

## DRAVA RIVER

|                       |            |                                                                                                         |               |
|-----------------------|------------|---------------------------------------------------------------------------------------------------------|---------------|
| <b>Title</b>          |            | <b>DRAVA LIFE – Integrated River Management</b>                                                         |               |
| <b>Organization</b>   |            | WWF Adria, Croatian waters, Legal entity for water management                                           |               |
| <b>Start</b>          | <b>End</b> | December 2015                                                                                           | November 2024 |
| <b>Length</b>         |            | 1438 km of actions in a 310 km river reach                                                              |               |
| <b>River typology</b> |            | From meandering to sinuous with channel bars due to the application of artificial channel straightening |               |
| <b>Q mean</b>         |            | 310-577m <sup>3</sup> /s                                                                                |               |
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## LOCATION

The Drava River is located at southern Central Europe. It is 749 kilometers long, running from the Italian Dolomites at 1,450 meters above sea level, to the vicinity of the Croatian city of Osijek, at 90 meters above sea level, where it flows into the Danube River on its right bank. This project covers a stretch of 310 km of the Drava River (i.e., ~43% of total) between Dubrava Križovljanska and Osijek (Fig. 1).



Figure 1. Location of the Drava River and restored reach

## CONTEXT

The Drava River has a classic fluvio-glacial regime as well as an enormous diversity of fluvial styles and habitats along its way. It includes 4 Natura 2000 sites in an area of 67,800 hectares. However, currently, the Drava River presences 24 dams in Austria, Slovenia and Croatia and several artificial channels built for hydroelectric power plants. This makes the upstream part of Drava River one of the most exploited rivers in Europe in terms of hydroelectric power.

The main impacts and problems are related with the lateral defences, cut off side channels and meanders, reduction of floodplain surface and channelization of the river, in order to gain arable land, to protect inhabited areas or arable land from flooding, or to restrict dynamic development of the river and keep the flow in one

plannable main riverbed. The building of river structures, the extraction of sediments and disconnection of side branches, together with an insufficient sediment transport from upstream, led to a straighter, shorter and narrower main river course. This led to continuous riverbed incision, lowering of groundwater and surface water levels, disconnection of the floodplain areas and reduction of flood retention capacity. Side - branches, forests and other water bodies are drying out, which in turn leads to the decline of riverine habitats.

The presence of dams on the Drava River caused a decrease in mean annual discharge, water levels, and sediment load (Bonacci et al., 1992). Their construction also accelerated the incision of the channel, although this had already begun in the 19th century due to the exploitation of groundwater for agricultural purposes, the extraction of sand and gravel, and the development of drainage and irrigation systems (Bonacci et al., 1992). Studies in the area show that although the incision of the bed near the dam has resulted in bed with coarser material, the apparent deposition of these eroded sediments downstream has resulted in a bed with much finer material (Słowik et al., 2018).

The colonization of the bars is one of the most visible signs produced by the Drava River dams (Kiss and Andrasi, 2015), and there is a wide catalogue of old maps and aerial images that show the change. Vegetation growth also favoured the accumulation of fine material and stabilized certain channels. Figure 2 shows how is modified the channel planform downstream of the Drava River dams, exemplifying an idealized sequence of channel changes at different time scales.

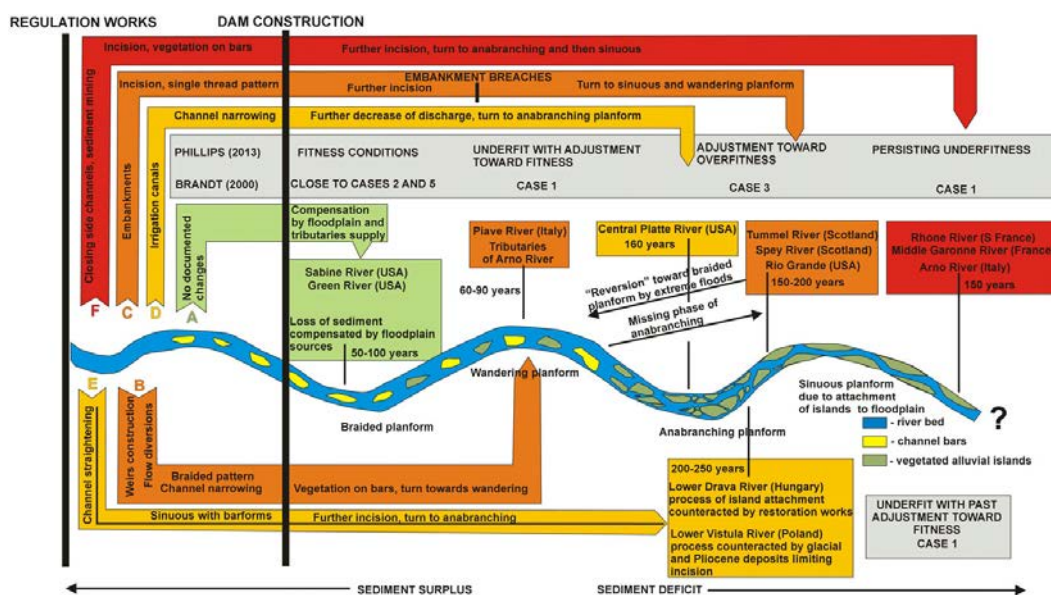


Figure 2. Evolution model of the channel planform downstream of the dams (inspired on the Drava River case), showing an idealized sequence of channel changes at different time scales (see Słowik et al., 2018)

Therefore, one of the most important elements of the natural dynamic Drava ecosystem is the rich bedload of gravel and sand. Due to 22 hydropower dams on the Drava's main stream only, river regulation and gravel, as well as sand extraction, a significant bedload deficit in the remaining free flowing stretches can be observed. As a consequence, the riverbed is continuously incising (at an average of 3 cm/year), which causes a reduction of gravel, sand and steep banks, lowers the groundwater tables, reduces flood retention capacity, declines habitats, natural succession and floodplain forests dry out.

The rich biodiversity of the river's habitats raises serious ecological concerns and conflicting objectives. This loss of naturalness derives from the processes of incision and disconnection with the alluvial plain that the river presents. The hydro-sedimentary imbalances caused by the reservoirs, bank revetments and groynes are some of the most outstanding pressures. Uncontrolled anthropogenic pressure is also another problem with notable negative effects, especially in the preservation of typical species of riparian birds (Fig. 3).



Figure 3. Key river bird species. Source: T. Nikowitz

#### **PRESSURES & IMPACTS**

- 1) Dams
- 2) Lateral defences
- 3) Embankments
- 4) Groynes
- 5) Agricultural use
- 6) Narrowing
- 7) Incision

The Drava LIFE project covers a length of 310 km of the Drava River in Croatia, and includes 4 Natura 2000 sites in an area of 67,800 ha from Dubrava Križovljanska (rkm 322.8) to Osijek (rkm 15). Except for the part from Osijek to the confluence with the

Danube (Kopački Rit Nature Park), the whole length of the Croatian Drava is included in the project.

## OBJECTIVES

The project has set itself three large bundles of goals. First of all, it proposed to increase the number of natural and dynamic riverine habitats and to better connect interdependent parts of the Drava's ecosystem. This is done through river restoration measures, such as re-connection of existing but partially or complete cut off former side channels, but also through creation of one new side branch. At some of the restoration sites riverbed widening has been proposed, in an attempt to slow down flow velocity and allow shallow water habitats to form. At other sites, removal of bank revetments/groynes and preservation of dynamic steep river banks has been planned, in order to enable side erosion and open the way for dynamic riverbank development. The latter types of banks are extremely rare along the Drava, but they are essential for many species protected under Natura 2000.

Secondly, it proposed to preserve existing and create new water bodies and flooding areas within already existing floodplains. These actions also reconnect the river with its floodplains and improve the dynamics between groundwater and surface waters, as well as improve sediment dynamics and minimize the risk of floods in inhabited areas along the river.

Thirdly, it proposed to reduce human disturbance of river birds, especially during the breeding season. During the project, a Visitor guidance plan and an Action plan for river birds have been developed and concrete visitor management measures and public awareness campaigns were implemented to avoid negative impacts of uncontrolled human activities. As part of this, but also accompanying the restoration measures, the aim to raise awareness and recognition of Natura 2000 sites along the Drava River has been pursued.

This project (and other project, WISEDRAVALIFE, Wise Water Management for the Conservation of Riverine and Floodplain Habitats along the Drava River) have a general objective to enhance the ecological and hydromorphological conditions of the river Drava at seven locations in five counties through international and national cooperation among all stakeholders in the river basin.

## OBJECTIVES

- **Reduce flood risk**
- **Opening and creation of new side-arms**
- **Remove and modification of embankments and groynes**
- **Healthier and more diverse nature**

During the duration of these projects, over 60 specific multidisciplinary project activities are planned for implementation. Through sustainable management of river resources, these concrete in situ actions include the restoration and expansion of the riverbed, preservation, and encouragement of valuable habitats along steep riverbanks and in floodplain forests and influencing a positive balance of groundwater in river inundation. Moreover, the projects aim to raise awareness and involve stakeholders from the river area in the decision-making process.

## Target species/habitats

**Hydromorphology, alluvial biodiversity**

## RESTORATION ACTIONS

Within the project, key natural features of the riverine ecosystem are being restored through an inter-sectorial cooperation between Hrvatske vode (Croatian Waters – the Croatian water management institution), public institutions for nature protection of three Croatian counties, and two NGOs (Austria, Croatia), who will showcase this innovative approach of river management on several sites along the Croatian Drava.

The planned restoration actions encompass the opening of existing side channels and creation of an initial channel, the removal and modification of embankments and groyne, as well as the preservation of retention areas and natural steep river banks. This will significantly benefit numerous types of endangered habitats and species within Natura 2000 sites.

The proposed restoration measures try to conform to the flood risk management regulations (EU Flood Directive). There are several pilot restoration sections (C1-C7). The actions will consist of the expansion of the lateral arms, the dismantling and modification of the existing regulation structures and the implementation of new methods of protection against floods (more) respectful with the environment, within the idea of conservation of nature and sustainable flood protection.

Another line of restoration actions looks at improving the management of groundwater use and its replacement, improving infiltration rates. All this to increase

the resilience of the ecosystems of the alluvial plains of the Drava River in the context of the negative impacts that climate change may cause.

Finally, educational water centre, river schools and educational paths will be established along the Drava River, and, in addition, they will implement orientation actions for visitors. In addition, various exhibitions and extensive awareness-raising activities will be organized in cooperation with local citizens and schools. In short, the project is intended to increase the recreational value of the river for the local population (fishing, swimming, relaxation, among others).

The pretended actions are:

- 40.8 ha land acquired for river restoration
- 13 ha new dynamic river zone with gravel, sand and muddy banks and succession stages of floodplain forests (91E0\*)
- 1 000 m dynamic river banks restored/preserved
- 11.9 km side-arms restored and 2.6 km newly created
- 306 ha floodplain forest (91E0\*) improved
- Breeding population of endangered birds (e.g. little tern (*Sterna albifrons*)) increased
- Human disturbance of river birds during breeding season (through information for visitors, placing of panels on breeding sites) reduced
- Knowledge of the Natura 2000 sites increased and awareness raising instruments established: e.g. information centre, info points, nature educational corners, monitoring towers, communication and educational material and workshops
- Cross-border cooperation fostered (e.g. International Drava symposium) and new inter-sectoral river management approach strengthened

These actions will be implemented in the following 7 locations along the Drava River (Fig. 4):



Figure 4. Drava LIFE project area

- Otok Virje (312 – 314.3 rkm). Side channel restoration and riverbed widening:
  - reconnection of an old side channel
  - initializing dynamic habitats
  - restrict forest use on the new island

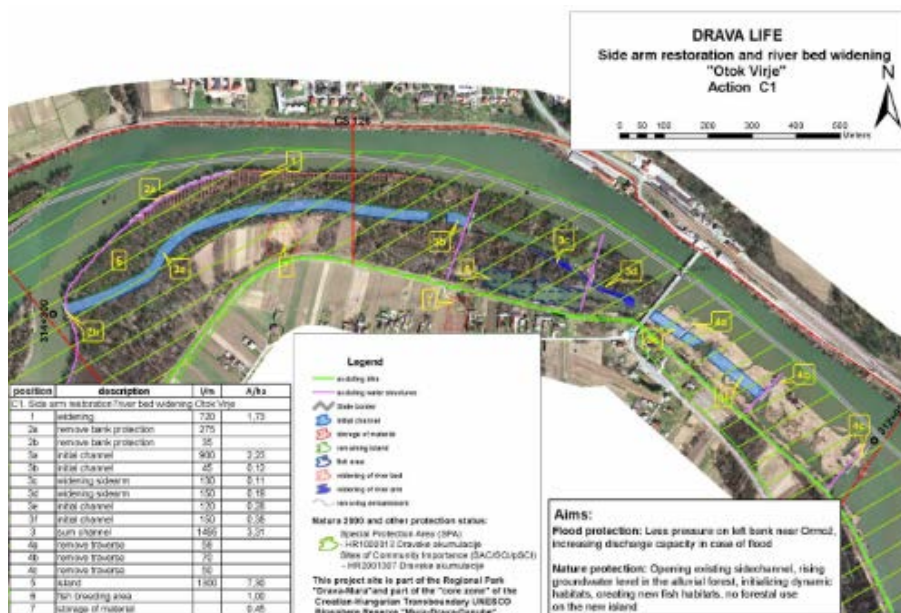


Figure 5. Restoration Site Otok Virje. Action c1

Restoration field implementation initiation on 2024

- Stara Drava Varazdin (289.3 – 292 rkm). Side channel restoration and riverbed widening:
  - reconnection of an old side channel
  - widening of the main riverbed
  - initializing dynamic habitats
  - extensive forestry in the floodplain area

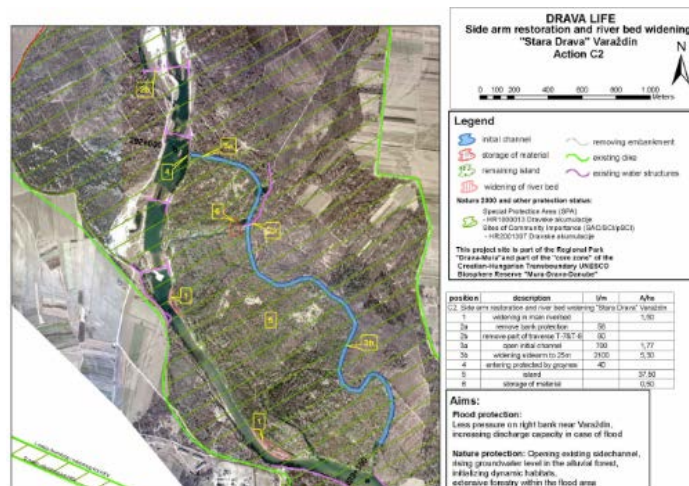


Figure 6. Restoration Site "Stara Drava" Varaždin. Action C2

- Donja Dubrava – Legrad (240 – 241.45 rkm). Opening existing side channel:
  - reconnection of an old side channel
  - initializing dynamic habitats
  - create a nature education path and a "Water School"

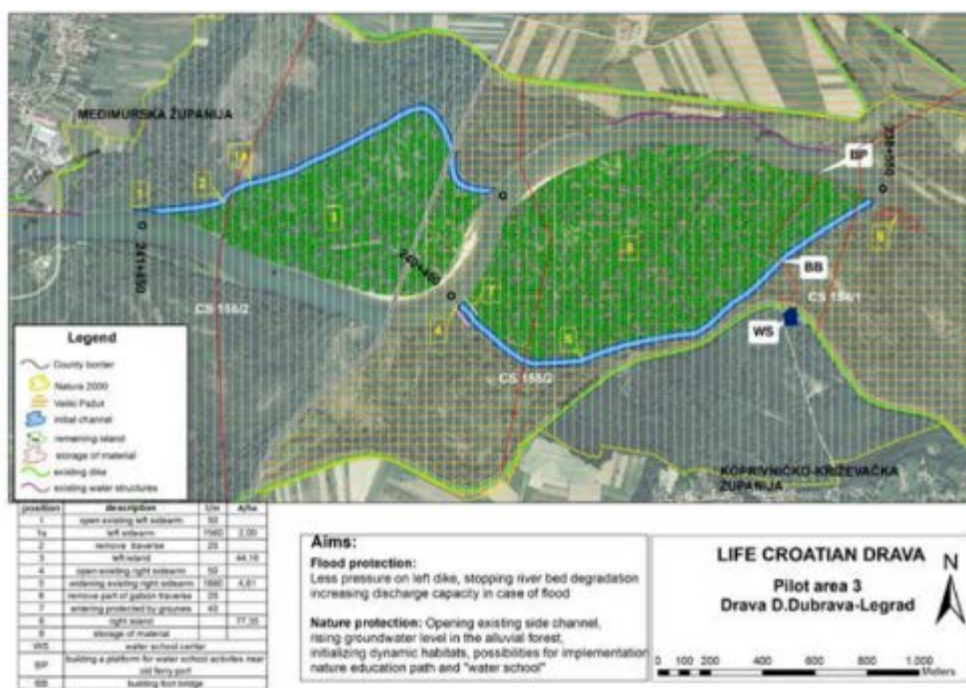


Figure 7. Restoration Site "Donja Dubrava" Legrad. Action C3

Restoration field implementation currently underway (September 2023)

- More Botovo (226.6 – 227.9 rkm). Opening existing side channel:
  - reconnection of an old side channel
  - land use change on recreated island
  - initializing dynamic habitats

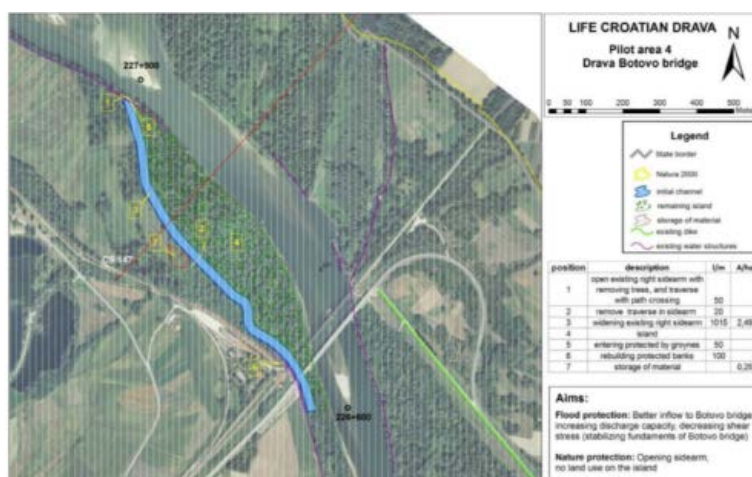


Figure 8. Restoration Site “Botovo bridge”. Action C4

Restoration field implementation initiation on 2024

- Novačka (214 – 217 rkm). Initial channel building:
  - reconnection of an old side channel on the upstream site left bank
  - create an initial channel on the downstream part right bank
  - actively allow old groynes on the left bank of the main riverbed (opposite to the new side channel entrance) to decay
  - land use change near riverbanks and on the newly created island

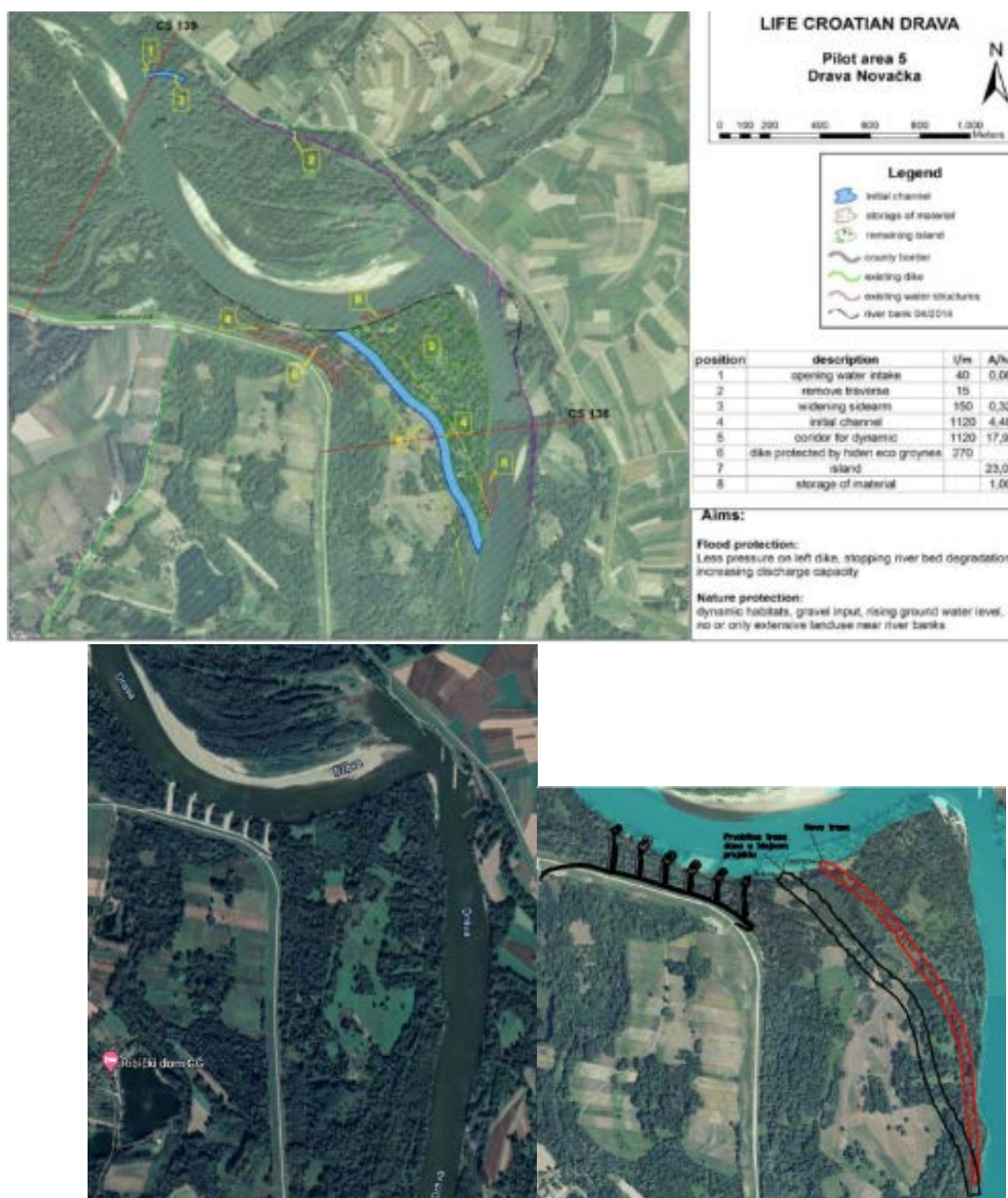


Figure 9. Restoration Site “Novačka”. Action C5. Bottom left: Current status © Map: Google Maps Satellite View 2021. Bottom right: Planned status with two versions of the initial channel © Croatian Waters

Restoration field implementation currently underway (September 2023)

- Miholjacki Martinci (104 – 106 rkm). Opening existing side channel:
  - reconnection of an existing side channel
  - initializing dynamic habitats
  - restrict / prohibit forestry use on the new island
  - land use change agreed with the land user of the land behind a steep bank in the reopened side branch where hidden groynes will be built, to avoid having to immediately protect the exposed riverbank. A dynamic

development land slip of 120 m width is left between the current side channel bank and the outer end of the planned hidden groynes.

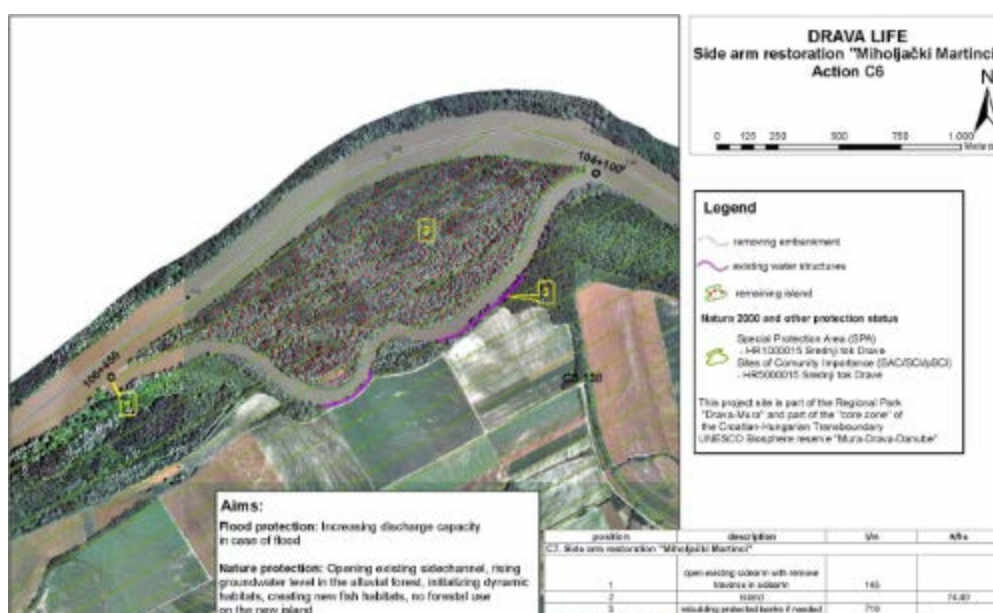


Figure 10. Restoration Site "Miholjački Martinci". Action C6.

- Podravska Moslavina (96 – 98 rkm/h).
  - active lack of intervention against dynamic bank erosion until intervention line
  - Land use change with compensation (in the form of land lease fee adjustment proportionately to the area eroded in the period of the lease agreement)
  - Communication and awareness raising regarding natural dynamic development of rivers, steep river banks and their function as habitats

Location C.7 (Podravska Moslavina) was abandoned during the Environmental Impact Assessment (EIA) process as it was deemed better to "do nothing" at that site.

The joint effect of the eight side channel reconnections (considering that some of the restoration sites entail two side channels) and one initial channel restoration is that of an increased dynamic of the Croatian river stretch within the active floodplain. We expect that through the initialized erosion, the return of sediments into the main riverbed, more dynamics in the sense of side erosion is possible, which, in turn, leads to the formation of sand and gravel banks on inner bends of the river. The reconnection of the old side channels will improve lateral connection of the floodplain and raise the groundwater level of the floodplains and floodplain forests. In turn, the expected effect is that of improved conditions for native flora.

The increased dynamics will re-initiate successive vegetation development with pioneer plant species followed by shrubs, then softwood forests and, finally, hardwood forests. In general, a recreation of the natural habitat that hosted, until recently, the *Myricaria germanica* and the *Typha minima*, is hoped for. The widened and again anabranching riverbed is expected to have a decreasing effect on flow velocity and thus more variety in fish habitats is expected, split between side channels that have shallower water suitable for spawning or for young fish. The riverbanks where artificial embankment is removed are expected to develop in a near natural manner, creating different structures, fallen trees, steep banks or shallow gravel banks, suitable for various fish species in the water and bird species above the water and along the various types of river banks and river bank structures.

## MONITORING

The idea of monitoring is mentioned, but more in the sense of “environmental surveillance” than follow-up of the actions carried out to restore the fluvial system. One of the objectives sets was also to establish monitoring towers.

## ACHIEVEMENTS

The project is still running (from 1<sup>st</sup> December 2015 to 30<sup>th</sup> November 2024), so the results are based on expectations, for example:

- Acquire land for river restoration.
- Stimulate fluvial dynamics and generate floodable forests.
- Increase gravel/sand breeding bird populations.
- Reduce the impacts on the habitat of the black stork (*Ciconia nigra*).
- Establish awareness instruments.
- Generate synergies between water management, nature conservation and NGOs.
- Establish transnational conservation actions.

## GOVERNMENT AND SOCIAL IMPACT

The project partnership is made up of five main parties. Hrvatske vode, the Croatian water management authority is the lead partner of the project and responsible for nearly all land purchases (WWF Austria is responsible for one land purchase) plus all

restoration actions. Three county level nature protection institutions (for Varaždin, Koprivnica-Križevci and Virovitica-Podravina counties) that are responsible for Natura 2000 and other protected areas' management along the project area, have partnered with them and contributed to all planning discussions. Not as official partners, but as interested and involved stakeholders, the nature protection institution of Međimurje County and the management authority of the Kopački rit Nature Park have been involved as well. Whereas they have not been directly consulted in the restoration action elaboration, the strategic and planning documents such as Natura 2000 Management Strategy for the Drava and the Natura 2000 Nature visitor Guidance Plan have been elaborated with their inputs, in an attempt to align across the project area and beyond its borders throughout the Drava floodplain in Croatia. The partnership is completed by the NGOs WWF Austria in close cooperation with their Croatian sister organization WWF Adria and the Croatian nature protection NGO Zeleni Osijek (Green Osijek). Green Osijek is coordinating the project. Restoration planning and alignment actions, as well as some of the mentioned strategic documents' drafts have been additionally aligned with the Croatian Energy and Environment Ministry and its Nature Protection Department (initially own institute: HAOP). In some actions and workshops, additionally stakeholders in nature protection, water management and selected experts across the borders, from Hungary, Slovenia, and Serbia, have been involved.

The expected impacts on society can be seen from different points of view. The integrated management of the river will help to improve fluvial biodiversity, flood management and the development of a balanced landscape. This integrated management incorporates conservation and the maximization of the social and economic benefits derived from water resources in an equitable manner.

More specifically, there will also be improvements for most river birds, especially those that depend on dynamic habitats (e.g., steep banks, gravel, and sandbars) along the Drava River, many of which are in a critical state. This will result in an improvement in the spaces for visits to the river by citizens.

The participants in the project are: Hrvatske vode, Legal entity for water management, Green Osijek, Association for Nature and Environment protection, WWF Austria, Public Institution for Management of Protected Natural Areas and Ecological Network in Virovitica Podravina County, Public Institution for Management of Protected Natural Values in Varaždin County, Public Institution for the Management of Protected Natural Values in Koprivnica – Križevci County.

## BUDGET

4,592,898 € where the EU Contribution was of 2,755,739 € co-financed.

60% co-funded by the European Union, LIFE NATURE Programme

40% co-funded by five project partners. Additionally:

- For WWF Austria's work: Austrian Federal Ministry for Sustainability and Tourism and the Coca Cola Foundation.
- For Zeleni Osijek's work: Office for the Cooperation with NGOs of the Republic of Croatia.

Unfortunately, there is no currently sufficient funding available in the LIFE program due to inflation for locations C.2 (Old Drava Varaždin) and C.6 (Miholjački Martinci), so they are actively seeking alternative sources of financing.

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