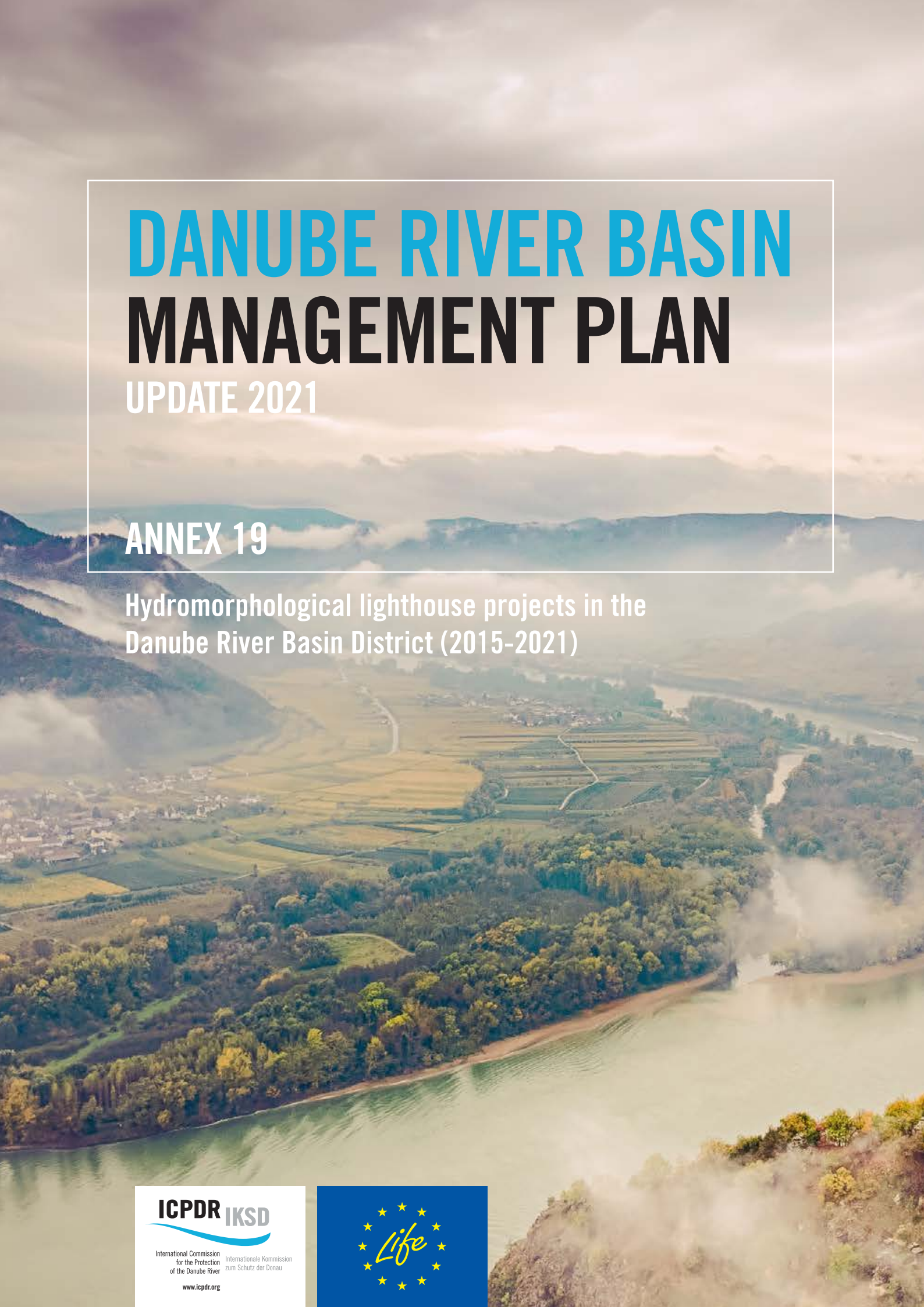
DANUBE RIVER BASIN MANAGEMENT PLAN

UPDATE 2021

ANNEX 19

Hydromorphological lighthouse projects in the Danube River Basin District (2015-2021)



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Internationale Kommission zum Schutz der Donau
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1. Overall context

Over the last century, legitimate water uses (hydropower generation, navigation and flood protection as well as activities related to urban settlements or agriculture) significantly changed the habitat and hydrological conditions of surface waters and thus impacted the ecological status and functioning of river systems.

The alteration of natural hydromorphological conditions can have negative effects on aquatic populations. Based on increased knowledge on hydromorphological alterations and their relevance for the achievement of the environmental objectives, measures have to be taken to restore natural or near-natural conditions. Measures to improve the hydromorphological conditions aiming at improved water status and increasing habitat diversity include

- Hydrological measures (e.g. increase of residual flow, dampening of hydropeaking),
- Restoration of river continuity for fish and sediment (e.g. construction of fish migration aids, improvement of sediment transport),
- Morphological improvements (e.g. removal of bank fixation, reconnection of floodplains).

During the last water management planning cycle (2015-2021), a significant number of appropriate hydromorphological measures were identified, many of them only started or already implemented by Danube countries. Table 1 shows, that most measures are related to the restoration of river morphology and continuity for fish, but also hydrological measures were implemented.

Table 1: Number of hydromorphological measures and their implementation status

	Planning on-going	Implementation on-going	Completed
Hydrological improvements	14	5	10
Restoration of river continuity	21	6	26
Morphological improvements	14	22	29

* for more details, see Annex 15 of the DRBMP Update 2021

To highlight the importance of hydromorphological measures, this brochure presents some lighthouse projects in the Danube River Basin District that were started or implemented since 2015.

2. Overview of measures

Overall, ten measures were reported by Danube countries. Their location within the Danube catchment is shown in Figure 1.

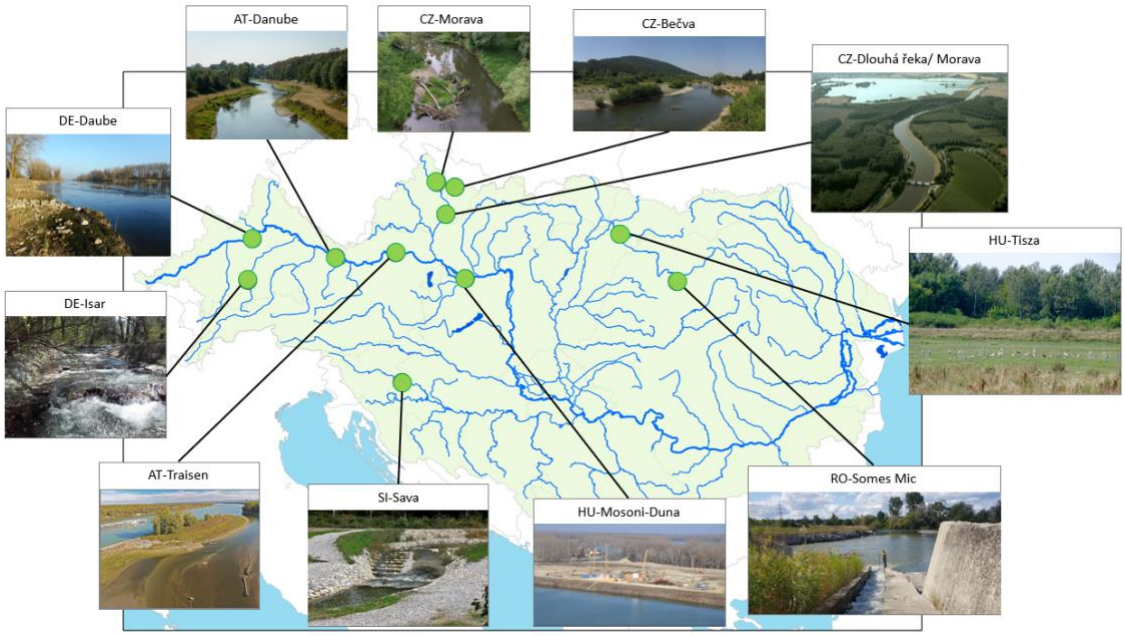

Figure 1: Overview map of hydromorphological measures in the Danube catchment

The main driving forces reported for the eleven lighthouse projects are hydropower (5 cases), flood protection (7 cases) as well as irrigation, land use and navigation (2 cases each). For five locations, several driving forces were reported, while six locations are dominantly changed by one driving force.

At most sites (i.e. 8) measures which serve the restoration of more than one hydromorphological impact type (i.e. related to hydrology, morphology, connectivity) are implemented. The here presented sites provide examples for restoration of river morphology and the riparian zone (7 sites), and/or floodplain areas (8 sites), connectivity for fish (7 sites) and sediment (3 sites). Furthermore, four sites provide examples for hydrological restorations, e.g. by improvement of water retention and flow variability.

Table 2: Overview of hydromorphological measures

Term used	Hydrology	Connectivity[1]	Morphology[2]	Benefitting directives	Status
AT-Danube		F	R, F	WFD, Habitats-D, Birds-D	Partly finished (2019, 2023)
AT-Traisen		F	R, F	WFD, Habitats-D, Birds-D	Finished (2019)
CZ-Becva		S	R ,F	WFD	Ongoing
CZ-Dhoulá reka	X	F	R, F	WFD, Habitats-D	Finished (2021)
CZ-Morava	X	F, S	R, F	WFD, Habitats-D, Birds-D	Finished
DE-Danube		F	R, F	WFD, Habitats-D	Finished (2018, 2019)
DE-Isar		F, S		WFD, Habitats-D	Finished (2018)
HU-Tisza	X		R, F	WFD, Habitats-D	Finished (2019)
HU-Monsoni-Duna	X		F	WFD, Floods-D	Finished (2021)
RO-Somes Mic		F		WFD, Habitats-D	Finished (2017)
SI-Sava		F	R, F	WFD, Habitats-D	Finished (2017)

1) Measures for fish (F) and/or sediment (S); 2) Measures for river/riparian (R) and/or floodplain areas (F)

Nine out of the eleven sites report that the planned or performed measures serve more than one directive (see Table 2). While all restoration measures serve the fulfilment of the European Water Framework Directive (WFD), nine are expected to bring benefits for the Habitats Directive (Habitats-D) and three for the Birds Directive (Birds-D). One is reported to be

beneficial for the Floods Directive (Floods-D). Those projects are thus also highlighting the importance of implementation of synergetic measures that are bringing achievement of different goals related to water management.

Nine lighthouse projects are already finished or expected to be finished by the end of 2021, while one is still ongoing. Another example (AT-Danube) comprises of two projects of which one was finished (2019) and one is still ongoing (2023).

Overall, more than 200 mill. were invested in the measures, whereby costs range from 38,000 € to 82 mill. These costs were often shared between EU, national and other funds (6 cases), or rely entirely on EU- (1 case), national- (3 cases) or other funds (1 case).

Monitoring results are available for five cases. The two fish passes in Romania and Slovenia were proven to be functional. In some cases, an improvement of the ecological status (e.g. from moderate to good status at AT-Traisen) or individual quality elements (e.g. from moderate to good fish-ecological status at DE-Danube) was achieved. A preliminary monitoring at AT-Danube also showed promising results with an increase in endemic species and juvenile life-stages. Further improvements area also expected for the remaining lighthouse projects.

The following chapter provides a more detailed description of the individual lighthouse projects.

3. Lighthouse projects

3.1 AT-Traisen: Creation of a meandering river section in the River Traisen

3.1.1 Initial (impacted) situation

The river Traisen is one of the biggest tributaries of the river Danube in Lower Austria. The river stretch runs through the Natura2000 site "Tullnerfelder Donauauen", Austria's largest enclosed wetland. It contains twelve protected habitat types acc. Annex I and 30 protected species acc. Annex II of the Habitats Directive as well as 24 protected bird species acc. Annex I of the Birds Directive.

The Danube floodplains were cut off from the river due to river regulation measures for navigation already in the 19th century. The Danube Hydropower Plant "Altenwörth" was built in the 1970ies and is operated by the VERBUND, Austria's leading electricity company. With a design flow rate of 2,700 m³/s, the run-of-river plant has a standard working capacity 1,967.6 GWh per year. This power plant thus generates about one sixth of the electricity generated on the Austrian Danube.

During the construction of the Danube hydropower plant of Altenwörth, in 1976 the mouth of the river Traisen was relocated about 7.5 km further downstream. The new river course was heavily regulated disconnecting the river from the surrounding riparian forest and supressing aquatic and terrestrial habitats that are usually found in floodplains. This situation led to an unfavourable conservation status for the whole Natura 2000 site. Additionally, the estuary was not passable for fish to migrate from the Danube into the river Traisen. For those reasons the concerned water body of the river Traisen reached only poor ecological status according to the Austrian National River Basin Management Plan 2009.

3.1.2 The measure

During the LIFE+ project a meandering river segment was built with a total length of approx. 10 km, which is allowed to develop dynamically during flood events and provides multiple habitats for aquatic species. The old channelized river course was maintained as backwater and flood drainage. The adjacent area of the Traisen was lowered to create about 60 ha of active floodplain habitats and approximately 30 ha of typical river habitats. Furthermore, the river Traisen was re-connected to the Danube and its fish population.

Figure 2: Construction works in the Traisen-area ©Verbund

Figure 3: Restored section of the Traisen River, next to the Danube River (upper right) ©Verbund

The large-scale excavations during the construction of the riverbed and its adjacent floodplain resulted in a material surplus of approx. 1.5 mill. m³, which was partly reintroduced downstream the Danube hydro power plant "Wien-Freudenau" to counteract riverbed incision.

The project has started in 2013 and the overall measure was finished in 2019. The costs of 30 mill. € were split between EU (5.3 mill. €, provided by LIFE funds), the national Environment Fund (3.3 mill. €), VERBUND as the operator of the hydropower plant (15 mill. €), regional funds (1.9 mill. €; Federal State Lower Austria, Fishery Association of Lower Austria, viadonau) and revenue from the excavated and sold gravel (4.5 mill. €).

3.1.3 Conclusion

The LIFE+ project "Traisen" is one of the largest ecological river engineering projects in Austria and in Europe and could only be realized through close cooperation of all project partners.

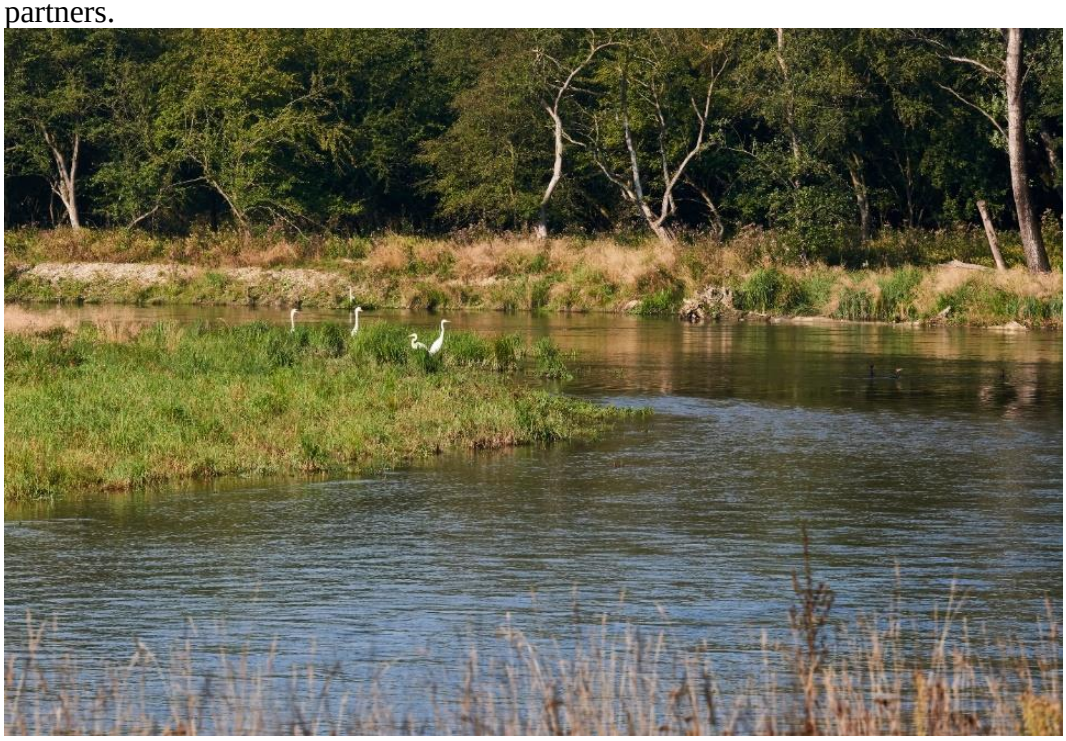

Figure 4: Restored river section of the river Traisen ©Verbund

Monitoring of the fish biocenosis was carried out during and after finalization (i.e. in 2014, 2016 and 2017). Focus of the monitoring was also laid on the assessment of juvenile fish, of spawning grounds and on temperature changes. Results show an increase from 20 to 33 species. While the old channel of the river Traisen did not provide suitable spawning- and rearing habitats, a high density of juvenile fish of various species were found in the new channel. The re-opening of the continuum to the Danube has directly led to an increase and reproduction of typical Danubian fish species. To sum up, the monitoring showed an increase in the number of species, an improvement in population structures due to higher reproduction rates and an increase in population density. The assessment reveals an improvement of the fish ecological status from moderate (status class 3) in 2014 to good status (status class 2) in 2017. Furthermore, the "good ecological potential" was achieved in the adjacent water body of river Danube.

The approach of providing both – fish migration and high-quality key habitats – ensures a significant contribution to the goals of the Habitats Directive, the Bird Directive, as well as the WFD, thus implementing EU legislation with the aim of best value for money.

3.2 AT-Danube: LIFE “Network Danube” and “Network Danube Plus”

3.2.1 Initial (impacted) situation

The Austrian share of the Danube has a length of 352 km. VERBUND, Austria's leading electricity company, is operating ten large run-of-river hydropower plants along the Austrian Danube which generate about 20% of the public electricity production in Austria
Large sections of the course of the Austrian Danube have been shaped by river regulation and damming measures already in the 19th century. The development of the Danube for hydroelectric power in the 20th century has additionally reshaped about 80% of its course. The ten existing hydropower plants have a significant ecological impact on the Danube river and its floodplains. They cause long stretches with reduced flow velocity and the dams have fragmented the river into environmentally disconnected sections. Moreover, the floodplains and floodplain water bodies along the river are for the most part cut off from the Danube by dams. In the Danube and its floodplains, the key habitat of permanently connected side arms, which provide spawning grounds and nurseries for rheophilic fish species and shelter from ship-induced waves, is missing. As a result of these alterations, the good ecological status/ potential is currently not reached in most of the Austrian waterbodies of the Danube.

3.2.2 The measure

Along the Austrian Danube there are several Natura 2000 protected areas and a National Park. The Natura 2000 area “Tullnerfelder Donau-Auen”, Austria’s largest enclosed wetland, contains 42 species protected under the EUs Birds Directive and Annex II of the Habitats Directive. The National Park “Donau-Auen” in the most eastern section of the Austrian Danube with an extent of over 9,600 ha is the largest complete, (near) ecologically intact natural riverine environment of its kind in Central Europe and provides home and refuge to many endangered plant and animal species.

Figure 5: Continuity restoration in the area of Abwinden-Asten ©Verbund

These areas are not ecologically connected due to the existing hydropower dams and flood protection measures. By restoring the continuity of the river and creating new habitats in the

river and its floodplains, the protected areas can be interconnected by a network of ecological stepping stones.
The two EU-funded projects **"**Network Danube" and "Network Danube Plus" aim for the restoration of connectivity and habitat improvements in the whole Danube upstream Vienna to the border with Germany. Thereby, they pursue objectives related to the WFD as well as the Habitats and the Birds directive.

Figure 6: Bypass channel at Ottensheim-Wilhering ("LIFE Network Danube") ©Verbund

The first project "LIFE Network Danube" started in 2011 and was finished in 2019. The following measures were successfully implemented:

- Construction of bypass channels at three hydropower dams to facilitate fish migration in the Danube
- Creation of gravel habitats (gravel banks, gravel islands) in the reservoirs of five hydro power plants on the Danube entailing 325,000 m³ of gravel; and
- Creation of 500 m of branches and side arms on the shores of the Danube.

The project is co-funded by the EU LIFE Programme. The total costs of the measure were 25.3 mill. Euro, whereby 4.3 mill. were funded by EU, 3.8 mill. by national funds, 16.7 mill. by VERBUND and 0.5 mill. by the Fishery Associations of Lower and Upper Austria.
The second project "LIFE Network Danube Plus: Closing the gaps and promoting a river corridor system with an European perspective" started in 2019 and is scheduled until 2023. The main aims of the projects are the following:

- Restoring the passability of the Danube for all fish species: In addition to the construction of fish migration facilities at three Danube power plants, feasibility studies on restoring the continuity are being carried out for the two remaining non-passable dams in the Austrian Danube. By the end of the project, unhindered fish migration will be possible between the Iron Gates gorge in Serbia and the Ybbs-Persenbeug hydropower plant in Austria (over 1,100 km) including the two last free-flowing stretches of the Austrian Danube;
- Creation of habitats by building gravel structures and lateral re-connection with tributaries
- Interlinking Natura 2000 sites (stepping stone biotopes between protected areas)

- Strengthening of fish populations also in the Danube floodplains and tributaries
- Closing the gaps between already implemented LIFE-Projects in Lower Austria
- Strengthening and appreciating the positive impacts of former ecological projects (e.g. the project Life-Traisen)

The project is co-funded by the EU LIFE Programme and the total costs are expected to be 10.1 mill. Euro, whereby 4.2 mill. will be funded from EU, 0.9 mill. from national funds, 4.9 mill. from VERBUND and 0.1 mill. from the Fishery Association of Lower Austria.

3.2.3 Conclusion

For the fish passes Ottensheim and Greifenstein interim results of the monitoring are available showing very good results. In Greifenstein 46 out of 58 endemic species could be evidenced. Furthermore, all stages of age were observed. Using pit-tags long-term monitoring is possible. With the upcoming fish passes and their monitoring more fish will be marked and can give new inputs on the topic of far-distance migration of fish.

Figure 7: Fish pass Greifenstein ©Verbund

The projects “LIFE Network Danube” and “LIFE Network Danube Plus” are demonstrating the suitability of a targeted stepwise approach for achieving the goals of the Habitats and Birds directives and the EU Water Framework Directive on a large spatial scale. The two projects complement each other with interlinking sets of measures and thus are multiplying the overall benefits of each individual project. Additionally, the measures to improve the river’s continuity enhance the positive effects of other renaturation projects. By re-connecting habitats in the Danube and its tributaries the biodiversity and the ecological status in the Danube itself as well as in its floodplains can be improved.

3.3 DE-Isar: Restoration of the ecological continuity in the Upper Isar Valley

3.3.1 Initial (impacted) situation

Due to river construction works in the river Isar for infrastructure protection (flood protection and agricultural land use) erosion caused a continuity interruption between the Isar and its tributary Aumühlbach. Important spawning areas and habitats for juvenile fish could not be reached and thus, the waterbody failed to achieve the good ecological status (in particular for fish).

3.3.2 The measure

In order to re-established the ecological continuity for biota (e.g. European grayling, barbal, nase) a structured ramp was established. It includes ten pools with a length of 4.3 m, which are connected by slots of 0.45 m in width and 0.52 m in height to overcome a fall height of 0.15 m each. As a consequence, important refuges and habitats in the near-natural tributary are once more accessible. The functionality of the structure for fish migration was ensured for a wide range of flow situations.

The measure was finished in March 2018. The overall costs of 90,000€ were covered by national funds.

Figure 8: Construction of the measure

Figure 9: View in upstream direction

3.3.3 Conclusion

The measure is expected to have a positive effect on the fish fauna in the Isar, which showed only a moderate ecological status with regard to its fish fauna before the measure was implemented. The success of the measure will be visible in the Isar in the medium term.

This measure is part of a bundle of measures that support and promote the development of a natural, species-rich and diverse fish community in order to achieve the good ecological potential/ status in the Isar by 2021.

From a nature conservation perspective, the measures are also suitable to support the conservation goals for the protected area (habitats directive) “Oberes Isartal” (Upper Isar Valley). Consequently, the measure supports the achievement of both, the WFD and the Habitats directive.

Figure 10: Finished bypass

3.4 DE-Danube: Improving a Danube water body in the Upper Danube by – inter alia – removal of bank fixations and creation of gravel banks

3.4.1 Initial (impacted) situation

One main reason for not achieving good status in the Danube between Vohburg and Staubing is a severe hydromorphological alteration of this water body at a length of about 20 km.
2015, the ecological status was „moderate“, because of the assessment of invertebrates und macrophytes/phytoplankton. An additional problem is caused by invasive species, which benefit from the bank protection with (armour-)stones.

3.4.2 The measure

In order to improve the ecological status of the river body and to ensure that a good ecological status could be maintained for the future, a comprehensive programme of measures for this river stretch was set up.

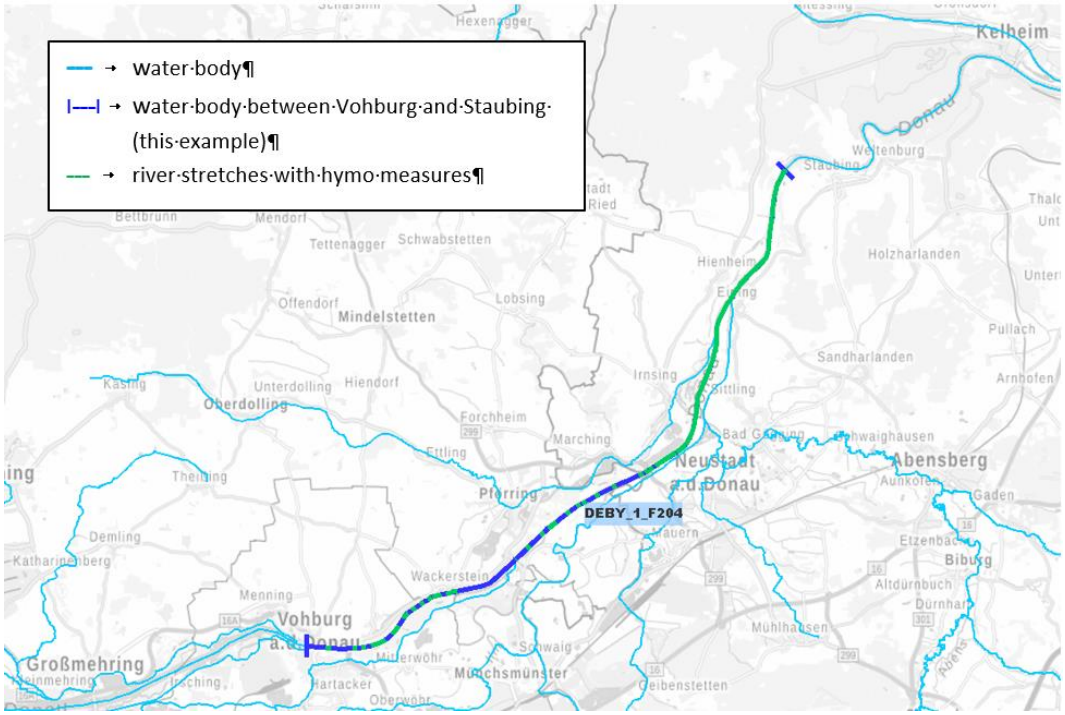

Figure 11: Overview map – location of water body and hydromorphological measures

The complete hydromorphological measures for this river stretch includes the following activities:

1. Structural measures to promote natural retention (~3.8 km)

The natural water retention in the Danube floodplain increases by removing riparian deposits along the riverbank. This was already done on a large scale during the last years and will be continued. In addition, a flood storage basin is to be reactivated by the removal of riparian land and artificial bank protection.

2. Removal/ reduction of bank reinforcement (15 locations, approx. 14 km)

The massive bank protection on the Danube is to be partially or completely removed in areas where it is not indispensable for the protection of settlements, bridges, roads and flood protection facilities.

3. Inserting structural elements in the existing water profile (11 locations, 11.6 km)

Armourstones that are left over from the removal of the bank protection can partly be placed in the river profile. Short groynes (up to about mean water level) increase the variety of currents

in the Danube and promote bank erosion, flow diversity and morphological development in adjacent downstream areas.

4. Creating and redesigning gravel banks

One additional gravel bank is to be created through the introduction of gravel around armourstones. Two existing gravel banks will be redesigned in order to create new spawning habitats for characteristic Danube fish species.

5. Developing floodplain habitats

The development of an approx. 900 m long and 50 – 80 m wide strip with typical floodplain habitats (succession areas, grassland, wet areas) and the development of alluvial forest areas on former intensively used meadows on a stretch of approx. 1.3 km is to be realised.

6. Recreating alluvial waters (5 locations, approx. 3.5 km)

In order to be able to develop a more natural watercourse again, it is planned to divert water from the Danube into new branches to be created at several points. These measures are also intended to improve the habitat conditions for typical fish species.

7. Connecting backwaters

Several backwaters are currently not or not permanently connected to the Danube river. Improvement measures are proposed for four areas.

8. Improving lateral connectivity

The three tributaries to the Danube are not optimally passable for fish, thus the mouth areas will be redesigned. Thereby, the backwaters in the floodplain could also be linked with the Danube.

9. Improving the sediment situation

Due to sediment retention upstream causing a strong bedload deficit, gravel was introduced into the river at two places. It is very likely that sediment input will have to be repeated every 5 to 7 years.

Example for realisation of measures: Creation of a gravel bank for rheophilic fish

A structured gravel bank located in the area of mean flow (~250m long, gradient of ~1:25) was created near the left bank of the Danube for which about 3,000 m³ of Danube gravel were used. A basic structure of hydraulic building blocks serves to stabilize the gravel bank and offers protection against erosion.

The measure was finished in July 2018. The overall costs of 100,000 € were entirely covered by national funds.

Figure 12: Finished gravel bank from aerial view

Since the measure is situated in a protected area (Habitats directive, “Donauauen zwischen Ingolstadt und Weltenburg”), the measure aligns with the WFD and the Habitats directive.

Example for realisation of measures: Removal of bank fixations

The bank fixation of the Danube was removed at approx. 500 m in order to promote the development of structures typical of natural rivers such as bank breaks, backwash and potholes. The lining material was used for creating different groynes. Due to the generous denudation of bank material, a softwood site with high flood dynamics has been created. The measure was finished in November 2018, whereby the overall costs of 60,000 € were entirely covered by national funds.

Figure 13: Removal of the bank fixation

The removal of the bank fixation and the flattening of the steep bank sections also improves access to the Danube and makes the river more tangible for the population.
Since the measure is situated in the protected area (Habitats directive): “Donauauen zwischen Ingolstadt und Weltenburg” (Danube floodplain between Ingolstadt and Weltenburg) the measure aligns with the WFD and the Habitats directive.

3.4.3 Conclusion

The habitat conditions in the river have improved and will further improve as measures are implemented step-by-step. Measure implementation will continue during the next management cycle as well as monitoring of the progress of status improvement. Until now, inter alia, spawning grounds for typical Danube fish species have been created and the floodplain has been reconnected to the river. This is vital for typical Danube fish species. The quality element “fish fauna” has already reached “good status”, invertebrates are still “moderate”.
We expect that the water body will be in good ecological status in the medium term, as the ecosystem needs some time to establish a new “good” equilibrium.

3.5 CZ-Dlouhá řeka/ Morava: Nedakonice water management node

3.5.1 Initial (impacted) situation

Nedakonice water management junction was created in connection with the navigation of the Morava River in the first half of the last century. A weir with a navigation lock was placed in the newly created river channel. By this solution a big part of the original Morava river bed was cut off from the rest of the river. In this section, the mouth of the Dlouhá řeka River was connected to the side arm of Morava, called Morávka. Due to the water management alteration, these flows were also separated from Moravia, which stopped the Morávka from being supplied with water from Moravia and became a continuation of the Dlouhá řeka River. The problems with siltation started very soon, because discharges of Dlouha řeka River was not sufficient to transport bigger gravel of Morávka. Morávka River gradually started to fall dry for most of the year. The river stretch locked with sediments was no longer sufficient to transport flood water out of the area and problems with flood protection started on the Dlouhá řeka River at municipalities upstream of the locality.

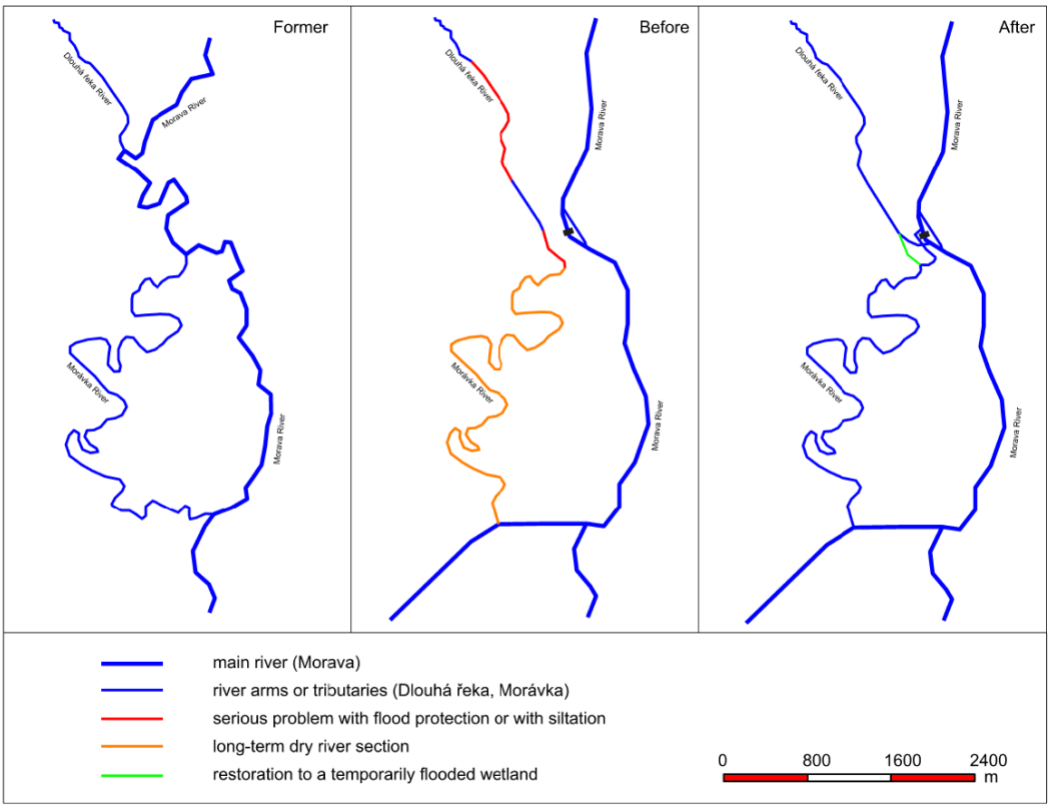

Figure 14: Historic (former), impacted (before) and restored situation (after) at the Nedakonice water management node

3.5.2 The measure

The aim of the revitalization measure is to ensure sufficient flow through the Morávka while at the same time limiting the entry of sediment from the Dlouhá řeka River into the system. Dlouhá řeka River will be taken downstream of the Nedakonice-weir. The new mouth of the Dlouhá řeka River will be created downstream of the weir ❶. The solution also will have a positive effect on the runoff conditions in the village of Nedakonice. The fish migration passage on the Morava River will be ensured by a new fish pass ❸. The water for the Morávka will be collected from the Morava River upstream of weir ❷ by a new channel. The solution will respect the requirements of the water regime of the floodplain and floodplain forest as well as the requirements of municipal flood protection. The solution restores a situation similar to the situation before water management and eliminates their negative impact. Only the siltation will

be removed from Morávka River ❺, the rest of this river will be cleaned by river flow itselve. The part of river bed, which will be no longer used for Dlouha řeka river ❹, will be re-created to a temporally flooded wetland.
The implementation of the measure is ongoing and is expected to be finished in 2021. The expected costs are around 3.2 mill. € (without VAT) which will be covered by EU and national funds.

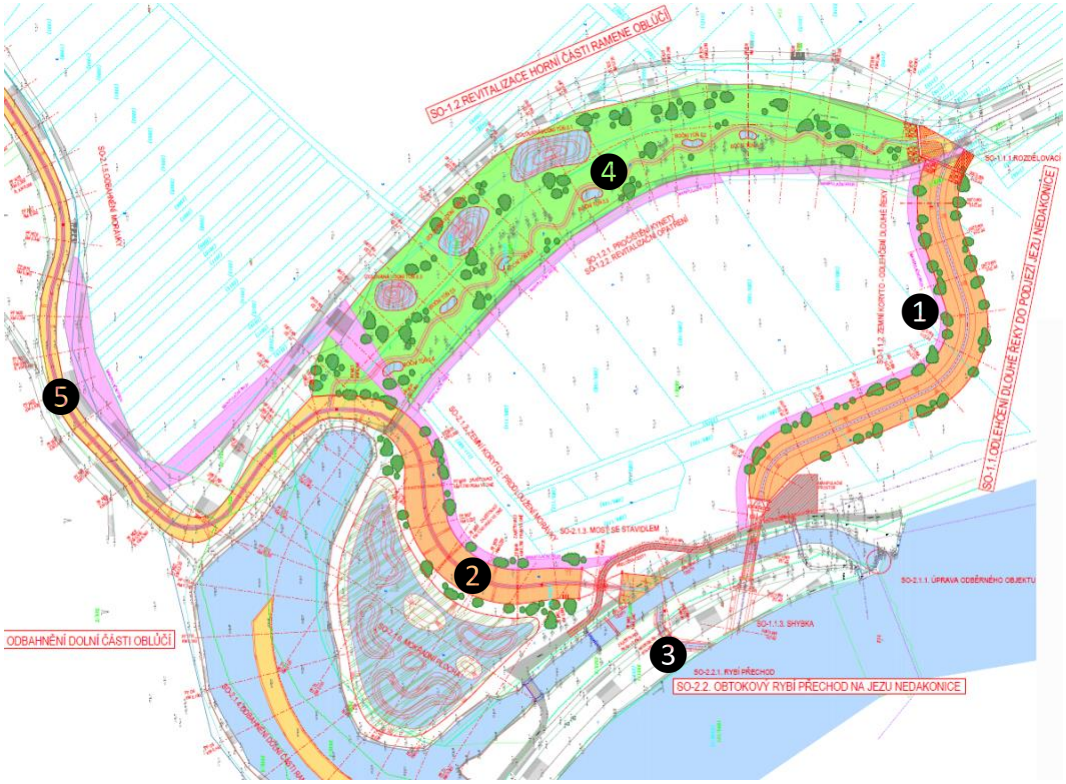

Figure 15: Overview of the measure

3.5.3 Conclusion

The measure is expected to have a positive effect on the runoff conditions in the village of Nedakonice and migration passage on the Morava River. The solution will respect the requirements of the water regime of the valley floodplain and floodplain forest as well as the requirements of municipal flood protection. The solution restores a situation similar to the situation before water management and eliminates their negative impact. Dlouha řeka and Moravka River are connected directly to the Morava River again which restores their flow regime and increase theirs morphological condition. More than 7 km of previously dry river bed of Morávka River are restored to a functioning river with full discharge again. Consequently, the measure serves both, the EU WFD and the Habitats Directive.

Figure 16: Morava River and Nedakonice water management node (on the lower right side)

3.6 CZ-Bečva: Restoration of the Bečva River

3.6.1 Initial (impacted) situation

Naturally, the Bečva River was a wild gravel flowing stream, but in the last century it was gradually modified to a monotonous capacity channel with a profile of a simple trapezoid. The effort of the river for shore erosion was suppressed by repeated building interventions. Restrictions on shore erosion and natural gravel run have led to the acceleration of bottom erosion and the gradual decomposition of the flow channel.

Figure 17: Already restored section of the Bečva River

3.6.2 The measure

Until the extreme floods in 1997, there was a spontaneous renaturation of several sections. These sites have become inspiration for revitalization. At present, a four-kilometre natural river bed rehabilitation project is being prepared. The narrow trapezoidal riverbed will be transformed into a triple-walled gravel stream with a moving shallow cunette and a large expanse of exposed gravel. The project envisages the restoration of the morphological processes within the created river corridor, the restoration of the natural regime of the gravel sediment load and the improvement of the river's function during the floods.

The measure is still ongoing and the expected costs of 13,4 mill. € (without VAT) will be covered by EU and national funds.

3.6.3 Conclusion

Restorations in larger rivers should always consider impacts on the catchment scale. Often, problems arise at the tributaries (e.g. sediment deficit) and are consequently inherited by the Danube itself. Disturbed gravel flows, which form a significant part of the hydrographic network, represent a fundamental problem. One older project coined the name "gravel crown Danube" for them. Bečva is just one of the typical gravel streams. For this reason, the solution of its revitalization is an important stone in the mosaic of achieving good status of the entire Danube basin.

Figure 18: Revitalizing intervention implemented the “nature model” of spontaneous river renaturation

Figure 19: In some places it was necessary to correct the development of nature-friendly river bed interventions

3.7 CZ-Morava: Morphological restoration of the Morava River

3.7.1 Initial (impacted) situation

In the 1970s, the Morava River was heavily stabilized by stone riprap between the confluence with Cholinka River and "Štěpánovska smuha". Nevertheless, it is still currently reported to exhibit unaffected flow conditions. Bank stabilization prevents lateral erosion processes and increases bottom erosion. The result is the unnatural recess of the river below the terrain of the surrounding floodplain (i.e. river bed incision). Although everything seemed fine at the first sight, it caused a significant deterioration of the morphological condition. This was unacceptable, especially because of the location in the Landscape Protected Area Litovelské Pomoraví.

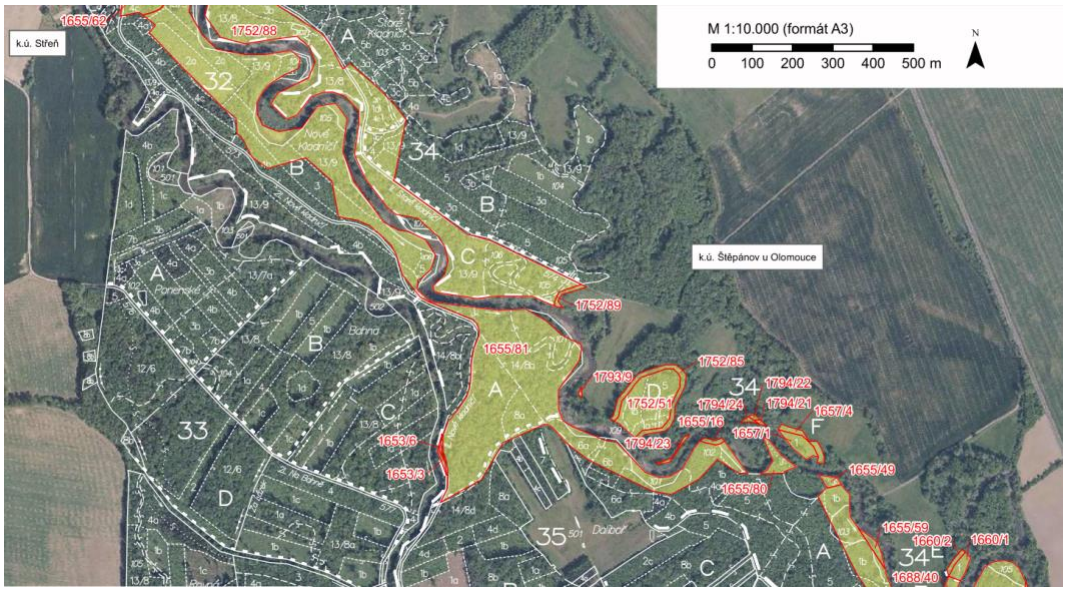

Figure 20: Before the implementation of the action was necessary to obtain ownership rights to coastal land

3.7.2 The measure

To improve the situation, the heavy stone riprap will be locally removed along a 2.6 km long section of the Morava River. In order to reduce the transport of material inside the protected landscape area, this material will be reintroduced directly in the stream on site. Initial channelling elements (stone shoots, islands and bottom elements) combined with wood mass (anchored strains) will be created. The initiating elements in combination with the riverwood contribute to the decaying of the bank and accelerate the desirable morphological development that has long been unnaturally suppressed.

The measure itself is already finished and caused expenses of 160,976 € (without VAT). However, the purchase of land, which accounts for 742,115 €, makes up a large proportion of the overall costs.

Figure 21: Inappropriate bank lining were removed and used for initiation elements

Figure 22: Restored section of the Morava river with a man-made peninsula

3.7.3 Conclusion

If the revitalization is well done, human intervention on the river should not be noticeable. This applies here. The river again develops freely and increases its morphological value of protected landscape area. The whole area is better adapted to climatic change, the ability to better manage water supplies is improved. The measure supports the achievement of the EU WFD. However, the restoration measure is also expected to have a positive effect on the Habitats- and Birds Directive (Litovelské Pomoraví"; EVL CZ0714073, CZ0711018).

3.8 RO-Somes Mic: Restoration of connectivity in the Somes Mic River

3.8.1 Initial (impacted) situation

The Manastirea River Dam is located on the river Someșul Mic, at a distance of approx. 3.5 km from the confluence with Someșul Mare river, on the territory of Mănăstirea locality, upstream of Dej municipality.

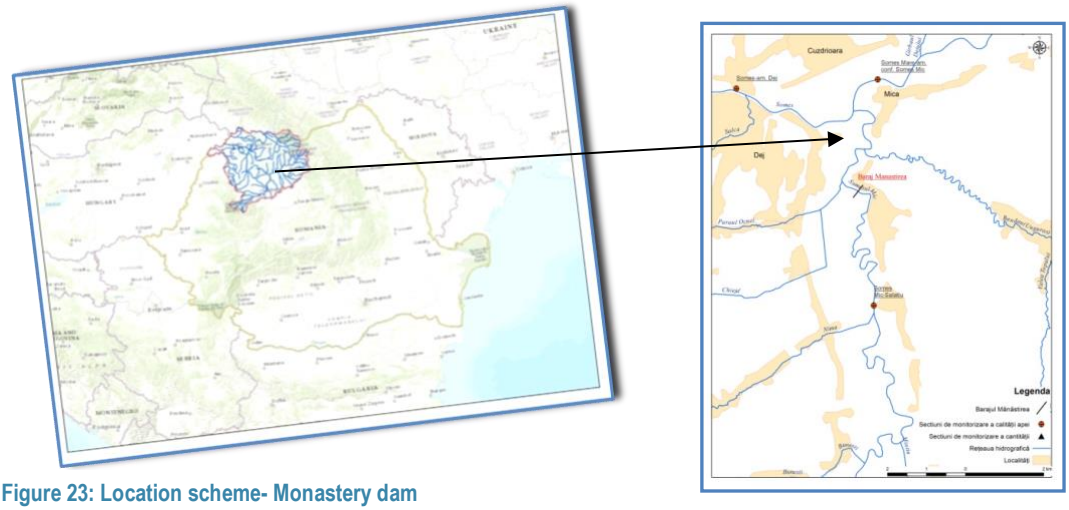

Figure 23: Location scheme- Monastery dam

The river dam and the hydropower plants were built a century ago, in the place where there used to be a water mill. Thus, in 1910, the Monastery was the first electrified rural locality in Eastern Europe. The current purpose of the river dam is the water intake for hydropower production in the hydropower plants (HPP) Manastirea 1 and 2, according to the planning scheme below (see Figure 24):

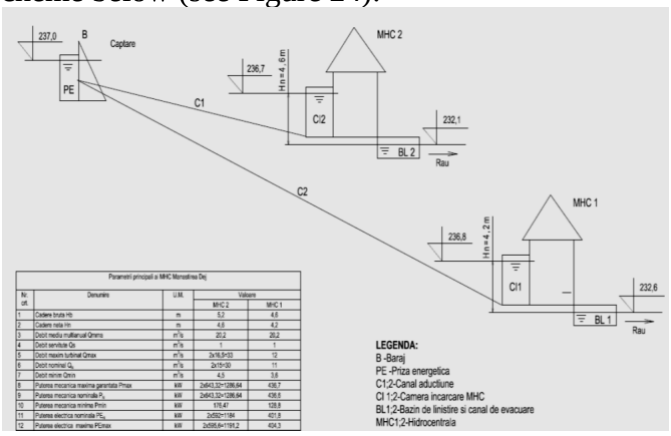

Figure 24: Planning scheme of HPPs Manastirea 1 and 2

Characteristics

- $P_{installed}$ = 0.8 MW,
- $V_{turbined}$ = 168.16 mill. m³/year
- Energy produced =5.91 GWh/year.
- The maximum flow that can be transited through the arrangement section is 138m³/s.
- Main features of the dam:
  - dam length = 47.6 m
  - dam elevation = 238 m above sea level
  - dam height = 4.5 m at the overflow ridge (7.5 m in total)

Two small hydropower plants are included in the hydropower planning scheme, Dej Manastirea 1 and 2, located on the banks of the Someșul Mic river, on both sides of the dam.
The water body RORW2-1-31_B4 / Someșul Mic - cf. Nadăș -cf. Someș Mare, on which the dam is located, has been designated a heavely modified water body (typology RO05CAPM) due to the hudromorphological pressures and transversal barrierres (3 obstacles with a height >0.5 m).

3.8.2 The measure

The measure of equipping the dam with a fish pass facility has been etablished in the frame of River Management Plan of the Someș-Tisa hydrographic area, estimated to be implement in the period 2015-2021. The following considerations have been considered:

1. The presence of migratory fish species downstream of the transversal barrier and their absence at the upstream monitoring sections. The monitoring of the quality element (QE) fish, performed in 2020, indicated the presence of migratory species nase (*Chondostroma nasus*), barbel (*Barbus barbus*) and vimba bream (*Vimba vimba*) in the monitoring section located after the confluence with Someș Mare river.
2. According to the distribution of the ichthyofauna in Romania (after Bănărăscu, 1964), on the respective segment of the river the barbel (*Barbus barbus*) is indicated as the dominant species.
3. The dam is located in a site of community importance (ROSCI0394 Someșul Mic) which was designated in 2011. Three fish species can be found on the list of protected species within this site.
4. An acceptable level of implementation costs, compared to environmental benefits.

Figure 25: Construction scheme / Photo - fish pass

In the period 2015-2017, the measure was implemented, together with the rehabilitation works of the dam, hydroelectromechanical equipment and HPP made by the new owner of the dam. The fish pass is located on the left bank of the dam with a total length of 28 m, the upstream level is 236.25 m above sea level, and the downstream is 230.0 mdMN. The flow through the fish pass is 1 m^3/s. Constructively, it consists of a system of pools with a size of 1.20x1.40 m, located at different heights and communicating through slots with a size of 20x60 cm. The thickness of the walls of the pools is 30 cm. The project was funded by Somes Tisa RB Administration budget. The total costs of the measure have been 38.000 €.

3.8.3 Conclusion

Following the monitoring of the ichthyofauna on the water body RORW2-1-31_B4 / Someșul Mic -cf. Nadas-cf. Someș Mare carried out by the laboratory of the Someș-Tisa hydrographic space in 2020, in the upstream section of the Manastirea dam, *Barbus barbus* were identified,

which indicates a properly functioning of the fish pass. The fish migration route was thus extended by 20.4 km.

Also, when monitoring the biological elements carried out by the owner of the small hydro power plant, according to the obligations contained in the water management permit, specimens belonging to the species *Barbus barbus* were caught, even in the fish pass.

Figure 26: Photo Collage - MHC fish fauna monitoring (source: SC Limnades LLC)

In the 3rd planning cycle of the RBMP, works for restoring the longitudinal connectivity on the water body RORW2-1-31_B4 are foreseen for another two transversal barriers, in the area of Gherla and Apahida localities. The implementation of these measures will lead to the complete restoration of longitudinal connectivity on this water body.

3.9 HU-Tisza: Measures to improve water retention in Bereg

3.9.1 Initial (impacted) situation

The landscape unit Bereg (579 km² in total) is located in Hungary and Ukraine. In Hungary 54% of the area is nature protected by Hungarian laws and/or part of Nature 2000. The area is situated between the Carpathians and the Tisza river which is flowing at the borders of Nyírség, a sandy hilly area. The area is typically characterised by small settlements having declining birth-rate and aging population.

Before river restorations, Bereg used to be an area of little waters; creeks running from the mountains, and swamps situated between these creeks. The mosaics of this landscape are still to be found and stand under nature protection.

The flood protection management technics since the 1870s of the river Tisza, the irrigation and land use changes formed the water system of the area. The floodplain became disconnected from its main river and the creeks channelized. New drainage and irrigation channels were built which do not necessarily follow the former river beds. The onetime wetlands are often under agricultural use, where water still appears in form of excess water. On average 26% of the area is affected by excess water. Maximal excess water inundation is affecting 44% of the area. It can also be mentioned that the area is within drought zones of medium and high intensity. The excess water channels are 935 km long in Bereg.

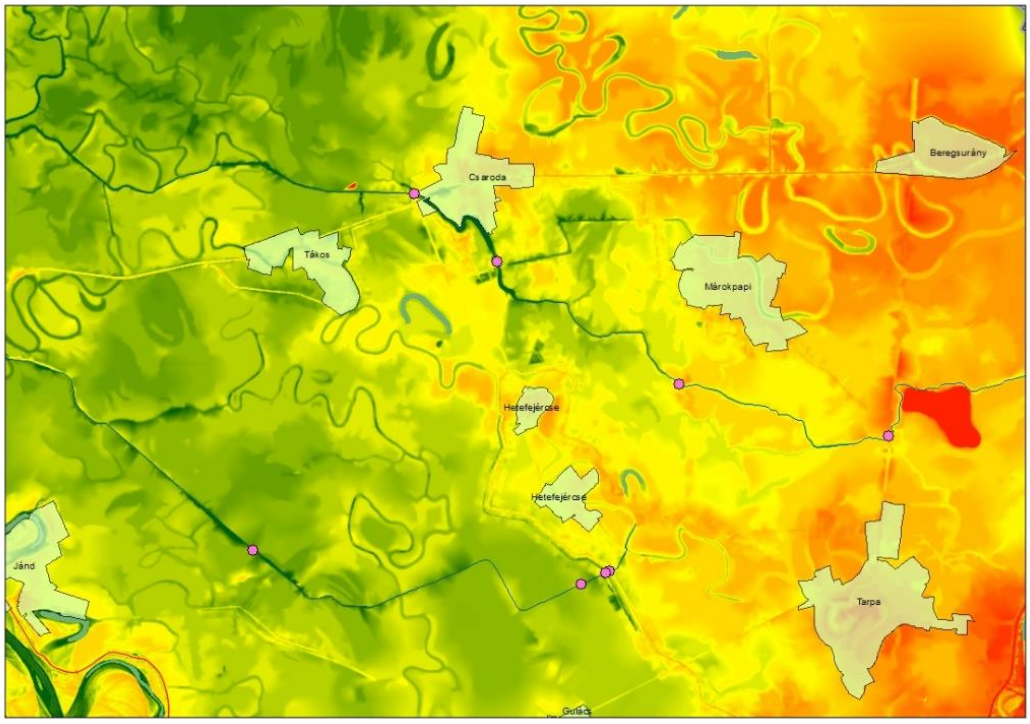

Figure 27: Original river system

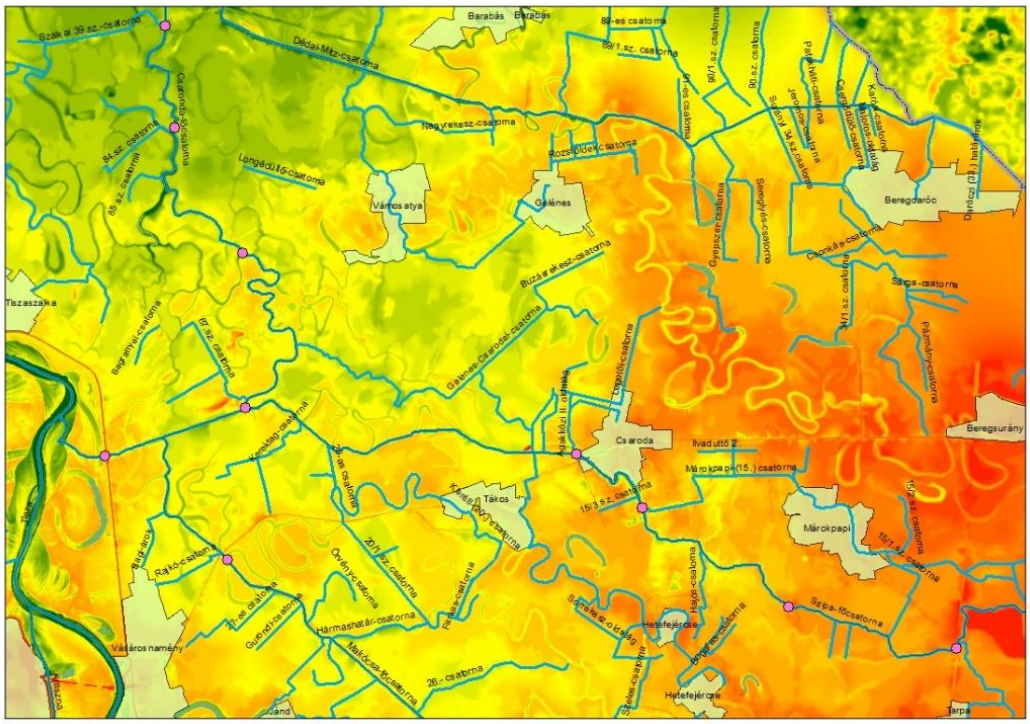

Figure 28: Drainage channels

The river regulations resulted in less water in the area, as swamps were drained, creeks abolished and new channels constructed also with the aim to drain the land. Excess water is regarded as a problem on the agricultural land. Climate change, the need for agricultural production and nature protection aims changed the relation to water, which is not regarded as part of the landscape.

The water managing structures of the area are mainly suitable for the drainage of water and not for managing/ retaining it. Furthermore, the agricultural use not fully takes into account the water regime characteristics of Bereg, which makes the agricultural production vulnerable. Nature protection is of high importance in the area, but is also not fully sustained by the existing water infrastructure.

The restoration aimed to change the water infrastructure to better accommodate it to landscape characteristics (small creeks, more water) and to make a land use change possible.

3.9.2 The measure

The Bereg project aimed to raise water retention possibilities by ensuring more water in the area and helping better water regulation. The concrete measures involve two new water abstraction possibilities from the river Tisza, three new channels for water supply, channel rehabilitations, building/reconstruction of structures to ensure water retention, rehabilitation of former mine pits to create wetlands as also building/modernisation of new monitoring stations. Also, a water supply possibility was analysed from the Borzsa river in Ukraine.

The creation of water retention possibilities has multiple effects:

- it sustains the water supply of dead arms and backswamps in Bereg
- landscape management can be now based on the concept of water retention. More water is available in the area in low water situations, it also sustains the quality of available water resources

- the new infrastructure ensures the basis for an optimal land use for e.g. forestry, nature protection, agriculture. It adumbrates the improvement of the environmental status of the area but also farmers' living conditions.
- landscape management can be attached to the function of overflow reservoirs. Two overflow reservoirs of the river Tisza are situated in Bereg. In case of high floods, the reservoirs will be able to transfer water to Bereg.
- Monitoring system (also structure operation monitoring) development in the area ensures the continuous information on water quality and quantity.

The project was finished in 2019. The overall costs of 34 mill. € were entirely covered by EU funds.

3.9.3 Conclusion

The project was initiated by foresters, nature protection experts, farmers and water managers. It was a good example for stakeholder participation where the change of water management principles was originating from local residents and famers.

More water in the area enables higher groundwater levels. During arid summer periods forests and agricultural land benefit from available groundwater as also protected water dependent wetlands do. It makes the change in land use possible that fits more to landscape characteristics. The project is beneficial for the EU WFD, Habitats directive and the European Landscape Convention and has connection to FD. Hungary built overflow reservoirs which intended to be multifunctional. By retaining water from floods/ excess water the water can be used for other aims as nature protection, landscape unit characteristic based agriculture. The project builds on the overflow reservoirs as also on other water resources (Tisza, Borzsa) by using a holistic view.

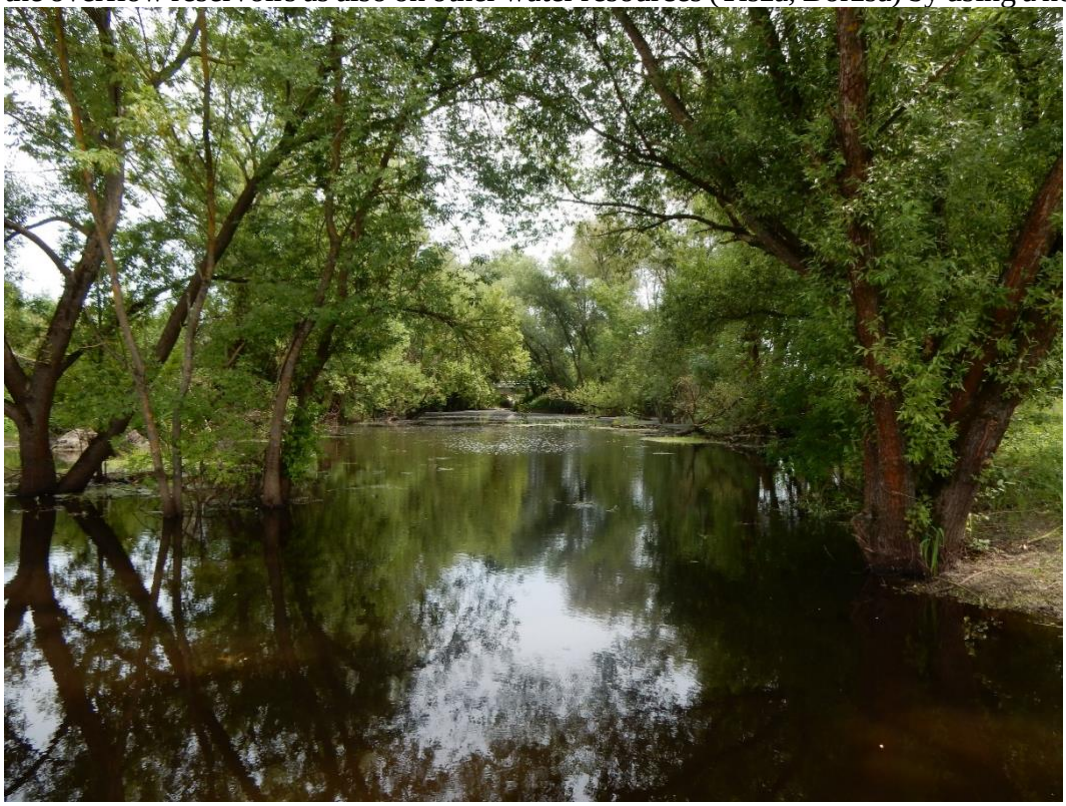

Figure 29: Restored section

3.10 HU-Monsoni-Duna: Measures at Mosoni-Duna estuary section

3.10.1 Initial (impacted) situation

Szigetköz is situated in north-western Hungary and depends on Danube water. This river stretch still shows the anabranching pattern of the Danube, while the river branches are already stationary. The regulated water levels and transfers are ensuring this situation. Still, this area has high values in nature protection, landscape management and recreation. The Szigetköz with its water dependent habitats is representing a unique value.

Szigetköz is depending on the water transferred from the Gabcikovo reservoir on the Danube. After the building of the HPP the arms of the anabranching river lost water. Several measures have been taken since 1992 on the Hungarian side to reduce the impacts of less water, mainly smaller and larger dams/ weirs were built to ensure water retention in the side arms.

Since the 1960s, the Danube is suffering from river bed incision, as a consequence of HPPs and river regulation in Germany and Austria.

The river bed incision of about two meters has a suction effect on the Szigetköz side arms and the groundwater. The dam newly built at the mouth of the Mosoni-Duna arm is situated on the lowest point of the area, where the anabranching character ends. It helps to sustain water retention on the lower part of the area (the mitigation measures started on the upper part of Szigetköz and continued on the middle part while the lower part was less taken into account until now).

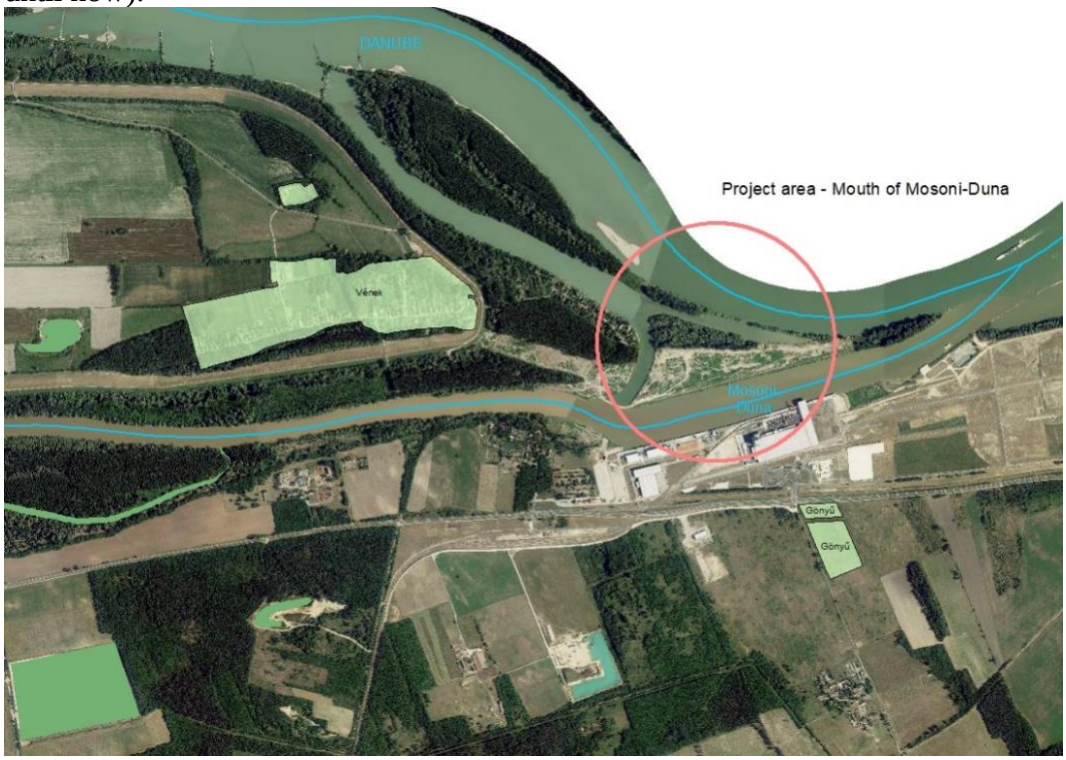

Figure 30: Project area (confluence of Mosoni-Duna with Danube)

3.10.2 The measure

The main aim of the project was to raise the medium and low water levels in the lower section of Mosoni-Danube and the connected area of Szigetköz, but also to restore the estuary water level corresponding to the supporting effect of the Danube. It was realised by the building of a new dam at the mouth of Mosoni-Duna.

The higher water levels in the lower Szigetköz will enable water supply for wetlands and floodplains in Szigetköz where the former Danube branches have important values with their colourful ecosystems.

Figure 31: Before the construction works started at Mosoni-Danube and Danube estuary section

Figure 32: Construction works – funding the structure

The building of the dam also sustains other water uses. Higher water levels ensure navigation of the Mosoni-Duna: The Győr-Gönyü national port –built from 1992 – and situated near the mouth of Mosoni-Duna will be better available for ships due to higher water levels. Also, the results of the project will provide a more attractive view of the city Győr, where river bed incision also indicated changes. The dam will also ensure the exclusion of too high water levels of the Danube reducing the flood risk of the cities along the lower Mosoni-Duna. The project is ongoing and expected to be finished in 2021. The overall costs of 82 mill. € will be shared between EU (50%) and national funds (50%).

3.10.3 Conclusion

The new dam raises the medium and low water levels and ensure higher water levels in lower Szigetköz. This higher water level will be adjusted to original water levels (before the HPP was built and the Danubean incision reduced water levels here), while ecosystem needs will be

considered. It will enable better water supply of river branches, wetlands and floodplains, and connect their woody and water related ecosystems. The main aim is to have a more natural conditions in this area. The measure serves the EU WFD by reducing the risk of low water situations in Szigetköz (and reaching good status) as also Floods Directive by increasing the flood safety for the city Győr. Furthermore, the Fertő-Hanság National park under the name Szigetközi Landscape Conservation Area and the Natura 2000 site as Szigetköz (HUFH30004) may benefit from the measure.

3.11 SI-Continuity restoration in the Sava River

3.11.1 Initial (impacted) situation

There are 8 HPPs built on the Slovenian part of the Sava River. Between the most downstream HPPs there is an additional dam that is needed for operation of a nuclear power plant. Fish passes are built on the three most downstream HPPs. With construction of the last HPP also the dam at the nuclear power plant becomes passable for fishes due to an increase in water level caused by the downstream HPP. The construction of a fish pass is one of numerous mitigation measures on the HPP. There were also other mitigation measures implemented, i.e. dynamic river banks, sand banks for kingfishers, floating islands for terns, banks for sand martins, riparian vegetation, passages for amphibians, passability between Sava River and tributaries etc.

3.11.2 The measure

The fish pass is located on the run-of-river HPP Brežice, on the left bank of the Sava River. The fish pass is divided in two parts – first, a near-natural part, designed as a side channel of the river and second, a technical part, designed as sequence of pools. The first part is 830 m long and is created as meandering channel with two larger resting places, five spawning grounds, six larger pools and nine sequences of rapids. Special attention was given to designing of spawning grounds, where specific river conditions are needed (water depth, flow velocity and substrate). These spawning grounds are mainly designed for following fish species: *Chondrostoma nasus, Rutilus pigus virgo, Squalius cephalus, Barbus barbus* and *Alburnoides bipunctatus*.

Figure 33: HPP Brežice and the fish pass on the Sava River after construction

At the inflow to the technical part of the fish pass, an automatic system of one main lock and six regulative locks enables inflow of the necessary discharge for every water level condition. The water flow in the fish pass is changing depending on the fish species needs in each particular season of the year. There is a higher discharge guaranteed in spring (800 l/s) during spawning season. Also, in summer and early spring discharge is slightly higher (650 l/s) and then reduced in autumn and winter time (500 l/s).

Figure 34: HPP Brežice and the fish pass on the Sava River one year after construction

The operation of the fish pass was also adjusted to high water flow conditions (when discharge of Sava is higher than 700 m^3/s). In these conditions the main lock is partially closed (7%), one of the regulative locks is opened and the other regulative locks are closed in order to guarantee a reduced inflow of suspended sediment into the fish pass and to prevent siltation in the fish pass. In high water conditions fishes are hidden in pools created within the fish pass.
The operation of the fish pass is also adjusted to winter conditions. In order to prevent freezing of water in the inflow part (when air temperature is lower than 3°C), only the first and sixth regulatory lock is opened.

3.11.3 Conclusion

After the fish pass construction in 2017, fish monitoring was established. Results showed appropriate functioning of the fish pass. In total, 27 different fish species were identified, whereby the near-natural part of the fish pass featured a higher diversity of fish species. It was found that fish species are present along the whole length of the fish pass.

The functionality of the fish pass depends mainly on guaranteed flow variability. This is of special importance for prevention of siltation of the substrate too that is crucial for effective spawning grounds. Beside this also regular maintenance works on the fish passes are recognised as very important for its appropriate working.

Figure 35: HPP Brežice on the Sava River 3 years after construction

4. Final remarks - Outlook

Most of the here presented lighthouse projects aim for the restoration of more than one impact type (e.g. hydrology, morphology, connectivity). Furthermore, most examples also serve the fulfilment of more than one directive (e.g. WFD, Habitats Directive, Birds Directive, Floods Directive). They therefore provide best-practice examples on how synergies can be used.

Four examples are located in the Danube River or in its vicinity. All of these projects focus on morphological restorations, while three also serve continuity restoration. Six examples are located in Danube tributaries. Since the Danube often inherits problems arising in tributaries (e.g. sediment deficit), restorations in tributaries are not only relevant locally but are beneficial for the Danube too in the long run.

The here presented lighthouse projects represent just an extract of many implemented measures in the DRBD between 2015 and 2021 (see Table 1). Since efforts to restore the Danube and DRBD tributaries will have to continue in the future, the here presented examples should provide some inspiration for future measure implementation.

Of course, several additional measures are planned for the DRBD. While several fish passes and river restoration projects are currently in planning or in construction phase, there are also additional measures planned for the period 2021-2027. With 211 measures, a clear focus is given to continuity restoration. But also 50 morphological and 25 hydrological restoration projects are foreseen. Finally, the reconnection of 30,845 ha of wetlands/floodplains are planned until 2027. Further exchange on their planning and implementation, the best use of synergies and contribution to fulfilment of the WFD are encouraged in order to make the best use of available resources.

5. Projects related to hydromorphology and supported by the ICPDR

Beside implemented hydromorphological measures, important progress in the field of hydromorphology in the Danube River Basin was made through the implementation of different projects supported by the ICPDR, mainly the DanubeSediment project, the Danube Floodplain project and the MEASURES project (on restoring corridors for migratory fish species), which results are presented in the DRBMP Update 2021.

Additionally, also other important projects, supported by the ICPDR, were implemented, including projects Aquacross (hydromorphological restoration, mitigation and conservation), coopMDD (restoration of ecological connectivity), DANUBEparksCONNECTED and WILDislands initiative (Danube wild islands habitat corridor), DriDanube (management of drought related risks), FRAMWAT (small water retention measures) and MARS (managing of aquatic ecosystems) or are in implementation phase in the Danube River Basin, including projects Living Danube Partnership (rivers, floodplains and wetlands restoration), IDES (integrative floodplain management), LIFELINE MDD (restoration of ecological connectivity). Several of these projects like DriDanube, FRAMWAT, MARS or IDES are also of pollution relevance and supported and/or support ICPDR.

More information about the projects, including a short description and weblinks, can be found in the table below.

Name of the project	Duration	Aim/results of the project with particular relevance for HYMO activities/objectives	Web page
AQUACROSS: Knowledge, Assessment and Management for **AQUA**tic Biodiversity and Ecosystem Services a**CROSS** EU policies	2015-2019	An assessment of pressures on inland waters was performed identifying the extent of hydromorphological alterations, and specifically for the Danube River Basin a prioritisation of the river-floodplain systems along the navigable stretch of the Danube for hydromorphological restoration, mitigation and conservation was conducted. Therefore, a novel integrative modelling approach was developed that used different data sets (inlcuding hydromorphological assessments) and considered multiple targets related to biodiversity, ecosystem services and socio-economic benefits, in line with Ecosystem-based management.	https://aquacross.eu/
Coca Cola Living Danube Partnership	2014-2021	Regional partnership between WWF, COKE system and ICPDR covering river and floodplain,wetland restoration projects across six countries (Austria, Hungary, Croatia, Serbia, Romania and Bulgaria). The partnership is working closely with local stakeholders and relevant authorities to restore areas and connect river stretches or , inclfloodplains to the river system by opening dams, reconnect side-arms, installing water retention artefacts, improving water supply channels, forest habitats or creating open water surface. At the same time regional movement is being created for river, wetland conservation and restoration.	https://www.icpdr.org/main/publications/working-together-living-danube
coopMDD	2017-2019	In the frame of the coop MDD project, a Transboundary Management Programme for the future 5-country UNESCO Biosphere Reserve "Mura-Drava-Danube" (TBR MDD) was jointly developed. The “Guidelines for a dynamic river corridor” as one of the project outputs show which objectives need to be reached to protect and restore the dynamic river corridor for the rivers Mura, Drava and Danube, also with regard to “River management and engineering”.	https://www.wwf.at/de/coopmdd/
DANUBEparksCONNECTED: Bridging the Danube Protected Areas towards a Danube Habitat Corridor	2017-2019	Within DANUBEparksCONNECTED (funded by the Interreg Danube Transnational Programme), the Danube River Network of Protected Areas (DANUBEPARKS) implemented transnational measures to counteract habitat fragmentation, and to strengthen the Danube as ecological corridor. The WILDisland initiative has been launched: Based on a Danube-wide inventory of all islands, the conservation campaign for these “flagship sites of river dynamics” resulted in pilot river restoration measures. Additionally, project actions preserved and restored riparian soft wood forests, promoted coherent management of Danube dry habitats, and protected thousands of bird lives against collision at electric powerlines (DANUBE FREE SKY initiative).	www.danubeparks.org http://www.interreg-danube.eu/

Name of the project	Duration	Aim/results of the project with particular relevance for HYMO activities/objectives	Web page
DriDanube	2017-2019	The project aimed at increasing the society's resilience to the occurrence of drought in the Danube region by developing a regional drought monitoring tool[1] and a strategic document on improved national response to drought[2]. The project results with particular relevance for HYMO activities/objectives is the drought monitoring tool "Drought Watch", developed for better drought characterisation and early warning over the region by allowing a spatial and temporal view of the state of soil moisture and vegetation through various drought-related datasets at regional and national level. The tool integrates also the results of the project-established "National Reporting Networks" in 10 Danube basin countries, which gather weekly observations on the state of soil and plants, and this way help deliver early awareness of drought damage in place. The other product of this project, also integrated into Drought Watch, are informative cross-border comparable maps of drought risk in the Danube region, prepared both in climatological sense and in relation to expected yield loss. They allow to recognise the areas prone to rainfall deficit or considerable crop losses.	http://www.interreg-danube.eu/approved-projects/dridanube [1] https://droughtwatch.eu/ [2] http://www.interreg-danube.eu/uploads/media/approved_project_out put/0001/38/0363f7bdde74184f0f372bc04744650d46445c49.pdf
FramWat: **Fram**ework for improving water balance and nutrient mitigation by applying small **wat**er retention measures	2017-2020	The main aim of the FramWat project was to support and boost knowledge on more systematic approaches towards the application of N(S)WRM in river basins. One of the main tools developed within the project is FroGIS – GIS based tool to analyse the needs and possibilities of water retention. The rest of the tools and outputs developed within the project, best practices from participating countries, and practical recommendations from pilot catchments are collected into 5-step process of N(S)WRM planning and presented in the Practical Guidelines on Planning Small Water Retention in River Basins. Addition to the Guidelines is the Decision Support System, created for people involved in planning water retention measures. The goal of the application is to familiarise the user with the catalogue of N(S)WRM and the planning process, as well as to survey their preferences for their area of interest.	www.interreg-central.eu/FramWat http://WaterRetention.sggw.pl https://www.interreg-central.eu/Content.Node/DT353-Guidelines.pdf https://planning.waterretention.sggw.pl/
IDES: **I**mproving water quality in the **D**anube river and its tributaries by integrative floodplain management based on **E**cosystem **S**ervices	2020-2022	IDES aims to identify the retention potential of floodplains by applying the model MONERIS and to integrate multiple interests along the river to accelerate the joint implementation of a sustainable water quality management along the Danube. The new IDES tool will help to derive optimized, nature-based solutions by assessing all relevant ecosystem services in an unbiased way, their trade-offs and synergies. Based on the results of Danube wide assessment and in pilot areas, national action	http://www.interreg-danube.eu/ides

Name of the project	Duration	Aim/results of the project with particular relevance for HYMO activities/objectives	Web page
		plans with prioritized areas and a joint strategy for improving water quality at transnational level will be developed regarding the Danube river basin management plan and targets of PA4 and PA6 of the EUSDR.	
lifelineMDD	2020-2022	The project lifelineMDD addresses the issue of an insufficient knowledge base and unused synergies within the transboundary MDD river corridor with a cross-sectoral partnership that aims to improve connectivity and biodiversity. The development of a strategic integrated approach to river restoration will be based on scientific studies of bio-indicators (fish and river birds) and abiotic framework conditions (sediment transport and climate change). A cross-sectoral learning process between nature protection and water management authorities based on pilot restoration actions will raise institutional competences and cooperation between key stakeholders.	http://www.interreg-danube.eu/approved-projects/lifelinemdd http://www.amazon-of-europe.com/en/lifelinemdd/ https://www.wwf.at/de/lifeline-mdd/
MARS: **M**anaging **A**quatic ecosystems and water **R**esources under multiple **S**tress	2014-2018	Aim/results of the project with particular relevance for HYMO activities/objectives (2-3 sentences): MARS has analysed data from various spatial scales, i.e. local water body, single river basin and European scale, in order to better understand and disentangle complex interactions between pressures (including HYMO), resulting stressors and their effects on aquatic biota. Multi-stressor situations require knowledge on the relative importance of different stressors (stressor hierarchy, including dominating stressors) and their impacts in order to find the best combination of mitigation or restoration measures. MARS therefore has generated a general framework supported by MARS tools for tackling multi-stressor conditions in River Basin Management and to select appropriate management strategies concerning the level and type of necessary mitigation measures, which are described in the MARS Recommendations document.	http://www.mars-project.eu https://freshwaterblog.net