries to Sava River) and temporary wetlands is an area of very high ecological value. These forests were formed in the network of lowland watercourses (Sava, Bosut and Studva) and represent a functioning forest, wetland and water habitats between the countries Serbia, Bosnia and Herzegovina and Croatia. They provide habitat for wild species that depend on old forests and are of international importance for nature conservation. The entire area is rich with groundwater but also a significant inflow of surface water. The soil types are hydromorphic and consist of mollic gleysols.

Within the study area there are various nature conservation areas, functioning as important feeding and breeding grounds, retreat areas and migration areas for numerous endangered species. Birds like the lesser spotted eagle *Aquila pomarina* and black stork *Ciconia nigra* can be found in the old forest stands with significant numbers of breeding pairs. Additionally, endangered mammals like Eurasian beaver *Castor fiber* and Eurasian otter *Lutra lutra*, Amphibia like the red toad *Bombina bombina* and reptiles like the European pond terrapin *Emys orbicularis* occur in the area. The oak forest complex of Spačva is a significant and important habitat for the saproxylic longicorn beetle *Cerambyx cerdo* and stag beetle *Lucanus cervus*. Protected plant species like longstem waterwort *Armoracia macrocarpa*, water soldier *Hottonia palustris* occur in the wetlands.

PHOTO BY: INCVP 2018
EURASIAN OTTER, BLACK STORK, EUROPEAN POND TERRAPIN, RED TOAD

PHOTO BY: ALEN KIŠ
SUMMER SNOWFLAKE

Ecological challenges and threats

The habitat conditions in the study area have changed fundamentally since the beginning of the construction of flood protection dikes along Sava (in the 18th century). Those measures led to the separation of the floodplain from the river. Due to the lack of proper flooding of the alluvial forest and further drainage of the area via channels (that are causing a decrease of groundwater level and forest drying) natural floods can occur, but they are very rare compared to the past. The forest vegetation is cut off its natural dynamics. Additionally, the construction of pumping stations and weirs on the Bosut River, that prevents natural flow and makes the river stagnant led to a fundamental change in the hydrological regime. Surface and groundwater levels in the study area are low, the soil moisture decreased, habitats are changing to dryer variations and breeding grounds for the typical species of the alluvial forest and wetlands get lost.

An actual thread is the raising speed of cutting old forest stands for species dependent on the availability of a larger area of old oak forest like *Aquila pomarina*. With the felling of large areas of forest, their habitats disappear and thus a significant part of the biodiversity of this area, especially the priority species of the Natura 2000 areas.
In some parts invasive species area spreading.

Serbia

On the Serbian side, several smaller national nature reserves can be found:

- Nature reserve Vinicna

- Nature reserve Majzecova basta

- Nature reserve Radjenovci

- Nature reserve Stara Vraticna

- Nature reserve Raskovica

The intention of nature reserves is to protect fauna, flora, habitats and landscapes.

Hydrological Analyses

The hydrographic network in the area consists of natural watercourses and numerous artificial canals. The Sava River in the project area receives a few tributaries, the biggest is the Bosut River followed by Spačva River and Studva River. The Sava has often changed course in the past, until regulation work (1870) fixed the riverbed and 103 km of dikes (until 1945) stopped flooding the alluvial floodplain. The Bosut sluice is a control gate at the confluence of the Bosut with the Sava that controls the flow from the Bosut River into the Sava and vice versa, depending on water level at Sava River.

The hydrological analysis of the gauging data from different stations along the Sava River and the Bosut River has shown, that during high flows the water level at the Bosut irrigation canal intake which is approximately 10 km upstream of the Slavonski Šamac gauging station is roughly 8 m higher than it is at the confluence with the Bosut River. This represents the head which is available to convey the water into and through the floodplain which at the end drains via Bosut River back into the Sava. At Bosut Sluice on the other hand, Sava River is 2 m higher then Bosut, which allows to convey water from this side.

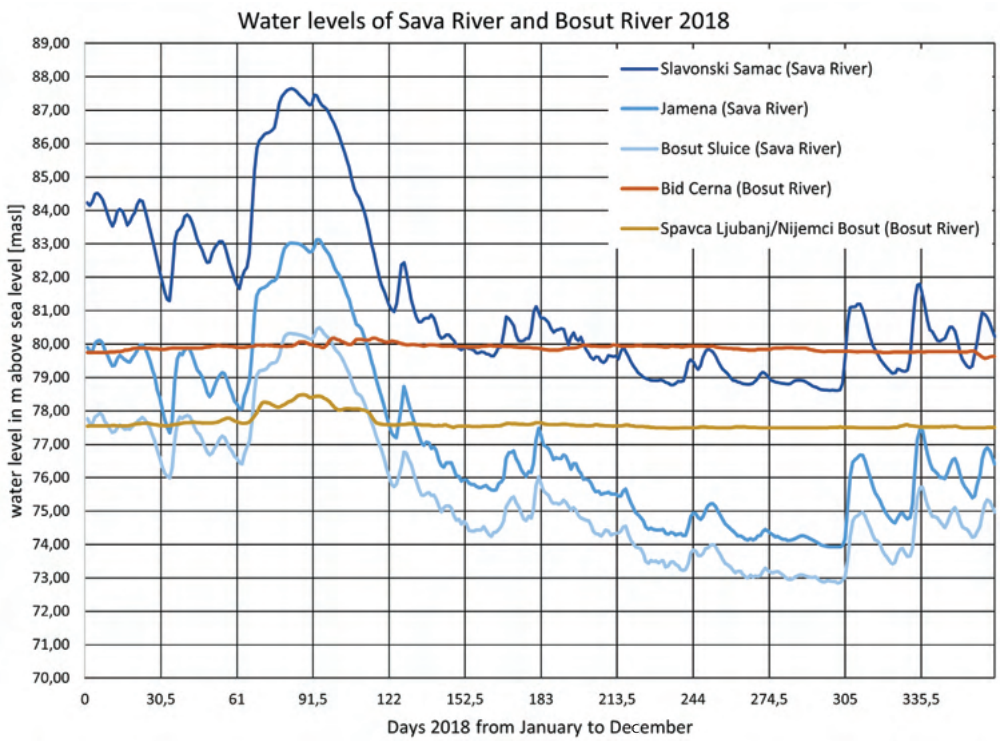


PHOTO BY: MARIO ŽILEC
CONFLUENCE OF SPAČVA RIVER AND BOSUT RIVER

Though the magnitude, the duration and the timing of the floods vary from year to year at Sava River, a certain level of flooding should be possible almost every year during March and April but may be very short in dry years. For the scenario development horizontal water levels between water level 79 masl (meter above see level) and 81 masl proved to represent the feasible range for controlled temporary inundation of the forest and wetland areas. The scenarios assume horizontal water levels across the entire area in comparison with the digital elevation data representing the land surface.

In reality the water surface of the inundated areas is not horizontal. Instead it is a wave that is slowly moving through the restoration area with water levels slowly increasing as water is entering the floodplain forests and decreasing again towards the end of the flood when the water is leaving the floodplain towards the lower Bosut and Sava River.

A more detailed analysis of how the water will be flowing through the restoration area and temporarily inundate various areas at different depths would require a hydrodynamic simulation model which should be developed in a next step. Such a model can also be used to analyse where dikes and levees or shallow canals would have to be built to guide the water to where it should go.

Minimum Scenario 79

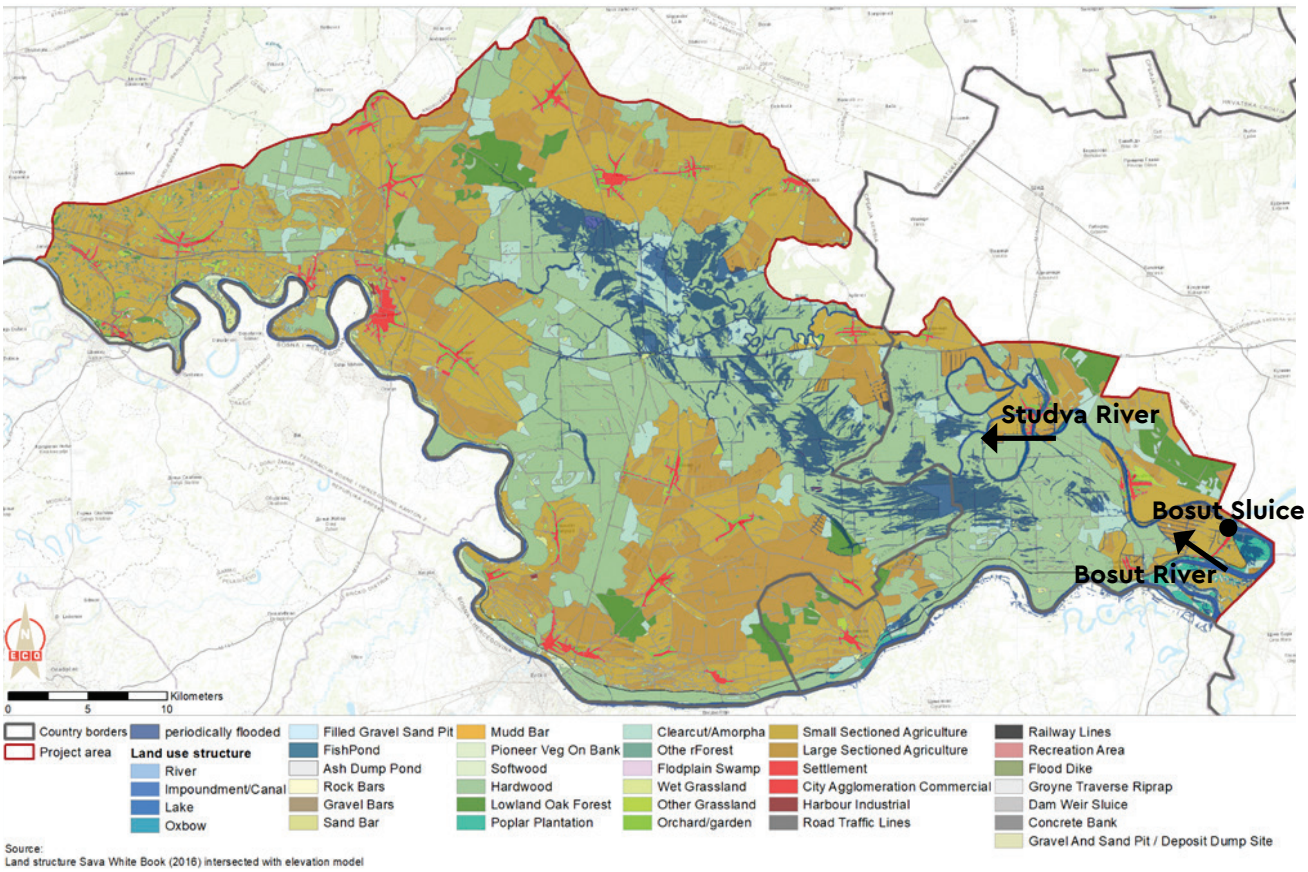
Waterlevel 79 can be reached every year in springtime via adapted operation of the Bosut sluice gate. The flow of water can be controlled by the gates in the sluice and water enters the Bosut and moves upstream. It eventually enters the Studva River and from there it moves into the various tributaries and drainage canals in the floodplain forest and starts filling it up from the bottom and filling up the depressions. Water will also eventually flow into the Spačva River and its tributaries and drainage canals connected to those, if the flood duration is long enough. The scenario is limited by the conveyance capacity of the Bosut River and the artificial embankment dam near Lipovac.

In total around 10,600 ha can be maximally temporarly inundated for some days in this scenario, 7,100 ha in Croatia and 3,500 ha in Serbia.

For higher water levels the available head at the Bosut sluice and the limited conveyance capacity of the Bosut River are limitations. There is also an artificial embankment dam (possibly with embedded culverts) crossing the Bosut River upstream near Lipovac just below the confluence with the Spačva River. This may form an additional bottleneck.

PHOTO BY: ALEN KU
BOSUT SLUICE

Land use structure temporarily flooded in Scenario Water level 79 masl



The costs of this scenario are roughly estimated from 10 - 100 € up to a maximum of 1.000.000 € (depending on local protection measures needed) including preparatory costs.

Cost estimation of restoration options

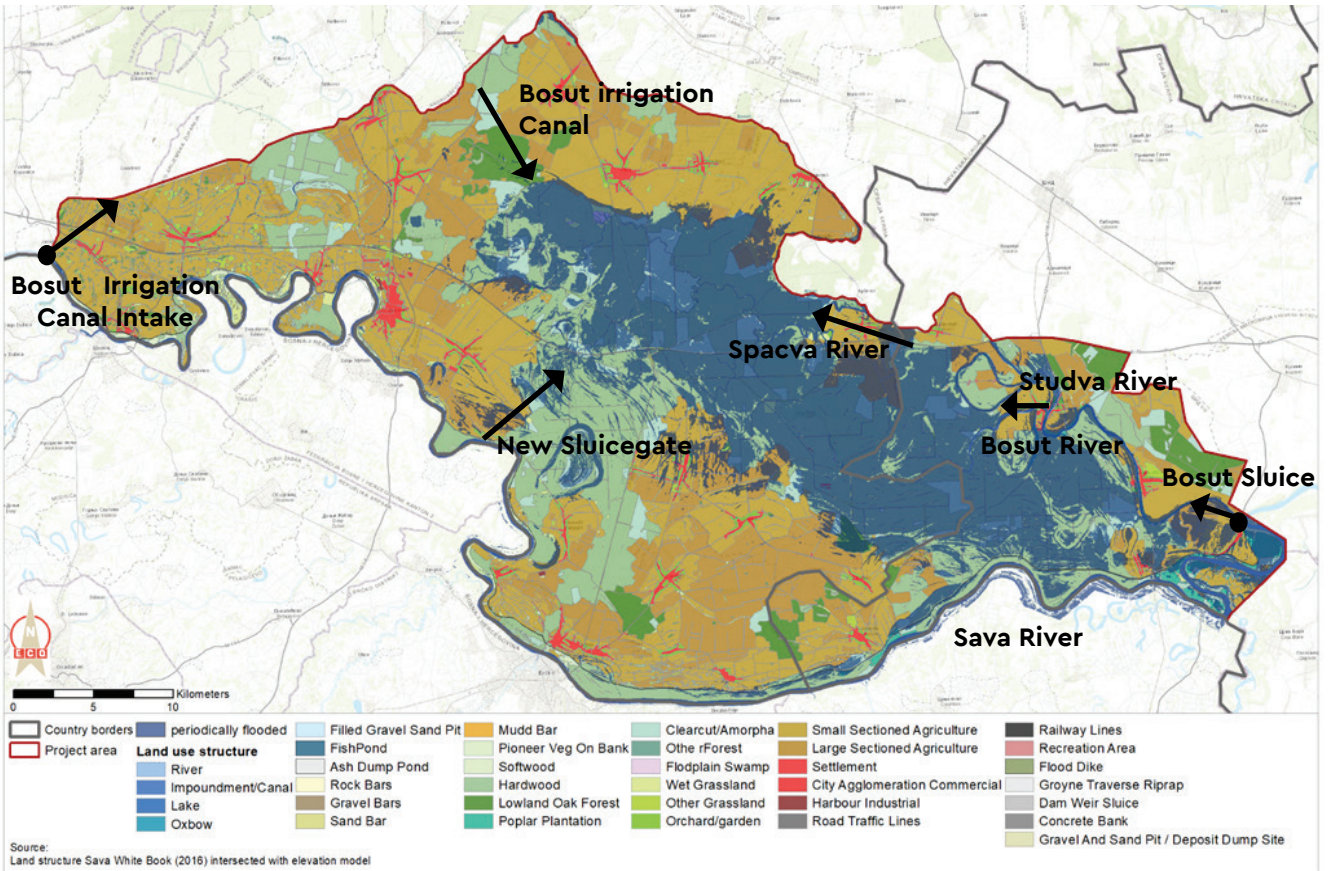
Items	Estimated cost range [* 1000 Euro]
Additional data collection for hydrodynamic model development	10 - 20
Hydrodynamic model development	20 – 30
Scenario development and simulation, depending on scenarios	5 - 50
Design and construction of Scenario 79.0 m (no significant new construction needed), local flood protection measures might be needed though	10 – 100/1 000
Design and construction of Scenario 80.5 m (dikes, levees, canals, culvert replacements, dike breach and several sluice gates)	5 000 – 15 000

Maximum Scenario 80,5

Waterlevels 80,5 up to 81 can be reached periodically but not every year during Sava high water level with an intake from three directions into the system. Beside of the adapted operation of the Bosut sluice gate, additional construction measures are needed for the maximum scenario. The second pathway to convey large quantities of water into the floodplain forest is via the Bosut irrigation canal. The water from the Sava would follow the irrigation canal into the upper Bosut River. From there it can be released into the floodplain forest approximately 2 km upstream of the village of Andrijaševci where a shortcut canal is cutting off from the Bosut and crossing a part of the forest. The water entering the floodplain forest in this area may have to be guided by a new canal or by small dikes to direct the water where it should go and to protect areas of the forest where flooding is not desired. This will have to be analyzed in detail at a later stage.

PHOTO BY: E.C.O.
BOSUT IRRIGATION CANAL INTAKE

Land use structure temporarily flooded in Scenario Water level 80,5 masl



Though the Bosut irrigation canal itself has a high conveyance capacity, there are limitations caused by box culverts and road crossings, and additionally only a certain head will be available for the entire length of the canal. Adaptions are needed if this scenario is realized.

Finally, there is the possibility of breaching the dike of the Sava River approximately 4 km downstream of the village of Bošnjaci where the forest is directly adjacent to the river dikes. A sluice gate would have to be built to allow a controlled flow of water from the Sava River into the floodplain forest. Most likely some small dikes would also have to be built to keep the water from flooding areas where this is not desired and convey it towards the restoration areas. This breach and sluice has to be designed according to the necessary conveyance capacity. Possible flow rates could be fairly high in comparison to the capacity of the Bosut irrigation canal and the Bosut sluice and river.

The costs of this scenario are estimated from 5 to 15 Million € including preparatory costs (depending on protection measures needed and selected in flow).

Ecological Impact

Reconnecting the Sava River with it`s original floodplain will respond to several ecological challenges in the area. From ecological point of view, the maximum scenario is the optimum scenario, which allows to re-establish natural dynamics in a major part of the alluvial forest.

Minimum Scenario 79 masl

All Natura 2000 habitat types in the study area have in common that they are moisture-dependent, and their favourable conservation status is connected to optimal hydrology. Regularly controlled flooding up to water level 79 will secure some natural dynamics for the habitat types 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoeto-Nanojuncetea* (20 ha) in Serbia and 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation (around 300 ha) in Serbia and 100 ha in Croatia.

- More than 88 % of the mapped standing waters will be regularly flooded in this scenario and could be hold in a favorable conservation status. Populations of amphibians and reptiles, which depend on lakes and standing waters like Fire bellied toad, Danube crested newt or European pond terrapin can at least be stabilized in their conservation status. The spawning grounds of fish species will be secured.
- Water birds which depend on sufficient availability of food will also profit. Herons for example or White Storks mainly feed on amphibian, mouse, and fish.
- Also 55 ha of the type 6440 Alluvial meadows of river valleys of *Cnidion dubii* in Serbia will regularly get flooded.
- The effect of Scenario Waterlevel 79 is limited on forest habitats. A maximum from 10 up to 20 % of the Forest type 91 E0 (Riparian Alluvial Forest) can be restored. The hydrostatic model includes areas adjacent to Sava River within the dike. So the restoration effect on those areas is not given.
- A bigger effect will be on the type 91F0 Riparian mixed forests, along the great rivers (*Ulmenion minoris*): Around 5329 ha in Croatia and 967 ha in Serbia will get regularly and temporally flooded for some days, during Sava river high water level. This is important for stabilizing this alluvial forest type. However, from the total area on this FFH Habitat just a maximum of 15 % can be restored if this scenario is realized. Part of this forest in Croatia could be just reached via Spačva river, were limitations are given.
- In total a maximum of 489 ha of the Habitat type 9160 Sub-Atlantic and medio-European oak or oak-hornbeam forests of *Carpinion betuli* can be restored in this scenario. This means that just 2 % of this target habitat in the study area will be positively affected.

PHOTO BY: MARIO ŽILEC
A HEALTHY RIVER ECOSYSTEM DEPENDS ON THE NATURAL DYNAMICS.

- According to this calculation a maximum of 10 % of the total area of the forest habitat types in the study area (64,189 ha) would be flooded. This could be a starting point and pilot areas should be defined. A good conservation status for at least 10 % of the flood depended habitats can be stabilized and will have a positive effect on the conservation status of the connected species.
- Depending on flood duration and frequency, it can be expected that the lowest parts of the forest type 91F0 will be transformed to forest type 91E0. However, there is a limited impact on the forest habitats, apart from depressions. The minimum scenario will not improve the alluvial forest in the majority of the protected areas.

Maximum Scenario 80,5 masl

The maximum scenario, where a major part of the Bosut and Spačva forest is periodically and temporarily flooded for some days can be considered as optimum flooding from ecologic perspective.

- The forested area that could be flooded for some days within a year or every few years will be 48,000 ha in total (32,000 ha in Croatia and 16,000 ha in Serbia). With this scenario around 65 % of the alluvial forest habitats can be restored. More than half of the area will reach maximum water levels of 0 – 1 m, flowing through the area slowly and filling up the depressions.

Besides of the positive effects on standing water surface, wetland habitats and the connected species already mentioned for the minimum scenario also the forested areas can be restored to a big extent by implementation of the maximum scenario.
All threats connected to drought and sinking ground water levels can be addressed.

- Besides nearly 100 % of restoration effect on standing water and wetland areas, 63 % of the habitat type 91F0 Riparian mixed forests, which is the target habitat of restoration measures will benefit from this maximum scenario.

A maximum of 19,000 ha in Croatia and around 7,000 ha in Serbia mapped as this type will be positively affected by this flooding scenario. Parts of it, especially those in depressions, will develop to the FFH-habitat type 91E0, if the water stays for more than 8 days within a year. 37 % of this habitat type would need even higher water levels up to 81 masl for full restoration. Especially the Natura 2000 site Spačva JZ is not fully covered.

Socio-economic Impact

The optimum scenario will be a trade-off between ecological and socio-economic impacts. After a century of conducting hydro meliorative measures to improve the floodplain for economic purpose, a paradigm change happens throughout European countries. Looking for synergies in terms of flood protection and ecological restoration reflects nowadays approach and becomes status quo in the big river basins. Using the retention capacity of floodplain areas is considered a promising option.

Minimum Scenario 79

Around 7,000 ha in Croatia and 3,500 ha in Serbia will be most likely affected by temporary flooding if the scenario is realized.

Though the biggest share of the scenario is covered by forest, it also contains some other land use types and critical human infrastructure, where protective measures must be set. The intersect of the land use data with the flooding scenario of water level 79 masl shows, that the settlements Morovic, Višnjićevo and Bosut in the area

PHOTO BY: ÁBEL MOLNÁR
TRADITIONAL PIG FARMING IN SERBIA

close to Bosut River and Studva river mouth will possible need local flood protected measures, if they are not yet in place. The old, and actual not functional railway is situated in the eastern part of the study area and has to be considered. Roads or traffic lines laying partly within the affected area, but their embankments are generally higher. Local protection (permeability) must be provided. Arable land is rather not affected in this scenario, a maximum of 200 ha mainly in Croatia of orchard/garden, a small area of large sectioned agriculture and grassland requires protection or compensation measures, depending on flood frequency, duration and season. The effect on forestry will be mainly positive.

Maximum Scenario 80,5 masl

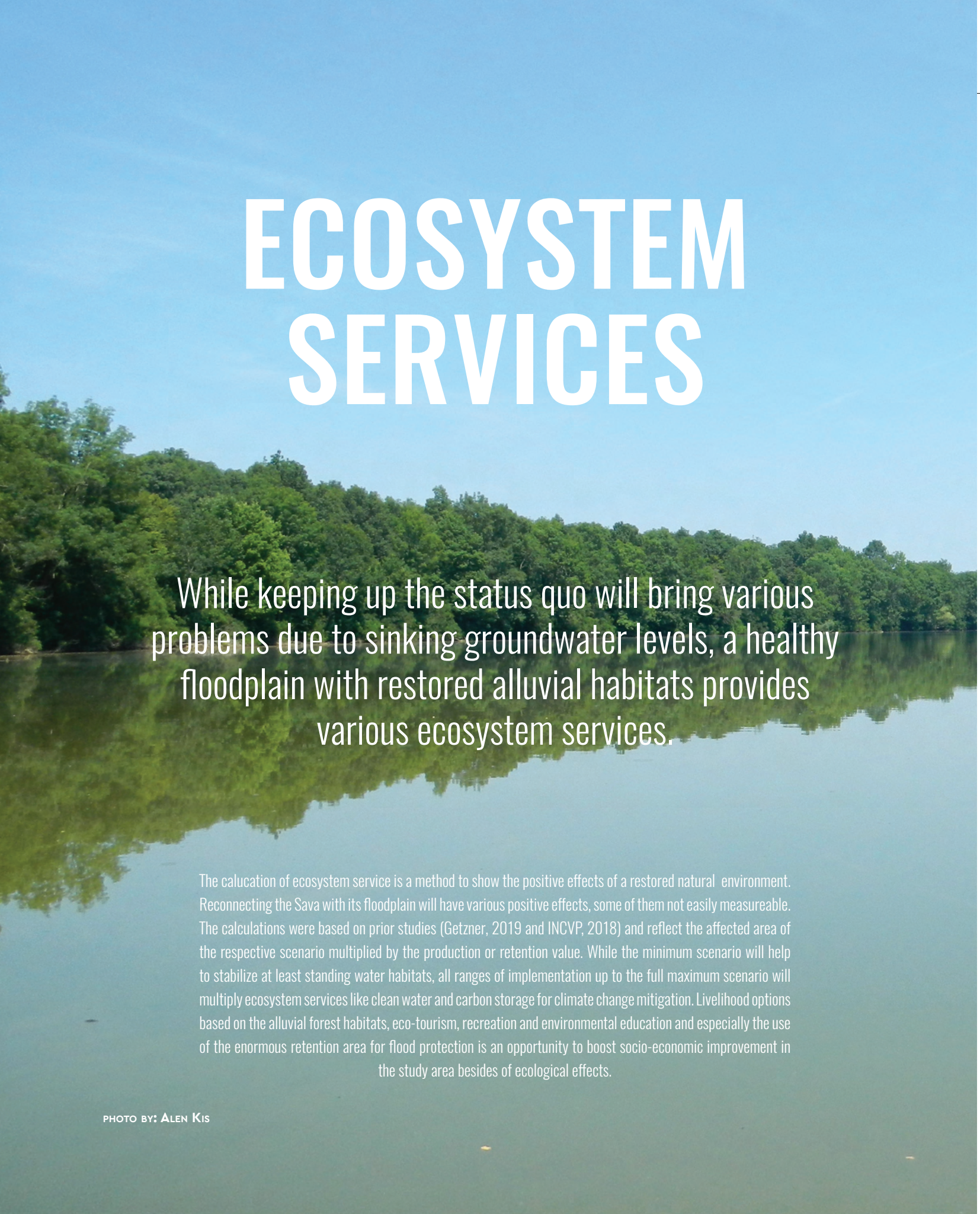
Waterlevel 80.5 masl represents the maximal feasible flooding scenario from a technical and an ecological point of view, aiming to cover and to restore the forested area as much as possible without affecting bigger parts of crucial infrastructure. Considering other criteria, the optimum flooding will be determined as a trade-off between ecological impacts and socio-economic limitations. The temporary raise of water level up to 80.5 masl within the floodplain during high flood periods in the Sava River will have local temporary effects on some land use types, also outside of the forest area. Around 33,000 ha in Croatia and 16,000 ha in Serbia are situated inside of this flooding scenario.

Considering human infrastructure, 2,5 % of the settlements in the study area require local protection measures. Areas around Morovic and Batrovci, Sremska Raca, Bosut, Višnjićevo and Bosut in Serbia and Bosnjaci and Vrbanja in Croatia will most likely need flood protection measures if they are not in place yet. Jamena and Zupanja will not be affected, but probably there is a need to protect surrounding orchards. In some places there will be a need to close the old Fok system canals during high floods like in Gradiste and Cerna, Strošinci and in Soljani. Also the old, and actual not functional railway needs to be checked if permeability (culverts) is given. It must be evaluated if such measures are already in place. Closing structures for the local canals which connect the forest with the settlements and the arable land (Fok system) must be put in place. Arable land, around 10 % of large sectioned agriculture and some ha of grassland could be partly affected and need protective or compensation measures depending on flood frequency, duration and season. However, protective measures are an intrinsic part of the scenario. By implementing scenario 80,5 a big share of different forest types can be restored.

PHOTO BY: MARIO ŽILEC
LOCAL PROTECTION MEASURES FOR SOME SETTLEMENTS AND AGRICULTURAL AREAS WILL BE NEEDED TO SOME EXTENT

Around 5 % of the Lowland Oak Forest within the study area are situated in the scenario, evenly distributed in Serbia and Croatia. It is expected that lowland oak forest will benefit from flooding and the raise of ground water levels. 59 % of the Hardwood forest can be temporarily flooded in this scenario. This type of forest is the target habitat and can deal with high water level very well. Around 50 % of clearcuts/amorpha in the area also lie in a temporary inundated area of the scenario. Generally, no or limited effects are expected, because the literature review has shown that oak seedlings are even positively affected by flooding. Depending on the actual vegetation, the flood frequency and duration and also seasonal aspects it must be investigated locally if this scenario can be verified or if compensation measures in some cases are needed.

ECOSYSTEM SERVICES



While keeping up the status quo will bring various problems due to sinking groundwater levels, a healthy floodplain with restored alluvial habitats provides various ecosystem services.

The calucation of ecosystem service is a method to show the positive effects of a restored natural environment. Reconnecting the Sava with its floodplain will have various positive effects, some of them not easily measureable. The calculations were based on prior studies (Getzner, 2019 and INCVP, 2018) and reflect the affected area of the respective scenario multiplied by the production or retention value. While the minimum scenario will help to stabilize at least standing water habitats, all ranges of implementation up to the full maximum scenario will multiply ecosystem services like clean water and carbon storage for climate change mitigation. Livelihood options based on the alluvial forest habitats, eco-tourism, recreation and environmental education and especially the use of the enormous retention area for flood protection is an opportunity to boost socio-economic improvement in the study area besides of ecological effects.

PHOTO BY: ALEN KIS

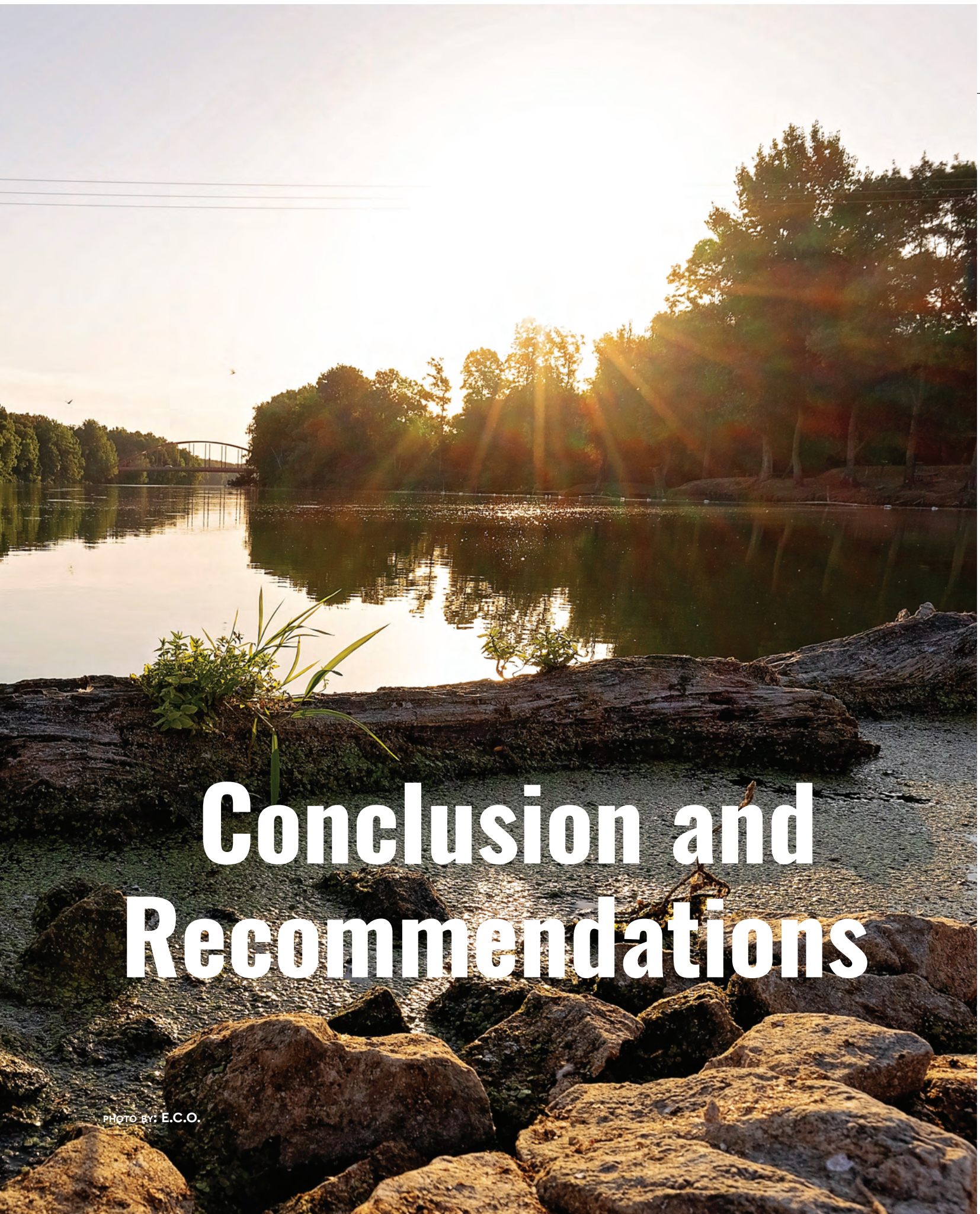
ESS Production * The detailed method description is provided in the technical report.	**Scenario 80,5 mean value €**	**Scenario 79 mean value €**	**Difference between scenarios**
Roundwood Production (Hardwood and Oak forest) increase of 30%	14,747,040	1,379,115	13,367,925
Firewood Production (Hardwood and oak forest) increase of 30%	1,297,296	121,329	1,175,967
Arable Land (Compensation cost if flooded)	-630,864	-20,243	-610,621
Other Grassland (Compensation cost if flooded)	-30,316	-5,044	-25,272
Potential Animal Husbandry (pigs pastoring)	2,176,102	408,958	1,767,144
Potential Fisheries (carp production, increased spawning area)	118,874	108,164	10,710
Avoided Pond Habitat Maintenance Cost	236,400	44,400	192,000
Total increase of Production	**17,914,532**	**2,036,679**	**15,877,853**
ESS Retention	**230,400,000**	**50,323,200**	**180,076,800**
Preparatory project costs (yearly, 50 year lifecycle)	-2,000	-1,000	-1,000
Construction costs including local protection measures (yearly, 50 year lifecyle)	-300,000	-2,000	-298,000
Total: Retention value	**230,098,000**	**50,320,200**	**179,777,800**
Total ESS:	**248,012,532**	**52,356,879**	**195,655,653**

The study reflects on those services where data were available. Provisioning services like wood production, potential fish production and potential pig pastoring were taken into account, as well as regulative services like the retention capacity and also the estimated project costs. The calculation of wood production is based on the assumption of an annual harvest of approximately 4.2 m^3 per hectare oak forest. The potential production of animal husbandry and fisheries were interpolated from INCVP, 2018.

Other ecosystem services, like the value of water quality for production, livelihood and tourism, the positive effects on filled groundwater levels for agriculture, the positive effect on climate change mitigation and storage of carbon (reduction of CO2 emissions) were not valuated in this study. Also the value of protection of biodiversity itself and the recreation potential were also not considered, but they will definitely contribute to a positive balance.

The productive output increases significantly in a healthy alluvial environment. Forestry will be more productive (30 %) if forest dyback due to drought will not occur anymore. There is also a potential for fisheries (carp production with increased spawning grounds) and traditional pig pastoring in some areas. The table above shows calculated annual mean values for ecosystem services for the minimum and the maximum scenarios. The column four shows the difference between minimum and maximum value. Production values for forestry, agriculture and fisheries were calculated and compared with the retention value and the estimated project costs.

The biggest benefit from ecosystem services is the retention capacity. The advantage of providing a retention capacity of more then 200 Million m^3 with Scenario 79 up to 600 Million m^3 with Scenario 80.5 or valued in Euro 50 Million or 230 Million € overweight the project costs significantly.



Conclusion and Recommendations

PHOTO BY: E.C.O.

The study results show that a multipurpose floodplain restoration project will address many problems of the status quo scenario. By applying a feasible range of periodically flooding and by integration of the needs of all sectors (operation of forestry, nature protection and flood alleviation needs) positive effects can be gained for all. The study confirms the high restoration and retention potential of the Sava river basin mentioned in many prior studies (e.g. SCHWARZ, 2016, INCPV, 2018, EPISTA SERVICIOS DE INGENIERA, 2018) and also highlights the range of the area feasible for restoration of the alluvial Spačva and Bosut forests.

The results prepared for this study offer a first analysis of the different scenarios that should be developed iteratively and studied in more detail.

- The visualizations provided by the hydrostatic analysis based on the elevation model are a simplification of the real conditions that will develop depending on where from the water is released into the floodplain, at what flow rate and for how long. The real range of possibilities how such flooding scenarios could be implemented depends on the shape of the natural flood wave which is propagating along the Sava River and which is differing in its magnitude, duration and shape from one year to another. The real situation is therefore not a horizontal water table as shown in the figures but in reality, a wave of water will be propagating not only down the river but also into and out of the floodplain.

- For a better identification of the restoration scenarios that should be analysed it is recommended to develop a set of habitat suitability criteria for different types of floodplain vegetation, relevant for this project, and to identify areas where these criteria can be fulfilled based on knowledge and input from all contributing stakeholders.

- More detailed technical data (like the capacity of the culverts, the location of existing flood protection measures and the proper functioning of the historic Fok system and its canals) can be taken into account.

- It is recommended to proceed with the development of a hydrodynamic simulation model which will help to analyze the possible restorations scenarios in more detail and to analyze which accompanying measures are required. The model can be linked with habitat suitability criteria for different types of floodplain vegetation to identify which areas will be suited for certain types of floodplain forest under each of the restoration scenarios.

- The next stage would be the preparation of the technical design and construction drawings. The construction itself can be implemented once all permits and licenses have been granted. The construction costs depend very much on the restoration scenario that is targeted for and how much the options for flood retention are considered in the design of the multipurpose project.

- However, the results at this stage show the general feasibility of an approach in the given range of the both scenarios and highlight the high potential and the high importance for a multipurpose restoration project in the Spačva and Bosut forests. The calculation of ecosystem services has shown, that the maximum scenario (wich is considered the ecological optimum) will multiply also the socio-economic benefits at least by a factor 4,5.

- Because of the high ecological value of Spacva/ Bosut forests, their international importance for conservation and the challenges mentioned the restoration scenarios should be implemented with highest priority.

photo by: Tibor Mikuska

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Sava.Restore

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