

# *Report about experience exchange on river restoration*

WP T2 / O.T2.1



## IMPRINT

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## I. Introduction

Mura, Drava and Danube (MDD) form the lifeline of one of the most valuable river corridors in the Danube Basin. With UNESCO's recognition of the world's first five-country biosphere park in September 2021 stretching across Austria, Slovenia, Croatia, Hungary and Serbia, Europe's largest river protection area is being created (TBR MDD). The area with its floodplain forests, gravel and sand banks, island, oxbows and riverine meadows has a rich biodiversity and is the livelihood of 900,000 people.

The ecological functioning of this river corridor largely depends on natural dynamic processes of the rivers, which provide the connectivity of habitats between river and floodplain, between water and bed habitats, between upper and lower reaches of the TBR MDD and the larger basin area. Although the river corridor still hosts highly valuable habitats, these are becoming dysfunctional or disconnected, because morphodynamics are currently reduced by human-made interventions.

The Interreg Danube Transnational project lifelineMDD aims at improving this situation by providing an integrated transboundary strategic framework for river restoration based on research, pilot restoration and joint learning, and, thus, contributes to protecting and restoring ecological corridors and raise cooperation between main actors.

One mean to achieve this objective is the report about experience exchange on river restoration. The report contains a summary of the experience exchange performed with the help of a study visit and an experience exchange on ongoing and past restoration projects within the TBR MDD shared by the project partners.

### **Goals of the report**

The study visit will enable the readers to gain first hand insights and lessons learned from restoration projects within the TBR MDD area.

The experience exchange on projects from within TBR MDD on contrary serves to gain an overview on the actual status quo of restoration projects within the TBR MDD.

### **Expectations for future benefit & use**

The report will be an important and valuable tool for planning restoration and/or learning from experiences also for other river managers across Europe. As the TBR MDD covers several different ecological river types (though not all) a large number of river regions can benefit from those outputs. The report will be an important practical tool for practitioners when planning and implementing new restoration projects in the future. It will let planners find institutions from within TBR MDD who may have implemented a similar project in the past and can share practical experience for more detailed planning.

## II. Experience exchange within TBR MDD – Study Visit

### A. Introduction

One of the planned activities for the lifelineMDD project within the work package T2 was a joint study visit, which should serve as a great opportunity to exchange knowledge and experiences in river restoration. At the beginning of the project, the study visit was planned outside of the TBR MDD area to Allier River in France. Allier River is a near-natural river in a cultural landscape, which in many ways can be compared to the rivers in the TBR MDD and would serve as best practice example for restoration activities. In 1985, a hydropower plant with a 14 m high dam was built on the banks of the Allier River, but in 1996 to 1998 huge restoration works were done on the river and the dam was removed.

However, due to the COVID-19 related restrictions in the time of the lifelineMDD project most of the partners were more interested into visiting the area of the TBR MDD since they have not had a chance to see restoration activities including the pilot restoration sites in the lifelineMDD project area yet. Moreover, the project partners haven't had a chance to meet in live as all of the meetings and workshops were online. Therefore, the study visit into the TBR MDD was a great opportunity for a live meeting, discussion and experience exchange among the project partners and associated project partners from all five countries: Slovenia, Austria, Hungary, Croatia and Serbia.

The area of TBR MDD in all five countries is unique, not just in the aspect of nature and the rivers, but also in culture. Each country forms different traditions, which are also closely related to the way of life near rivers. Rivers and the surrounding floodplains, wetlands, floodplain forests and meadows form the typical mosaic landscape. As people adapted to the rivers, they tried to adapt rivers to themselves too. However, in some areas of the TBR MDD such mosaic landscape is still present. We implemented the study visit in two parts because of the time available. The first part in May 2022 and the second part in June. In the frame of a study visit, the project partners and associated partners of the lifelineMDD project had the chance to see the different conditions in all five countries, understand the difference in the dimensions of the three rivers, from Mura downstream to Drava and Danube, compare the restoration sites and actions and use the gained knowledge in the future planning of the actions for TBR MDD.

Moreover, a study visit inside the TBR MDD offered a better insight into the whole area of the transboundary biosphere reserve. Each project partner made some proposals, which locations to visit in their area. Those locations are representative for the TBR MDD, for example pilot sites, other similar restoration sites, example of good practise, tourist points, etc. This also enabled the exchange of information between all 5 countries, the exchange of good practices and experiences in live. From every site that we have visited, each participant got a slip of paper with one site that we have visited. After the visit, they had to write their impression of the site. These impressions are included in the descriptions of the sites marked in green. Some visited sites are also described in detail in chapter III of the report (current and past projects) and a corresponding page reference is given.

## B. General on the TBR MDD

### General stretch characteristic of Mura, Drava, Danube

Mura, Drava and Danube, that are flowing through Austria, Slovenia, Croatia, Hungary and Serbia, represent the world first 5-country UNESCO biosphere reserve designated in September 2021. With a total area of 930,000 hectares and a length of 700 kilometres, the wildlife along the Mura, Drava and Danube is the largest river protection area in Europe. Habitats as floodplain forests, meadows, gravel and sand banks, islands, oxbows and secondary channels represent biodiversity of the area like no other in the Europe. The true treasure of the area is the bond between nature and local people who feel the rivers and are living sustainable with them. In these three rivers we can observe all typical fluvio-morphological river types, from straight to braided and meandering to river delta types are present. Some of the river parts are near natural and on the other hand we can see channelized river stretches. The sediment consists of gravel and coarse sand, which is leading to a very rich morphological diversity. Comparison of the historical maps of the river areas shows us that the river characteristic has changed significantly. In Figure 1 you see an example for the river Mura in the section around Gibina. But still, we have to have in mind that our three rivers are very different in the sense of size, velocity, width and several other parameters.



Figure 1: River Mura at Gibina from historical map and present state © photo mapire19 st. and google maps 2021.

### Pressures

It probably won't be wrong, if we write that the biggest influence on nature belongs to humans. By demanding the land for more agricultural or construction land for developing the economy, different types of embankments such as bank protection, groynes, rip-rap structures and dams are built on rivers; river are straightened and side channels are cut off. But these activities in many cases do not solve, but only intensify the problems. The river is becoming narrower, shorter and steeper which means the water flow increases and the erosion is intensified. Due to embankments, the river can erode only by incising the river bed, which also lowers the groundwater level. The lowering of groundwater levels further results in drying up the area which causes problems not only with drying floodplain forests and farmland but is also a significant problem due to the lack of drinking water. With gravel extraction the problem is only increasing.

Similar problems are caused by the upstream chain of hydropower dams, which cause interruptions of the sediment transport, flushing, hydropeaking and a significant impact on the quality of the water. Also the increasing climate change effect, such as less frequent and intense rain events or severe droughts, causes a complex issue that is threatening our rivers. The covid-19 pandemic showed us the increasing interest in recreational activities by and on the river and a lack of clear visitor guidance, aligned with nature protection's goals.

### **River restoration activities in general**

Disappearing or destruction of wetlands is one of the biggest problems in the whole world. This and other existing problems in water management requires a different approach to river and habitat protection. With knowledge of threats and understanding of the necessity of natural river dynamics, environmental perception is changing. River restoration processes have started, previously designed structures are being removed where we can give rivers their natural space. Focus is given on measures for sediment mobilization and improvement of sediment balance, structures as side channels, gravel banks, steep banks are being created to increase diverse habitats and slow down the riverbed incision. One example of restoration measures is the removal of bank protections and widening of the riverbed by erosion. The river can naturally widen and shape its bed, which reduces the sediment transport capacity in the river and stabilise the bed level. With erosion there is always deposition of material, so on the one hand steep banks are created and on the other hand, gravel and sand banks - both are important habitats at least for fish and bird species. Gravel banks represent a pioneer habitat type for the endangered forest habitat type 91E0\* ((Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae). A wide range of different stakeholders are involved in restoration activities, all of them have slightly different views on the problems/solutions. Most important are water, forest, nature and agriculture management, but without cooperation with landowners, hunters, fishermen and NGOs there cannot be effective sustainable land use/restoration. Giving a focus to change the mindset and raising awareness among local people means giving inspiration to future stakeholders to engage in such initiatives.



## C. Study visit

### 1. General

#### Agenda 1<sup>st</sup> part, short general description (16<sup>th</sup> -18<sup>th</sup> May 2022)

In the first part of the study visit project partners and associated partners of the lifelineMDD project have visited the project pilot sites in Austria (Gosdorf) and Slovenia (Hrastje-Mota) and other examples of river restoration in Austria, Slovenia, Croatia and Hungary. We have visited sites with great examples of habitat restoration in the frame of other similar projects such as NaturaMura, coopMDD, DRAVA LIFE, WISEDRAVALIFE and DRA-MUR-CI.

#### Agenda 2<sup>nd</sup> part, short general description (14<sup>th</sup> -15<sup>th</sup> June 2022)

In the second part of study visit we have visited three countries of the TBR MDD – Croatia, Serbia and Hungary. On the first day we have visited Nature Park Kopački rit and the Serbian pilot site near Karađorđevo on Lovrenac Channel. The second day started with Special Nature Reserve Gornje Podunavlje and its Karapandža River School and we finished our study visit with a boat ride in Mohács (Hungary) to Liberty Island.



Figure 2: 5-country Biosphere Reserve Mura-Drava-Danube (TBR MDD): Overview of the locations visited in the two-part study visit

**Location of the pilot sites:** a - Austria, Gosdorf | b - Hrastje Mota, Slovenia | c - Karađorđevo, Serbia

**Other sites visited:** 1 - Mill channel Mureck-Radkersburg | 2 -Riverbed widening Sieldorf | 3 - Zaton oxbow lake in Petanjci | 4 - River'sCool in Velika Polana | 5 - Lankóc Forest water retention improvement | 6 - Prelog – Dubrava Lake, Tamarisk tour | 7 – Legrad, DRAVA LIFE planned restoration site, Mura-Drava confluence, River'SCool and Libanovec steep riverbank | 8 - Nature Park Kopački rit | 9 - Gornje Podunavlje Special Nature Reserve: River'SCool and sustainable forest management, 10 - Mohács, Liberty Island

## 2. Study visit to lifelineMDD pilot sites

### Pilot Site Mura, Austria, Gosdorf (a)

Country	River	Project name	Host	see also chapter III
Austria	Mura	Interreg DTP lifelineMDD	STMK	-

In the 19<sup>th</sup> century, the so called “Border Mura” along the state border between Austria and Slovenia was straightened to a monotonous channel for flood protection reasons. Most of secondary channels were cut off and large areas were drained to make them available for agriculture. Increased flow velocity and the lack of sediments that were retained through numerous hydropower plants upstream caused river bed incision and led to disconnection of the river Mura from surrounding land and side channels, to the partial loss of alluvial forest along the river. In order to establish a balanced sediment transport and to prevent the lowering of the groundwater a large river widening entitled “Gosdorf I” was implemented in 2008. For this purpose, existing bank protection was removed and a secondary channel was created in the hinterland. Initially, the measures developed as planned. After some time, the planned development stopped and the main branch of the Mura continued to flow in a straight line.

In the frame of the lifelineMDD project new measures are conducted at this site with the goal to improve water habitats, to ecologically upgrade them, to promote the inherent dynamic development of the Mura by the mean of an initial measure and, subsequently, to counteract the progressive deepening of the Mura riverbed. The area of the measure is about 500 m long, a new channel is being excavated and about 35,000 m<sup>3</sup> of gravel was put on the river bank, which will be eroded in high water levels. Deterioration of the ecological status will be prevented by the creation of structuring measures and other ecological compensation measures.



Figure 3: Pilot site in Gosdorf; descriptive boards © IRSNC



Figure 4: Construction works in Gosdorf © IRSNC

“It is a good example for learning process in river restoration action; sediment replenishment essential for long time morphodynamics.”

“Interesting to see a restoration in action, which looks like it could become anything. It is a complete contrast to the kind of restoration where the river does most of the work.”

## Pilot Site Mura, Slovenia, Hrastje Mota (b)

Country	River	Project name	Host	see also chapter III
Slovenia	Mura	Interreg DTP lifelineMDD	VGP Promgrad	-

The Slovenian pilot site can be found in the area of Hrastje-Mota. In the past, in Slovenia there were proposals for building hydro-power plants on the Mura river. The Slovenian pilot site was the location of one of these planned hydro-power plants. As the Mura river here is facing serious issues regarding the riverbed incision due to the past river regulation measures which led to the channelization of the riverbed and lack of sediments, this was an appropriate river section for renaturation measures. Project partner VGP Pomgrad together with IRSNC, obtained all the permits for its implementation.

First, the selection and marking of trees was implemented. Afterwards, the trees were cut down and moved from the area, so the field would be ready for removing the bank protection. Riverbed widening in the length of approximately 250 m was enabled through removing the bank protection structures along the left bank. The embankment was removed from the bottom to the top of the slope. After that, the bank protection was moved about 50 m to the hinterland. The next steps were the excavation of 3 semi-circular shaped areas and forming a stone structure in the river, which directs the water current and hopefully a gravel bar will be created behind the structure dividing the river in two main flows. The excavated gravel material was partly used for the construction of the new road at the pilot site and the rest was moved into the river.

Works on the pilot site started in February 2022 and finished at the end of March 2022. A positive effect of the measure is already seen on the pilot site as a colony of Sand Martins (*Riparia riparia*) and a pair of Kingfishers (*Alcedo atthis*) have already been observed nesting in the new steep bank.



Figure 5: Participants at the pilot site in Slovenia © IRSNC



Figure 6: Pilot site Hrastje - Mota © IRSNC

“I found it great, that nature conservation took place, instead of building a power plant. The measures haven't been finished for a long time, but birds already came to build their nests – amazing how fast nature takes back the area.”



### Pilot Site Danube, Karađorđevo, Serbia (c)

Country	River	Project name	Host	see also chapter III
Serbia	Danube	Interreg DTP lifelineMDD	INCVP	-

A pilot site in Serbia, at the Lovrenac channel near the Danube River is also under threat. Over the years, a huge amount of organic material accumulated in the channel, reducing the flow of water and therefore drying out the area. The Serbian pilot site is divided in three areas. We have visited two locations with completed works; at the third location works have not started yet. Before the field works, they had to obtain all the permits, also from all land owners. Works on the Lovrenac channel started in mid of December 2021 and finished at the end of February 2022. The works have been presented to us by INCVP and the contractors, which were responsible for excavation of excess deposited organic material (silt) in the channel and later siltation/drying off the channel. The material was taken to a landfill located outside the protected area. After the material has dried it will be compacted and will serve as a kind of reinforcement of the embankment or it will be transported and spread to the fields. The landfill with approx. 15,000 m<sup>3</sup> of excavated silt is approx. 2 km from the pilot site. With these measures, they reached the depth of the channel between 1-2.5 m. The works carried out greatly improved the flow and condition of the channel at the pilot site. Similar measures will have to be repeated several times on the same channel. The last high water was in 2014 but for the last 4-5 years there has been a drought. The consequences of the drought are expressed in the disappearance of the carp fish and mosquitoes. Both locations of the pilot area are used by local fishermen, the measures with excavating the material have been well received because they also improved the habitat for fishes. In addition to fishermen, they also included other stakeholders, such as the municipality and army (ownership). The municipality agreed with the measures, as long as INCVP obtained all the necessary permits. Locations for the pilot site were chosen because there were no projects in this protected area yet. In this case, it was also very important to include local stakeholders and showing them that preserving nature impacts biodiversity and endangered species which is good for the local environment. The area of Karađorđevo between the dyke and the Danube River was once Tito's famous hunting ground, today it is a state hunting ground of red deer, fallow deer, white-tailed deer and other animals.



Figure 7 and Figure 8: Lovrenac channel – discussion of project partners; local fisherman. © IRSCN



“It was interesting to hear which parties participated in the restoration process and the lack of the involvements of the local communities that turned into their advantage at the end. Overall, thank you for the study visit. It was great.”

“It is very useful to check different parts and subsites of the same project site. There are new experiences everywhere.”

“Interesting to learn about the historic situations in terms of individual flow regulations out of outlets of side channels for fishing. Architecture by locals... Dredging required due to lack of sediments”

“I appreciated the measures and works done here.”

“Local people were used to regulate connectivity already 500 years ago -> strong connection between river and people in the past. Situation of side channels is a natural process, but should be compensated by lateral erosion at other places. Main channel banks are protected, so only vertical erosion there. Siltation disconnects channel and pumped groundwater from agricultural fields becomes a problem for water quality because of nutrients. Lessons learned: 1) consider water quality, need to prevent stagnation waters? Vs Adjustments of agricultural uses? 2) Free the main channel course however possible to have automatic development of new side channels, so that one may accept also siltation of side channels. 3) Understand humans as riverine species with acceptable uses.”



Figure 9: Participants of the second part of the study visit at Lovrenac channel © Ante Gugić

### 3. Study visit to other TBR MDD sites

#### Mill channel Mureck-Radkersburg (1)

Country	River	Project name	Host	see also chapter III
Austria	Mura	Interreg IIIa – Maßnahmen unteres Murtal	STMK	-

Due to the deepening of the Mura river, the mill channel hardly received any water from the river, so a new section of the mill channel was modelled. Hence, the mill channel was extended about one kilometre upstream and a new intake structure was built. This new section of the mill channel was designed and inspired by the natural floodplain streams. In 2001 they dug a 1 km long artificial channel into the alluvial forest, between Mureck and Bad Radkersburg, whereas 45,000 m<sup>3</sup> of material was excavated, which was later returned to the Mura river. Downstream between Mureck and Bad Radkersburg discharge obstacles were cleared.

Because of the new artificial channel, the groundwater level along the millstream rose which has a positive effect on the area. It has created an important cultural landscape with new habitats for diverse species. Besides the occasional excavation of debris and gravel, no other work along this channel is necessary. According to the water law permit, 3 m<sup>3</sup>/s shall flow into the mill channel. Because of river bed incision this is not possible at all time anymore. An adaption of the intake area is being discussed that will enable more waterflow into the channel.



Figure 10: Mureck Mühlbach location © IRSNC

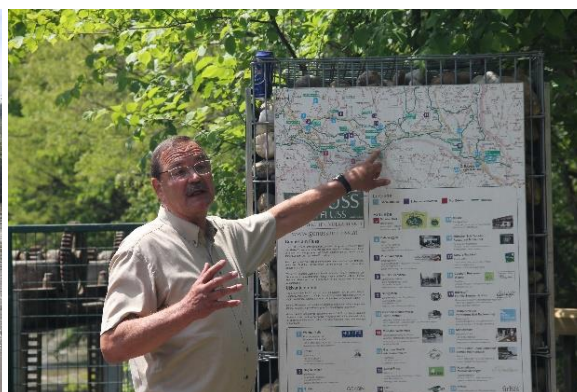


Figure 11: Rudolf Hornich explained the creation of the artificial channel © IRSNC

“At the ship mill we got excellent food and we had the first chance to talk to the others. I liked it!”



## Riverbed widening Sieldorf (2)

Country	River	Project name	Host	see also chapter III
Austria	Mura	DRA-MUR-CI	STMK	p. 92

The aim of the riverbed widening was the ecological revaluation and the morphological improvement of the Mura river as well as an improvement of the adjacent alluvial forest. The main threat of the river is riverbed incision caused by lack of sediment inflow from upstream. For initiating erosion of the left riverbank, the concrete bank protection was removed in a length of 1,400 m. It was reused as hidden protection in the hinterland. Initial structures should additionally stimulate the erosion process and development of the area without any further human intervention.

But the flood event in July 2012 showed, that erosion was faster than expected. For securing adjacent land and the agricultural road along the project area the process had to be stopped. Whole trees as wooden groynes were fixed in the riverbank for focusing the flow to the middle of the river. At a short section, the agricultural road had to be secured through riprap structures. Small fish species should find new habitats at the restoration site.

Across the river at the Slovenian side, a nice gravel bar, which is pioneer habitat for willow and poplar developed. The gravel was probably carried from Gosdorf site, where restoration works have been carried out before. We had a guided walk along this river section, where all the measures which were carried out were presented to us with the help of info-boards that are set up in the area.



Figure 12: Sieldorf descriptive boards © IRSNC



Figure 13: Interpretation of measures © IRSNC

“I learnt how to widen a river and how to think about it. I learnt how to slow a river flow and also how to slow my stepping into the nature. I learnt how to make small islands and how these make better connections in the nature.”

“I preferred this site on the 1st day. The other two were a typical water. I liked what they showed us.”

### Zaton oxbow lake in Petanjci (3)

Country	River	Project name	Host	see also chapter III
Slovenia	Mura	NaturaMura	IRSNC	p. 44

The restoration of this oxbow lake is part of the NaturaMura project. Because the level of groundwater is decreasing, this very important biodiversity oxbow lake dried up and was overgrown with vegetation. The whole length of the oxbow is approximately 1 km, they restored around 600 m, but first they had to get all the permits from a huge number of landowners, as the oxbow lake is in private ownership. Project documentation and other permits were obtained.

After that, they dug out around 16,000 m<sup>3</sup> of material of which transportation is still ongoing. It is difficult to excavate and transport the material due to the soaked terrain. When the material will be dried out, it will be spread on the fields of the owners and partly be used for the renewal of the protection dyke. On some localities there is a deeper excavation, which is necessary in big droughts, as the water will always be available there. Amphibians and other species already occupied the lake.

An interpretation path will lead from the tourist point Spa Radenci to the oxbow lake where an info board about amphibians and other species connected to oxbows will be implemented in the frame of the project.



Figure 14: Explanation of finished works © IRSNC



Figure 15: Oxbow lake Petanjci © IRSNC

“What impressed me the most was the way they got permits from a huge number of landowners during New Year’s Day. Also, that they want to make it more accessible to visitors and for educational activities (e.g. water tower) for this 600 m stretch. And that in some floodplain forest restoration site they use pigs to forage the forest ground in order for willow and poplar seedlings to more easily propagate.”



## River’sCool in Velika Polana (4)

Country	River	Project name	Host	see also chapter III
Slovenia	Mura	Interreg DTP coopMDD and NaturaMura	Municipality Velika Polana	p. 44

We have visited the River’scool in Velika Polana. Project partner Municipality of Velika Polana is using the location for presenting the natural and cultural heritage of the area. They are also presenting the TBR MDD, with a focus on the Biosphere reserve Mura in Slovenia. Cultural heritage is presented on the nearby homestead Pomelaj, where they are working on local typical products.

The River School is located between a floodplain forest and wet meadows, which were overgrown and due to that restored in the ongoing project NaturaMura. In the center is the Copek mill, which is the only preserved stream mill around here. The host has presented us the River school with a movie about the Biosphere Reserve. We also had a walk on the wooden path through the black alder forest (*Alnus glutinosa*), which is equipped with the interpretation of nature. The plans for the future includes turning an old barn into a museum with old tools. Additionally, we enjoyed lunch and a wine tasting.



Figure 16: Old barn © IRSNC



Figure 17: Copekov mlin © IRSNC

“The River school needs a lot of maintenance and other staff would be needed. There are many different educational facilities that would need more visitors.”

“It was impressive to see how the restoration works and actions were realized in this region. The collection of ideas and experiences was inspiring and also, they welcomed us warmly. Velika Polana: I like that the municipality can use the benefit of the project, floodplains and that it creates jobs and develops tourism in the region. It is worth to spread such good example with other municipalities.”

“The river school in Velika Polana should be open to public.”

## Lankóc Forest water retention improvement (5)

Country	River	Project name	Host	see also chapter III
Hungary	Drava	WISEDRAVALIFE	Drava Danube National Park	p. 54

The main objective of the project is to contribute to the conservation and resilience of the riparian habitat types along the Drava River on the Croatian–Hungarian stretches, by improving the water regime with retention works and biodiversity of riparian forests. At the first location, we have seen a restored wet meadow with a surface area of approximately 10 ha. Before the restoration, intensive field farming was carried out on the location. With no other use and just mowing the land twice per year for several years, a flowering meadow with also endangered species Siberian iris (*Iris sibirica*) has developed. Part of the meadow is also protected as a park.

Near the restored meadow, water retention works were conducted. The works were done to retain the water in the area in order to improve the hydrological state of the meadow and the near forest. Altogether six water retentions were built to retain water there. On the third location, we checked one of the 53 bat nests and took a walk through hardwood forest in the Danube – Drava national park. We have also seen the measuring station for water in the forest.

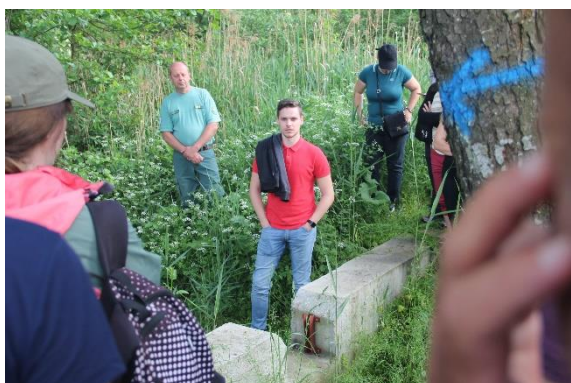


Figure 18: Concrete water retention structure © IRSNC



Figure 19: Hardwood forest in Danube – Drava National Park © IRSNC

“In Lankóc I was especially impressed by the restored meadows and also the fact that part of the meadows are protected as a park. It’s interesting that the protected / endangered species have occurred although they were lost due to agriculture. Water retention works just contributes to more extensive use of the area, which is good. Big area of forest is ideal habitat for many species. I hope that the conservation of the area will continue”

“Sometimes it may be better to buy land and simply leave it to nature itself.”

## Prelog – Dubrava Lake, Tamarisk tour (6)

Country	River	Project name	Host	see also chapter III
Croatia	Drava	DRAVA LIFE	WWF Austria	p. 30

We took a short tour at Dubrava Lake to see the German tamarisk (*Myricaria germanica*) and Dwarf cattail (*Typha minima*). These species are endangered due to lack of their habitats. Both plants are pioneer species which occupy bare surfaces of newly created gravel and sand bars of natural rivers in the Alps and their foothills. They are specialists, adapted to the unique ecological conditions of their habitats. Therefore, they are regarded as being one of the most important indicator species of intact rivers which are characterized through natural hydro-morphological dynamics of sediments and changing of the riverbed.

The German tamarisk is a small deciduous shrub, up to 2.5 m in height. Leaves are small, greyish-green, branches are brown to reddish. It flowers from June to September. There were two attempts of reintroduction (in 2018 and 2019) with young plants, cuttings and seeds but the efforts didn't show significant results. Within the DRAVA LIFE project, the action on the reintroduction of the two riverine plants German tamarisk and Dwarf cattail is ongoing on several locations on the Drava River in Croatia. Currently, two plants are in Klagenfurt botanical garden and additional activities for seed and cutting propagation are in the planning stage.



Figure 20: German tamarisk (*Myricaria germanica*) © IRSNC



Figure 21: Lake Dubrava © IRSNC

“Study trip was excellent. I did not know about ecological importance and pioneer role of Tamarisk in dynamic river habitats and also this conservation activities implemented are very encouraging. Good motivation for my work.”



## Legrad; DRAVA LIFE planned restoration site, Mura-Drava confluence, River'SCool and Libanovec steep riverbank (7)

Country	River	Project name	Host	see also chapter III
Croatia	Drava	DRAVA LIFE, Interreg DTP coopMDD	Croatian Waters	p. 30

In Legrad we have visited 3 locations. The first location was the water keeping house “vodočuvarice”, which is in the final stage of renovation. This will be the first educational water centre in Croatia, where they will organize various workshops, fieldtrips and conferences, whereas 6 schools and 1 association for kids with special needs, already signed a contract for collaboration. We also went on a walk, where flood protection will be improved and a few side channels on Drava River will be reconnected. The purpose of the intervention is to increase river dynamics. On the side channels there is a concrete crosswalk which will be removed. We have prolonged the walk to the watchtower at the Drava River, there a white-tailed eagle (*Haliaeetus albicilla*), a charismatic species of TBR MDD, has honoured us with a flyover.

The highlight of the trip was definitely the confluence of Mura and Drava, where we took a group photo and tried two games from the lifelineMDD Training handbook which was created within the lifelineMDD project. We took a walk to the River'SCool in Legrad and finished our trip in Legrad with visiting the high steep bank near Libanovec, where the biggest Sand Martin colony of the Croatian Drava is nesting.



Figure 22: Observing the steep bank in Libanovec © IRSNC



Figure 23: Mura - Drava confluence © IRSNC

“Study visit was useful and good organized. We now can use this experience as ideas for similar projects. On this location of Mura – Drava confluence there is a good growth example of former river side arms.”



## Nature Park Kopački rit (8)

Country	River	Project name	Host	see also chapter III
Croatia	Drava	-	NP Kopački Rit	-

The Nature Park Kopački Rit is located in eastern Croatia in the municipalities of Bilje and Kneževi Vinogradi. It has been designated as a zoological reserve (17,000 m<sup>2</sup>) as it has a great number of typical species connected to wetland habitats and it is also a very well-known tourist point in Croatia. It comprises many backwaters and ponds along the Danube (50,000 m<sup>3</sup> floodplain area). It is one of the most important, largest and most attractive preserved intact wetlands in Europe, the largest inland delta of the Danube.

We had a guided tour by boats and a short walk in the Nature Park through one of the largest wetlands. The Nature Park had its last flood in 2013 with water 5 m higher than today. During our visit we have seen European pond turtle (*Emys orbicularis*), Grey Herons (*Ardea cinerea*), Great Cormorants (*Phalacrocorax carbo*), Black Storks (*Ciconia nigra*), Mallard Ducks (*Anas platyrhynchos*), Kingfishers (*Alcedo atthis*) and other species. They have the largest known Grey Heron colony in Croatia which is not migratory and stays all the time in the Kopački Rit. Cormorants are also an important species in the park as their estimated number is 1,000 breeding pairs. Their food is exclusively fish (around 0.5 kg/day -> ton per day).

The Nature Park is also home to one of the largest birds – White-tailed Eagle (*Haliaeetus albicilla*) with a wingspan up to 2.5 m and with the estimated number of 50 breeding pairs, in which is the largest nesting colony in Central Europe. We had luck with zero mosquitoes which is very atypical for this area and season because there was no high water in the spring at all. The floodplain consists of 90% white willow and 10% poplar. Visiting the educational centre was followed by a walk through the park and a guided tour by boats.



Figure 24: Walking path in Kopački Rit © IRSNC



Figure 25: Visitor center NP Kopački rit © IRSNC

“Info centre in Kopački Rit is very nice. A lot of good interpretations of nature and its animals. The boat ride was very calm and we had seen almost all of the special bird species – the stars.”

“The boat trip was nice, but too short accordingly to the size of NP. We will visit it again for sure and take more time and a canoe trip.”

“The trip to KR was very nice, the interactive presentations are a great way to show different scenarios, sounds.... I have learned a lot about animal species in KR and it is impressive how preserved the area is.”

“During our visit to the KR NP, we felt strong connection between us and the nature. Variety of animals and other species have a strong impact on humans and take it back to the roots.”

“I have visited this park as a child. Now, when I am working and dealing with Drava river; good and bad practices and impact of our nature and environment. I am really proud of this untouched and stunning part of Drava. Of course the impressions are nowadays stronger and better and I am looking forward to help nature lovers and stakeholders to enjoy in Drava beauty and diversity.”

“Still an amazing area, but a little worried about the climate change and the lack of water.”

“I was surprised about the dimensions of NPKR and how many different animal species live there. The Park has very nice facilities and very attractive modern experiences. I recommend visit to everyone.”

## Gornje Podunavlje Special Nature Reserve: River'SCool and sustainable forest management (9)

Country	River	Project name	Host	see also chapter III
Serbia	Danube	Interreg DTP coopMDD	Vojvodinašume	-

In the Special Nature Reserve Gornje Podunavlje, which is the largest floodplain area in Serbia, is one of the eight River'SCool along the TBR Mura-Drava-Danube that was built in the coopMDD project. The Special Nature Reserve "Gornje Podunavlje" is a protected area and it represents a complex mosaic of water and land ecosystems. It is a part of the large marsh flooded complex, which extends through the neighbouring countries, Hungary and Croatia. Besides its biodiversity, Gornje Podunavlje is famous for its authentic cultural heritage. The reserve is an important center of biodiversity. The wealth of the protected area is reflected in 55 different species of fish, 11 species of amphibians, 9 species of reptiles, 230 species of birds and 51 species of mammals, as well as numerous species of invertebrates, especially butterflies.

At Karapandža River School they also renovated the old forestry house and prepared a program for a 1-day excursion. First, we visited the Štrbac walking path where nature interpretation boards are set up. It was a nice walk also through the forest. After the walk we did some activities from the lifelineMDD Training handbook and took a boat ride on the Bajski channel. This channel was built in the 18<sup>th</sup> century in order to drain the floodplain area and in this way 150,000 ha of agricultural land was created, where before there were flooded areas.



Figure 26: Guiding in the Karapandža River School © IRSNC

Figure 27: Boat ride on the Bajski channel © IRSNC

“Due to climate change it is becoming increasingly important not to drain a region anymore, but to hold back the water in the region. Good projects work particularly well if several institutions (departments) work together or one institution is responsible for several areas. It is important to teach the children how the interaction of nature works and how quickly it can get out of time, when a part of it stops working.”

“I did not know, that there is the largest deer population in Gornje Podunavlje and that is a famous hunting area. It was also interesting to hear that the hunting area and the nature protection area are cooperating. The river school and education centre are a great opportunity to learn about the nature reserve.”

“I learnt how important is to make a great and natural place for the children in the forest, close to the river and show them the importance of the nature. So, the River School NR Gornje Podunavlje fulfilled these expectations. And there are eight of them in the country. The Serbian state and enthusiastic co-workers showed that they can make a place for the children, where young folks can enjoy the beauty of the nature, the trees, the birds, the rivers but also can learn useful knowledge. So thus, the experiences and the knowledge meet in their mind during the various activities. The workers give a good example to the other communities. I also kept in mind the Hungarian history line of the place, which is coming from the period of Maria Theresia, when oaks were planted here.”



## Mohács, Liberty Island (10)

Country	River	Project name	Host	see also chapter III
Hungary	Danube	LIFE DANUBEISLANDFOREST Liberty Island	WWF Hungary	p. 72

We took a boat ride from Mohács to the Liberty Island, where restoration work took place in the past within a LIFE+ project. The Liberty Island is located in South Hungary northward from Mohács at the left side of the Danube. Its length is about 3 km, its width is 150-200 m, and its surface is 70 ha.

The Liberty secondary channel was blocked by a rock-fill dam which stopped the natural water flow and induced intensive silting up. The island was partly privately owned, so the nature conservational purpose of the island's management was not ensured. WWF Hungary together with other partners, purchased the privately owned land to ensure the implementation of the project. The forests on the island were managed for commercial forestry purposes by hybrid poplar plantations with a high coverage of invasive species. WWF Hungary together with its partners implemented a LIFE+ Nature project to restore the secondary channel and forest habitat. The secondary channel of the Danube River was restored, which created riverine habitats again and a floodplain forest was restored on the island – it is left to natural processes and it is now strictly protected nature conservation area, it is part of the Danube-Drava National Park and the Natura 2000 network, a Ramsar site as well and operates as an important ecological corridor along the river.

After the restoration, water flows again in the previously closed secondary channel. They have reforested around 18 ha of forest by removing invasive alien species and planting indigenous tree species. The success of the project is presented by a newly established White-tailed Eagle nest and the presence of individuals of more than 5 protected rheophilic fish species which are staying permanently in the free flowing side channel and using this habitat not only to stay and feed, but as a spawning site.



Figure 28: Guiding in the Karapanđa River School © IRSNC



Figure 29: Boat ride on the Bajski channel © IRSNC



“It was really great to hear and see great results of reconstruction works in Mohacs in Hungary. Lots of problems discussed during our boat ride are similar in Serbia and it is very useful to hear this.”

“Liberty Island is located north of Mohács. It was the first time here for me. I have learned about this restoration, which I am fascinated about the size, impact, cooperation and good organization. It is a great example for full time projects. The boat on Danube was a cherry on top.”

“It was interesting to hear that the land on the island was bought from 8 owners (including some local municipality representatives) in 2010 and the protected area managers had to come to a sort of agreement with the electrical company to convince them not to clear cut the trees; but just around electrical pillars. And it was fascinating to learn that there is poplar plantation as well as the autochthonous poplars and willow trees.”

“Landscape is very nice and inspiring.”

“The land on the island had to be bought from several private owners by WWF and was given to the government. For planting new vegetation there were three different methods used: 1) All cleared out and new trees planted in rows. 2) All cleared and planted by hand. 3) Some old vegetation was kept and new planted between. A flood event a year ago helped plantation to grow a vegetation. To protect young plants, a fence had to be put around the island. Because of the wild boars. Success of the project is also that one pairs of eagles has built a nest on the island.”

#### 4. What can be learned from the experiences of the study visit?

LifelineMDD connects people and rivers from five different states, and different cultures with the purpose to conserve our three beautiful rivers. We are all aware of the problems that our rivers are facing and we know the basic solutions to these problems. The organization for such a diverse and big group was not so easy and many meetings between project partners were held before the study visit. Visiting the sites and seeing what other project partners are working on brought a nice insight into the situations and sharing the experiences from the lifelineMDD project and also other projects that are running or were implemented in the area. We all face similar problems such as communication with different stakeholders, management bodies, landowners, silting of side channels and oxbows, drying of the floodplain (forests and meadows), riverbed incision and many others. We could jointly speak about them on the study visit and share our experiences.

We learned from the study visit, that the general problem in TBR MDD is acquiring land for restoration projects. The importance of connecting all stakeholders and all sectors should therefore be emphasized. The involvement of the local community is essential. Creating networks, acquiring knowledge, and building trust are the only ways to guarantee a successful restoration project as well as a successful management in the Mura-Drava-Danube biosphere area. Also, today's implemented river restoration projects lack monitoring (especially of species and habitats) to ensure learning from them.

Despite not being able to arrange a study visit sooner, its purpose was still a success. The participants got to know each other, new friendships were forged and cooperation among us will now be easier. In general, the participants have complimented the organisation, food, drinks and seen results/sites. The organization crew thanks the participants for their contribution, patience and understanding. Without such a great team the study visit would not have been such a success.

Studying abroad helped us realize that sometimes the impossible is actually possible. Why? Because we saw live that what has seemed as "impossible" has already been achieved in some other TBR MDD country. As a result, the study visit inspires new hope for all project partners about the value of restoring the rivers.

“As someone who is not a biologist or ecologist, this was all extremely helpful to learn. Great organization, great team!”

“Study visit was very interesting. We saw beautiful places in Croatia, Serbia and Hungary. We had fun in Serbia where we saw two pilot locations.”

“Lesson learned: a) I like red wine more than white, b) The swing at the river school is not that dangerous, c) IRSNC is perfect in organizing this trip.”

“It was so great, that after 2 years hearing about the sites only online, to see and feel the beautiful nature at these spots, especially to see birds in their habitats I didn't know before. This is like a booster for the work for the biosphere reserve.”

### III. Experience exchange within TBR MDD – Collection of ongoing and past restoration projects

#### A. Introduction

In this chapter, 14 ongoing and past restoration projects in the TBR MDD area presented. However, also projects situated in the catchment or having some influence on the TBR MDD area were considered. We did not seek to just collect best practice examples, but to share the gained knowledge including challenges that might have appeared in order to support other restoration sites. The target group are experts familiar with the topic of river restoration. Technical terms are not explained separately.

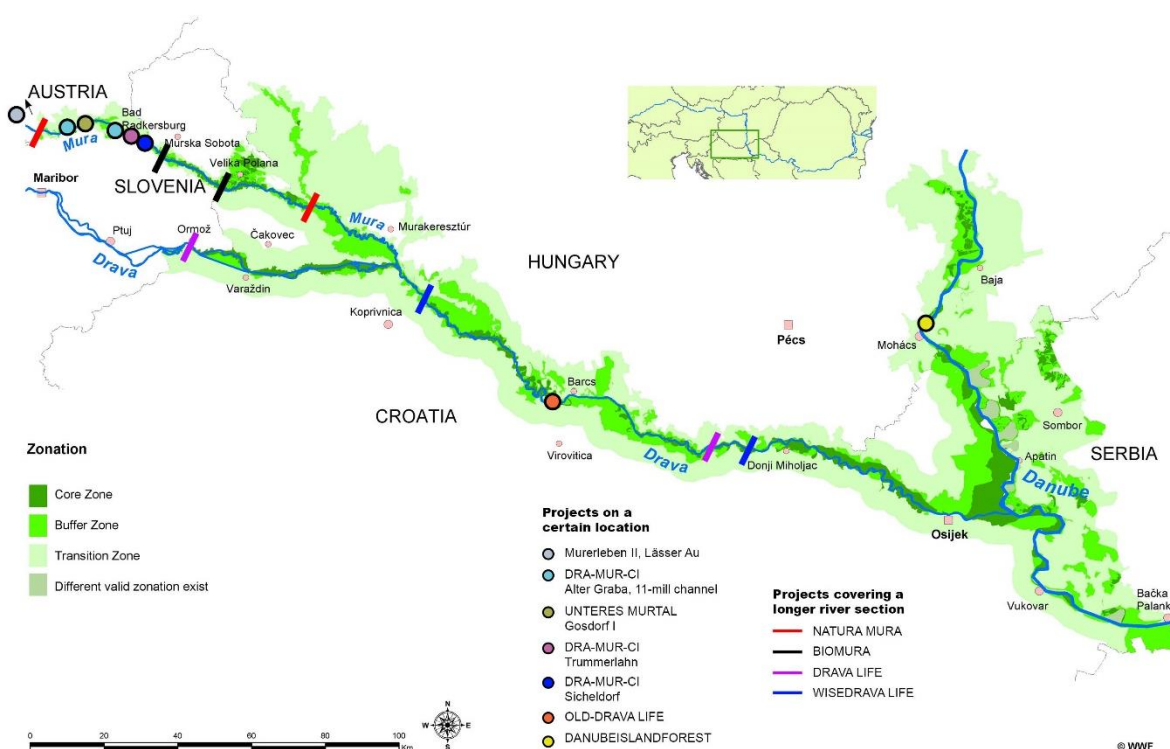


Figure 30: 5-country Biosphere Reserve Mura-Drava-Danube (TBR MDD): Overview location of the projects, modified

The projects cover a wide range of different project types, river section types and river stretch characteristics, addressed problems, restoration goals, and ways to involve interested bodies and measures. 3 projects are described in a compact form and less detailed based on the limited available information and are marked with the keyword „a glimpse into“. The measures can be directly linked to the lifelineMDD River Restoration Toolbox, as the same categories are addressed.



Table 1: Fully described ongoing projects

Name	Countries	River	Duration	Total costs
DRAVA LIFE	Croatia	Drava	2015 - 2024	-
NATURA MURA	Slovenia	Mura	2020 - 2023	-
WISEDRAVALIFE	Hungary, Croatia	Drava	2018 - 2023	-

Table 2: Fully described past projects

Name	Countries	River	Duration	Total costs
BIOMURA	Slovenia	Mura	2006 - 2011	€ 1,975,519
DANUBEISLAND-FOREST	Hungary	Danube	2009 - 2013	€ 1,795,529
DRA-MUR-CI Alter Graba 11-mill channel	Slovenia	Mura	2009 - 2013	No data
DRA-MUR-CI Sicheldorf	Austria	Mura	2012	€ 147,826
DRA-MUR-CI Trummer-Lahn	Austria	Mura	2012	No data
MUERERLEBEN II, Lässer Au	Austria	Mura	2012 - 2013	€ 470,000
OLD-DRAVA LIFE	Hungary, Croatia	Drava	2014 - 2019	€ 833,985
Unteres Murtal – Gosdorf I	Austria	Mura	2006 - 2008	€ 600,000

Table 3: A glimpse into past projects

Name	Countries	River	Duration	Total costs
Boroš-Drava & Aljmaški rit branches	Croatia, Hungary	Drava	2017 - 2019	€ 1,340,124
ECOWET	Croatia, Serbia	Danube, Sava	2017 - 2019	€ 355,013
Wetland Restore	Croatia, Serbia	Danube, Sava	2019 - 2021	No data

## B. Working approach

### **Joint perspective**

As starting point for this chapter, a joint perspective of all project partners and associated partners on river restoration was established during an online workshop on 04/11/2020. In addition, a second online workshop was held from 12-13/04/2021, where a joint review of past and current restoration projects within TBR MDD took place. These activities developed a common understanding for the report. In a third online workshop on 23/09/2021 key facts about the collected projects were presented, a virtual walk through the projects was done, the report structure and an overview about the lessons learned was presented. The last online workshop took place on 01/02/2022 where an overview about addressed problems, goals and river characteristics was given in order to explain the audience what information can be expected from the report.

### **Joint development**

For the report itself, firstly, the project partners nominated their projects to share for the report. In order to collect the information in a structured and standardized way, to guarantee their comparability and achieve a high quality a template was created. A guidance for the authors was part of the template explaining the requested input in detail. In some chapters, predefined categories are applied to ensure the comparability of the projects for the readers. In terms of content, emphasis was set on giving a detailed insight in the carried out project and providing information that might support others in realizing river restoration measures. The blank template can be found in the annex.


As support for the project partners, the template and the determined workflow were presented in a virtual meeting on 11/03/2021. In addition, a fill-in help and an example were provided.

After receiving the contributions of the project partners a quality check was applied. The formal and content-related requirements were checked and the feedback was sent to the project partners. In case needed, several feedback loops respectively bilateral coordination were carried out. The final versions were incorporated into the draft report. Taking into account the project partners' comments on the draft report, the report was finalized.

## Linkage to the lifelineMDD River Restoration Toolbox

The lifelineMDD River Restoration Toolbox<sup>1</sup> offers information about measures to improve sediment balance of rivers in the 5-country biosphere reserve Mura-Drava-Danube. It presents six planning modules with a description, basic rules and knowledge, information where to apply them, effects, challenges as well as best practise examples. In the report about experience exchange on river restoration the planned and implemented measures of the projects are described based on problems they are addressing, whereof one is sediment management. Hence, it is beneficial to interlink the report and the toolbox as this provides additional information about the measures described for the report and more application examples for the river restoration toolbox. Therefore, the six planning modules, including their icons, represent the sediment management categories for stating the planned and implemented measures in the report.

Figure 31: Planning modules of the River Restoration Toolbox

	Erodible ("soft") banks		Lowering the foreland
	Mechanical widening		Sediment input
	Initial channels		Structures to enhance erosion

### C. Project descriptions

All 14 ongoing and past projects are described on the following pages.

<sup>1</sup> S. Mühlmann et al. (2022)



# DRAVA LIFE

*The project aims at creating benefits for numerous types of endangered habitats and species in four Natura 2000 areas along 310 km of the Drava river.*

ONGOING  
PROJECT

## Key Facts

<b>Project</b>	DRAVA LIFE – Integrated river management
<b>Country</b>	Croatia
<b>River</b>	Drava
<b>River section type<sup>2</sup></b>	Drava I, Drava II, Drava III
<b>Planned measures</b>	<ul style="list-style-type: none"> <li>• Restoration or reconnection of seven old side channels</li> <li>• Riverbed widening</li> <li>• Creation of an initial channel to increase dynamics</li> <li>• Securing land for restoration</li> <li>• No interaction erosion /restore dynamics of a steep bank</li> <li>• Habitat management for river birds</li> <li>• Habitat management and reintroduction of river plants</li> </ul>
<b>Implementation period</b>	2015 - 2024
<b>Funding Source</b>	<p>60% co-funded by the European Union, LIFE NATURE Programme 40% co-funded by five project partners. Additionally:</p> <ul style="list-style-type: none"> <li>• For WWF Austria’s work: Austrian Federal Ministry for Sustainability and Tourism and the Coca Cola Foundation</li> <li>• For Zeleni Osijek’s work: Office for the Cooperation with NGOs of the Republic of Croatia</li> </ul>
<b>Project participants</b>	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
<b>Contact</b>	Hrvatske vode (Croatian Waters), <a href="http://www.drava-life.hr/en/project">www.drava-life.hr/en/project</a> , <a href="mailto:info@drava-life.hr">info@drava-life.hr</a>

## Introduction

The DRAVA LIFE project area 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.

<sup>2</sup>

Morphological reference conditions of Mura, Drava and Danube within the 5-Country Biosphere Reserve, Schwarz, U. (2014, modified) in: Mühlmann et al., 2022. River Restoration Toolbox, Measures to improve sediment balance of rivers in the 5-country biosphere reserve Mura-Drava-Danube, compiled in the frame of the Project DTP3-308-2.3- lifelineMDD, co-funded by European Union funds (ERDF, IPA)

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.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	X
Barriers/connectivity	X	Habitat degradation	X
Channelization	X	Invasive species	-
Disturbed sediment regime	X	Water abstraction	-

**Barriers/connectivity (lateral) and channelization.** Starting from the second half of the 20<sup>th</sup> century, several side channels or anabranches of the Drava river were cut off either completely, or for most runoff levels, 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.

**Flow alteration.** Starting from the 19<sup>th</sup> century and then more intensively from the mid-20<sup>th</sup> century, cutting of meanders of the Drava has become a practice for the reasons described above. Focusing the runoff into one main riverbed ensured that flood effects are restricted to a narrow strip of land and more arable land becomes available and less prone to damage by flood.

**Habitat degradation.** 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.

**Disturbed sediment regime.** 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.

## Restoration goals

RESTORATION GOALS			
Adapt land use	X	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	X
Re-establish/ improve longitudinal connectivity	-	Sediment management	-

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.

## Involvement of interested bodies/parties

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.

## Planned measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	-
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	X
	Initial channels	X	Reintroduction of plant species	X
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

Site	Intervention description
Otok Virje	Side channel restoration and riverbed widening: <ul style="list-style-type: none"> <li>- reconnection of an old side channel</li> <li>- initializing dynamic habitats</li> <li>- restrict forest use on the new island</li> </ul>
Stara Drava Varazdin	Side channel restoration and riverbed widening: <ul style="list-style-type: none"> <li>- reconnection of an old side channel</li> <li>- widening of the main riverbed</li> <li>- initializing dynamic habitats</li> <li>- extensive forestry in the floodplain area</li> </ul>
Donja Dubrava- Legrad	Opening existing side channel: <ul style="list-style-type: none"> <li>- reconnection of an old side channel</li> <li>- initializing dynamic habitats</li> <li>- create a nature education path and a “Water School”</li> </ul>
Botovo	Opening existing side channel: <ul style="list-style-type: none"> <li>- reconnection of an old side channel</li> <li>- land use change on recreated island</li> <li>- initializing dynamic habitats</li> </ul>
Novačka	Initial channel building: <ul style="list-style-type: none"> <li>- reconnection of an old side channel on the upstream site left bank</li> <li>- create an initial channel on the downstream part right bank</li> <li>- actively allow old groynes on the left bank of the main riverbed (opposite to the new side channel entrance) to decay</li> <li>- land use change near riverbanks and on the newly created island</li> </ul>
Miholjački Martinci	Opening existing side channel: <ul style="list-style-type: none"> <li>- reconnection of an existing side channel</li> <li>- initializing dynamic habitats</li> <li>- restrict / prohibit forestry use on the new island</li> <li>- 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</li> </ul>
Libanovec steep bank	<ul style="list-style-type: none"> <li>- active lack of intervention against dynamic bank erosion until intervention line</li> <li>- 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)</li> <li>- Communication and awareness raising regarding natural dynamic development of rivers, steep river banks and their function as habitats</li> </ul>

## Expected results & effects

- 41 ha of land acquired for river restoration
- 1,000 m of dynamic river banks restored and preserved
- 13 ha of new dynamic river zones with gravel, sand and muddy banks created
- 14.5 km of side channels restored or newly created
- Quality of more than 300 ha of floodplain forests 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

All of the results described below are expected results, based on the assumptions that restoration plans were based on and the developments that were observed during the project elaboration and development.

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.

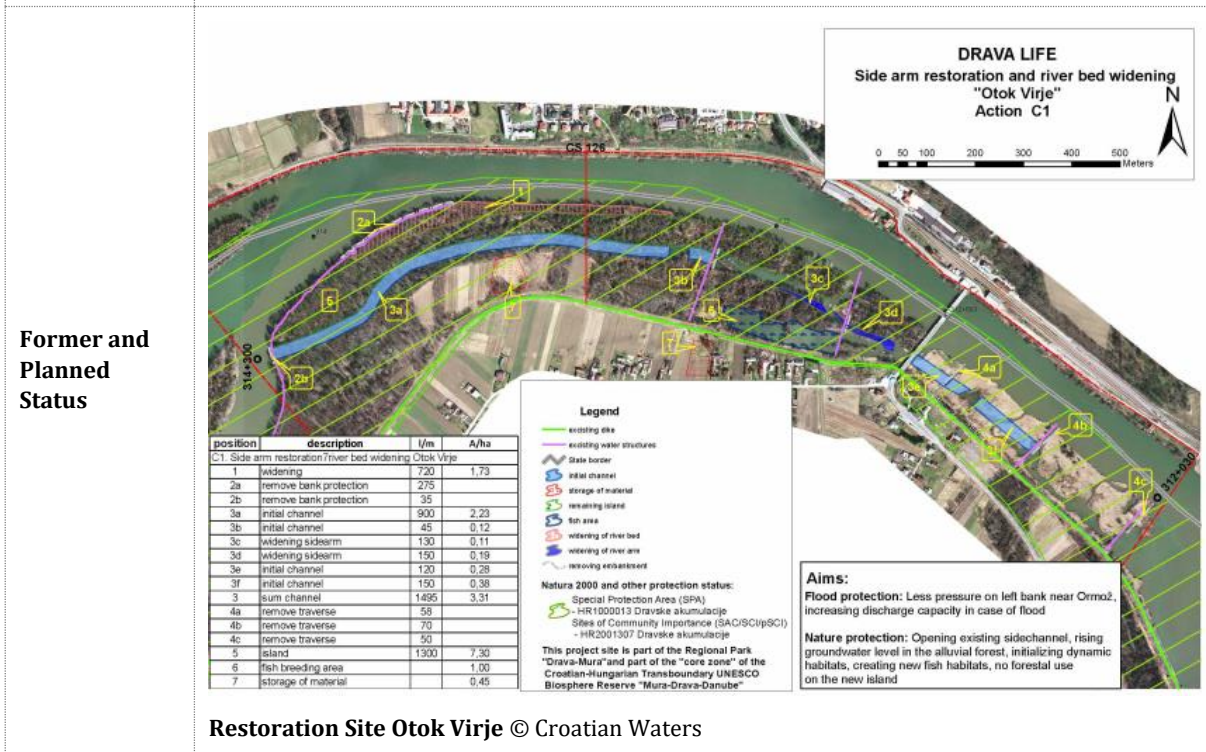
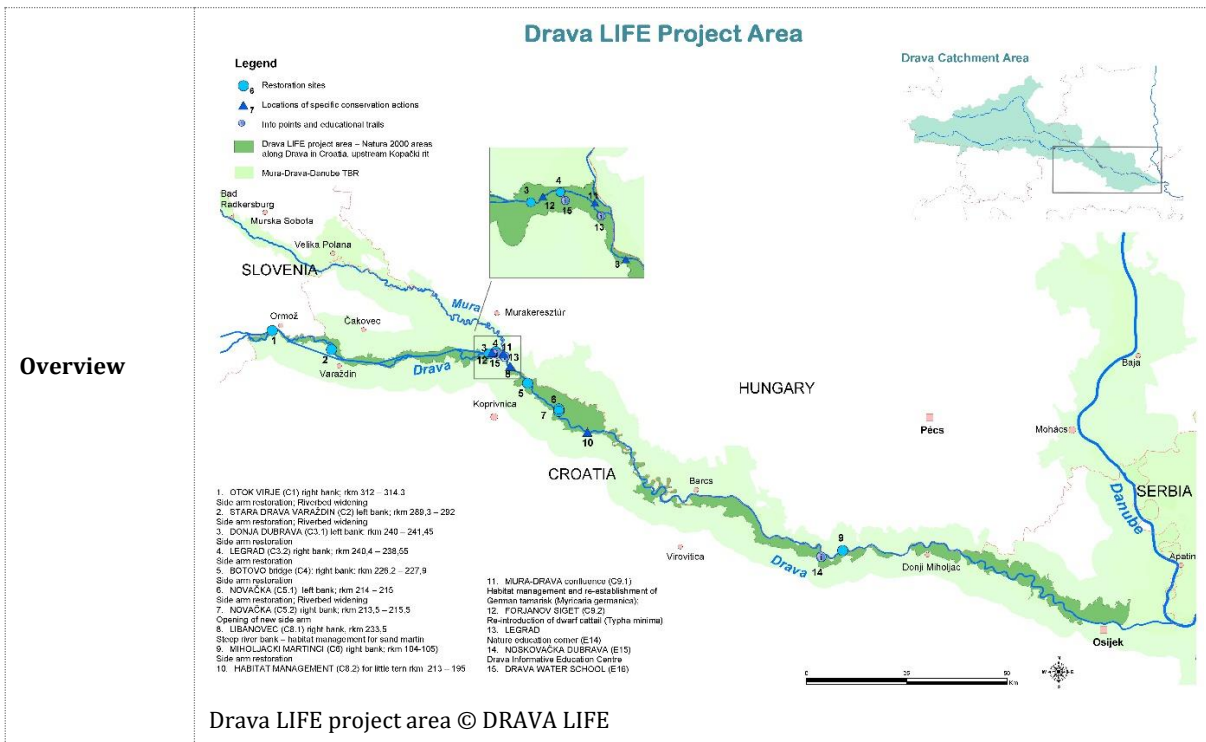
The increased dynamics will re-initiate successive vegetation development with pioneer plant species followed by shrubs, then softwood forests and, finally, hardwood forests. In general, a recreation of the natural habitat that hosted, until recently, the *Myricaria germanica* and the *Typha minima*, 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.



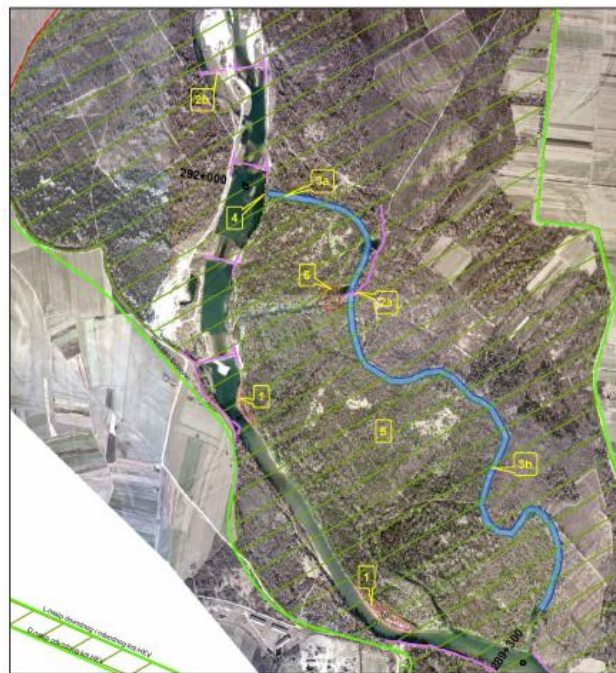
## Lessons learned so far

- The existing framework conditions greatly influence the possibilities within a project. In many cases, a second-best option was chosen, e.g. initial channel without active floodplain widening (dyke removal or dyke shifting) due to cost factors. The process has proven tedious and moderately transparent due to a legal framework that is tailored for infrastructure-related permitting processes, but hasn't been set up to accommodate restoration actions.
- Stakeholder processes are long and difficult and important stakeholders can be forgotten even in the best preparation, as was the case with forest management at some of the sites.
- Long and tedious discussions bear fruit, such as discussions about river dynamics and its importance. Results and actions that had been unimaginable only months or years before the project can become reality if all impacted parties sit together. Land users can prove to have understanding for nature protection needs, if asked, and water management becomes flexible, if the impacted parties show understanding

## Map of the project areas



Former and Planned Status



**DRAVA LIFE**  
Side arm restoration and river bed widening  
"Stara Drava" Varaždin  
Action C2

0 100 200 400 600 800 1,000  
Meters

**Legend**

- initial channel
- storage of material
- remaining island
- widening of river bed
- removing embankment
- existing dike
- existing water structures

**Natura 2000 and other protection status:**  
Special Protection Area (SPA)  
- HR100013 Dravske akumulacije  
Sites of Community Importance (SAC/SCI/PSCI)  
- HR2001307 Dravske akumulacije

This project site is part of the Regional Park "Drava-Mura" and part of the "core zone" of the Croatian-Hungarian Transboundary UNESCO Biosphere Reserve "Mura-Drava-Danube"

position	description	l/m	A/ha
C2	Side arm restoration and river bed widening "Stara Drava" Varaždin		
1	widening in main riverbed		1,50
2a	remove bank protection	56	
2b	remove part of traverse T-7&T-8	80	
3a	open initial channel	700	1,77
3b	widening sidearm to 25m	2100	5,30
4	entering protected by groynes	40	
5	island		37,50
6	storage of material		0,50

**Aims:**

**Flood protection:**  
Less pressure on right bank near Varaždin, increasing discharge capacity in case of flood

**Nature protection:** Opening existing sidechannel, rising groundwater level in the alluvial forest, initializing dynamic habitats, extensive forestry within the flood area

Restoration Site "Stara Drava" Varaždin © Croatian Waters

Former and Planned Status



**Legend**

- County border
- Natura 2000
- Veliki Pažub
- initial channel
- remaining island
- storage of material
- existing dike
- existing water structures

position	description	l/m	A/ha
1	open existing left sidearm	50	
1a	left sidearm	1560	3,00
2	remove traverse	20	
3	left island		44,16
4	open existing right sidearm	50	
5	widening existing right sidearm	1880	4,61
6	remove part of gation traverse	20	
7	entering protected by groynes	40	
8	right island		77,35
9	storage of material		
WS	water school center		
BP	building a platform for water school activities near old ferry port		
BB	building foot bridge		

**Aims:**

**Flood protection:**  
Less pressure on left dike, stopping river bed degradation increasing discharge capacity in case of flood

**Nature protection:** Opening existing side channel, rising groundwater level in the alluvial forest, initializing dynamic habitats, possibilities for implementation nature education path and "water school"

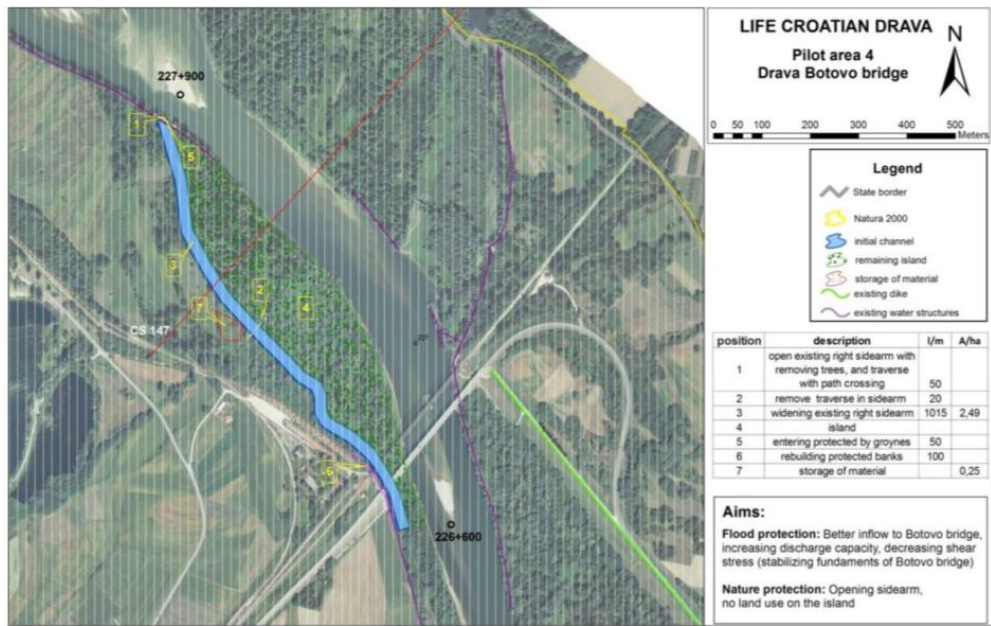
**LIFE CROATIAN DRAVA**  
Pilot area 3  
Drava D.Dubrava-Legrad

0 100 200 400 600 800 1,000  
Meters

Restoration Site "Donja Dubrava" Legrad © Croatian Waters

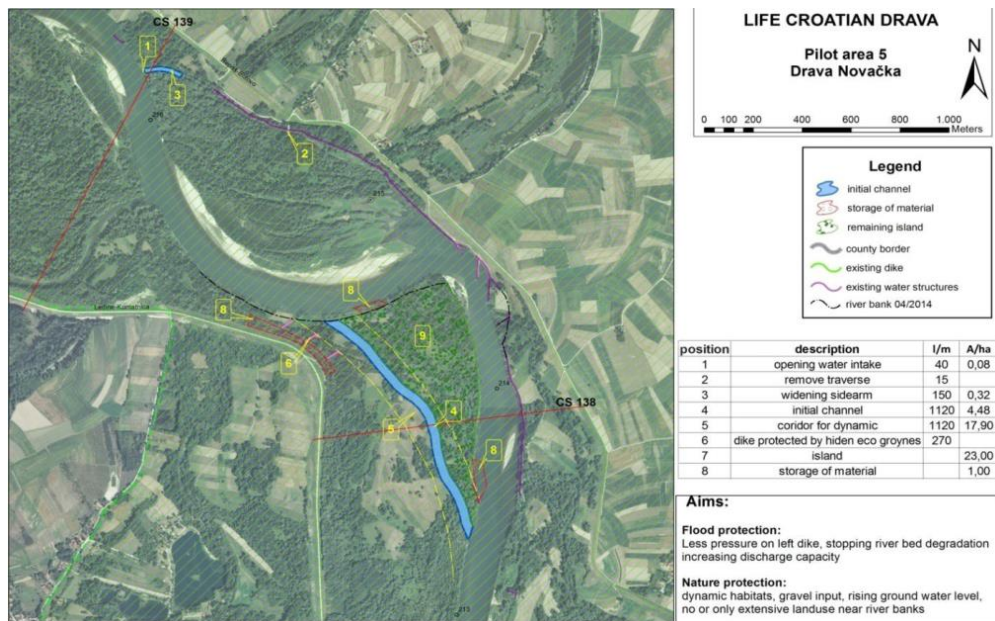


Former and Planned Status



Restoration Site Drava "Botovo bridge" © Croatian Waters

Former and Planned Status



Restoration Site Drava "Novačka" © Croatian Waters



**Former and Planned Status**

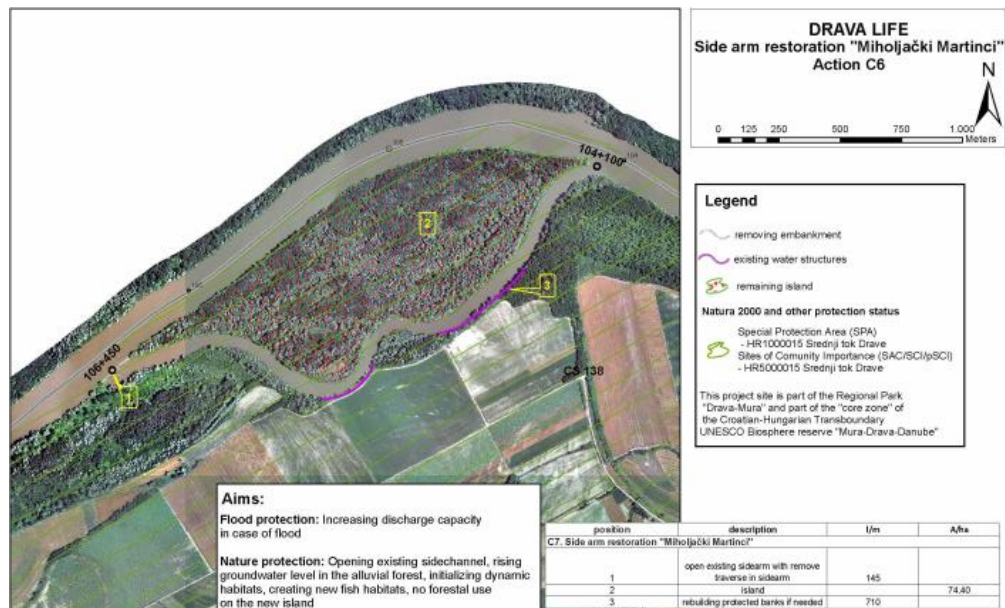


**Restoration site Drava "Novačka"**

Left: Current status © Map: Google Maps Satellite View 2021

Right: Planned status with two versions of the initial channel © Croatian Waters

**Former and Planned Status**



**Restoration Site "Miholjački Martinci" © Croatian Waters**

## River stretch characteristics

River
Drava
Width
approx. 110 - 250 m
Average discharge
310 - 577 m <sup>3</sup> /s

Planform	
Straight	-
Braided	-
Oscilating	X
Anabranching	X
Sinous	X
Meandering	-
Planned restoration actions within the project encompass the opening and creation of new side branches, the removal and modification of river regulation structures, as well as the preservation of retention areas and natural steep river banks. These actions should have a positive effect on groundwater too.	

Habitat types	
Flowing water	X
Floodplain water bodies	-
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	X
The Drava floodplain is dominated by softwood floodplain forests (willows, poplars), as well as hardwood floodplain forests (field ash, black alder and pedunculate oak, hornbeam, elm tree). On the Croatian Drava stretch about 70 species of fish can be found (predominantly salmonid). It also hosts some of the most significant bird habitats.	

Area (UTM)
33T E: 588786 N: 5139467 - 33T E: 725551 N: 5074648
Gradient
Downstream water stage drop is 15.07 cm/km <sup>2</sup> (near settlement Terezino polje/Barcs). The data is from Hydrographic atlas of Drava River (1972).
Sea level
84 - 218 m

Bed material	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	X
Psammal	X
Pelal	-
Near settlement Ormož the diameter of grain size is up to 25 cm, near city of Koprivnica up to 10 cm, and near city of Virovitica up to 7 cm.	

Riparian Structures	
Steep bank	X
Shallow bank	X
„Other“ banks	-
Inlets & outlets of secondary channel	X
Due to the lack of sediment (especially bedload), there are fewer and fewer natural steep and high banks. Still, there are steep banks and gravel bars of high importance for steep-bank breeding birds like sand martin and bee-eater or gravel breeders like common and little tern. There are numerous former side branches, oxbow lakes, lagoons and depressions with revitalization potential.	





**Restoration site “Donja Dubrava – Legrad”:** Side channel entrance area, gradual sedimentation noticeable



**Restoration site “Donja Dubrava – Legrad”:** Site overview – former, nowadays partly sedimented, side channels that will be restored



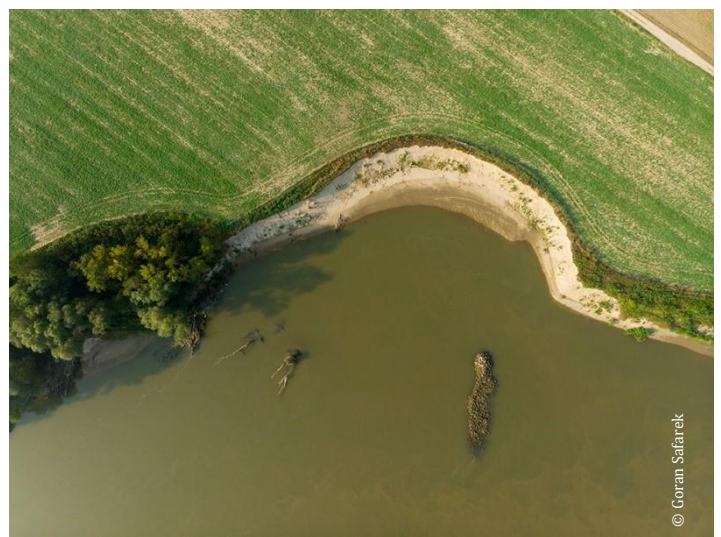
**Restoration site “Botovo bridge”:** Former side channel, 200 m long dried side channel



**Restoration site “Novačka”:** Site overview – Initial channel planned in order to ease the bottleneck and pressure on the left dike



**Restoration site “Miholjački Martinci”:** Disconnected side channel will be restored



**Restoration site “Libanovec”:** Conservation of the steep bank – no intervention against dynamic bank erosion through landuse change with compensation



# NATURA MURA

*The project is addressing some of the key problems to improve the situation of river dynamics, key habitat and habitat species at the Mura river.*

ONGOING  
PROJECT





## Key Facts

<b>Project</b>	Restoration of wetland habitats along the Mura - Natura Mura
<b>Country</b>	Slovenia
<b>River</b>	Mura
<b>River section type</b>	Mura I, Mura II
<b>Planned measures</b>	<ul style="list-style-type: none"> <li>● Riverbed widening</li> <li>● Restoration of side branches</li> <li>● Reforestation</li> <li>● Oxbow lake restoration</li> <li>● Restoration of wet meadows</li> <li>● Raising awareness</li> </ul>
<b>Implementation period</b>	2020 – 2023
<b>Funding Source</b>	80% co-funded by the European Union, European Regional Development Fund 20% co-funding by the Republic of Slovenia, Cohesion fund
<b>Project participants</b>	Institution of the Republic of Slovenia for Nature Conservation, Municipality of Velika Polana, Slovenian Water Agency, Slovenian State Forests, Slovenia Forest Service
<b>Contact</b>	Institution of the Republic of Slovenia for Nature Conservation, <a href="http://www.zrsvn-varstvonarave.si">www.zrsvn-varstvonarave.si</a> , zrsvn.oemb@zrsvn.si

## Introduction

With its floodplain, the Mura river represents an exceptional natural and cultural heritage of Pomurje, Slovenia and the world. Floodplain forests, river branches, oxbow lakes and a diverse cultural landscape are the habitat of many rare and endangered plant and animal species, which is why the area has multiple conservation status by several national and international nature conservation conventions. These include protection as a Natura 2000 site and since 2018, as the UNESCO Mura Biosphere Reserve. The Mura Natura 2000 site, which consists of the Mura SPA and SPA areas, is the richest Natura 2000 site in the Republic of Slovenia in terms of the total number of qualification species (66) and habitat types (9). These are especially endangered species on a European scale.

Due to past interventions and inappropriate management, the river, floodplain and most of the qualification species and habitat types of the Natura 2000 site at the Mura river are today in poor conservation status, which will decrease even more without appropriate actions. As a result of river regulations in the 19<sup>th</sup> century, the river's dynamics is limited and new habitats are not created. The Natura Mura project is addressing some of the key problems to improve the situation of river dynamics and key habitats and habitat species.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	-
Barriers/connectivity	-	Habitat degradation	X
Channelization	X	Invasive species	X
Disturbed sediment regime	X	Water abstraction	-

Change of the river dynamics and hydro-morphological conditions are the strongest threat to habitat conservation and ecosystem services dependent on the Mura river's water regime. In the past, the Mura riverbed was leveled, narrowed and fortified for most of its flow through the Republic of Slovenia. Combined with the reduced inflow of gravel from the upstream sections of the river, riverbed incision is caused in several sections and the groundwater is declining in the floodplain. As a result, drying of wetland habitats such as side branches, oxbow lakes, floodplain forests and wet grasslands can be increasingly observed. The process of formation of new gravel bars, branches, oxbow lakes, pioneer sites of floodplain forest is stopped because of the artificial embankments built in the past.

The groundwater level is declining in certain areas, due to the lack of gravel inflow and incision of the riverbed. Lack of gravel is caused by chain of hydro power plants/dams upstream the river. By enabling processes of natural riverbed widening, we will improve the dynamics of the river and the condition of some important habitat types. Restoration and reconnection of the former side branches that were separated in the past is going to be implemented. The purpose of the measure is to enable the formation of habitat structures for species and related habitat types. These measures also contribute to reducing riverbed incision due to the increase in the width of the river and the releasing of gravel into the riverbed.

The largest system of floodplain and wetland forests in the Republic of Slovenia is located in the floodplain of the Mura river and its tributaries. Due to changes in the hydro-morphological regime of the area, the location in the middle of an intensive agricultural landscape, climate change, and other factors, the floodplain forests are in poor condition and in many places with further negative prospects. The river and river habitats of the Mura river are highly exposed to the introduction and spread of various alien organisms, including many invasive species. The absence of the necessary hydro-morphological processes is a key threat to the long-term existence of floodplain forests in the area. In recent decades a serious threat to the forests in the area is also caused by various diseases of some key tree species (e. g. ash, elm, black alder, oak).

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	-
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	X

The measure of the expansion of the riverbed envisages the provision of space to enable natural river dynamics on sections of the Mura riverbed where these processes are prevented or limited in the existing state, due to riparian structures and sections where lateral erosion threatens private land already. Shift of the riparian structures on the locations from 50 m to 100 m are planned, which will allow river dynamics processes to create new riparian structures in the hinterland. Purpose of the measure is the establishment of habitat structures such as dunes, erosive banks, pioneer habitats, dynamic riverbed, etc. The measure contributes to the reduction of riverbed incision due to increasing the width of the riverbed and gravel input.

Restoration and reconnection of the former side branches that were separated in the past is going to be implemented. The purpose of the measure is to establish habitat structures for species and related habitat types. These measures also contribute to reducing riverbed incision due to the increase in the width of the river and the introduction of gravel into the riverbed.

The implementation of measures indirectly contributes to the achievement of following objectives: ensuring and maintaining good ecological status of waters, increasing retention ability and flow of high waters, reducing the riverbed incision and restoration of river structures. In the case of the implementation of measures on private land, their purchase is planned within the project.

## Involvement of interested bodies/parties

During 2017-2019, within the Interreg project coopMDD, an Action Plan for Restoration of the Natura 2000 Site Mura was created. While preparing the document key stakeholders were asked about their needs, wishes and interests in cooperating in the restoration of the river and river habitats along the Mura river. Key stakeholders were municipalities, hunters, fishermen, farmers, foresters, NGOs, individuals and other associations operating in the Natura 2000 area. All the measures included in the Action plan are based on the knowledge and experience of measures already implemented on







the Mura river in the past and experiences from similar revitalizations of rivers and floodplain habitats elsewhere in the Republic of Slovenia and in Central Europe.

The Natura Mura project includes key activities that are listed in the Action plan that could be carried out, depending on the complexity of implementation, location, ownership, consent of stakeholders in the area, etc.

IRSNC is the lead partner of the project and responsible for the coordination and land purchase. The project partnership consists of: the Slovenian Water Agency, which is primarily responsible in terms of strategic planning and implementation of water activities such as sediment management, re-establishing of the morphological river type etc. The Slovenia Forest Service and the Slovenian state forests company d.o.o. (Slovenski državni gozdovi) are responsible for the implementation of restoration and improvement of floodplain forests in the project area. The Municipality of Velika Polana is responsible for restoring wet meadows, and the Development Centre Murska Sobota is responsible for the awareness raising activities, development of info centers and other communication activities such as a website and a short movie.

## Planned measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	-
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	X	Reintroduction of plant species	X
	Lowering the foreland	-	Reforestation of floodplain forest	X
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	-
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

Within the pilot area we plan to implement restoration actions to restore river dynamics by implementing riverbed widenings on 4 pilot stretches of the Mura river. In the length from 300 m to 950 m existing bank protection will be relocated about 100 m into the floodplain to widen the riverbed and to enable processes of natural extensions of the active Mura riverbed. Natural hydromorphological processes are allowed in the area of the riverbed extension up to the limit of the new riparian protection. The measure will enable controlled natural river dynamics on sections of the Mura riverbed, where these processes are prevented or limited in the existing state. The purpose of the measure is to establish habitat structures such as pioneer sites (sand banks, gravel banks, eroded steep banks) a diverse riverbed, etc. The measure contributes to reducing riverbed incision by increasing the width of the riverbed and gravel input.



The implementation of the measure indirectly contributes to the achievement of the objectives: ensuring and maintaining good ecological status of waters, increasing the retention capacity and flow of high waters, stopping the riverbed incision, protecting private land from river erosion, restoring the structure and function of floodplain forests.

The project envisages the restoration of inflows into the side branches. Depending on the state quo, the accumulated gravel in the side branches will be removed, the angle of inflow into the branches will be corrected or the inflow will be deepened to a depth that will allow the branch to be overflowed even at low water discharge.

By enabling the necessary hydrological processes of the Mura river, the flooding of floodplain forests along the river will be improved (lateral reconnection of the floodplain), which is crucial for the growth of two important habitat types 91E0\* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) and 91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Fraxinus excelsior* or *Fraxinus angustifolia* along the great rivers (*Ulmion minoris*). Measures to promote natural rejuvenation or in-semination of trees will be implemented on an area of 2 ha. For the purpose of restoration, typical trees of two habitat types will be planted on approximately 20 ha in the area. Invasive alien plant species will be removed in these areas or clonal poplar plantations will be cut down. Also 7 ha of overgrown wet meadows will be restored.

A comprehensive, more detailed interpretation plan will be prepared for the establishment of interpretation units. In order to interpret the target species and habitat types and the general interpretation of the Natura 2000 area of Mura and its approach to the local people of the area and visitors, three information centers will be equipped.

## Expected results & effects

- Restoration of forest and grassland habitat types
- Improving hydro-morphological conditions
- Habitat restoration measures for species related to wetland habitats along the Mura river
- Raise awareness of stakeholders in the area about the importance of preserving the biodiversity of the Natura 2000 Mura area.

With the relocation of the existing bank protection, natural river dynamics processes will be enabled. The implementation of the measure indirectly contributes to the achievement of the objectives: ensuring and maintaining the good ecological status of waters, increasing the retention capacity and flow at high water discharge, stopping the incision of the riverbed, restoring the structure and function of floodplain forests, decreasing flood risk to private land through the above-mentioned land purchase and retention capacity increasing measures and avoiding the need for flood protection for private land. We also expect that new habitat structures such as, pioneer sites (sand/gravel bars, cut banks), a diverse riverbed, etc. will be established.

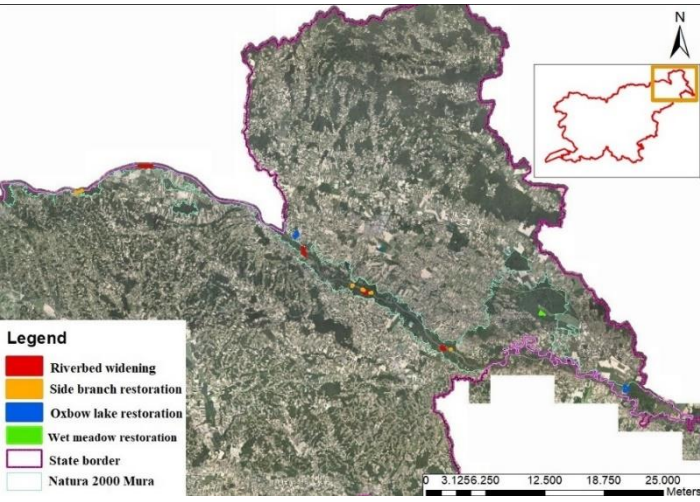


With the restoration of river side branches the water flow will slow down and the water will supply a larger floodplain area. Side branches are an important habitat for many fish species and other animal or plant species. Different forest habitat types will improve with the possibility of a bigger flooding area. With planting indigenous tree species and removing invasive alien species we will improve the condition of floodplain forests, which will have a significant impact on other forest species as well.

Raising awareness and respect for nature among the local population and visitors is in the long run one of the most important mechanisms for achieving the goals of Natura 2000 in the Mura river area as well. With our work and planned measures, we will achieve general and scientific public.

## Lessons learned so far

- **Preparation:** Good preparation and planning of individual phases of the project is important for the successful implementation. In the Natura Mura project, a large part of this was already done in the coopMDD project, where specific locations for the implementation of certain activities were coordinated with key stakeholders in the area. All the measures were also financially valued. Desires to carry out activities are present in a wider area, but an obstacle to the implementation is often represented by private land, which must be purchased in advance. However, the owners are tied to the land and are not willing to sell it. A good knowledge of the local area is important for both planning and carrying out activities.
- **Communication:** Communication with stakeholders in the area before, after and during the project plays an important role. With proper communication, we can avoid unnecessary problems that could arise or be solved before the implementation. There are many stakeholders in the area and everyone has their own wishes and needs, which need to be rationally checked and, if necessary, taken into account. It is almost impossible to anticipate all possible obstacles for implementation of activities. An active partnership in which each member performs their tasks makes an important contribution to the project.
- **Implementation:** The start of concrete works is planned for the second half of 2021 and until the end of the project. So far, we have managed to easily restore 7 ha of wet meadows and prepare some permits and expert bases for the planed measures without which it is not possible to carry out activities. Between November 2021 and March 2022 we have reconnect 2 side chanel on the Mura river, first results are very impresing. The reconnected side chanel are wetted even at low discharges of river. Also two oxbow lakes were restored and 20 pounds for ampibians were excavated, which are already ful of life. First steps in the project are important and we are doing well so far.

## Map of the project area

<p><b>Overview</b></p>	
<p>Project area © Tadej Törnär</p>	
<p><b>Former status</b></p>	
<p>Mura river in Hrastje Mota © Tomaž Berke</p>	
<p><b>Current status</b></p>	
<p>Visualization of a side branch © Samo Jenčič</p>	

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
80 m
<b>Average discharge</b>
153 m <sup>3</sup> , gauging station: Cmurek

<b>Area (UTM)</b>
33T E: 549750 N: 5172689 – 33T E: 622505 N: 5147808
<b>Gradient</b>
Average 2.08 ‰, Slovenian part 1.11 ‰
<b>Sea level</b>
248 m, Ceršak; 147 m, Murska Šuma, confluence with Big Krka

<b>Planform</b>	
Straight	-
Braided	-
Oscilating	-
Anabranching	-
Sinous	X
Meandering	-
Low sinuosity with some side branch specially on the lower part of Mura river.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	X
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	X
The most important forest habitat types are riverine willow, alder and ash stands ( <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> ).	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	X
„Other“ banks	X
Inlets & outlets of secondary channel	X
The Mura changes slowly from the fast-flowing to the slow-flowing river in the middle and lower part of the river from the border with Austria, where it is very fortified. Especially in the lower part of the river there is less riparian protection and more secondary channels, gravel, etc.	





Side branch Besnica before restoration



Restored side branch Besnica



Floods are crucial for forest HT 91E0\*



Natural rejuvenation of forests habitat type 91 E0\* with indigenous pig species



Oxbow lake Zaton before excavation



Restored oxbow lake Zaton



# WISEDRAVALIFE

*Main objective is to contribute to the conservation and resilience of the riparian habitats along the Drava river by improving water regime and biodiversity of riparian forests.*

ONGOING  
PROJECT



## Key Facts

<b>Project</b>	WISEDRAVALIFE, Wise Water Management for the Conservation of Riverine and Floodplain Habitats along the Drava River
<b>Countries</b>	Hungary, Croatia
<b>River</b>	Drava
<b>River section type</b>	Drava II, Drava III
<b>Planned measures</b>	<ul style="list-style-type: none"> <li>• Reconnection of Heresznye side branch</li> <li>• Elimination of three river training structures</li> <li>• Water retention in Lankoc Forest</li> </ul>
<b>Implementation period</b>	2018 – 2023
<b>Funding Source</b>	<p>59.45% co-funded by the European Union, LIFE NATURE Programme</p> <p>25.85% co-funded by</p> <ul style="list-style-type: none"> <li>• National funding (Ministry of Agriculture)</li> <li>• Coke</li> </ul> <p>14.7% co-funded by contributions of project partners</p>
<b>Project participants</b>	<p><u>Coordinating beneficiary:</u> WWF Hungary</p> <p><u>Associated beneficiaries:</u> DDVÍZIG South-Transdanubian Water Management Directorate , DDNPI Danube–Drava National Park Directorate, Croatian Waters, SEFAG Forest Management and Wood Industry Share Co.</p>
<b>Contact</b>	WWF Hungary, <a href="http://www.wwf.hu/wisedrava">www.wwf.hu/wisedrava</a> , panda@wwf.hu

## Introduction

The main objective of the project is to contribute to the conservation and resilience of the riparian habitat types 91E0 (Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Pandion, Alnion incanae, Salicion albae), 3260 (Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitriche-Batrachion* vegetation) and 6440 (Alluvial meadows of river valleys of the *Cnidion dubii*) along the Drava River on the Croatian–Hungarian stretches by improving water regime and biodiversity of riparian forests.

The root cause of the deteriorated status of riverine and floodplain habitats is the riverbed degradation. Due to that the significantly low water levels during dry periods have been prolonged in the previous decades. The project purpose is to apply new approaches of combating riverbed degradation.

By the end of the project the assessment and evaluation of the causes of riverbed degradation will be compiled. This evaluation is elementary for selecting effective measures (during the project and long term) and feasible measures (during the project) targeting the decrease of riverbed degradation. The restoration works of the project combine different measures.

Integration of project results (especially proposed short and long term measures) into river basin management and nature conservation practices and policies is also aimed at by sharing knowledge on national and international levels to generate a multiplication effect.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	-
Barriers/connectivity	X	Habitat degradation	X
Channelization	-	Invasive species	-
Disturbed sediment regime	X	Water abstraction	-

Lankoc Forest is mainly a hardwood forest close to Drava river. The riverbed incision of the river and the drainage by Dombó Channel, together with the increasing frequency of precipitation deficient periods, caused a remarkable drying in the area and degradation of forest and meadow habitats there.

The formerly meandering Drava river was regulated, or even channelized on some stretches in the past. The negative results of this regulation were a riverbed incision and degradation of the ecological condition of riverine and floodplain habitats and species. Degradation of softwood forests and other wetland and forest habitats of alluvial rivers is a general problem along regulated rivers.

Although there are almost unregulated river stretches on the Drava River at the Croatian-Hungarian border, the signs of degradation can also be recognized there. This is due to fluctuating water levels, which is the result of hydropeaking effects of upstream sections' hydropower plants, and lowering water levels in the main channel, which is the result of channelization and lack of sediment in the riverbed.

The lack of sediment in the riverbed has two reasons: 1) it was excavated in hundreds of thousands cubic meters per year in the previous decades, 2) the sediment is blocked by HPPs' reservoirs of Drava, upstream Mura-Drava confluence. Due to a lack of sediment the river started digging its own riverbed. The lateral erosion is kept on minimum through bank revetments and the channelized character. These processes all generate riverbed degradation. The groundwater table also reduces quickly, because of its direct connection with the river. Due to these harmful processes water related soft- and hardwood forests and other wetland habitats don't have a proper water supply along the Drava river.



## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	-	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	-

The project aims at the assessment of the root causes of riverbed incision, which has resulted in the degradation of floodplain forests and wetlands. In the Drava main course, the selection of river training structures to be eliminated by using hydraulic models that analyse the cumulative effects of different measures are in focus. This includes the revision of river training structures of Drava and eliminating them on three sites to improve the hydromorphological conditions. Based on the assessment's results, activities on the field on selected sites that tackle the root causes of riverbed degradation are implemented.

The project involves the reconnection of Heresznye side branch to improve its water supply and increase the groundwater table. This results in the improvement of the status of the riparian habitats and decreases the riverbed incision as well.

In Lankoc forest the project aims at the improvement of water supply of wetlands by water retention works. Land purchase of 44 ha Natura 2000 habitat here secures the proper management of the area, and the installed artificial nests and bat boxes provide reproduction and feeding facilities for bird and bat species of community interest. A forest lot in Lankoc forest, dominated by non-native Black locust is being converted to semi-natural 91F0 forest (=Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and minor, *Fraxinus excelsior* or *angustifolia*, along the great rivers).

## Involvement of interested bodies/parties

Local stakeholders (farmers, private foresters) are involved in forums, where the necessity and consequences of water retention are discussed. The local stakeholders' viewpoints are mapped also by interviews, and assessed by professionals, joined as external experts to the project.

Representatives of special fields (hydrology, forestry, ecology, biodiversity, economy) are involved in the project as experts, providing studies, participating as consultants and improving the professional network via expert consultations.

Project activities and results are available for the public in thematic magazine(s), and through information materials (animation, information graphics, infoboards, educational toolkit) provided in the project and disseminated via web and web2 platforms.

The partnership plans to use the project activities for policy purposes, in order to promote the complex approach of river management. The most effective way of using lessons learned from field implementations is to upscale them on policy level, and to work on multiplication of the positive effects.

## Planned measures

*The planned measures in this project does not fit into the predefined categories used in the description of the other projects. They are listed below with a reference to the problems adressed.*

- Problems with regards to **sediment management**: Surveys on sediment conditions, measurements and tools to stop riverbed incision
- Problems with regards to **river continuity**: Eliminating of river training structures, reconnecting Heresznye side branch
- Problems with regards to **habitat**: Improving water regime and biodiversity of riparian forests by water retention works
- Problems with regards to **flood protection**: Side branch reconnection and installment of water retention works

The following surveys and studies were contracted and completed aiming at the understanding of riverbed incision and possible tools to stop it, to explore the land use types along Drava river: 1) Examination of causes of riverbed incision between 0+000 - 236+000 rkm, 2) Analysis of the possibilities of stopping the riverbed incision along Drava river between sections 0+000–236+000 rkm, 3) Surveys of the Drava River Basin and River Branches at the 198.6–236 rkm (hydraulic modelling, sediment conditions, designation procedure), 4) Research on the subject of land-use along the Drava river and impact assessment for types of planned interventions between the sections of 0 rkm – Mura confluence (236 rkm), 5) Decision preparation material. River regulation structures. River training structures along Drava river were reviewed with the aim to select and determine suitable locations for necessary human interventions.

Aiming at water regime and habitat improvement in Lankoc Forest, the following baseline studies were contracted and prepared: 1) Digital terrain model: data collection from the air with LiDAR method and data processing for Lankoc Forest site, 2) Field minutes of geodetic survey, 3) Inundation modelling of Lankoc Forest.

Decisions on the localities of water retention artefacts and river training structures to be eliminated were developed by project partners based on the findings of the studies. Six localities along Dombó Channel were designated where bottom weirs with sluices were installed. Localities of three river training structures to be eliminated were designated in a similar way.

## Expected results & effects

- Water retention in Lankoc Forest
- Elimination of river training structures
- Reconnection of one side branch
- Elimination of invasive black locust

The water retention improvement in Lankoc forest is implemented by six water retention structures. These bottom weirs with sluices retain water in (usually dry) canals during dry periods, thus increasing the groundwater level and improving the conditions of riverine forests and meadows in the Natura 2000 area.

The elimination of three river training structures at villages Felsőszentmárton and Vejtí will result in facilitating the free flowing of the river and elimination of artefacts that are not fitting in the natural landscape. With the promotion of the free flowing of the river, the extension of natural species and habitat elements will be expanded.

The reconnection of the Heresznye side channel will improve the water management of surrounding natural and cultivated areas, the natural flow of the river and the management of floods in a natural way.

The elimination of non-native, and invasive black locust (*Robinia pseudoacacia*), and its replacement by natural woodland constituting in native species (*Quercus robur*, *Fraxinus angustifolia*, *Alnus glutinosa*, *Cerasus avium*) will result in the development of 91F0 (=Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and minor, *Fraxinus excelsior* or *angustifolia*, along the great rivers) Natura 2000 habitat and the settling of its characteristic and naturally inhabiting species.

## Lessons learned so far

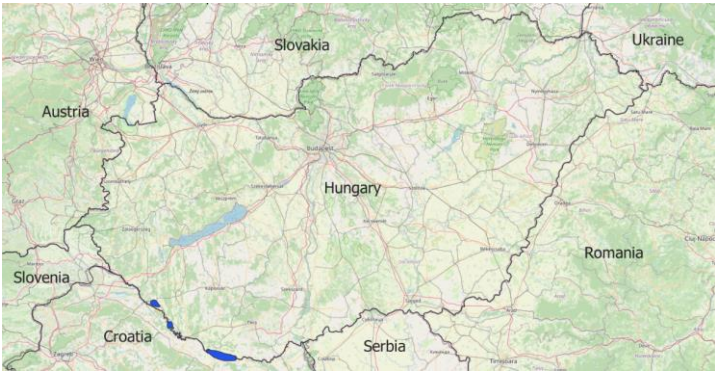
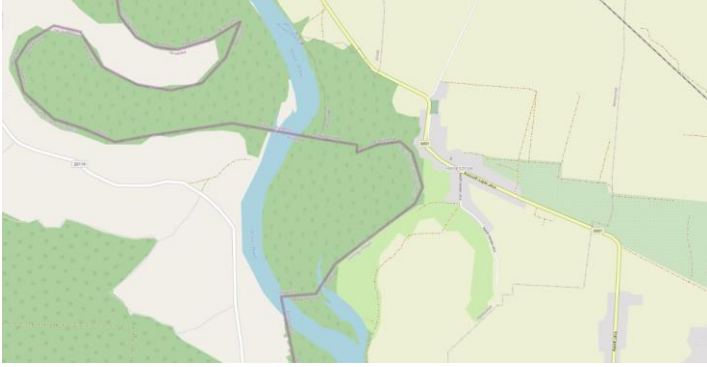
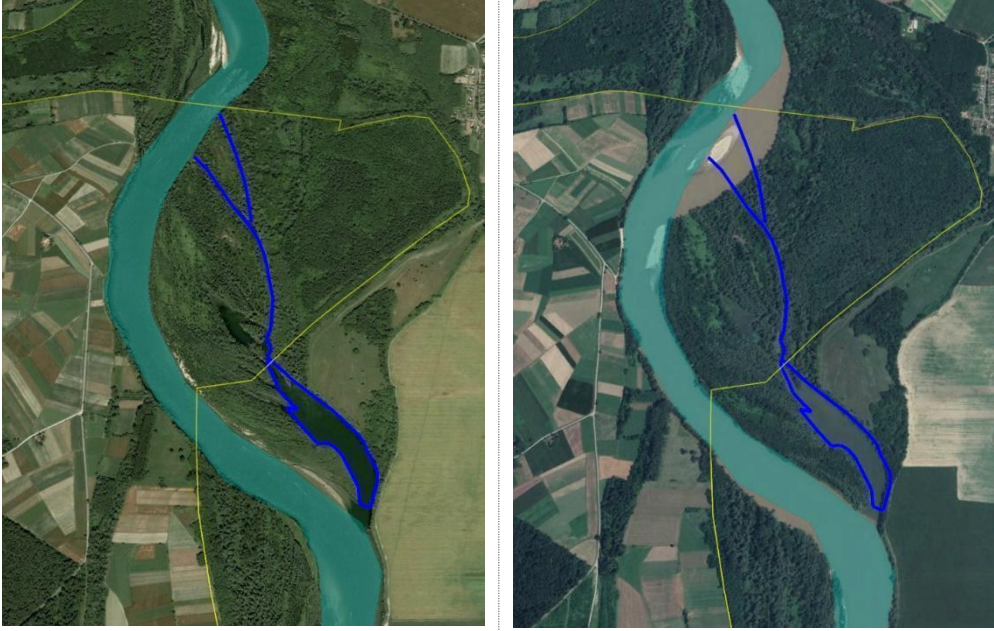
- Riverbed incision is a finite process
- The project area is a socially trust deficient region
- Lessons learned in the project ensures the multiplicability of its results

In many regards, the project pilot character, as its output studies, provides fairly new approaches and results about Drava River and its conservation problems, in some cases against entrenched beliefs. One study in the project revealed that riverbed incision can have a resting point when reaching a new equilibrium.

The importance of the social environment has been revealed during the project. The surroundings of the Drava river, far from any economic and cultural centres, evolved in a special way over time and reached a trust deficient attitude which makes any cooperation, especially the introduction of new ideas that are not rooted locally, harder.

The project started in 2018 and ends in 2023, consequently a number of lessons learned will be recognised in the near future when field implementations will be achieved.

## Map of the project area

<p><b>Overview</b></p>	
<p><b>Former status</b></p>	
<p><b>Planned status</b></p>	
<p>Planned reconnection of Heresznye side branch and quick lateral moving of the rivers main course (left: 2006, right: 2020), © WWF HU, Google Map</p>	



## River stretch characteristics

<b>River</b>
Drava
<b>Width</b>
250 m
<b>Average discharge</b>
No data available.

<b>Area (UTM)</b>
33T E: 655548 N: 5123804 – 34T E: 268335 N: 5073985
<b>Gradient</b>
No data available.
<b>Sea level</b>
95 – 125 m

<b>Planform</b>	
Straight	X
Braided	-
Oscilating	-
Anabranching	-
Sinous	X
Meandering	X
The stretch is situated in the Carpathian Basin in lowland situation, therefore the potential type is sinuous to meandering, but some sections are straight due to artificial backwaters.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	-
Mikrolithal	-
Akal	X
Psammal	X
Pelal	-
The project area lies in the lower, lowland section of the Drava. Larger compartments of bed material are missing here, gravel and sand is characteristic.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	X
The habitat types show a remarkable variability in the project area. Attached to the river there are side channels and backwaters fringed by softwood forests. In a higher elevation, Lankoc Forest is dominated by hardwood forests.	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	X
„Other“ banks	X
Inlets & outlets of secondary channel	X
A long stretch of the Drava in the project area is characterized by shallow banks along the river. In some riverbends, e.g. near the Heresznye side channel, a high and continuously eroding bank is specific.	



Locality of water retention work No 1 in Lankóc Forest, 13/10/2020



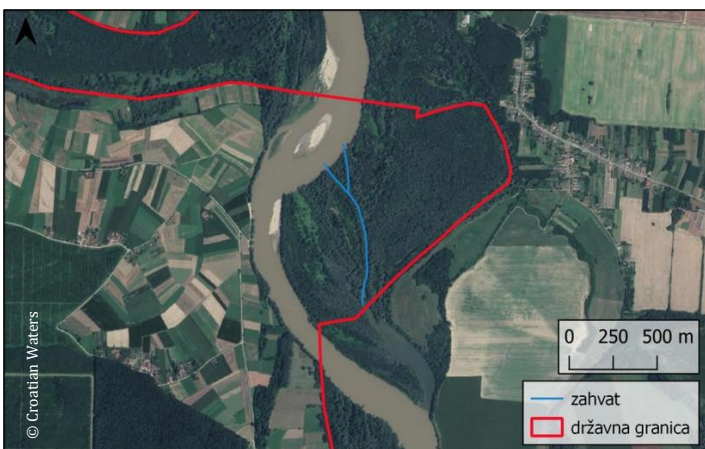
Installed water retention work No 1 in Lankóc Forest, 16/12/2020



River training structure at Felsőszentmárton, will be eliminated in the project, 13/10/2020



Heresznye side branch, site of reconnection, 13/10/2020



Aerial view of Heresznye side branch, site of reconnection; field implementation starts in 2022



# BIOMURA

*The project goal was to provide preservation of natural resources and biodiversity by establishing better ecological circumstances for the existence of wetlands and sustainable natural habitat structures.*

PAST  
PROJECT





## Key Facts

<b>Project</b>	Conservation of Biodiversity for the Mura river in Slovenia - BIOMURA
<b>Country</b>	Slovenia
<b>River</b>	Mura
<b>River section type</b>	Mura I, Mura II
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Connection of the main riverbed with secondary channels</li> <li>• Establishing an adequate height of river water level at the inflow into the secondary channels</li> <li>• Widening of the main riverbed for the formation of erosive banks and gravel pits</li> <li>• Connection of selected oxbow lakes with groundwater</li> <li>• Restoration of the secondary channels</li> </ul>
<b>Implementation period</b>	2006 – 2011
<b>Total costs</b>	€ 1,975,519
<b>Funding source</b>	<p>49.07% co-funded by the European Union, LIFE Programme 50.93% co-funded by</p> <ul style="list-style-type: none"> <li>• Ministry of the Environment and Spatial Planning</li> <li>• Institut for Water of the Republic of Slovenia</li> <li>• Project partners</li> </ul>
<b>Project participants</b>	<p><u>Project partners:</u> Inženiring za vode, d.o.o., Mura vodnogospodarsko podjetje, d.d., Institute of the Republic of Slovenia for Nature Conservation, Regionalna razvojna agencija Mura, Prleška razvojna agencija, giz, Društvo za preučevanje ptic in varstvo narave, World Wide Fund for Nature Austria – WWF Austria Institutions in the Steering Committee: Ministry of the Environment and Spatial Planning, Environmental Agency of the Republic of Slovenia, Slovenia Forest Service, SOLINE Pridelava soli d. o. o. and partners</p> <p><u>Other cooperating institutions:</u> Ribiška družina Ljutomer, Zavod za turizem in kulturo Beltinci, Faculty of Civil and Geodetic Engineering, University of Ljubljana, LUTRA, Institute for Conservation of Natural Heritage, Zavod Umbrá; EBRA d.o.o., Slovenian Forestry Institute, Zveza društev MOJA MURA</p>
<b>Contact</b>	Institute for Water of the Republic of Slovenia, <a href="http://www.izvrs.si">www.izvrs.si</a> , info@izvrs.si

## Introduction

The area of the Mura river in Slovenia was designated as an environmentally significant habitat exhibiting high levels of biodiversity. A major part of this area has been included in the Natura 2000 network. The woodlands along the Mura constitute some of the most important lowland floodplain forests in Slovenia. The river dynamics of this area has the potential to create gravel bars, river branches, islands, oxbows and erosion banks. Conservation of biodiversity in an area and protection/restoration of wetlands largely depend on the preservation or raising of the groundwater level and intensive hydrodynamic processes in the river corridor. The purpose of the project was to provide preservation of natural resources and biodiversity by establishing better ecological circumstances for the existence of wetlands and a sustainable natural habitat structure of the area. The Mura channel was reconnected with the secondary channels, conditions necessary for an adequate water level at points of the inflow into the branches were established, the channel was widened locally, and sustainable maintenance of branches and oxbows in the floodplain forest was carried out.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	X	Flow alteration	X
Barriers/connectivity	X	Habitat degradation	X
Channelization	X	Invasive species	-
Disturbed sediment regime	X	Water abstraction	X

Intensive water use, activities in the water area and change of land use in the Mura hydrographic basin have thoroughly transformed the area along the river. The number of flood events is decreasing, while the periods of low discharge rate are becoming longer, causing the floodplain forests along the Mura to receive less and less water. The water dynamics in oxbows, side branches and in the ground is decreasing. Water can only flow into the branches at times of flooding, while a normal water inflow from the Mura channel is not possible due to the heightened banks. The connection between the river and its branches was cut due to the banks built in the past at the points where the water enters the branches. The creative power of water, needed for the sustenance of the water habitat and wetland habitat structure in the floodplain area, has been reduced. Ecological conditions, necessary for the existence of water and wetland habitats and indigenous plant and animal species in the Mura floodplains, are deteriorating, also due to improper management in the forest and agricultural area. Hydropower plants and river trainings affect the sediment management in the river and also lead to deepening of the river bed. In addition far-reaching surface drainage and groundwater withdrawals also have an impact on the interaction of groundwater and the river system.

On the Slovenian-Austrian border, the Mura channel became as much as 1.5 m deeper in the past 30 years. The trend of the riverbed incision has been noticed in Slovenia as well. The study made by Halcrow – Water Management Institute and Institute for Water of the Republic of Slovenia (as cited in Institute for Water of the Republic of Slovenia, 2011) shows that hydrological conditions are also changing.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	X	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	X
Re-establish/ improve longitudinal connectivity	X	Sediment management	-

The overall objective of the project was to provide preservation of natural resources and biodiversity by establishing better ecological circumstances for the existence of wetlands and sustainable natural habitat structure of the area. The most important forest habitat types are riverine willow, alder and ash stands (*Alnus glutinosa* and *Fraxinus excelsior*). The focus was on improving of conditions in water habitats and riparian habitats, protection of endangered animal species, and consequential improvement of biodiversity and preservation of the landscape. BIOMURA target animal species were: White Stork (*Ciconia ciconia*), Collared Flycatcher (*Ficedula albicollis*), Little Bittern (*Ixobrychus minutus*), Black Stork (*Ciconia nigra*), Spotted Crake (*Porzana porzana*), Little Crake (*Porzana parva*), Barred Warbler (*Sylvia nisoria*), Middle Spotted Woodpecker (*Dendrocopos medius*), Honey Buzzard (*Pernis apivorus*), Common Kingfisher (*Alcedo atthis*), Jersey Tiger Moth (*Callimorpha quadripunctaria*), Green Club-tailed Dragonfly (*Ophiogomphus cecilia*), Weather Loach (*Misgurnus fossilis*), Bitterling (*Rhodeus sericeus amarus*), Schraetzer (*Gymnocephalus schraetzer*), European Mudminnow (*Umbria krameri*), Asp (*Aspius aspius*) and Fire-bellied Toad (*Bombina bombina*). The BIOMURA project was focused not only on fieldwork but also on educating and informing the general public. It raised public awareness about the importance of biodiversity and landscape complexity along the Mura river.









## Involvement of interested bodies/parties

The BIOMURA project was focused also on educating and informing the general public. It raised public awareness about the importance of biodiversity and landscape complexity along the Mura river. Ten issues of the BIOMURA newsletter were published, a webpage with project updates was created (no longer available) and an educational trail at Mota was established with information boards for visitors. At Mota, a local information centre was also established. In Murska Sobota, a regional promotional centre with a branch office on the Island of Love was opened. Two brochures and several boards and posters with information on the project as well as several TV and radio footages were produced. Numerous articles about the project were published and five workshops organized. This creative and holistic approach to informing the public improved and strengthened the knowledge and awareness of the locals, interest groups and important decision-makers, contributing towards closer relations among the main stakeholders from the area. The feedback of the locals, local communities, private owners, important beneficiaries from the area and visitors was very positive and stimulating.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	-
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	X	Reintroduction of plant species	X
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	X	FLOOD PROTECTION	
	Structures to enhance erosion	X	Protection of the hinterland	-
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

The project area covers 15 km<sup>2</sup> and lies in the captive floodplain of the Mura river, within the flood protection embankments of the Mura, between the villages of Bakovci, Dokležovje, Ižakovci, Melinci, Bunčani, Veržej, Krapje and Mota.

- Cleaning of former secondary channel at Bunčani to provide better sun exposure and ground water connections of the oxbow
- Construction of a new 550 m long river channel connected to the Besnica channel (secondary channel of the Mura river) to enable water inflow from the river
- Construction of two stone riffles on the Mura river

- Initiation of the natural widening of the Mura channel in Bakovci, forming a new 260 m long left bank and an island
- Removal of bank protections between Mura and former secondary channel at the west bank at Veržej
- Removal of vegetation and sediments from the secondary channel in the area of Dokležovje at the length of 490 m to enable bank erosion
- Deepening and cleaning the secondary channel banks at the Nemščak farm and Ižakovci at a length of 120 m
- Planting of indigenous species
- Land purchase

## Results & Effects

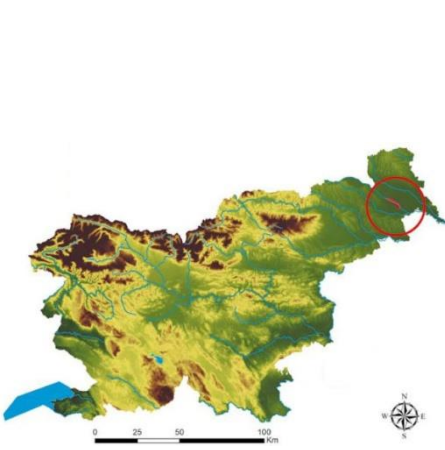


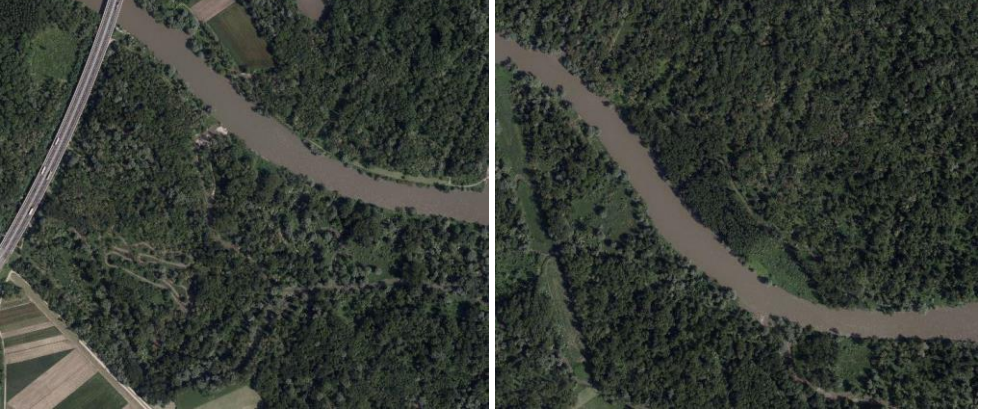
- Increased water inflow into Besnica
- Forming new river sediments
- Creating an oxbow habitat
- Providing constant wetness of the ground and allowing bank erosion at high discharge rates
- Improvement of ecological conditions needed for the existence of wetland and water habitats
- Improved hydraulic connections between surface waters and groundwater
- Positive effect on the structure and ecological character of the Mura floodplain
- Beavers settled in the area in 2009

## Lessons learned

BIOMURA was the first nature conservation project on the Mura river and in a broader region in Slovenia. The lessons learned were the basis for all the following projects.

- The pilot actions were executed relatively conservatively. The experience has shown that the implemented measures were effective for a period of time. But some years after the project ended problems started to show. Neophytes spread in the pilot measure sites and wider, secondary channels and pits filled up with sediment during the first floods. No funds were predicted for maintenance of the pilot sites after the project ended.
- The project showed the importance of funds for the long-term maintenance of developed project outputs.
- The project showed the importance of informing and educating the local and general public, as well as their feedback, for understanding the project's objectives and the success of pilot actions execution.

## Map of the project area

<p><b>Overview</b></p>	 
<p>Location of the project area © BIOMURA LIFE06 NAT/SI/000066</p>	
<p><b>Former status</b></p>	
<p>Area of the measures left: Besnica, right: Dokležovje 2006 © <a href="http://www.naravovarstveni-atlas.si/">www.naravovarstveni-atlas.si/</a>, 2021, ZRSVN</p>	
<p><b>Current status</b></p>	
<p>Area of the measures left: Besnica, right: Dokležovje 2016 © <a href="http://www.naravovarstveni-atlas.si/">www.naravovarstveni-atlas.si/</a>, 2021, ZRSVN</p>	



## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
80 m
<b>Average discharge</b>
153 m <sup>3</sup> /s, gauging station: Ceršak

<b>Area (UTM)</b>
33T E: 586661 N: 5161896 – 33T E: 595112 N: 5156011
<b>Gradient</b>
1.3 ‰
<b>Sea level</b>
From 185 m (Bakovci) to 172 m (Mota)

<b>Planform</b>	
Straight	-
Braided	-
Oscilating	-
Anabranching	-
Sinous	<b>X</b>
Meandering	-
Low sinuosity with some secondary channels.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	<b>X</b>
Mikrolithal	<b>X</b>
Akal	<b>X</b>
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	<b>X</b>
Floodplain water bodies	<b>X</b>
Gravel and sand bars	<b>X</b>
Softwood floodplain forests	<b>X</b>
Hardwood forests	-
The most important forest habitat types are riverine willow, alder and ash stands ( <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> ).	

<b>Riparian Structures</b>	
Steep bank	<b>X</b>
Shallow bank	<b>X</b>
„Other“ banks	<b>X</b>
Inlets & outlets of secondary channels	<b>X</b>
No additional information.	





Restored secondary channel



Building of the river ramp on Mura



Restored secondary channel 2



Bank opening and the secondary channel connection to the river at Besnica 2010/2011



Restored inflow into the secondary channel



Bank opening and the secondary channel connection to the river at Bunčani



# DANUBEISLANDFOREST

*The project targeted to revitalize the side branch of Liberty Island near Mohács and to restore the forest habitats of the island.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	Danubeislandforest - Conservation of alluvial habitats of community interest on the Szabadság (Liberty) island and side channel in Béda-Karapanca
<b>Country</b>	Hungary
<b>River</b>	Danube
<b>River section type</b>	Danube I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Purchase of the island</li> <li>• Revitalization of the side-arm</li> <li>• Restoration of the alluvial forest</li> </ul>
<b>Implementation period</b>	2009 - 2013
<b>Total costs</b>	€ 1,795,529
<b>Funding source</b>	60% co-funded by the European Union LIFE NATURE Programm 40% co-funded by Coca-Cola Hungary, Municipality of Mohács Town
<b>Project participants</b>	<u>Coordinating beneficiary:</u> WWF Hungary <u>Partners:</u> Danube-Drava National Park Directorate, Hungary, Lower Danube Water Management Directorate, Hungary, Trans-Danubian Regional Water Supplier, Hungary, Municipality of Mohacs
<b>Contact</b>	WWF Hungary, <a href="http://www.szabadsagsziget.hu">www.szabadsagsziget.hu</a> , <a href="mailto:tamas.gruber@wwf.hu">tamas.gruber@wwf.hu</a> , <a href="mailto:panda@wwf.hu">panda@wwf.hu</a>

## Introduction

Life of the Danube has changed over the past 150 years significantly: the altered river dynamics (due to conventional river regulation works) and the lack of sediment (due the upstream hydropower development and significant commercial dredging activities) cause the river to be hardly able to form new islands so the development of new side branches are also missing. The blocking of the side branches through river regulation structures resulted in intensive silting up. The lack of new islands and the silted up secondary channels causes the extinction of unique habitats.

In order to overcome these challenges, WWF Hungary decided to implement the Liberty Island project, which is only one island from the many with the same problem.

The Liberty Island is located in South Hungary northward from Mohács at the left side of the Danube. Its length is about 3 kilometers, its width is 150-200 m, and its territory is 47 ha. The island and the side branch is part of the Danube-Drava National Park, the Natura 2000 network, a Ramsar site as well and operates as an important ecological corridor along the river. Despite of the island's as a strictly protected nature conservation area, it was privately owned, so the nature conservational purpose of the island's management was not ensured. Along the bank of the Danube the local water service company has its bank filtered water wells to provide drinking water for the settlements of South Baranya county.

The forests of the island were managed for commercial forestry purposes by hybrid poplar plantations with a high coverage of invasive species. The Liberty side branch was blocked by a rock-fill dam which stopped the natural waterflow and induced intensive silting up.

WWF together with its partners implemented a LIFE+ Nature project to restore the potentially unique habitats of the Liberty Island and its side branch. After the restoration, water flows again in the previously closed side branch, and the branch itself has continuous connection with the Danube again. An undisturbed semi-natural alluvial forest as an important habitat of many species has grown on the island.

The success of the project is presented by a newly established white-tailed eagle nest and the presence of individuals of more than 5 protected rheophilic fish species which are staying permanently in the free flowing side branch and using this habitat not only to stay and feed, but as a spawning site.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	-
Barriers/connectivity	X	Habitat degradation	X
Channelization	-	Invasive species	-
Disturbed sediment regime	-	Water abstraction	-

**Barriers/connectivity (rock-fill dam in the side branch):** The side branch was blocked by a rock-fill dam in 1982, splitting up the branch into two parts, stopping the natural river flow. This caused the accelerated silting up of the side branch's riverbed. Finally, it became a big mud pond with mostly stagnant water. At the northern and southern end of the island, only two narrow trickles provided connection with the main riverbed. Waders were searching in the little puddles, but after they dried out, they found nothing there. The shallow puddles became an ecological graveyard. Inside the rock-fill dam waterpipes connect the left side wells with the right side water purification station. Thus the dam reached a height of 6 meters, which could be overflowed only by the highest floods and stopped the water flow in 95% of the year.

**Habitat degradation due to forest management and invasive species:** The island is covered with soft-wood alluvial forest. Before the launch of the project, commercial forestry was going on, even in spite of its protected status. Consequently, hybrid poplar plantations and non-native, fast growing invasive tree species threatened the habitat.

All the species living in a natural **side branch** require lower waterflow (but still flowing water) compared to the main branch, warmer water, riparian vegetation and rambling hideouts. Many fish species are simply unable to reproduce elsewhere: it is difficult to

survive in the main riverbed for juveniles because of the tough conditions. As a consequence of the built rock-fill dam, the waterflow stopped in the side branch and the habitat of natural rheophilic fish species and macroinvertebrates changed to stagnant water.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	-
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	-	Secure land in the river corridor	X
Re-establish/ improve longitudinal connectivity	-	Sediment management	-

This project targeted to revitalise the side branch of the Liberty Island near Mohács and to restore the forest habitats of the island.

**Secure land in the river corridor:** The island was purchased from private people for the Hungarian State to be managed by the Danube-Drava National Park Directorate, which ensures that the area is forever dedicated exclusively for nature conservation.

**Re-establish / improvement of lateral connectivity:** Revitalization of the side branch by the opening of the rockfill dam which closed the side branch, and its slight dredging for the removal of the silted up sediments to improve the connectivity and to restore the aquatic habitats especially the habitats of the fish and the macroinvertebrate fauna.

**Restoration/ improvement of floodplain habitats:** Forest restoration by the planting of native riparian soft wood forest instead of non-native tree plantations, and the control of invasive plants.

Furthermore, the project focused on communication activities to raise awareness for the restoration by the highlighting of the ecosystem services of the side branch.

## Involvement of interested bodies/parties







To involve the local stakeholders who were not directly part of the project development three forums were organized to reach them and to raise public awareness. The first forum was held on 17/03/2010 with the aim to raise the general awareness of the project. About 50 people participated, each project partner was represented and gave a short presentation and then answered questions. This forum generally was open-minded, participants expressed their happiness about the restoration works. Local people were excited to get the 'good old times' back. The second forum was held on 07/09/2010 in



order to ensure that locals understand and accept the necessity and ecological justification of the clearcut of the poplar plantation as well as to address the sensitive issue of people believing that the National Park aimed to benefit from the timber. The third forum was held on 04/07/2012 in order to prepare local people for the heavy works (dredging, relocation of water pipe, opening of the rockfill dam), all the noise and inconveniences. On each forum the nature conservation goals and the context of “people and nature” were emphasized, and the concept of ecosystem services was introduced.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	-	Neophyte management	-
	Mechanical widening	-	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	-	Reintroduction of plant species	-
	Lowering the foreland	-	Reforestation of floodplain forest	X
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	-
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	X

First step of the LIFE+ project was the purchase of the island from private people. The owner now is the Hungarian State, the land manager is the Danube-Drava National Park Directorate. This ensures that the area is forever dedicated exclusively for nature conservation. The forests of the island are not used for commercial forestry and logging anymore, and natural processes can take place without intervention.

The key element of the revitalisation was the opening of the rockfill-dam and the dredging of the silted up side branch. Two excavators were working for 7 months and 12 hours a day, to remove the 160,000 m<sup>3</sup> sediment, mainly sand from the side branch. The dredged material was transported to the main riverbed to decrease the sediment deficit of the Danube. The shape and depth of the dredged channel was designed on a scientific basis: the aim is that the side branch should be self-sustaining to the best possible extent to prevent fast sedimentation. Because of the natural process of river-dynamics and the narrowed floodplain, the sedimentation of side branches is happening and unavoidable, but slowing down is possible. A very big challenge was that before opening the dam, the waterpipes located in the dam had to be relocated under the riverbed by horizontal directional drilling, which is a very specific method. This huge work required years of preparatory work of technical designing and permissioning. After the relocation of the waterpipes, the opening of the rockfill dam was started, according to the depth and shape of the dredged sections.

During the restoration process native, alluvial softwood forests which are typical for floodplain areas were planted, instead of the non-native tree plantations and colonising invasive plants. The young forest needed nursery in the first few years, so the faster growing invasive species were cut off two or three times each year in order to help the young plants to strengthen. The closing canopy of the native forest did not let the light in, thus the light-demanding invasive plants could not grow and finally die. The aim of the restoration is to provide an open field for the natural processes and provide undisturbed habitat for wildlife, such as for the rare birds of prey nesting here.

A nature trail along the side branch for recreational reasons was installed, in particular for water sports activities (tables which are moving up and down in parallel with the change of the water level).

## Results & Effects

- The island was purchased
- The side branch is revitalised
- The selected floodplain forest site is restored

The biomonitoring (forest, fish and macroinvertebrates) on the Liberty Island and in its side branch continued after the implementation of the project till 2020.

**Purchased island:** The nature conservation management of the island is ensured forever.

**Revitalization of the side branch (the rockfill-dam was opened and the silted up sediments were dredged):** The fish fauna monitoring activities proved that after the reconnection of the side branch (the partly elimination of the rockfill dam) the individuals of more than 5 protected rheophilic species are staying permanently in the free flowing side branch (when the water level is not extremely low) and they are using this habitat to stay and feed and even more they are using the side branch as spawning site. These species were not here at all before the side branch was opened, so this is a very important result of the whole rehabilitation project. The macroinvertebrate assemblages of the side branch changed corresponding to a former stage of succession, since the lotic fauna elements exchanged several typical lentic species, and despite the water shortage due to the extremely low water level the ecological state has risen. After the restoration works finished a pair of white-tailed eagle inhabited the remaining old forest part and has been nesting there since the project was completed. (At first sight it would seem the new nest is the result of the riparian forest rehabilitation, but we think this is the result of the calm and undisturbed area, so the dam elimination significantly limited people's visits to the island, as they cannot come there by foot). The ecosystem services of the side branch significantly improved, the quality of the nearby drinking water resources is ensured for longer term, the local communities are using the side branch for recreational and sport purposes.

**Restored floodplain forest:** Two methods were tested for native plantation. One method was a dense plantation with much more trees, and another was a plantation with classic (wide) line-spacing. The canopy of the dense plantation is closed earlier, which helps to

limit the growth of the invasive species. This part of the restored forest looks very good now. The classic line spacing plantation is not as successful as the dense one.




The biological monitoring results before and after the side branch opening clearly proved the necessity of these kinds of rehabilitation projects, thanks to the significant positive impacts that were found.

## Lessons learned

- The riparian gallery forest restoration needed longer term nursery, than it was initially thought. Some of the planted poplars have not survived in the classic line spacing plantation. But the dense plantation with much more trees for the same sized area looks really successful.
- Monitoring data shows that during low water periods in the main channel of the Danube the water supply of the side branch is not good. Further actions for improving water supply during low water seasons (e.g. redesigning the groynes on the left bank upstream the side branch, or removing sediment /sand/ right upstream the side branch) can be developed, very precise hydromorphological planning is necessary based on proper and enough data if we would like to define the minimum water discharge of the side branch.
- Consecutive projects are necessary on the restored sites if the objectives are planned to be properly achieved and maintained. Projects that run for 3 or 5 years can't satisfy this expectation or only with high risk.
- Wide partnership is an added value during the implementation of the project. This helps to identify problems to be solved with an integrated approach and to increase the motivation of partners.



## Map of the project area

<p><b>Overview</b></p>	
<p><b>Former status</b></p>	
<p><b>Current status</b></p>	

Mohács in Hungary (Magyarország), © Google Earth Pro

Liberty island 25.03.2006, © Google Earth Pro

Liberty island 25.08.2020, © Google Earth Pro

## River stretch characteristics

River
Danube
Width
Danube main branch: cc 400 m, side-arm: cc 60-80 m
Average discharge
2000 m <sup>3</sup>

Area
UTM 34T E: 321166 N: 5099246
Gradient
No data available.
Sea level
90 m

Planform	
Straight	-
Braided	-
Oscilating	-
Anabranching	-
Sinous	X
Meandering	X
Before the river regulation works the Danube built a meander here. The island was formed as a gravel cored sand bar.	

Bed material	
Megalithal	-
Makrolithal	-
Mesolithal	-
Mikrolithal	-
Akal	X
Psammal	X
Pelal	-
Mostly sand and smaller fractions.	

Habitat types	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	-
91E0 Riparian forests also with willow-poplar softwoods [Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (Alno-Padion, Alnion incanae, Salicion albae)]	

Riparian Structures	
Steep bank	-
Shallow bank	X
„Other“ banks	-
Inlets & outlets of secondary channels	X
Island 47 ha; side-arm with some silted up sand bars (with gravel cores) approximately 50 ha	





Aerial photo of the Liberty Island



The side-arm before the restoration



The side branch before the restoration in 2008



Channel dredging in the side branch



Relocation of the water pipes



New water pipes





The side branch before the project



The side branch after the restoration, 2021)



Rockfill dam which blocks the side branch before the restoration, 2012



Partly eliminated rockfill dam after the restoration



White tailed eagle



*Gymnocephalus schraetser* from the main branch and also from the side branch



# DRA-MUR-CI

## Alter Graba, 11-mill channel

*The project highlights collaborative solutions and actions to prevent flood risks and the loss of biodiversity.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	DRA-MUR-CI: Drava-Mura Crossborder Water Management Initiative, measures: Alter graba, 11-mill channel
<b>Country</b>	Slovenia
<b>River</b>	Mura
<b>River section type</b>	Mura I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Widening of the riverbed</li> <li>• Restoration and connection of side branches</li> </ul>
<b>Implementation period</b>	2009 – 2013
<b>Total costs</b>	€ 3,500,000 for the whole project DRA-MUR-CI, no data available for measures „Alter Graba and 11-mill channel“
<b>Funding source</b>	85% co-funded by the European Union, European Territorial cooperation, operational programme Slovenia-Austria 2007-2013 15% co-funded by national funds
<b>Project participants</b>	<p><u>Slovenia</u>: Ministry of Agriculture and the Environment of the Republic of Slovenia, Centre for Water Management of the Drava river basin, Environmental Agency of the Republic of Slovenia, Office of the State Government of Maribor, Ministry of Agriculture and the Environment of the Republic of Slovenia, University of Maribor: Faculty of Civil Engineering, University of Ljubljana: Faculty of Civil Engineering and Geodesy, MURA – Water Management Company, Plc., DRAVA – Water Management Company, Plc.</p> <p><u>Austria</u>: Office of the State Government of Styria: Department A14 Water Management, Resources and Sustainability, Department A13 Environment and Spatial Planning, Provincial Government of Carinthia: Department 8, Environment, Water and Nature protection</p>
<b>Contact</b>	University of Maribor, Faculty of Civil Engineering, <a href="http://www.fgpa.um.si/fakulteta-se-predstavi/raziskovalna-dejavnost/mednarodni-projekti">www.fgpa.um.si/fakulteta-se-predstavi/raziskovalna-dejavnost/mednarodni-projekti</a> , fgpa@um.si

## Introduction

The project »Crossborder water initiative for the Drava and Mura« with the acronym DRA-MUR-CI, was selected in the framework of the Operational Programme Slovenia-Austria 2007-2013. It is located in the 2<sup>nd</sup> priority programs, whose main objective is to achieve sustainable and harmonious development. It is a strategy of sustainable and balanced development stemming from the potential of the regions, which can be (further) used in a sustainable and responsible way to improve the quality of life for present and future generations. Since the program area has a relatively well preserved environment, rich biodiversity and valuable natural resources, the conservation of resources, promotion of their sustainable and responsible use is necessary. This should include existing knowledge and skills of participants in cross-border areas and support the protection of biodiversity and the preservation of ecosystems. The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water



management, specifically for the Drava and Mura. Collaborative solutions and actions are focusing on preventing flood risks and biodiversity loss as well as the issue of the declining number of species and habitats types which are constantly under threat.

**While the project covers different sites at the Drava and Mura river in Slovenia and Austria, the goals described above, as well as the addressed problems, implemented measures and results relate only to the implementation sites “Alter Graba” and “11-mill channel” in Slovenia.**

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	X	Flow alteration	-
Barriers/connectivity	-	Habitat degradation	X
Channelization	X	Invasive species	-
Disturbed sediment regime	X	Water abstraction	-

Systematic river regulation, beginning at the end of the 19<sup>th</sup> century, caused substantial changes in the course of the river Mura’s flow. This water course was originally characterised by numerous elements typical for natural rivers such as secondary channels, shallow zones, gravel, partly eroded sand and mud banks. As a result of the so called „Hochenburger“ river regulation (1874 – 1892), the river Mura’s dynamics were substantially limited at the stretch from the city of Graz (Austria) to Radenci (Slovenia). The river was straightened to a monotone channel, where all secondary channels were cut off and large areas were drained to make them available for agriculture.

Increased flow velocity and the lack of sediments due to numerous hydropower plants upstream caused a riverbed incision and led to disconnection of the Mura from surrounding land and side channels, to the partial loss of alluvial forest along the river and of river dynamics. Regulation and massive securing measures along many stretches of river bank led to few possibilities for the emergence of new habitat along the Mura river.

The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water management, specifically for the Drava and Mura, in collaborative solutions and actions to prevent flood risks and prevent the loss of biodiversity and the issue of the decline in the number of species and habitats which are constantly under threat. The project is also addressing the problem of sediment transport in both rivers. For this purpose, a number of sites were selected where the measurements have been carried out to monitor the correlation between the flow rate and the amount of suspended material.

One of the project aims was to prevent further incision of the Mura river, protecting a stable riverbed and to increase the level of groundwater, as well as establishing a network of river sections with sand dunes enabling the sustainable natural and dynamic development of the river. For this purpose the sites “Alter Graba” and “11-mill channel” were chosen.

## Restoration goals







RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	X	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	X	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	X

## Involvement of interested bodies/parties

The internet platform [www.dramurci.eu](http://www.dramurci.eu) provided information in 3 levels for project partners, experts and general public in three languages (Slovenian, German, English) during project period. A trilingual glossary of terms related to water management in the framework of this web portal was published. As the project ended some time ago, the website is no longer active. 5 workshops had been organised for experts and general public in Slovenia and Austria. For the purpose of presenting the results of the project in the media, at workshops and conferences, communication materials in the form of posters, brochures and leaflets were produced. Results and research carried out in the framework of the project was also presented at international conferences and journals. Information boards inform visitors of the measures at the site.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	-
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	X	Reintroduction of plant species	-
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

The measures "Alter Graba" and "11-mill" channel belong to a set of five measures on the Slovenian and Austrian (Sicheldorf, Trumer-Lahn, Gosdorf) side of the border Mura river that aim on improving the ecological conditions. Following measures have been implemented:

- Widening of the riverbed at the "11-mill" channel site
- Restoration of the channel and the lateral connectivity along 240 m at the "11-mill" channel site
- Restoration and revitalization of a secondary channel at the "Alter Graba" site along 800 m with connection to a former gravel pit, thus creating an island
- Relocation of an existing footpath from the river bank to the secondary channel banks for creating calm zones for the wildlife.
- Removal of bank protection in the length of 400 m at the "Alter Graba" site and
- Protection of the hinterland by relocating the bank protection to widen the riverbed

## Results & Effects

- River bottom stabilization
- Improving the geomorphological and ecological status of rivers through dynamic sediment movements
- Improving the conditions for achieving a good state of the natural environment
- Maintaining current groundwater level in the Alter Graba gravel area
- Prevention of a further riverbed incision
- Lateral erosion for increased sediment input
- Establishment of rare habitats and improved conditions for plant and animal species

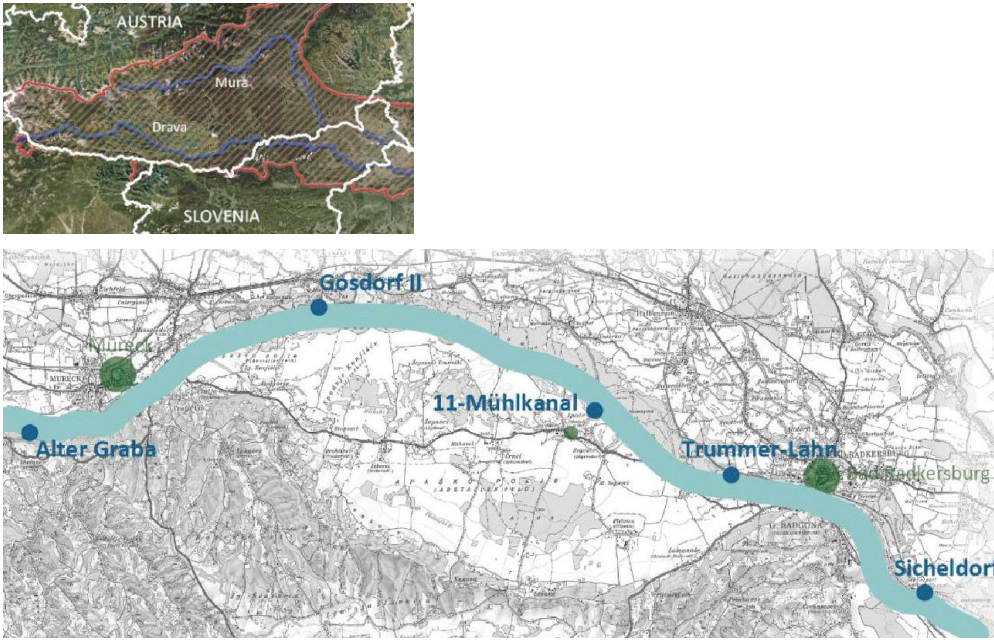




The widening of the riverbed and the simultaneous connection of the secondary channel in the proposed form significantly improved the ecological status of the Mura section of the river in question, as well as the riparian habitats (e.g. floodplain forest). The effects of the riverbed widening were significantly larger than those from the re-connection of the secondary channel, as the balance in the river was permanently improved, at least the current river bottom level and groundwater level were maintained. The number of endangered plant and animal species and habitat types improved significantly in the implementation sites after the measure implementation.

## Lessons learned

- The project DRA-MUR-CI is an example of strengthening common approaches and exchange of experience in the field of water management, providing flood protection and conservation of biodiversity in the Drava and Mura catchment area. The value of the project is a realization that water management and governance in the basin could be effective only if both countries (Slovenia-Austria) are participating in the development and considering all parts of both rivers. Cross-border cooperation is inevitable to achieve coordinated planning and implementation of measures in the riverbed.
- The experience has shown that the implemented measures were effective for a period of time. But some years after the project ended problems started to show. Neophytes spread in the pilot measure sites and wider secondary channels and pits filled up with sediment during the floods. A relocated footpath was moved back to the waterfront, crossing the island and cancelling out the calm zone for wildlife.
- Despite the small scale of the pilot measures implementation, the project nevertheless contributed to the revitalisation of such a monotonous (channelized) river. It is important to take the opportunity to start the river revitalization process. It was a valuable learning opportunity, since there was no possibility to investigate the restoration options in a laboratory and not many practical examples available.

## Map of the project area

<p><b>Overview</b></p>	
	<p>Location of the project area © Ministry of Agriculture and the Environment of the Republic of Slovenia, Ljubljana, 2013</p>
<p><b>Former status</b></p>	
	<p>Left: Alter Graba, right: Apače, 2006 © <a href="http://www.naravovarstveni-atlas.si">www.naravovarstveni-atlas.si</a>, 2021, © ZRSVN</p>
<p><b>Current status</b></p>	
	<p>Left: Alter Graba, right: Apače, 2019 © <a href="http://www.naravovarstveni-atlas.si">www.naravovarstveni-atlas.si</a>, © 2021, © ZRSVN</p>

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
70 m
<b>Average discharge</b>
153 m <sup>3</sup> /s, gauging station: Ceršak

<b>Area (UTM)</b>
33T E: 557737 N: 5171843 – 33T E: 571851 N: 5171422
<b>Gradient</b>
1.3 ‰
<b>Sea level</b>
From 232 m (Alter graba) to 209 m (Apače)

<b>Planform</b>	
Straight	X
Braided	-
Oscilating	-
Anabranching	-
Sinous	-
Meandering	-
The stretch of Mura river is situated on the border of Slovenia and Austria between Sladki vrh and Gornja Radgona where the river was completely regulated in the past.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	-
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	-
Softwood floodplain forests	-
Hardwood forests	X
No additional information.	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	-
„Other“ banks	X
Inlets & outlets of secondary channels	X
No additional information.	





Alter Graba secondary channel excavation



Apače secondary channel excavation



Alter Graba final result (2013)



Apače final result, 2012



Removed embankment at Crnci



Restored secondary channel at Alter Graba



# DRA-MUR-CI

## Sicheldorf

*The aim of the measure was the ecological revaluation and the morphological improvement of the Mura river as well as the improvement of adjacent alluvial forest.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	DRA-MUR-CI: Drava-Mura Crossborder Water Management Initiative, measure Sieldorf
<b>Country</b>	Austria
<b>River</b>	Mura
<b>River section type</b>	Mura I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Removal of bank protection</li> <li>• Widening of the Mura-riverbed</li> <li>• Introduction of deadwood structures</li> </ul>
<b>Implementation period</b>	2012
<b>Total costs</b>	€ 3,500,000 for the whole project, € 147,826 only measure Sieldorf
<b>Funding source</b>	85% co-funded by the European Union, European Territorial cooperation, operational programme Slovenia-Austria 2007-2013 15% co-funding national fund
<b>Project participants</b>	<p><u>Austria</u>: Office of the State Government of Styria: Department A14 Water Management, Resources and Sustainability, Department A13 Environment and Spatial Planning, Provincial Government of Carinthia: Department 8, Environment, Water and Nature protection</p> <p><u>Slovenia</u>: Ministry of Agriculture and the Environment of the Republic of Slovenia, Centre for Water Management of the Drava river basin, Environmental Agency of the Republic of Slovenia, Office of the State Government of Maribor, Ministry of Agriculture and the Environment of the Republic of Slovenia, University of Maribor: Faculty of Civil Engineering, University of Ljubljana: Faculty of Civil Engineering and Geodesy, MURA – Water Management Company, Plc., DRAVA – Water Management Company, Plc.</p>
<b>Contact</b>	Office of the State Government of Styria – Department 14 Water Management, Resources and Sustainability, <a href="http://www.wasserwirtschaft.steiermark.at">www.wasserwirtschaft.steiermark.at</a> , <a href="mailto:abteilung14@stmk.gv.at">abteilung14@stmk.gv.at</a>

## Introduction

The project »Crossborder water initiative for the Drava and Mura« with the acronym DRA-MUR-CI, was selected in the framework of the Operational Programme Slovenia-Austria 2007-2013. It is located in the 2<sup>nd</sup> priority programs, whose main objective is to achieve sustainable and harmonious development. It is a strategy of sustainable and balanced development stemming from the potential of the regions, which can be (further) used in a sustainable and responsible way to improve the quality of life for present and future generations. Since the program area has a relatively well preserved environment, rich biodiversity and valuable natural resources, the conservation of resources, promotion of their sustainable and responsible use is necessary. This should include existing knowledge and skills of participants in cross-border areas and support the protection of biodiversity and the preservation of ecosystems. The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water



management, specifically for the Drava and Mura. Collaborative solutions and actions are focusing on preventing flood risks and biodiversity loss as well as the issue of the declining number of species and habitats types which are constantly under threat.

While the project covers different sites at the Drava and Mura in Slovenia and Austria, the goals described above, the addressed problems, implemented measures and results relate only to the implementation site “**Sicheldorf**” in Austria.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	X
Barriers/connectivity	-	Habitat degradation	X
Channelization	X	Invasive species	X
Disturbed sediment regime	X	Water abstraction	-

Systematic river regulation, beginning at the end of the 19<sup>th</sup> century, caused substantial changes in the course of the river Mura’s flow. This water course was originally characterised by numerous elements typical for natural rivers such as secondary channels, shallow zones, gravel, partly eroded sand and mud banks. As a result of the so called „Hochenburger“ river regulation (1874 – 1892), the river Mura’s dynamics were substantially limited at the stretch from the city of Graz (Austria) to Radenci (Slovenia). The river was straightened to a monotone channel, where all secondary channels were cut off and large areas were drained to make them available for agriculture.

Increased flow velocity and the lack of sediments due to numerous hydropower plants upstream caused a riverbed incision and led to disconnection of the Mura from surrounding land and side channels, to the partial loss of alluvial forest along the river and of river dynamics. Regulation and massive securing measures along many stretches of river bank led to few possibilities for the emergence of new habitat along the Mura river.

The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water management, specifically for the Drava and Mura, in collaborative solutions and actions to prevent flood risks and prevent the loss of biodiversity and the issue of the decline in the number of species and habitats which are constantly under threat. The project is also addressing the problem of sediment transport in both rivers. For this purpose, a number of sites were selected where the measurements have been carried out to monitor the correlation between the flow rate and the amount of suspended material.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	-
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	-	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	-







The aim of this measure was the ecological revaluation and the morphological improvement of the Mura river as well as improvement of adjacent alluvial forest. Small fish species should find new habitats.

## Involvement of interested bodies/parties

The internet platform [www.dramurci.eu](http://www.dramurci.eu) provided information in 3 levels for project partners, experts and general public in three languages (Slovenian, German, English) during project period. A trilingual glossary of terms related to water management in the framework of this web portal was published. As the project ended some time ago, the website is no longer active. 5 workshops had been organised for experts and general public in Slovenia and Austria. For the purpose of presenting the results of the project in the media, at workshops and conferences, communication materials in the form of posters, brochures and leaflets were produced. Results and research carried out in the framework of the project was also presented at international conferences and journals. Information boards inform visitors of the measures at the site.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	X
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	-	Reintroduction of plant species	-
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

For initiating erosion of the left riverbank the concrete bank protection was removed at a length of 1,400 m. It was reused as hidden protection in the hinterland.

Initial structures should additionally stimulate the erosion process and development of the area without any further human intervention. But the flood event in July 2012 showed that erosion was faster than expected. For securing adjacent land and the agricultural road along the project area the process had to be stopped. Whole trees as wooden groynes were fixed in the riverbank for focusing the flow to the middle of the river. At a short section the agricultural road had to be secured through riprap.

A neophyte management was not foreseen in the project. But at all construction sites it has been shown, that invasive species spreaded strongly at places where vegetation was damaged und soil was opened by machines. Therefore a neophyte management was carried out for five years after the end of the project financed by other fundings.

## Results & Effects

- Improvement of morphology and dynamic processes of the riverbed and riverbank
- Lateral erosion for increased sediment input
- Decline of invasive species by a neophyte management program after the end of the project.

The widening of the riverbed caused the development of a steep eroded bank at the left (Austrian) side and a big gravel bar at the inner bank at the right (Slovenian) side. The former straight river section is slightly curved now.

Therefore the left (Austrian) side shows a steep riverbank with wooden structures.



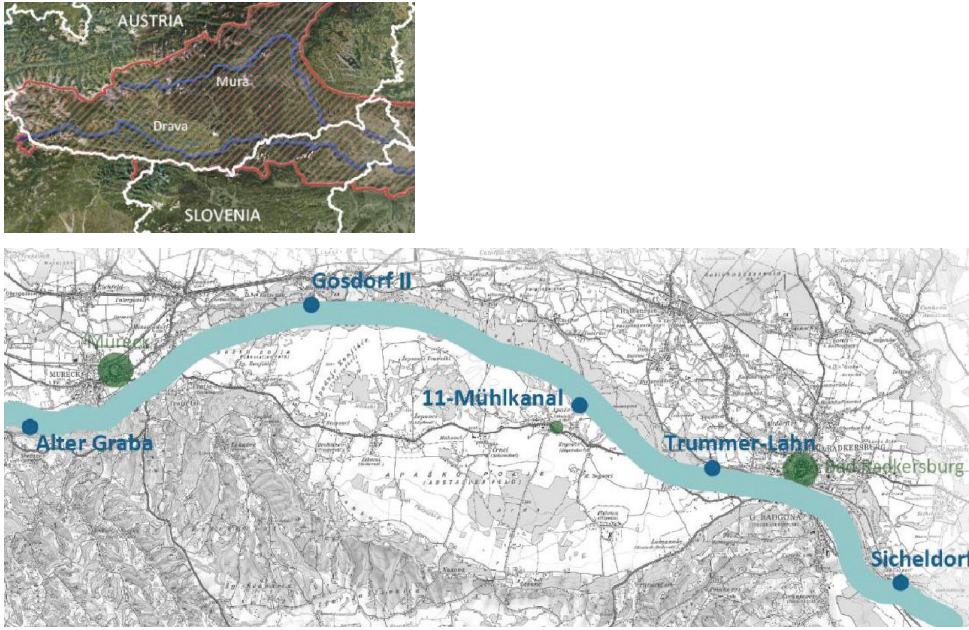


The fish monitoring for the project included a pre- and a post-monitoring in 2010 and 2012 at two sites in the Mura river: one in Gosdorf (with tributary Saßbach) and one in Sichelendorf (with tributary Drauchenbach). The data showed a massive decline of biomass and abundance for the most fish species in both sites. It is supposed that several flood events combined with flushing sediments of reservoirs of hydropower plants in 2012 caused the reduction.

The measures of the neophyte management program reduced effectively invasive species as Himalayan balsam (*Impatiens glandulifera*), knotweed-species (*Fallopia* spp.), golden-rod-species (*Solidago* spp.), black locust (*Robinia pseudoacacia*) and trees of heaven (*Ailanthus altissima*). The success was great: The typical native species of alluvial forest could develop well and gaps caused by the construction measures were closed.

## Lessons learned

- For the choice of the right measures and to get an approval a good planning process is important and necessary. The measure „Sichelendorf“ has shown that it is not always possible to predict exactly the development of measures in a dynamic system. In this case, a big flood event, which had happened at the end of the construction period caused an accelerated development process. The riverbed of the Mura would have changed dramatically if no measures had been implemented to stop it.
- Management of invasive species is very important for measures in alluvial forests. They like the nutrient-rich soils and will be spreaded by machines and floodings rather quickly. So it is an advantage to start with removing them before implementing the restoration measures. At Sichelendorf this topic was not foreseen within the project, so that other funds had to be found.

## Map of the project area

<p><b>Overview</b></p>	 <p>Location of the project area © Ministry of Agriculture and the Environment of the Republic of Slovenia, Ljubljana, 2013</p>
<p><b>Former status</b></p>	 <p>Area of the measure „Sicheldorf“ during building period 2012 © GIS Land Steiermark</p>
<p><b>Current status</b></p>	 <p>Area of the measure „Sicheldorf“ 2016 - 2018 © GIS Land Steiermark</p>

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
87 m (regulated) – 166 m (widened)
<b>Average discharge</b>
156 m <sup>3</sup> , Bad Radkersburg

<b>Area (UTM)</b>
33T E: 578468 N: 5168041
<b>Gradient</b>
1.4 ‰
<b>Sea level</b>
199 m

<b>Planform</b>	
Straight	-
Braided	-
Oscilating	-
Anabranching	-
Sinous	X
Meandering	-
The stretch is situated at the border to Slovenia in a broad valley, therefore the potential type is mainly anabranching, sinuous and meandering.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	-
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	-
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	X
No additional information.	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	X
„Other“ banks	-
Inlets & outlets of secondary channels	-
No additional information.	





Removing of the bank protection 2012



Fixing wooden structures in the new riverbank 2012, view upstream



New riverbank formed by machines, May 2012, view downstream



Development after flood event, July 2012, view downstream



Development of a steep riverbank by a flood event July 2012, view downstream



Development of the area May 2016, view downstream



# DRA-MUR-CI

## Trummer-Lahn

*Aim of the measure was to provide small fish species new habitats in increased lentic water bodies and to offer fishes in the Mura river protection in flood periods.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	DRA-MUR-CI: Drava-Mura Crossborder Water Management Initiative, measure Trummer-Lahn
<b>Country</b>	Austria
<b>River</b>	Mura
<b>River section type</b>	Mura I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Removal of bank protection of the Mura river</li> <li>• Widening and deepening of the confluence of Trummer-Lahn with the Mura river</li> <li>• Creation of lentic water bodies for small fish species</li> <li>• Construction of a landing area for boats</li> <li>• Access for general public and bicycle-tourists</li> </ul>
<b>Implementation period</b>	2012
<b>Total costs</b>	€ 3,500,000 for the whole project DRA-MUR-CI, no data available for measure „Trummer-Lahn“
<b>Funding source</b>	85% co-funded by the European Union, European Territorial cooperation, operational programme Slovenia-Austria 2007-2013 15% national funding
<b>Project participants</b>	<p><u>Austria</u>: Office of the State Government of Styria: Department A14 Water Management, Resources and Sustainability, Department A13 Environment and Spatial Planning, Provincial Government of Carinthia: Department 8, Environment, Water and Nature protection</p> <p><u>Slovenia</u>: Ministry of Agriculture and the Environment of the Republic of Slovenia, Centre for Water Management of the Drava river basin, Environmental Agency of the Republic of Slovenia, Office of the State Government of Maribor, Ministry of Agriculture and the Environment of the Republic of Slovenia, University of Maribor: Faculty of Civil Engineering, University of Ljubljana: Faculty of Civil Engineering and Geodesy, MURA – Water Management Company, Plc., DRAVA – Water Management Company, Plc.</p>
<b>Contact</b>	Office of the State Government of Styria – Department 14 Water Management, Resources and Sustainability, <a href="http://www.wasserwirtschaft.steiermark.at">www.wasserwirtschaft.steiermark.at</a> , <a href="mailto:abteilung14@stmk.gv.at">abteilung14@stmk.gv.at</a>

## Introduction

The project »Crossborder water initiative for the Drava and Mura« with the acronym DRA-MUR-CI, was selected in the framework of the Operational Programme Slovenia-Austria 2007-2013. It is located in the 2<sup>nd</sup> priority programs, whose main objective is to achieve sustainable and harmonious development. It is a strategy of sustainable and balanced development stemming from the potential of the regions, which can be (further) used in a sustainable and responsible way to improve the quality of life for present and future generations. Since the program area has a relatively well preserved environment, rich biodiversity and valuable natural resources, the conservation of resources,



promotion of their sustainable and responsible use is necessary. This should include existing knowledge and skills of participants in cross-border areas and support the protection of biodiversity and the preservation of ecosystems. The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water management, specifically for the Drava and Mura. Collaborative solutions and actions are focusing on preventing flood risks and biodiversity loss as well as the issue of the declining number of species and habitats types which are constantly under threat.

While the project covers different sites at the Drava and Mura in Slovenia and Austria, the goals described above, as well as the addressed problems, implemented measures and results relate only to the implementation site “**Trummer-Lahn**” in Austria.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	-
Barriers/connectivity	X	Habitat degradation	-
Channelization	X	Invasive species	X
Disturbed sediment regime	X	Water abstraction	-

Systematic river regulation, beginning at the end of the 19<sup>th</sup> century, caused substantial changes in the course of the river Mura’s flow. This water course was originally characterised by numerous elements typical for natural rivers such as secondary channels, shallow zones, gravel, partly eroded sand and mud banks. As a result of the so called „Hochenburger“ river regulation (1874 – 1892), the river Mura’s dynamics were substantially limited at the stretch from the city of Graz (Austria) to Radenci (Slovenia). The river was straightened to a monotone channel, where all secondary channels were cut off and large areas were drained to make them available for agriculture.

Increased flow velocity and the lack of sediments due to numerous hydropower plants upstream caused a riverbed incision and led to disconnection of the Mura from surrounding land and side channels, to the partial loss of alluvial forest along the river and of river dynamics.

The project DRA-MUR-CI highlights opportunities for cooperation and finding solutions in areas of common water management, specifically for the Drava and Mura, in collaborative solutions and actions to prevent flood risks and prevent the loss of biodiversity and the issue of the decline in the number of species and habitats which are constantly under threat. The project is also addressing the problem of sediment transport in both rivers. For this purpose, a number of sites were selected where the measurements have been carried out to monitor the correlation between the flow rate and the amount of suspended material.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	-







The aim of this measure was the ecological revaluation and the improved lateral connectivity of an area of 1 ha between the Mura river and the Trummer-Lahn. Small fish species should find new habitats in increased lentic water bodies. For fish species of the Mura river, areas, that offer protection in flood periods, should be provided.

## Involvement of interested bodies/parties

The internet platform [www.dramurci.eu](http://www.dramurci.eu) provided information in 3 levels for project partners, experts and general public in three languages (Slovenian, German, English) during project period. A trilingual glossary of terms related to water management in the framework of this web portal was published. As the project ended some time ago, the website is no longer active. 5 workshops had been organised for experts and general public in Slovenia and Austria. For the purpose of presenting the results of the project in the media, at workshops and conferences, communication materials in the form of posters, brochures and leaflets were produced. Results and research carried out in the framework of the project was also presented at international conferences and journals. Information boards inform visitors of the measures at the site.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	X
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	X
	Initial channels	-	Reintroduction of plant species	-
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

The confluence of „Trummer-Lahn“ with Mura river was widened combined with a deepening of the bed in stages for offering protection for fish species in flood periods. For widening of a 130 m long river stretch up to 37 m width the concrete bank protection was removed and reused as hidden protection in erosion zones in the hinterland. Another part of the widening area is modified as a landing area for boats. The whole area is dedicated as recreation zone for the public and is accessible for bicycle-tourists.

A neophyte management was not foreseen in the project. But at all construction sites it has been shown, that invasive species spreaded strongly at places where vegetation was damaged und soil was opened by machines. Therefore a neophyte management was carried out for five years after the end of the project financed by other fundings.

## Results & Effects

- Improvement of morphology and dynamic processes of the Mura-riverbank
- Improvement of aquatic and terrestrial habitats in the „Trummer-Lahn“
- Decline of invasive species by a neophytic management program after the end of the project.
- Enhanced access for recreation

For this measure there is no specific fish monitoring available.

The general fish monitoring for the project included a pre- and a post-monitoring in 2010 and 2012 at two sites in the Mura river, one in Gosdorf (with tributary Saßbach) and one in Sieldorf (with tributary Drauchenbach). The data showed a massive decline of biomass and abundance for the most fish species in both sites. It is supposed that several



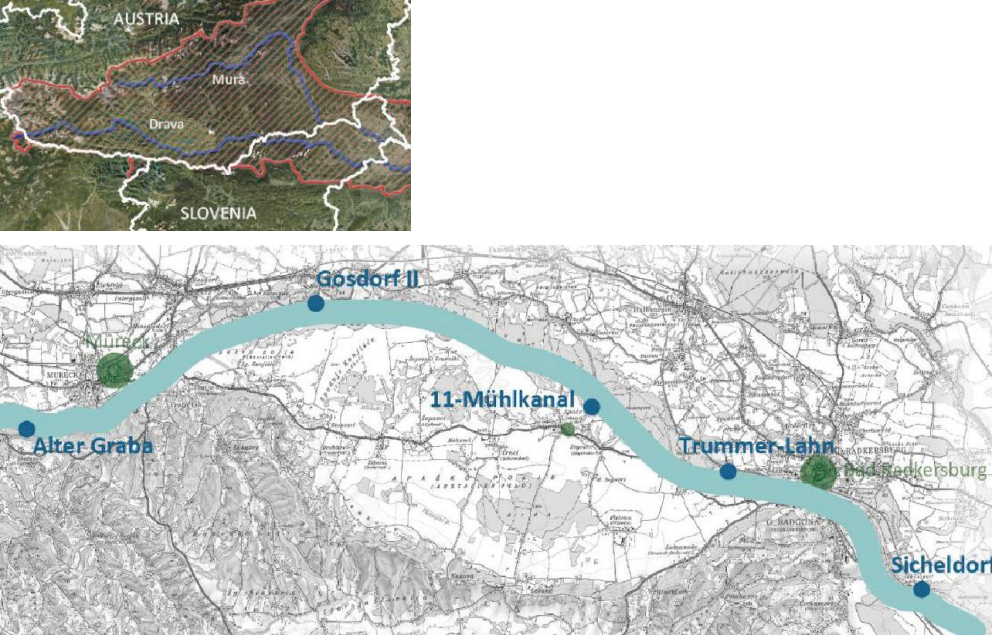
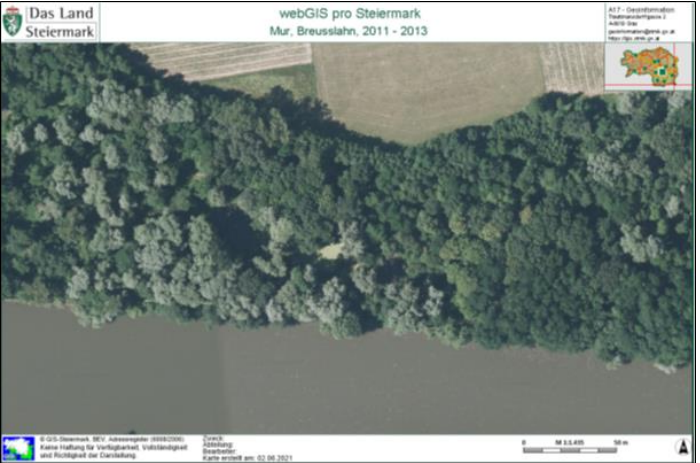

flood events combined with flushing sediments of reservoirs of hydropower plants in 2012 caused the reduction.

The measures of the neophyte management program reduced effectively invasive species as Himalayan balsam (*Impatiens glandulifera*), knotweed-species (*Fallopia* spp.), goldenrod-species (*Solidago* spp.), black locust (*Robinia pseudoacacia*) and trees of heaven (*Ailanthus altissima*). The success was great: The typical native species of alluvial forest could develop well and gaps caused by the construction measures were closed.

## **Lessons learned**

Management of invasive species is very important for measures in alluvial forests. They like the nutrient-rich soils and will be spreaded by machines and floodings rather quickly. So it is an advantage to start with removing them before implementing the restoration measures. At Trummer-Lahn this topic was not foreseen within the project, so that other funds had to be found.

## Map of the project area

<p><b>Overview</b></p>	 <p>Location of the project area © Ministry of Agriculture and the Environment of the Republic of Slovenia, Ljubljana, 2013 Situation</p>
<p><b>Former status</b></p>	 <p>Area of the measure „Trummer-Lahn“ 2011 © GIS Land Steiermark</p>
<p><b>Current status</b></p>	 <p>Area of the measure „Trummer-Lahn“ 2019 © GIS Land Steiermark</p>

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
87 m (regulated) – 124 m (widened area)
<b>Average discharge</b>
156 m <sup>3</sup> , Bad Radkersburg

<b>Area</b>
UTM 33T E: 573630 N: 5170872
<b>Gradient</b>
1.4 ‰
<b>Sea level</b>
209 m

<b>Planform</b>	
Straight	X
Braided	-
Oscilating	-
Anabranching	-
Sinous	-
Meandering	-
The stretch is situated at the border to Slovenia in a broad valley, therefore the potential type is mainly anabranching, sinuous and meandering.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	-
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	-
Softwood floodplain forests	X
Hardwood forests	-
No additional information.	

<b>Riparian Structures</b>	
Steep bank	-
Shallow bank	-
„Other“ banks	X
Inlets & outlets of secondary channels	X
No additional information.	





Widening of the Mura riverbed 2012, view upstream



Floodplain water body during implementation 2012, view upstream



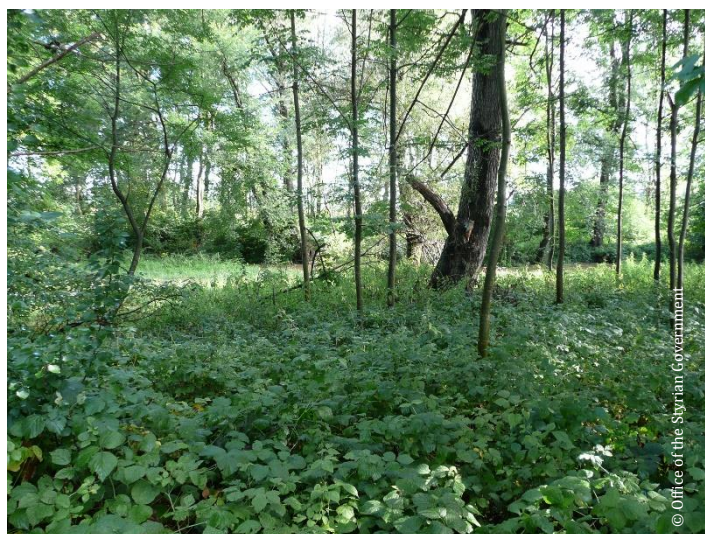
Development of the widened Mura riverbed, 2013



Development of floodplain water body, 2014



People using landing area for boats, 2017



Floodplain forest after Neophyte management work, 2017



# Murerleben II

## Lässer Au

*The objective of the project was to maintain, improve and regenerate the characteristic river landscape in the long term of the upper Mura.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	Muererleben II - Inner-alpine river basin management on the upper Mura river, measure Lässer Au
<b>Country</b>	Austria
<b>River</b>	Mura
<b>River section type</b>	upstream of the 5-Country Biosphere Reserve
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Removing of existing revetment on the left bank</li> <li>• Creation of a structured secondary channel</li> <li>• Creation of numerous amphibian ponds</li> <li>• Alluvial forest areas were secured or initiated</li> </ul>
<b>Implementation period</b>	2012 – 2013
<b>Total costs</b>	€ 470,000
<b>Funding source</b>	<p>50% co-funded by the European Union, LIFE+ Nature Programme 50% co-funded by national funds</p> <ul style="list-style-type: none"> <li>• Federal Ministry of Agriculture, Forest, Environment and Water Management (70% of national funding)</li> <li>• Office of the Styrian Government, Department 13 Nature Conservation, Upper West Styria Building Authority</li> <li>• Owner of fishing rights</li> <li>• Municipality Knittelfeld</li> </ul>
<b>Project participants</b>	<p><u>Coordinating beneficiary:</u> Office of the State Government of Styria – Department 14 Water Management, Resources and Sustainability <u>Associated beneficiaries:</u> Office the Styrian Government – Department 13 Nature Conservation; Upper West Styria Building Authority</p>
<b>Contact</b>	Office of the State Government of Styria – Department 14, Water Management, Resources and Sustainability, <a href="http://www.wasserwirtschaft.steiermark.at">www.wasserwirtschaft.steiermark.at</a> , <a href="mailto:abteilung14@stmk.gv.at">abteilung14@stmk.gv.at</a>

## Introduction

Systematic river regulation, beginning at the end of the 19<sup>th</sup> century, caused substantial changes in the course of the Mura river's flow. This water course was originally characterised by numerous elements typical of natural rivers such as secondary channels, shallow zones, gravel, sand and mud banks with some collapse. As a result of regulation, the River Mur's dynamics were substantially limited along extended sections, with secondary channels cut off and large areas drained to make them available for agriculture. Moreover, the construction of hydro-electric power installations influenced access along the river and sedimentary transport and, as a result of the introduction of untreated waste water from paper factories and settlements, by the middle of the last century the Mura river was one of the most polluted rivers in Europe. At the end of the 1970s, large national programmes commenced with a view to restoring water quality, accompanied by the first moves towards water management close to nature. Under the auspices of the 'LIFE Natur' EU funding programme, in 2003 the first LIFE III project 'Murerleben I' on the upper Mura



river was launched, entitled „Inner-alpine river basin management on the upper Mura river“. This 5-year renaturation project was succeeded by the ‘Murerleben II’ project from 2010 till 2015. Within the period of the 2 projects 18 measures had been implemented at the length of an 88-km riversection.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	-
Barriers/connectivity	-	Habitat degradation	X
Channelization	X	Invasive species	-
Disturbed sediment regime	-	Water abstraction	-

In addition, also loss of river flow dynamics was one of the problems addressed.

These changes in the water course led to disconnection of the Mura river from surrounding land and side streams, to the partial loss of alluvial forest along the river and of dynamics of flow conditions and, thus, to a substantial reduction of valuable habitat for fish, amphibians and birds. Forest management measures that were not adjusted to suit local conditions lead to the transformation of essentially natural stocks of trees into unnatural forests with a dearth of structure. This resulted in both, a steady reduction of original alluvial forest stocks and the loss of habitats typical of riparian zones.

## Restoration goals

RESTORATION GOALS			
Adapt land use	X	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	X
Increase of (cultural) ecosystem services	X	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	X
Re-establish/ improve longitudinal connectivity	-	Sediment management	-

The overall objective of the project was to maintain, improve and regenerate the characteristic river landscapes in the long term of the upper Mura river as a prerequisite for maintaining rare and endangered species of fauna and flora, listed in the 92/43/EEC Fauna Flora Habitat directive. Therefore in the “Lässer Au” area the Natura 2000 coverage area was enlarged by 3.9 ha. Ecological education and increase of environmental awareness of the local/ regional population was an additional goal.

## Involvement of interested bodies/parties







It was an advantage that the relevant public bodies, the Department for Environment and Spatial Planning - Nature Conservation and the Upper West Styria Works Department, were directly involved in the project as associated beneficiaries. The benefits of the previous project „Murerleben I“ convinced the most important stakeholders, the affected owners of fishery as well as the municipalities, to support the subsequent „Murerleben II“ project as co-financiers.

For exchange of experiences with other LIFE-projects in Austria exists the annually occurring LIFE-platform, which is organized by the Federal Ministry of Agriculture, Regions and Tourism. Additionally, „Murerleben II“ was presented at different international symposiums in Austria, Germany, Suomi-Finland as well as in Australia, where it was nominated for the „International River Prize 2015“.

For a broader publicity a lot of folders, a layman’s report, a [LIFE-film](#) and last but not least the website [www.murerleben.at](http://www.murerleben.at) provide a lot of information. The highlights were the 20-year-LIFE-festivity and press conference in the Lässer Au 2012 and the LIFE+ Festival in St. Peter Au 2014. Associations, such as St. Peter’s women’s group, fire service, a local music club, as well as schools and a kindergarten were involved for delivering an outstanding varied program and catering. Newspaper articles and TV-Programs of the local TV-stations reached the general public.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	-
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	X
	Initial channels	X	Reintroduction of plant species	-
	Lowering the foreland	X	Reforestation of floodplain forest	-
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

The measure „Lässer Au“ belongs to a complex of measures to create a structured and dynamic river course at a stretch of 3.9 km. Following measures have been implemented:

- Initiation of a new secondary channel with partially lowered forelands: 1.350 m
- Removal of bank protection: 950 m
- Development of new floodplain forest: 3.5 ha and securing existing floodplain forest: 4.5 ha
- Creation of new and securing existing amphibian ponds: 4,100 m<sup>2</sup>
- Protection of the hinterland by a floodprotectiondam. The dam is located at the border to the agriculturally used area and it is built by using excavated material of the secondary channel.

## Results & Effects

- Improvement of morphology and dynamic processes of the Mura river
- Improvement of aquatic and terrestrial habitats
- New flood protection dam in the hinterland
- Improvement of passive flood protection by securing floodzones
- Revaluation of landscape
- Enhanced access for recreation

The focus of a LIFE-Project is on improving conditions of seldom and endangered habitats and species (protection properties). These are e.g. the following habitat types and species according to the Habitat-Directive and the Birds-Directive: Natural eutrophic lakes with Magnopotamion or Hydrocharition -type vegetation (3150), Alluvial forests with *Alnus glutinosa* und *Fraxinus excelsior* (\*91E0) and Alpine rivers and bank vegetation with rosemary willow (3240), Danube salmon (*Hucho hucho*), Bullhead (*Cottus gobio*), Ukrainian brook lamprey (*Eudontomyzon* spp.), Yellow-bellied toad (*Bombina variegata*), Italian crested newt (*Triturus carnifex*), Common kingfisher (*Alcedo atthis*), Grey woodpecker (*Picus canus*), Black stork (*Ciconia nigra*) Black woodpecker (*Dryocopus martius*).

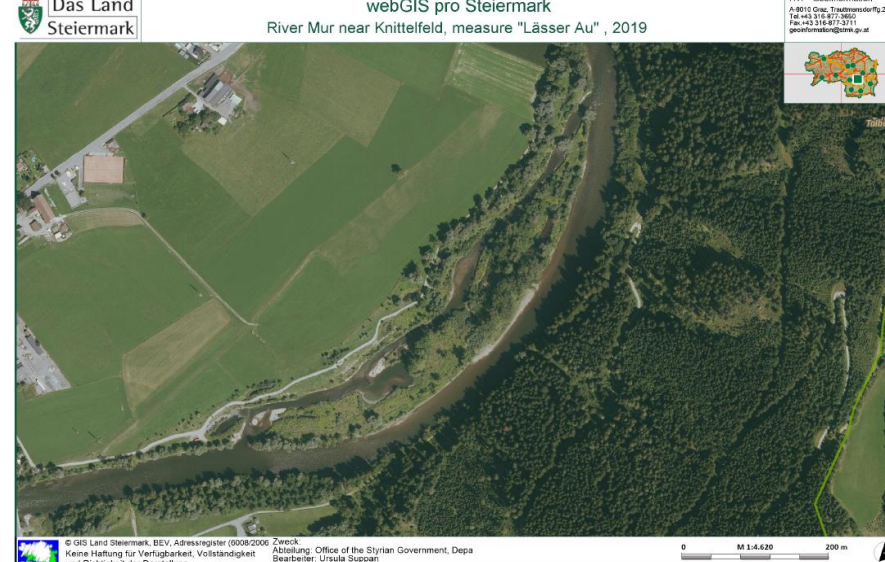
The people of the region are very happy to have a new access to the Mura river, the path along the measure is frequently used by young and old. The identification of the population in the region with the river has been highly increased.



## Lessons learned

- The more area is provided, the more dynamic is the development process and the effect for the ecosystem. It is better to implement initially just a few steering components and let the river do dynamically its work, than to fix the measures by stones, geotextiles or similiar building materials. The river needs space!
- The conception of an integrated project is the basic condition for a successful and sustainable management of a river basin and for the realisation of river-restoration measures. It is important to bring together all institutions and stakeholders to establish a win-win-situation for all participants.
- The choice of appropriate monitorings for the proposal is important. Which parameters will bring significant results and when? The experience has shown, that postmonitorings are often carried out to short after implementing the measure. Organisms need time to recolonise and habitat types need time to develop! It would be better to seperate the investigations. A qualitative monitoring at the end of the project for showing if the measure will comply with the requirements for your subjects of protection and a quantitative monitoring after 5-10 years for more detailed results.

## Map of the project area

<p><b>Overview</b></p>	
<p>Location of the project area (black) in federal state Styria (red) © freiland</p>	
<p><b>Former status</b></p>	 <p>Das Land Steiermark   webGIS pro Steiermark   River Mur near Knittelfeld, measure "Lässer Au", 2011</p> <p>A17 - Geoinformation A-8010 Graz, Trautsonstraße 2 Tel. +43 316 877-3500 Fax +43 316 877-3711 geoinformation@stmk.gv.at</p> <p>© GIS Land Steiermark, BEV, Adressregister (0008/2006) Zweck: Keine Haftung für Verfügbarkeit, Vollständigkeit und Richtigkeit der Darstellung. Bearbeitung: Ursula Suppan, Karte erstellt am: 25.02.2021</p> <p>M 1:4.620 200 m</p>
<p>Area of the measure „Lässer Au“ 2011 © GIS Land Steiermark</p>	
<p><b>Current status</b></p>	 <p>Das Land Steiermark   webGIS pro Steiermark   River Mur near Knittelfeld, measure "Lässer Au", 2019</p> <p>A17 - Geoinformation A-8010 Graz, Trautsonstraße 2 Tel. +43 316 877-3500 Fax +43 316 877-3711 geoinformation@stmk.gv.at</p> <p>© GIS Land Steiermark, BEV, Adressregister (0008/2006) Zweck: Keine Haftung für Verfügbarkeit, Vollständigkeit und Richtigkeit der Darstellung. Bearbeitung: Ursula Suppan, Karte erstellt am: 25.02.2021</p> <p>M 1:4.620 200 m</p>
<p>Area of the measure „Lässer Au“ 2019 © GIS Land Steiermark</p>	

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
55 m
<b>Average discharge</b>
57 m <sup>3</sup> /s, gauging station: Zeltweg

<b>Area</b>
UTM 33T E: 488258 N: 5227641
<b>Gradient</b>
1.5 ‰
<b>Sea level</b>
622 m

<b>Planform</b>	
Straight	-
Braided	-
Oscilating	-
Anabranching	X
Sinous	X
Meandering	-
The stretch is situated in the Central Alps in a braod valley, therefore the potentiell type is mainly oscilating, but also sinuous to meandering with some sections having secondary channels.	

<b>Bed material</b>	
Megalithal	-
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	-
Psammal	-
Pelal	-
No additional information.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	X
Softwood floodplain forests	X
Hardwood forests	-
In the area of „Lässer Au“ 2 Natura2000 habitat types have been profiting by the measures: Alluvial forest with black alder and common ash (Alnus glutinosa und Fraxinus excelsior - Natura2000 habitat 91E0) and Alpine rivers and bank vegetation with rosemary willow (Salix eleagnos excelsior - Natura2000 habitat 3240)	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	X
„Other“ banks	-
Inlets & outlets of secondary channels	X
No additional information.	





Mura river (right) and inlet of the secondary channel (left), 2014



Secondary channel, 2014



Secondary channel with structures of rootstocks, 2014



Amphibian pond, 2014



By dynamic processes born island in the secondary channel, 2017



Information and recreation area designed by students of BG/BRG Judenburg grammar school, 2014



# OLD-DRAVA LIFE

*The main objective of the project was to improve the water supply and restore the open water surface of the Old-Drava oxbow in order to maintain the status of the water body and surrounding floodplain forests.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	Transboundary cooperation for revitalization of riverine habitat complex in Drava region within Natura 2000 sites, LIFE Old-Drava
<b>Countries</b>	Hungary, Croatia
<b>River</b>	Drava
<b>River section type</b>	Drava I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Construct one bottom weir to retain raised water levels</li> <li>• Plant native tree and shrub species</li> </ul>
<b>Implementation period</b>	2014 - 2019
<b>Total costs</b>	€ 833,985
<b>Funding source</b>	74.8 % co-funded by the European Union, LIFE NATURE Programme co-funded by 10,4 %, DDNPI; 0,01 JUUZVP; 0,2%, VIDRA; 6% Pitomaca; 3 %, WWF Hu; 0,4, HESSZ; 3%; co-financer contribution, Hu Ministry of Rural Development
<b>Project participants</b>	<u>Coordinating beneficiary:</u> Danube-Drava National Park Directorate <u>Partners:</u> WWF Hungary, VIDRA – Virovitica-Podravina County Development Regional Agency, Municipality of Pitomaca, JUUZVP (Public Institution for Management of Protected Parts of Nature and Ecological Network in Virovitica-Podravina County), HESSZ – Anglers' Association Somogy County Society
<b>Contact</b>	WWF Hungary, <a href="http://www.olddrava.com">www.olddrava.com</a> , <a href="mailto:tamas.gruber@wwf.hu">tamas.gruber@wwf.hu</a> , <a href="mailto:panda@wwf.hu">panda@wwf.hu</a>

## Introduction

The Drava river has experienced regular changes in the course of its main channel due to both natural meandering and man-made diversions. The result has been the formation of many side channels and oxbows. There is a 15 km long oxbow, just west of the town of Barcs.

The fact that nature doesn't know boundaries, counts as a cliché. This applies particularly to the Drava region where the river and the country border intersect a dozen times between Hungary and Croatia. It is protected in both countries and it is also part of the Transboundary Biosphere Reserve Mura-Drava-Danube.

The Old-Drava oxbow still marks the international border between Croatia (to the south/right bank) and Hungary (to the north/left bank), even though the main riverbed has moved southwards. The water level in the Old-Drava has dropped in recent decades so that there is almost no open water surface during hot summer periods, and a part of the oxbow dries out for short periods, with a resulting negative impact on ecology and angling (recreational fishing).



## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	X
Barriers/connectivity	-	Habitat degradation	X
Channelization	-	Invasive species	-
Disturbed sediment regime	-	Water abstraction	-

**Flow alteration:** The Old-Drava oxbow didn't receive proper water supply and its water flows to Drava river along Fekete creek.

**Habitat degradation:** Due to the riverbed deepening of the main course of Drava, the longest oxbow's water flow to Drava river after wet periods and the length of the dry periods with low water levels increased; the status of gallery forests along the Old-Drava degraded.

The Barcs Old-Drava is a 15 km long oxbow which is the longest side-channel of the Drava River. It was shaped by both natural processes and human interventions. The well-developed meander was cut off at the end of the 18<sup>th</sup> century, separating the river from its meander and forming an oxbow lake. In recent decades, more water used to flow out from the oxbow than flowed in due to the difference in elevation between the main channel of the Drava River and the floodplain due to incision of the Drava riverbed and siltation of the oxbow. The oxbow has suffered from declining water levels especially during dry periods that have deteriorated the ecology of the area, with impacts on the ecosystem goods and services it provides.

There are complicated reasons for the decreasing water level in the Old-Drava: the water level of the main channel of the Drava River is decreasing due to riverbed incision, which has a knock-on impact on nearby groundwater and surface water levels. Due to a significant difference in the elevation between the riverbeds of the Drava and the Old-Drava, the water of the oxbow usually flows out through a small channel (Fekete Creek) into the main course of the river. The Rinya Stream, which flows from the north into the oxbow, can provide enough water during wet periods. But during dry seasons more water can flow out from the oxbow than can flow into the oxbow from the Rinya stream.

Low water levels have a negative impact on angling. Moreover, current fishing activities in some sections of the Old-Drava are unfavourable for nature conservation. There are also problems with abandoned and illegal fishing platforms, huts and litter.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	-
Increase of (cultural) ecosystem services	X	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	X
Raising awareness	X	Secure land in the river corridor	-
Re-establish/ improve longitudinal connectivity	-	Sediment management	-

- **Increase of (cultural) ecosystem services:** improve recreational fishing conditions
- **Raising awareness:** work with fishermen and locals
- **Re-establish / improvement of lateral connectivity:** to improve the water supply of the Old-Drava
- **Restoration / improvement of floodplain habitats:** to improve the floodplain forest's status on the left side of the oxbow

The aim of the restoration is to restore water levels and water ecology, improve conditions for the riparian forest (176 ha) and for sustainable angling.

The main objective of the project was to improve the water supply and restore the open water surface of the Old-Drava oxbow in order to maintain the status of the water body and surrounding floodplain forests.

Although the oxbow and its surroundings are very rich in nature values, as a result of the changing environment and human activity, negative processes were captured. To develop and implement the solutions, a common LIFE proposal was submitted. The decreasing water level in the oxbow, the dropping groundwater level in the surrounding gallery forests or the abandoned fishing platforms, which are all detrimental to nature, were considered as a challenge that should be solved.

The aim of the restoration was to restore water levels and water ecology, improve conditions for the riparian forest (176 ha) and for angling.

## Involvement of interested bodies/parties







**What does the Old-Drava provide us? Ecosystem service assessment:** One of the key elements of the project is to map out why the Old-Drava oxbow is important for locals, to whom it is unique and why it is useful or precious. In order to find it out, four meetings were organized, involving local residents, anglers frequenting the Old-Drava, foresters, fishermen, nature protection and border control officials, hunters, farmers, researchers and others concerned with the oxbow due to their official tasks. Meetings were organized

both in Hungary and Croatia, so the project consortium could learn from the residents of both sides of the oxbow what Old-Drava provides them with and what the border of the two countries means in their mind.

**Communications and awareness-raising:** An interactive exercise book was printed in 2000 copies. This exercise book includes many playful tasks and games about wetlands, rivers and freshwaters. The ‘pilot site’ of the games is the Old-Drava oxbow and the children can learn from it, the restoration approach and its benefits for the surrounding environment of the Old-Drava. The target audience is 8-12 year-old students and it is available in Hungarian. The printed exercise books were distributed in a package of WWF materials for families. A virtual toolkit for teachers was created. The 45-minute lecture empowers teachers to give a full lecture for students. The virtual toolkit was developed in Hungarian. It is a 45-minute lecture for teachers based on the tasks of the exercise book. The toolkit includes instructions and a description of tasks and games. By using the toolkit teachers are able to lead a 45-minutes colourful lecture for students. The link for the virtual toolkit is available among the references.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	-	Neophyte management	-
	Mechanical widening	-	Structures for reintroduction of native animals (design of steep banks)	-
	Initial channels	-	Reintroduction of plant species	X
	Lowering the foreland	-	Reforestation of floodplain forest	X
	Sediment input	-	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	-
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	-

In addition, also water retention in the oxbow was one of the measures implemented to deal with problems in regards to habitat.

Water construction and environmental permits are needed for implementation of the field works on both the Hungarian and Croatian sides of the river. After a long procedure, the project partners finally obtained all of the necessary permits.

The constructed water retention artefact (bottom weir) is at the site named Black creek that is in the lower stretch of the oxbow. The function of the weir is to increase and stabilise the water level. In the first phase of the field work, a road was built on the high bank of the oxbow on the Hungarian side for heavy machinery. It was not necessary to remove any wood in the forest for this. The next step was to remove the brush that had



grown in the silted up zone of the oxbow, the construction of a temporary road beyond the high bank, then developing the conditions for the temporary roads.

Construction of the water retention structure on the Old-Drava oxbow was completed within about three months. The sluice with embedded lockable culvert and an apron-protection against erosion was finalised. Visible elements of the structure consist of quarry stone placed in wire mesh, a walking surface leading to the closing structure was constructed from water resistant locust and oak. Firstly, construction of the sluice was finished; thereafter landscaping work of the right bank next to Croatia and the dyke was finalized. Construction of a low dyke has been completed on the right (Croatian) bank of Fekete Creek. At the same time, construction of a fish passage started, including digging of the channel, then stabilization with riprap. In the last working phase the height of the road on the left bank was finalised and the construction area was cleared from building materials. In accordance with the plans, three gauges were built-in, which serve as a monitoring tool for the water levels.

The completed actions are as follows:

- Raising the average water level in the Old-Drava by more than 1 metre and reducing the likelihood of extremely low water periods or drying out of some short stretches. A rise in the surrounding water table will also bring benefit to the riparian vegetation.
- Planting native tree and shrub species
- Ecological monitoring
- Removing abandoned platforms and other litter, and raised awareness of anglers on how to continue angling without endangering species and habitats.
- Removing 30 angling platforms which are in poor condition or abandoned
- Raising public awareness on the value of floodplains and a sustainable natural environment

## Results & Effects

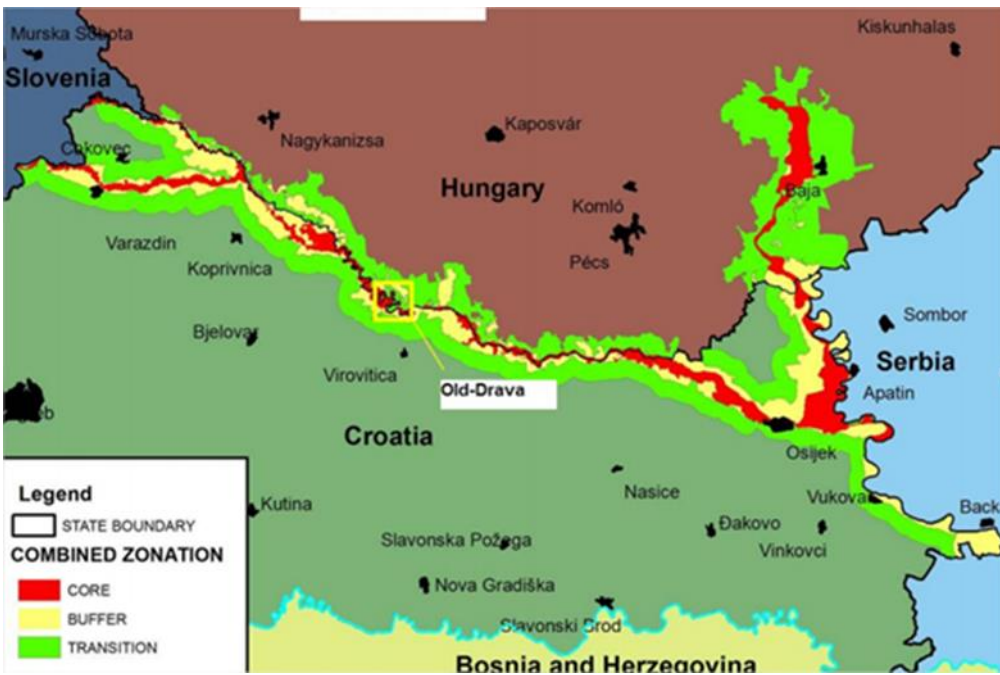




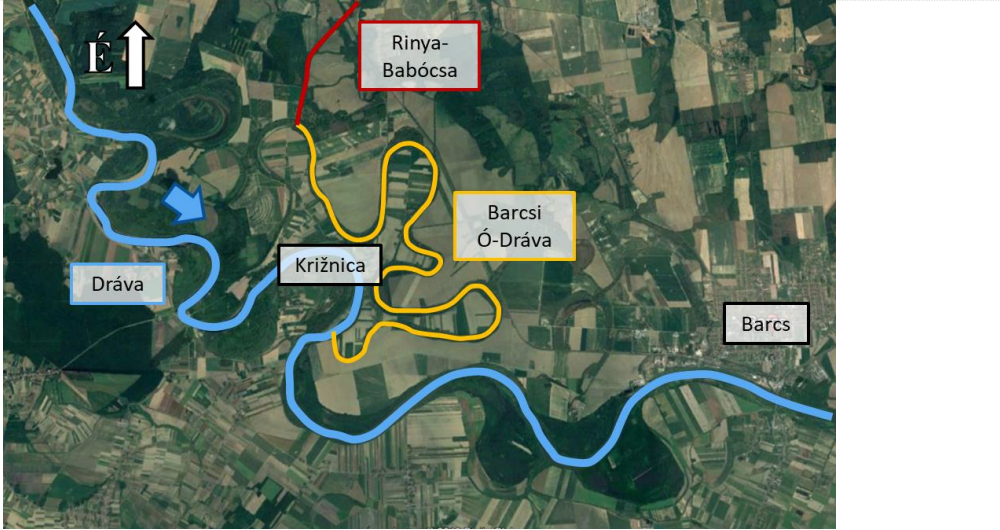
- A new water retention structure is under operation in Old-Drava
- 15 forest pitches were renewed (25 m x 25 m) in the gallery forest
- 7,000 m<sup>3</sup> of silt was removed from the Old-Drava
- The gallery forest's status improved, the native tree and shrub species (e.g. Tatar maple, *Populus tremula*, wild fruits) are in more stable status.
- 40 pieces from the abandoned fishing platforms were disassembled and garbage was removed. 30 fishing platforms were reconstructed which can be used by fishermen and 6 new fishing platforms were built for community use. This led to improved fishing conditions and an expected decrease in demand for new fishing platforms.
- Printed publications were also prepared, firstly a Hungarian/Croatian/English flyer, secondly a thematic newspaper was printed which was spread in 4,200 copies between the inhabitants of Barcs city.

- Schools and pupils were reached with educational materials to increase awareness. The most important stages of the last five years with regard to Croatian-Hungarian cooperation were documented in an educational film.

## Lessons learned

- Personal meetings among partners are essential to get to know each other and to harmonize the project activities even during the preparation phase.
- Language barriers can be a challenge in cross-border projects. The targeted stakeholders may have to use a third language to exchange views which can make the meetings and workshops longer. This has to be calculated into the project preparation and implementation.
- For efficient cooperation with stakeholders, start their involvement as early as possible and keep contact with them regularly. One round of discussions may not be enough. Take care to clarify the specific role/s of stakeholders among all of the project partners.
- Legal and administrative procedures can vary significantly across national borders – something to take into account in cross-border projects. It is difficult to harmonize the obligatory processes (environmental, water permissions) and secure all of the necessary permits from both countries in a timely manner. Thus, in cross-border cooperation, the permitting procedures have to be designed accordingly and include sufficient time buffers in the implementation plan.
- Ownership of the project by project partners is fundamental to the successful and timely development and implementation of the project.

## Map of the project area

Overview	 <p> <b>Legend</b>   STATE BOUNDARY  <b>COMBINED ZONATION</b>   CORE   BUFFER   TRANSITION     </p>
	<p>Location of the Old-Drava in the transboundary biosphere reserve Mura-Drava-Danube © DDNP</p>
Former status	<p>No map available.</p>
Current status	
	<p>The restored Old-Drava oxbow along river Drava upstream Barcs © DDNP</p>



## River stretch characteristics

River	
Drava, Old-Drava oxbow	
Width	
Not relevant.	
Average discharge	
No data available.	

Area	
UTM 33T E: 683678 N: 5091223	
Gradient	
No data available.	
Sea level	
104 m	

Planform	
Straight	-
Braided	-
Oscilating	-
Anabranching	-
Sinous	-
Meandering	-
No data/information available.	

Bed material	
Megalithal	-
Makrolithal	-
Mesolithal	-
Mikrolithal	-
Akal	-
Psammal	-
Pelal	-
No data/information available.	

Habitat types	
Flowing water	-
Floodplain water bodies	-
Gravel and sand bars	-
Softwood floodplain forests	X
Hardwood forests	X
No additional information	

Riparian Structures	
Steep bank	-
Shallow bank	-
„Other“ banks	-
Inlets & outlets of secondary channels	X
No additional information.	





The Old-Drava in late autumn



The project team on an angler platform



The site of the construction



The site of the construction



Aerial photo, Old-Drava oxbow is on the right, Drava main course is on the left



Educational trail near Kriznica



# UNTERES MURTAL

## Measure Gosdorf I

*The project strived for a long-term re-establishment of a balanced sediment budget and to prevent the lowering of the groundwater level in order to maintain the water supply.*

PAST  
PROJECT



## Key Facts

<b>Project</b>	Maßnahmen Unteres Murtal – Measure Gosdorf
<b>Country</b>	Austria
<b>River</b>	Mura
<b>River section type</b>	Mura I
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Purchase of land</li> <li>• Revmoval of bank protection</li> <li>• Widening of the Mura-riverbed</li> <li>• Prolongation of Saßbach</li> </ul>
<b>Implementation period</b>	2006 - 2008
<b>Total costs</b>	€ 600,000
<b>Funding source</b>	<p>50% co-funded by the European Union, Interreg IIIA 50% co-funded by national funds</p> <ul style="list-style-type: none"> <li>• 85% Federal Ministry of Agriculture, Forest, Environment and Water Management</li> <li>• 15% Styrian Government</li> </ul>
<b>Project participants</b>	Water Association Water Supply District Radkersburg; Office of the Styrian Government: Department A14 Water Management, Resources and Sustainability , Department A13 Environment and Spatial Planning,
<b>Contact</b>	Office of the State Government of Styria – Department 14 Water Management, Resources and Sustainability, <a href="http://www.wasserwirtschaft.steiermark.at">www.wasserwirtschaft.steiermark.at</a> , abteilung14@stmk.gv.at,

## Introduction

Systematic river regulation, beginning at the end of the 19<sup>th</sup> century, caused substantial changes in the course of the river Mura's flow. This water course was originally characterised by numerous elements typical of natural rivers such as secondary channels, shallow zones, gravel, sand and mud banks with some collapse. As a result of the so-called „Hochenburger“ river regulation (1874 – 1892), the river Mura's dynamics were substantially limited at the stretch from the city of Graz (Austria) to Radenci (Slovenia). The river was straightened to a monotonous channel, where all secondary channels were cut off and large areas were drained to make them available for agriculture.

Increased flow velocity and the lack of sediments that were retained through numerous hydropower plants upstream caused river bed incision and led to disconnection of the River Mura from surrounding land and side channels, to the partial loss of alluvial forest along the river.

Within the EU-co financed INTERREG IIIA Project „Maßnahmen Unteres Murtal“ the measure Gosdorf I“ was the most important and largest measure carried out at the Austrian reach of the so called „Border Mura“ along the state border between Austria and Slovenia.

## Addressed problems

ADRESSED PROBLEMS			
Bank degradation	-	Flow alteration	X
Barriers/connectivity	X	Habitat degradation	-
Channelization	X	Invasive species	-
Disturbed sediment regime	X	Water abstraction	-

In addition, also lowering of the groundwater table was one of the problems addressed.

Human interventions including systematic river training and hydro power plants caused a lack of sediment in the Mura riverbed and led to channel incision. Between 1970 and 2000, the mean degradation in the 34 km long border reach was about 0.5 m, the maximum about 1.2 m. A sediment transport model predicted further incision if no countermeasures would be implemented.

The channelization and the incision increasingly led to technical/economic and ecological problems. The incision induced scouring and destabilization of bank protection structures in built-up areas, separated old river branches and alluvial forests from the main channel, and lowered the adjacent groundwater table. Bank protection structures had to be repaired or repeatedly reconstructed to avoid uncontrolled erosion and flood damage. The lowering of the groundwater table compromised the water supply.

## Restoration goals

RESTORATION GOALS			
Adapt land use	-	Re-establish/ improve lateral connectivity	X
Flow management	-	Re-establish morphological river type / improve morphology	-
Increase of (cultural) ecosystem services	-	Reservoir flushing management	-
Mitigate hydropeaking	-	Restoration/ improvement of flood habitats	-
Raising awareness	X	Secure land in the river corridor	X
Re-establish/ improve longitudinal connectivity	-	Sediment management	X

In addition, also securing water supply was one of the restoration goals.

At the Mura river, a long-term re-establishment of a balanced sediment budget was the main goal. Furthermore, the lowering of the groundwater level was to be prevented in order to maintain the water supply.

In addition to the goals of improving the hydromorphological condition, the goals of the EU Habitats Directive and the EU Birds Directive had to be taken into account as the project area belongs to the European nature reserve “Styrian Border Mura with the Gamlitzbach and Gnasbach streams”. Monitoring for fish, birds, groundbeetles, dragonflies, as well as for terrestrial habitats should prove the success of the measures.

## Involvement of interested bodies/parties

During the project period, numerous events were held on the project level, addressing not only the Gosdorf measure as the most important river widening but also the widenings in Oberschwarza, Weitersfeld and Donnersdorf.







The “Life on the Mura” exhibition, as well as 10 River Landscape Antenna Info-Points belonging to the “Museum im Alten Zeughaus,, in Bad Radkersburg, show the interdependency between human beings, their living and cultural space and the environment from a historical and contemporary viewpoint.

An extensive supporting programme, including a film, walks through the alluvial forest, children’s adventure days on the subject “Using your eyes in the alluvial landscape” and a lecture series entitled “Mura Conversations”, complemented the exhibition.

The Mura cycle path runs along the measure „Gosdorf“, allowing numerous visitors to view the measure. On the 27 m high observation tower, completed in 2010, they can enjoy the outstanding panoramic view of the entire measure area and beyond. 3 „Infopoints“ provide information on the project.

## Implemented measures

To deal with problems with regards to

SEDIMENT MANAGEMENT			HABITAT	
	Erodible ("soft") banks	X	Neophyte management	X
	Mechanical widening	X	Structures for reintroduction of native animals (design of steep banks)	X
	Initial channels	X	Reintroduction of plant species	-
	Lowering the foreland	-	Reforestation of floodplain forest	-
	Sediment input	X	FLOOD PROTECTION	
	Structures to enhance erosion	-	Protection of the hinterland	X
			RIVER CONTINUITY	
			Removing or scaling back migratory obstacles	X

As recommended in the Basic Water Management Concept, the first major measure was implemented between river km 115 and 116 at Gosdorf, directly at the beginning of a reach suffering from severe riverbed incision. There, the concept proposed a riverbed widening to about 200 m and artificial bed load supply. Widening was enabled through



removing the bank protection structures along the left bank over a length of 1 km and thereby creating dynamic (“soft”) banks. An initial channel was excavated, and the dredged material was introduced into the main channel as an immediate artificial sediment input (approximately 150,000 m<sup>3</sup>). According to the assumed lateral development, another 300,000 m<sup>3</sup> bank-derived gravel should enter the channel. In the middle of this section, a bottom sill emerged from the bed because of the past incision. The brook Saßbach with a mean discharge of 1.6 m<sup>3</sup>/s, which previously flowed directly into the Mura river in the middle of this section, now flows into the side channel.

## Results & Effects




- Increased sediment supply through side erosion for a certain period of time
- Improvement of the ecological functioning of the river
- Settlement of rare and endangered animal species
- Improved recreational function

Apart from the positive effect on water management through creating an additional retention area, the widening of the river had also a revitalising effect on nature and recreation along the Mura. During the construction works threatened species already started to inhabit the new structures: the nose carp, a rheophilous (current-loving) fish, spawned in the side channel, sand martins were able to utilise an undercut bank for their nesting tunnels while common sand pipers nested on the newly-formed gravel banks.

## Lessons learned

- In the Basic Water Management Concept for the Border Mura from 2001, bank erosion was attributed an important role for the success of restoration measures. It was assumed that the Mura would widen to 150 m within 17 years and would be supplied with sediment from bank erosion over this period. However, this only occurred to a limited extent, which reduced the general effectiveness of the measure. In the year 2018 the bed levels of the border Mura reached a record low and showed again an urgent need for action. What was the reason for the failure of the measure? In Gosdorf the straight course of the river concentrates the discharge in the middle of the riverbed. Therefore the shear stress isn't high enough to induce the required riverbank erosion. The second point is that the sediment input from upstream is too low to maintain a certain bed level in the main channel of Mura river. But this would be necessary to induce floodings and lateral erosion. Within the framework of the Interreg SI-AT project goMURra (2018 - 2021), a new management plan has been developed. Further measures are proposed for the Gosdorf widening area to reactivate lateral erosion. Besides local measures, solutions are needed that re-establish sediment connectivity in the catchment.
- At the beginning of the project, large areas of the island, created between the newly dredged side channel and the main channel of the Mura, were logged. As the area was not eroded as intended, a massive neophyte emergence occurred. Robinia pseudoaccacia in particular contributes to the consolidation of the soil through its roots, which additionally stopped the desired bank erosion.

## Map of the project area

<p><b>Overview</b></p>	
	<p>Project area © Office of the State Government of Styria – Department 14</p>
<p><b>Former status</b></p>	 <p>Das Land Steiermark   webGIS pro Steiermark   Mura Measure Gosdorf</p> <p>A17 - Geoinformation Transnationale Programme 2        Address: geoinformation@stmk.gy.at        http://gis.stmk.gy.at</p> <p>© GIS-Steiermark, BEV, Adressregister (0008/2006)   Zweck: Abbildung, Bearbeitung   Karte erstellt am: 13.09.2021</p> <p>Keine Haftung für Verfügbarkeit, Vollständigkeit und Richtigkeit der Darstellung.</p> <p>0 M 1:4.382 200 m</p>
	<p>Project area of measure „Gosdorf“ before implementation (period of flight 2003 – 2007)        © GIS Land Steiermark</p>
<p><b>Current status</b></p>	 <p>Das Land Steiermark   webGIS pro Steiermark   Mura Measure Gosdorf</p> <p>A17 - Geoinformation Transnationale Programme 2        Address: geoinformation@stmk.gy.at        http://gis.stmk.gy.at</p> <p>© GIS-Steiermark, BEV, Adressregister (0008/2006)   Zweck: Abbildung, Bearbeitung   Karte erstellt am: 13.09.2021</p> <p>Keine Haftung für Verfügbarkeit, Vollständigkeit und Richtigkeit der Darstellung.</p> <p>0 M 1:4.382 200 m</p>
	<p>Project area of measure „Gosdorf“ after implementation (period of flight 2011 – 2013)        © GIS Land Steiermark</p>

## River stretch characteristics

<b>River</b>
Mura
<b>Width</b>
80 m (regulated) - 120 m (widened)
<b>Average discharge</b>
148 m <sup>3</sup> /s, Mureck

<b>Area</b>
UTM 33T E: 562514 N: 5174382
<b>Gradient</b>
1,4 ‰
<b>Sea level</b>
223 m

<b>Planform</b>	
Straight	X
Braided	-
Oscilating	-
Anabranching	X
Sinous	-
Meandering	-
The stretch is situated at the border to Slovenia in a broad valley, therefore the potential type is mainly braided, anabranching and meandering.	

<b>Bed material</b>	
Megalithal	X
Makrolithal	-
Mesolithal	X
Mikrolithal	X
Akal	-
Psammal	-
Pelal	-
A bottom sill in the main channel stabilizes the riverbed in the main channel.	

<b>Habitat types</b>	
Flowing water	X
Floodplain water bodies	X
Gravel and sand bars	X
Softwood floodplain forests	-
Hardwood forests	X
No additional information.	

<b>Riparian Structures</b>	
Steep bank	X
Shallow bank	X
„Other“ banks	-
Inlets & outlets of secondary channels	X
No additional information.	





Development of the new side channel , May 2008,



Inlet of the new side channel 1 year after implementation, 2008



Prolongation of tributary „Saßbach“ in the new side channel, May 2010



Bank erosion at the main channel of Mura river, May 2010



Main channel of Mura river with eroded riverbank in front, outlet of the new side channel in the background, May 2010



Development of the side channel, May 2016



A glimpse into

# Ecological revitalization Boroš-Drava & Aljmaški rit branches

*The objective of the project was to restore and preserve biodiversity of important indigenous and other habitats and to improved cross-border cooperation on establishing a sustainable environment.*

PAST  
PROJECT



<b>Project</b>	Ecological revitalization of Boroš -Drava and Aljmaški Rit branches to renew aquatic habitats, increase biodiversity and fishing tourism possibilities
<b>Countries</b>	Hungary, Croatia
<b>River</b>	Drava
<b>Implementation period</b>	2017 - 2019
<b>Total costs</b>	€ 1,340,124
<b>Funding source</b>	85% financed by the European Union, 15% partner contribution
<b>Project participants</b>	<u>Croatia</u> : Hrvatske vode, Zeleni Hrvatske <u>Hungary</u> : Dél-dunántúli Vízügyi Igazgatóság, Horgász Egyesületek Baranya Megyei Szövetsége
<b>Addressed problems</b>	<ul style="list-style-type: none"> <li>• Habitat degradation</li> <li>• Barriers/connectivity</li> </ul>
<b>Restoration goals</b>	<ul style="list-style-type: none"> <li>• Re-establish / improvement of lateral connectivity</li> <li>• Restoration/ improvement of flood habitats</li> </ul>
<b>Involvement of interested bodies/parties</b>	During the project, and also in the period after the project implementation, there was continuous cooperation with stakeholders in the project area, the public and all other interested parties. Several awareness raising events were organised to promote project results on both side of the border, Hungary and Croatia. Involvement of the public in these events was assessed as satisfactory. Several meetings were organized with project area stakeholders during project implementation, Hrvatske šume, local NGOs, Duna-Dráva Nemzeti Park Igazgatóság etc. All of them expressed satisfaction with project results, and in the spirit of this, some future projects have been planned and prepared.
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>• Problems with regard to sediment management: Mechanical widening</li> <li>• Establishment of a favourable hydrological regime</li> </ul>
<b>Results &amp; Effects</b>	<ul style="list-style-type: none"> <li>• 7.2 ha of better conservation status of aquatic and wetland habitats</li> <li>• 4,0 ha of area where indigenous fish species were reintroduced</li> <li>• 1 joint environmental study elaborated by the project</li> </ul>
<b>Lesson learned</b>	Cooperation and exchange principles of similar project in two different countries. With identification of mutual development interests of the area it contributes to laying the foundations of the growth of mutual relationship between responsible institutions as a prerequisite of further joint activities. This project contributed to the closer cooperation between responsible agencies, in the field of common water



management on Drava river. Side sbranches, including natural, artificially influenced, and restored, are similar on the two sides of the state border. Provided that information is well presented and distributed, any lesson learned and achievement made can bear significance beyond the borders as well, especially when shared within a single project.

Best Practice lesson. The project used the best practices for restoring floodplain habitats in Croatian and Hungarian nature protection areas. The floodplains restoration work was executed combining the best practices of excavation work with ecological and ichthyological knowledge. The shape of the riverbed was created considering the local natural conditions and potential habitat variations. The process of restoring floodplains has several stages that are carried out over several years. In addition, the best practice ex-situ protection measure in the field of reintroduction of indigenous fish species was used and developed. Stakeholders with different goals and interests were involved and necessary decisions were made and approvals were obtained. The best practices and knowledge of various national authorities were combined to achieve the best possible environmental result. Great support from local people and the municipality was gained.

**Contact**

Hrvatske vode, [www.voda.hr](http://www.voda.hr), voda@voda.hr

**Boroš-Drava**



Project pilot site Boroš-Drava

**Aljmaški rit**



Project pilot site Aljmaški rit



Restoration activities at Boroš-Drava



Restored pilot site in Aljmaški rit



A glimpse into

# ECOWET

*The project provided solutions by introducing and applying a new EU methodology for assessing the ecosystems' importance and developing innovative methods for their conservation.*

PAST  
PROJECT



<b>Project</b>	ECOWET - Wetlands Ecosystem Services Assessment in Croatia-Serbia cross border region
<b>Countries</b>	Croatia, Serbia
<b>Rivers</b>	Danube, Sava
<b>Implementation period</b>	2017 – 2019
<b>Total costs</b>	€ 355,013
<b>Funding source</b>	85% financed by the European Union, Interreg IPA CBC Croatia-Serbia 2014-2020 15% partner contribution
<b>Project participants</b>	<u>Serbia</u> : Nature Conservation Movement of Sremska Mitrovica, Institute for Nature Conservation of Vojvodina Province <u>Croatia</u> : Association for nature and environment protection Green Osijek, Public institution agency for management of protected natural values in Osijek-Baranja County
<b>Addressed problems</b>	<ul style="list-style-type: none"> <li>● Habitat degradation</li> <li>● Barriers/connectivity (lateral &amp; longitudinal)</li> </ul>
<b>Restoration goals</b>	<ul style="list-style-type: none"> <li>● Re-establish morphological river type/ Improvement of morphology</li> <li>● Re-establish /improvement of lateral connectivity</li> <li>● Restoration/ improvement of flood habitats</li> <li>● Re-establish/ improvement of longitudinal connectivity</li> <li>● Increase of (cultural) ecosystem services</li> <li>● Raising awareness</li> </ul>
<b>Involvement of interested bodies/parties</b>	No information available.
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>● Problems with regards to sediment management: Erodible („soft“) banks, mechanical widening</li> <li>● Problems with regard to river continuity: Removing or scaling back migratory obstacles</li> <li>● Problems with regard to habitat: Neophyte management, structures for reintroduction of native animals (design of steep banks)</li> </ul> <hr/> <ul style="list-style-type: none"> <li>● Restoration of Ivovac side channel</li> <li>● Ecosystem analysis</li> <li>● Communication activities</li> <li>● GPS mapping</li> <li>● Organising stakeholder workshops</li> <li>● Setting up the ecosystem processor for wastewater purification</li> <li>● Guideline for mapping, assessment and monitoring of wetland ecosystems services</li> </ul>



	<ul style="list-style-type: none"> <li>Action plan for improvement of ecosystem services of Special Ornithological Reserve Podpanj and fishponds Donji Miholjac, Northern Middle Podunavlje, Spačva basin, Special nature reserve Zasavica, Bara Trskovača and Bosut forest</li> </ul>
<b>Results &amp; Effects</b>	<ul style="list-style-type: none"> <li>800m of the Iovac secondary channel restored</li> <li>Guideline for mapping, assessment and monitoring of wetland ecosystems services</li> <li>Action plan for improvement of ecosystem services tested on Special Ornithological Reserve Podpanj and fishponds Donji Miholjac, Northern Middle Podunavlje, Spačva basin, Special nature reserve Zasavica, Bara Trskovača and Bosut forest</li> </ul>
<b>Lesson learned</b>	No information available.
<b>Contact</b>	Green Osijek, <a href="http://www.interreg-croatia-serbia2014-2020.eu/project/wetlandrestore">www.interreg-croatia-serbia2014-2020.eu/project/wetlandrestore</a> , <a href="mailto:zeleniosijek@zeleni-osijek.hr">zeleniosijek@zeleni-osijek.hr</a>



Iovac sidearm before the works



Iovac sidearm before the works



Iovac sidearm during the works



Iovac sidearm during the works



Iovac sidearm after the works



Iovac sidearm after the works

# WETLAND RESTORE

*The project demonstrates findings from various EU directives and conventions for solving contemporary problems of river and wetland ecosystems.*

PAST  
PROJECT



<b>Project</b>	WetlandRestore - Restoration of Wetlands in Middle Danube
<b>Countries</b>	Croatia, Serbia
<b>Rivers</b>	Danube, Sava
<b>Implementation period</b>	2019 – 2021
<b>Funding source</b>	85 % co-funded by the European Union, Interreg IPA CBC Croatia-Serbia 2014-2020 15% co-funded by project partners
<b>Project participants</b>	Nature Conservation Movement of Sremska Mitrovica (SER), Association for nature and environment protection Green Osijek (CRO), Croatian Waters (CRO), Public water management company “Vode Vojvodine” (SER) , Public institution agency for the management of protected natural values in Osijek-Baranja County (CRO)
<b>Addressed problems</b>	<ul style="list-style-type: none"> <li>● Bank degradation (embankments, levees &amp; dikes)</li> <li>● Barriers/connectivity (lateral &amp; longitudinal)</li> <li>● Habitat degradation</li> </ul>
<b>Restoration goals</b>	<ul style="list-style-type: none"> <li>● Improvement of morphology</li> <li>● Re-establish / improvement of lateral connectivity</li> <li>● Restoration/ improvement of flood habitats</li> <li>● Re-establish/ improvement of longitudinal connectivity</li> <li>● Increase of (cultural) ecosystem services</li> </ul>
<b>Involvement of interested bodies/parties</b>	<p>Involvement of interested stakeholders was carried out in the frame of several workshops where the project, project goals and expected results were presented to interested members of public bodies, NGOs and other interested stakeholders.</p> <p>In addition, public bodies will be included in the official permitting processes to follow after the project ends, based on the documentation developed in the course of the project.</p>
<b>Implemented measures</b>	<ul style="list-style-type: none"> <li>● Problems with regards to sediment management: Eroble („soft“) banks, mechanical widening</li> <li>● Problems with regard to habitat: Neophyte management, river bank management, building of islands for birds</li> <li>● Problems with regard to river continuity: Removing or scaling back migratory obstacles, ensuring enough water in the side channel by water regime management, formation of ponds</li> </ul> <p>-----</p> <ul style="list-style-type: none"> <li>● Restoration activities in the upper watercourse of Special Nature Reserve Zasavica (removal of sediment, removal of vegetation and transport of sediment)</li> <li>● Restoration of Čarna side channel (removal of sediment, removal of vegetation, transport of sediment and discharge of water into side channel)</li> </ul>



	<ul style="list-style-type: none"><li>● Draft restoration plan for 3 pilot areas in Serbia: Zasavica, Bara Trskovača, Jegrička</li><li>● Guidelines for wetland monitoring</li><li>● Monitoring activities in 3 pilot areas in Croatia</li><li>● Training on restoration planning</li><li>● Public outreach campaign in Croatia</li><li>● Draft restoration plan for 3 pilot areas in Serbia: Zasavica, Bara Trskovača, Jegrička</li></ul>
<b>Contact</b>	Green Osijek, <a href="http://www.interreg-croatia-serbia.eu/project/wetlandrestore/">www.interreg-croatia-serbia.eu/project/wetlandrestore/</a> , zeleniosijek@zeleni-osijek.hr



Biljski rit

## IV. Conclusion

Mura, Drava and Danube, that are flowing through Austria, Slovenia, Croatia, Hungary and Serbia, represent the world first 5-country UNESCO biosphere reserve designated in September 2021. With a total area of 930,000 hectares and a length of 700 kilometres, the wildlife along the Mura, Drava and Danube is the largest river protection area in Europe and the livelihood of 900,000 people.

Although the river corridor still hosts highly valuable habitats, these are becoming dysfunctional or disconnected, because morphodynamics are currently reduced by human-made interventions. However, restoration projects in all five countries aim at improving this situation.

In this context, experience exchange is a crucial key to enhance knowledge and capacities of institutions and people working towards preserving or improving the ecological functioning of the rivers.

The river restoration report provides first hand insights and lessons learned from a **study tour** carried out in May and June 2022 within the TBR MDD area. It shows the importance to not only learn theoretically about technical measures, but to experience the restored environment and talk to those people who were responsible for the implementation. New perspectives often emerge in the discourse, connecting already existing knowledge with not yet known approaches. Informal knowledge shared in this way is usually not found in any project report. In the frame of a study visit, the project partners and associated partners of the lifelineMDD project had the chance to see the different conditions in all five countries, understand the difference in the dimensions of the three rivers, from the Mura downstream to the Drava and the Danube, compare the restoration sites and actions and use the gained knowledge in the future planning of the actions for TBR MDD.

The most important learnings can be summarized as follows:

- All institutions face similar problems such as communication with different stakeholders, management bodies, land owners, silting of side channels and oxbows, drying of the floodplain, river bed incision, ...
- A general problem in the TBR MDD is acquiring land for restoration projects.
- Emphasis should be put on connecting all stakeholders and involving the local community.
- Creating networks, acquiring knowledge and building trust are the only ways to guarantee a successful restoration project.
- Implemented river restoration projects lack monitoring to ensure learning from them.
- The study tour enhanced the cooperation among the project partners, also for joint project in the future.
- It was important to see, that in some countries the „impossible“ has been already achieved.

Besides the information gained in the study tour, the report gives an **overview of past and ongoing river restoration projects** in the TBR MDD area shared by the project partners. In the collection of 3 ongoing and 11 past projects, emphasis was put on informal knowledge and making this available for interested parties. All descriptions follow the same structure, which makes it easy for the readers to compare the projects in regard to key facts, addressed problems, restoration goals, involvement of interested parties, planned or implemented measures, results and effects as well as lessons learned. In addition, interlinkages to the lifelineMDD River Restoration Toolbox are included.

Subsequently, the main take away messages are summarized:

- Wide partnership is an added value during the implementation of the project.
- Good preparation and planning of individual phases of the project is key for the successful implementation.
- It is important to bring together all institutions and stakeholders to establish a win-win-situation for all participants.
- Communication with stakeholders and the public in the area before, after and during the project plays an important role. With proper communication, unnecessary problems that could arise or be solved before the implementation can be avoided.
- For efficient cooperation with stakeholders, start their involvement as early as possible and keep contact with them regularly.
- Management of neophytic species is very important for measures in alluvial forests.
- The choice of appropriate monitorings for the proposal as well as funds for the long-term maintenance of the developed project outputs are important.
- Legal and administrative procedures can vary significantly across national borders, this needs to be taken into account in cross-border projects.
- Cross-border cooperation is inevitable to achieve coordinated planning and implementation of measures in the riverbed.
- Language barriers can be a challenge in cross-border projects.

As the TBR MDD covers several different ecological river types (though not all) a large number of river regions can benefit from the outputs of the report about experience exchange. It can be used as important practical tool for practitioners when planning and implementing new restoration projects in the future.



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DRA-MUR-CI: Alter Graba, 11-mill channel

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## VII. List of abbreviations

<b>INCVP</b>	Project partner: Institute for Nature Conservation of Vojvodina Province
<b>IRSNC</b>	Project partner: Institute of the Republic of Slovenia for Nature Conservation
<b>STMK</b>	Project partner: Office of the Styrian Government – Department 14 Water Management, Resources and Sustainability
<b>VGP Promgrad</b>	Project partner: Pomgrad - water management company



# **ANNEX:**

## Template for the collection of ongoing and past projects

[Name of the project, river, country]

## TITLE

### Key Facts

Country	[name]
River	[name]
Planned / Implemented measures	<ul style="list-style-type: none"><li>• [list measures]</li><li>• [list measures]</li></ul>
Total costs (past projects)	<ul style="list-style-type: none"><li>•</li></ul>
Implementation period	[yy – yy]
Funding Source	
Project participants	[name of institutions/stakeholders]
Contact	[name of institution, website link and general valid e-mail address, only one - leading institution]

### Introduction

[Short overview, what it's all about. Intro that makes the reader curious to learn more, max. 1.500 characters]

### Addressed problems

[Choose from following: Bank degradation, Barriers/connectivity, Channelization, Flow alteration, Habitat degradation, Water abstraction, Disturbed sediment regime, and Invasive species]

[Describe the problems in more detail, max. 1.500 characters]

### Restoration Goals

[Choose from following: Secure land in the river corridor, Re-establish morphological river type/ Improvement of morphology, Re-establish / Improvement of lateral connectivity, Restoration/ improvement of flood habitats, Flow management, mitigate hydropeaking, Sediment management, Reservoir flushing management, Re-establish/Improvement of longitudinal connectivity, Adapt land use, Increase of (cultural) ecosystem services, raising awareness]

[Describe the goals in more detail, max. 1.500 characters]

### Involvement of interested bodies/parties

[How was the involvement of public bodies, stakeholders and the public carried out?, max. 1.500 characters]

### Planned / implemented measures

[Choose from following:

- Problems with regards to sediment management: Establishment of soft banks (removal of bank protection), Mechanical widening, Initial channel, lowering of the foreland, bedload supply, structures stimulating erosion
- Problems with regard to river continuity: Removing or scaling back migratory obstacles
- Problems with regard to habitat: Neophyte management, Structures for reintroduction of native animals (design of steep banks), Reintroduction of plant species, Reforestation of floodplain forest
- Problems with regard to flood protection: Protection of the hinterland

[Describe the measures in more detail, including a technical description, max. 1.500 characters]

### (Expected) results & effects

[List your (expected) results here in brief, no selection is given]

[Describe the results in more detail, including the long-term effects and effects on hydromorphology. Please indicate, if your information is based on monitoring results, or on presumed effects, max. 1.500 characters]

### Lessons learned (so far)

[List your lessons learned (so far). Think of main success factors, challenges, conflicts, constrains, synergies and beneficial aspects and describe them briefly, max. 1.500 characters in total]

## Map of the pilot area

Max. 1 page for this chapter

[Insert 3 maps in total: map 01: overview, to show where in the country the measure will be / was implemented , map 02: former status , map 03: planned / current status]

Overview



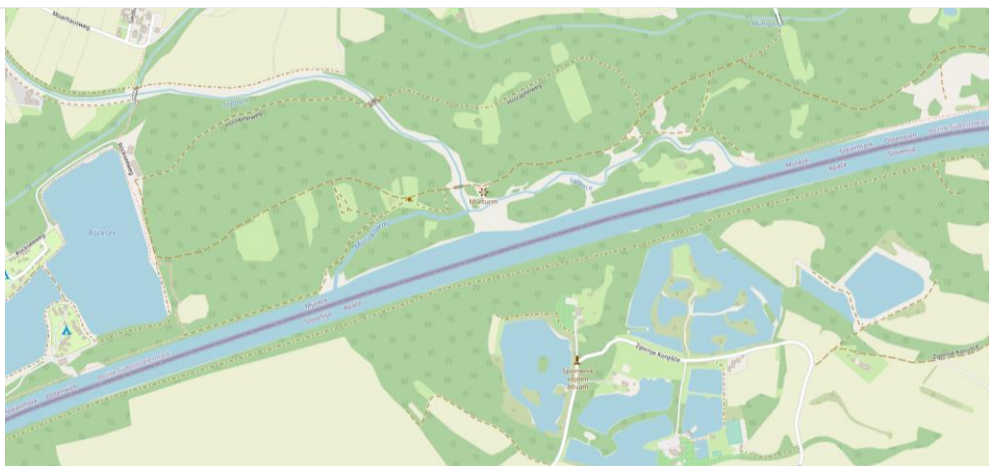
[Image caption & copyright]  
sed diam voluptua

Former status



[Image caption & copyright]  
sed diam voluptua

Planned /  
Current status



[Image caption & copyright]  
sed diam voluptua



## River stretch characteristics

[Max. 1 page for this chapter, Ongoing: The status before the measure implementation shall be described., Past: The status after the measure implementation shall be described ]

River	Area
[river name] diam voluptua. At vero	[coordinates from XX to YY in the project area, UTM] diam voluptua. At vero
Width	Gradient
[average, m] diam voluptua. At vero	[average, ‰] diam voluptua. At vero
Average discharge	Sea level
[m <sup>3</sup> , reference point] diam voluptua. At vero	[m, reference point] diam voluptua. At vero

[Indicate the applicable characteristics by ticking the right boxes, mark them green and bold, multiple choice possible]

Planform	Bed material
<input type="checkbox"/> Straight <input type="checkbox"/> Braided <input type="checkbox"/> Oscilating <input type="checkbox"/> Anabranching <input type="checkbox"/> Sinuous <input type="checkbox"/> Meandering	<input type="checkbox"/> Megalithal <input type="checkbox"/> Makrolithal <input type="checkbox"/> Mesolithal <input type="checkbox"/> Mikrolithal <input type="checkbox"/> Akal <input type="checkbox"/> Psammal <input type="checkbox"/> Pelal
<p>[max. 300 characters   short explanation text]</p> <p>Dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. ea rebum.</p>	<p>[max. 300 characters   short explanation text]</p> <p>Dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. ea rebum.</p>

Habitat types	Riparian Structures
<input type="checkbox"/> Flowing water <input type="checkbox"/> Floodplain water bodies <input type="checkbox"/> Gravel and sand bars <input type="checkbox"/> Softwood floodplain forests <input type="checkbox"/> Hardwood floodplain forests	<input type="checkbox"/> Steep bank <input type="checkbox"/> Shallow bank <input type="checkbox"/> „Other“ banks <input type="checkbox"/> Inlets & outlets of secondary channels
<p>[max. 300 characters   short explanation text]</p> <p>Dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. ea rebum.</p>	<p>[max. 300 characters   short explanation text]</p> <p>Dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. Stet clita kasd gubergren, no sea takimata sanctus est Lorem ipsum dolor sit amet dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum. ea rebum.</p>

## Pictures

Max. 1 page for this chapter

[Insert 6 representative pictures showing the status before, during and after the implementation]



[Image caption & copyright]  
sed diam voluptua



[Image caption & copyright]  
sed diam voluptua



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sed diam voluptua



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sed diam voluptua



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## List of reference

[Author (Year): Title, Institution, Location, published/not published, in case applicable: link]



 **Bundesministerium**  
Land- und Forstwirtschaft,  
Regionen und Wasserwirtschaft



LifelineMDD is a project co-funded through the Danube Transnational Programme of the European Union (ERDF and IPA funds). The project started on 1<sup>st</sup> July 2020 and lasts until the 31<sup>st</sup> December 2022. The total budget of the project is 2,987,789.19 €, divided between 12 full partners. This Interreg project is co-financed for the support and development of the UNESCO-MAB 5-country Biosphere Reserve Mura-Drava-Danube, by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management (BML), and by the Croatian Government Office for Cooperation with NGOs. The participation of the Hungarian partner was supported by the Hungarian government.



