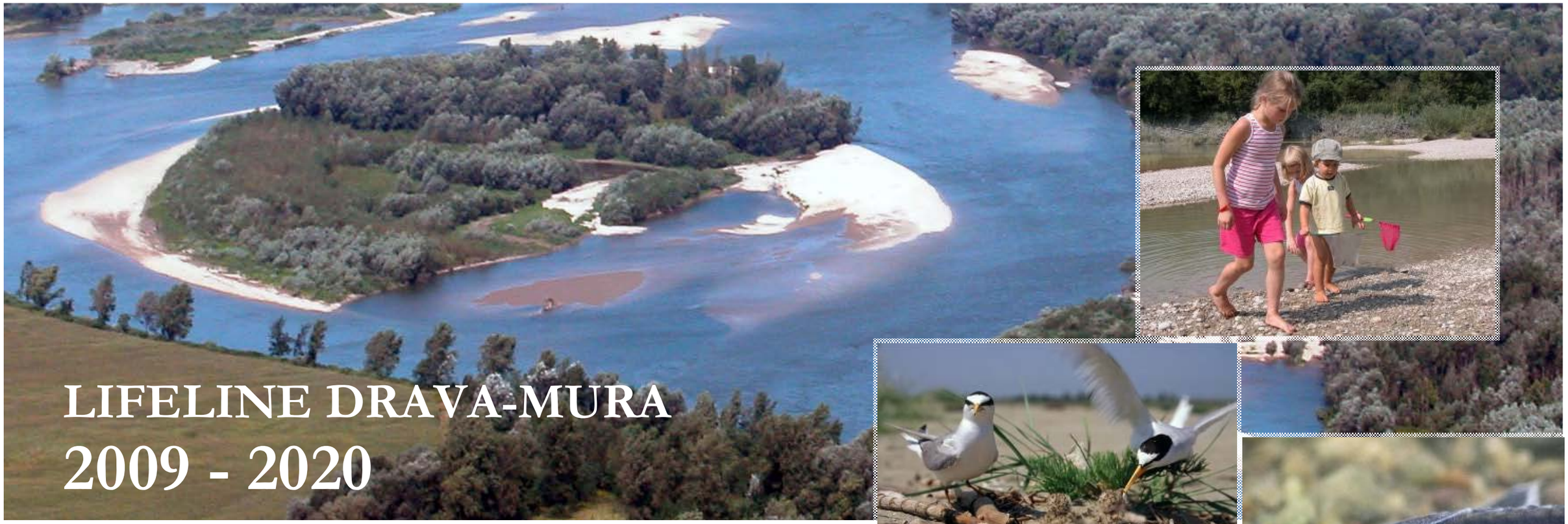

LIFELINE DRAVA-MURA
2009 - 2020

A Plan for Conserving and Restoring the Drava and Mura Rivers for Nature and People

WWF for a living planet®

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Drava River, children (Credit: A. Mohl/WWF), Sturgeon (Credit: D.Kaltenegger/4nature), Little Tern (Credit: Roberto Sauli/www.ilsalesullacoda.it)

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Executive summary

Spanning Austria, Croatia, Hungary, Serbia and Slovenia, the lower courses of the Drava and Mura Rivers are among Europe's most ecologically important riverine areas.

Once "protected" under the "Iron Curtain" during the Cold War, this trans-boundary river system (including related sections of the Danube River) now forms a 600 km long "green belt" connecting more than 400,000 ha of highly valuable natural and cultural landscapes.

The area is a hot spot of natural habitats that are rare in Europe such as large floodplain forests, river islands, gravel banks and oxbows. It is home to the highest density of White-tailed Eagles in the Danube River Basin and hosts endangered species such as little tern, otter and sturgeons.

Moreover, the river ecosystem is the major source for quality water, for natural flood protection and fisheries as well as an important area for recreation.

Over 40 protected areas along the rivers underline their ecological values. Most recently Croatia has declared about 145,000 ha of the Danube, Drava and Mura area as a future Regional Park.

However, the riverine landscape has seen many changes and human impacts. Channelling of the natural river courses, extraction of gravel and sand from the riverbed and hydropower dams are having a major impact on its ecological integrity, biodiversity values and natural resources.

In order to better preserve the trans-boundary ecosystem over the long term, innovative conservation and management efforts are needed.

An international NGO network – with members including WWF, EuroNatur, Drava League, Green Action, Croatian Society for the Protection of Birds and Nature, Green Osijek, ZEO Nobilis, ZEUS, Drava Federation and DOPPS-Birdlife Slovenia - has taken up this challenge and is working towards the establishment of a Trans-Boundary UNESCO Biosphere Reserve "Danube-Drava-Mura" (TBR "DDM").

The protection of the area as a TBR is one of Europe's most ambitious and exciting nature conservation projects, covering an overall area of more than 400,000 ha and spanning current and future EU members. The plan for a TBR is already highly developed in Croatia and Hungary.

Once established it will be Europe's largest single river protected area, providing a strong framework for protection and ecological management of the area's unique natural values and forming a catalyst for sustainable development in the region.

It would form a crucial part of the "European Green Belt" proposed by the World Conservation Union (IUCN), which aims to create an ecological network along the former Iron Curtain from the Barents to the Black Sea.

The central management goal of a TBR should be to halt any further degradation of the riverine landscape and to begin the improvement of the natural river dynamics. This will be achieved through implementing a trans-boundary "River Restoration Programme" (RRP) for the Lower Drava and Mura.

This brochure attempts to provide the perspective for such a RRP by highlighting the restoration potential of eight selected areas along the rivers.

Passive management measures are proposed which will prevent further damage to the river landscape. Important steps in achieving this include to ban further river regulation and sediment extraction activities as well as to prevent further impacts from hydropower dams.

Active restoration measures are recommended which include the removal of river training structures in order to promote the self-restoration processes of the rivers.

River restoration and ecological river management have the benefit of promoting and improving:

- habitats and species populations
- flood protection
- groundwater conditions
- drinking water
- water quality
- fish populations
- sustainable forestry
- eco-tourism and recreation

River restoration and ecological river management also are essential steps necessary for achieving compliance with the requirements of the EU Water Framework Directive, Flood Directive and Habitats and Birds Directives.

Vision

The long term vision for the Lower Drava and Mura Rivers is to have fully wild rivers over a large area and to secure their health and productivity for all time. The aim is to ensure a variety of river dynamics, natural habitats and species while also producing greater benefits in natural goods and services for local people.

This should be achieved through the establishment of trans-boundary protection and ecological management of the riverine area as well as the restoration of degraded river stretches and floodplain areas.

Natural Drava River course in Croatia (Credit: B. Stumberger)

River restoration and ecological river management would have multiple benefits including biodiversity protection, natural flood protection, water quality improvement, forestry and fisheries.

A Trans-Boundary UNESCO Biosphere Reserve (TBR "DDM") is proposed to provide the international framework for the conservation and management of the area.

This would span five countries, including current and future EU members Austria, Croatia, Hungary, Serbia and Slovenia.

Once established the TBR "DDM" would be:

➔ "Europe's Largest River Protection Area" with an overall size of more than 400,000 ha

➔ The World's first Biosphere Reserve, that is commonly shared and managed across five countries

➔ A backbone for regional cooperation, international understanding and peace keeping along the former "Iron Curtain"

Living Drava – Space for children (Credit: Revital)

The Living Drava and Mura need space –
For humans
For nature
For life

Table of contents:

1. Drava and Mura Rivers: Ecological values, international importance and protection status

1.1. Ecological values and international importance

The Drava has a length of 750 km and the Mura, its most important tributary, is 420 km long. These rivers spring in the Alpine mountains at 3,500 m a.s.l. with the Drava joining the Danube on the edge of the Pannonian lowland at 80 m a.s.l.. Together the rivers drain an area of 48,000 km² shared by Austria, Croatia, Hungary, Italy and Slovenia. With an average discharge of 550 m³/s at its mouth the Drava is one of the most important tributaries of the Danube.

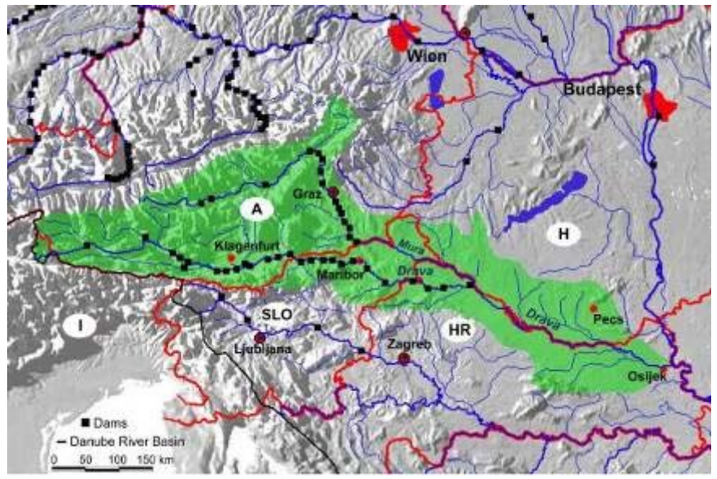


Fig. 1: The Drava-Mura basin (Credit: Schwarz/FLUVIUS).

The lower courses of the Drava and Mura Rivers, spanning Austria, Croatia, Hungary, Serbia and Slovenia, are among Europe's most ecologically important riverine areas. They are extraordinary in having a 380 km long stretch that remains free-flowing without any dams retaining the unity of an original riverine landscape. Adjacent stretches of the middle Danube in excellent condition bring this figure to almost 600 river kilometres. The well preserved alluvial wetlands along the Danube in the trilateral area between Croatia, Hungary and Serbia include the famous Nature Park "Kopački Rit". This area covers about 23,000 ha of swampy softwood floodplain with shallow and very dynamic floodplain lakes (compare fig.40 in the chapter 3 "future perspectives") (WWF 1999).

Fig. 2: More than 100 pairs of White-tailed Eagles breed along the Danube-Drava-Mura river system (Credit: M. Romulic/ www.romulic.com).

The river system connects more than 400,000 ha of landscapes with extremely high natural and cultural values and an amazing biological diversity.

Fig. 3: Natural stretch of the Mura along the border between Croatia and Slovenia (Credit: A. Mohl/WWF).

The area hosts the best examples of rare natural habitats such as large softwood forests, wet meadows, natural islands, gravel and sand banks, steep banks, side branches and oxbows.

The hydrological dynamics of both rivers, its active erosion and sedimentation, combined with periodic flooding of the riverine areas of different duration, level and frequency, have determined the formation of the landscape, their unique vegetation and rich biological diversity. Excellent hydromorphological conditions can be found on shorter stretches along the Lower Mura, downstream of the Mura confluence in the Drava and along the Lower Drava (Schwarz 2007, compare figure 4). In total over 60% of the Lower Drava and Mura falls at least into the "good" hydromorphological assessment class (for the upper catchment including Austria this good classification can be estimated for only some 20% of the river courses).

Fig. 4: Hydromorphological assessment of the Drava and Mura Rivers: Blue and green colours indicate still highly valuable river stretches (Schwarz 2007).

The river system and its surrounding habitats host threatened plant and animal species of national, European and Global importance. An estimated 5,000 different animal (including all insects) and over 600 different plant species alone in the Danube-Drava National Park in Hungary

illustrates its great value for species protection and gene pool preservation. For some species, the riverine landscape constitutes one of their main or only habitats: for example more than 100 breeding pairs of the White-tailed Eagle (*Haliaaetus albicilla*) live here - which make up to 40% of the population across the entire Danube basin population (compare fig. 5) (Schneider-Jacoby et al. 2003).

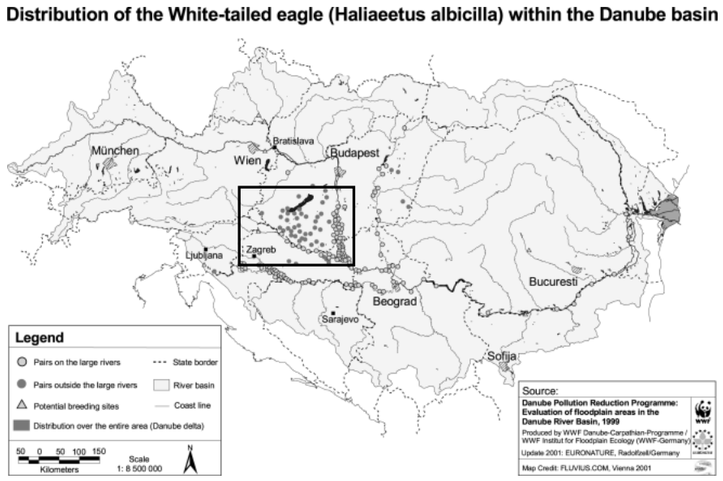


Fig. 5: Distribution of the White-tailed Eagle within the Danube River Basin. Note the concentration along the Danube-Drava-Mura river system (Credit: WWF/EuroNatur).

The Drava with its natural river banks is one of the best breeding spots in the Danube basin for birds depending on these structures such as the Sand Martin *(Riparia riparia)* with about 14.000 pairs (fig. 6 and 7), or for the Bee-eater *(Merops apiaster)* with about 2.000 pairs.

Fig. 6: The Sand Martin, a typical inhabitant of steep natural river banks (Credit: H. Kretschmer/ 4nature).

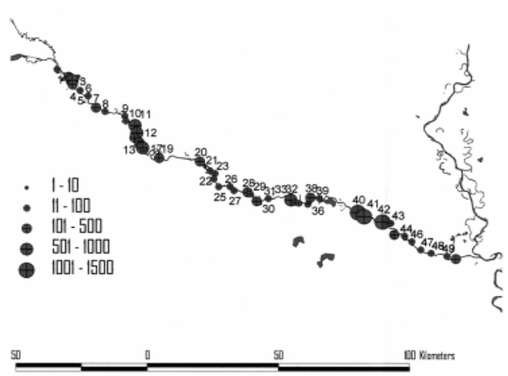


Fig. 7: Colonies of the Sand Martin and Bee-eater indicate intact river dynamic along the Drava (Credit: WWF/EuroNatur).

The gravel and sand banks of the Drava River provide one of the last breeding grounds for the Little Tern (*Sterna albifrons*) in inland Europe (Mohl 2001, Reeder et al. 2006).

Fig. 8: One of the last river populations of the Little Tern in Europe can be found on the gravel and sand banks along the Drava between Croatia and Hungary (Credit: S. Steiger).

Other species include the Common Tern (*Sterna hirundo*), the Common Sandpiper (*Actitis hypoleucos*) and the Little Ringed Plover (*Charadrius dubius*). Furthermore, the Black Stork (*Ciconia nigra*), the Ferruginous Duck (*Aythia nyrocia*) and the Otter *(Lutra lutra)* find an important habitat in the area. The Drava region is one of the major areas for wintering birds in Europe with about 250,000 birds using the region during their migrations.

The river system hosts more than 50 fish species amongst them the sturgeon. Endangered plant species include the German Tamarisk *(Myricaria germanica)* which needs open gravel and sand banks.

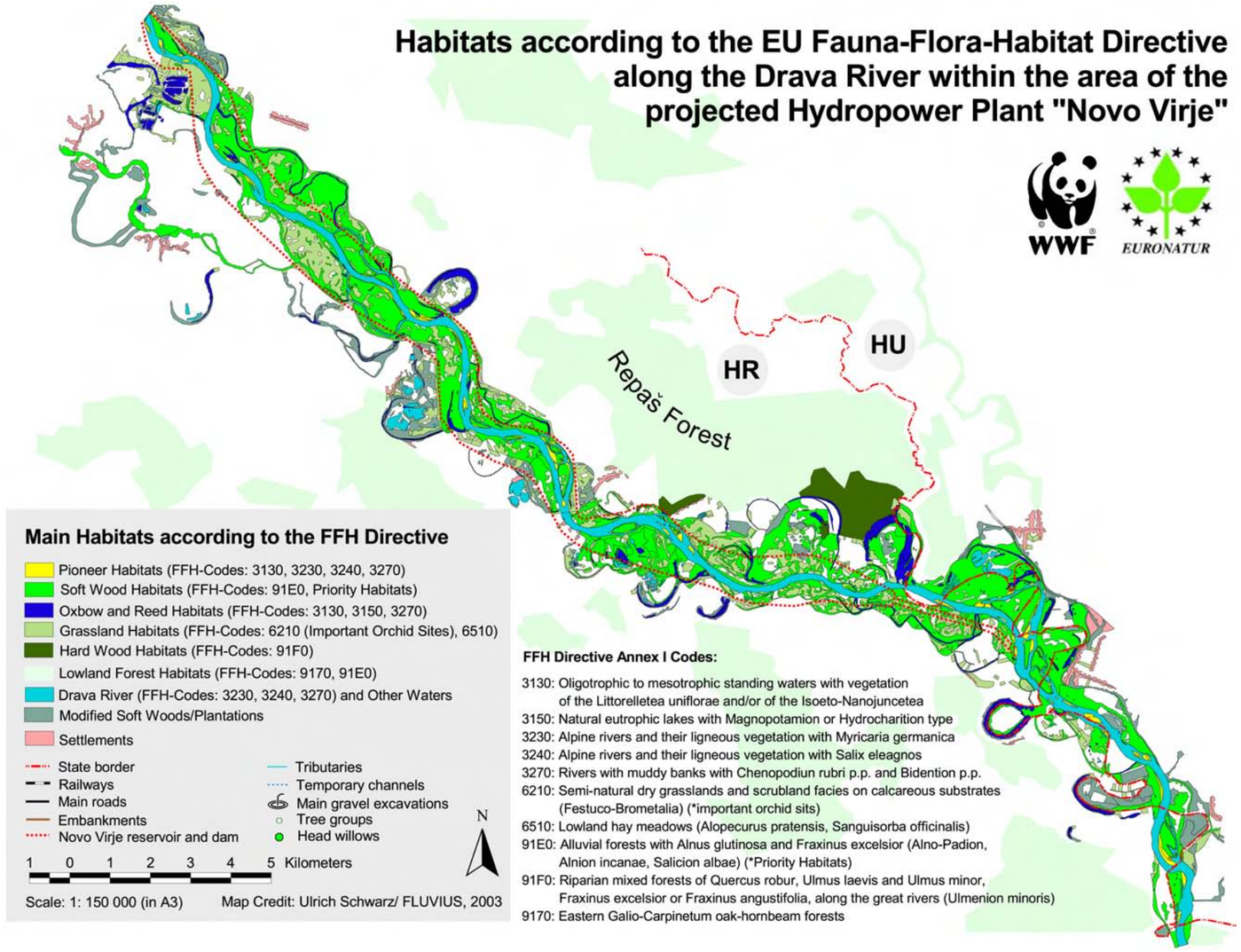
Fig. 9: The Drava River is the only area for the German Tamarisk in Croatia (Credit: U. Schwarz/ FLUVIUS).

1.2 Protection Status

The ecological importance of the Drava-Mura and Danube areas are reflected in the declaration of more than 40 protected areas on national level such as the Danube-Drava National Park in Hungary, the Nature Park "Kopački Rit" in Croatia and the Gornje Podunavlje Nature Reserve in Serbia. In February 2008 the Croatian Government has given preliminary protection to the Drava and Mura and related areas of the Danube as a Regional Park, covering 145,000 ha of valuable natural and cultural landscape (compare fig. 42 in the chapter 3 "future perspectives").

The natural values of the river system satisfy the criteria to be recognised and protected under international conventions such as *Ramsar*, *Bern* and *Bonn* as well as EU environmental legislation, the Habitats and Birds Directives, and as part of the European wide Natura 2000 network. Natura 2000 sites have already been established in Austria, Slovenia and Hungary and are planned in Croatia.

Fig. 10: Habitats according to Annex II of the EU Habitats Directive along the Drava between Botovo and Ferdinandovac (Credit: WWF/EuroNatur 2005).



Within a 30 km long river stretch of the Drava downstream of the Mura confluence over 50 main types and combinations of habitats (EUNIS classification) have been described. This diversity is as high as many national parks in the area and is comparable with the Bulgarian Danube Islands on the Lower Danube.

Beside biodiversity conservation the riverine system also offers multiple benefits including flood protection, water purification, nutrient reduction, groundwater recharge and drinking water supply, sustainable forestry, fisheries, recreation and ecotourism (Schneider-Jacoby 2002).
An assessment study on the effects of Natura 2000 on the Mura between Austria and Slovenia has shown the high importance of the natural resources of the floodplain area for the socio-economic well being of this region. The natural resources in the area help to minimise expenditure e.g. on water purification and supply, irrigation and flood prevention systems. Natura 2000 on the Border Mura also attracts public funding for the region and has middle- to long-term positive economic benefits for quality tourism and agriculture (WWF 2002a).

Fig. 11: River mill: Economic benefits from sustainable tourism along the Mura (Credit: Ecology in progress)

The monetary value of the riverine landscape can also be considerable. According to a calculation of the Faculty of Forestry in Zagreb, the value of the Koprivnica-Đurđevac lowland forests, including the important Repaš forest (4,000 ha of typical Slavonian oak lowland forest) which is directly depending on the riverine dynamic groundwater of the Drava in Croatia, is about € 900 Million. It includes the beneficial functions of the river and the raw material and energetic function (without subsidiary forest products such as hunting, fruits, mushrooms, medicinal herbs and others). Other forest functions (carbon dioxide absorption, water and air cleaning, the positive influence of forests on climate, have not been included in this calculation (Pripić 2001).

Fig. 12: The natural Drava River provides space for fun and recreation (Credit: A. Mohl/WWF)

2. Historical state, pressures and impacts on the Drava-Mura Rivers

2.1. Historical state

Up to the end of the 18th century, the Lower Drava and Mura Rivers were free flowing wild rivers. Maps, pictures and travel reports from that time show a dynamic river landscape. The rivers were characterized by braided and meandering river reaches with extended riverine habitats such as gravel and sand banks, steep banks, oxbows, woodlands, pastures and meadows (see fig. 3 and 14).

This natural river system was fairly wide, not too deep, and characterised by unstable banks. Large-scale floods occurred at regular intervals. The location and shape of gravel and sand banks, islands and river branches used to change continuously. The rivers would regulate themselves through this state of dynamic balance.
The only significant changes came from landuse in the catchment, through deforestation in upper catchments which increased the sediment load. Also the usage of floodplain areas as source for wood and fish or as pastures led to a reduction of riparian forests.

Fig. 13: River stretch at Varaždin with high hydromorphologcial dynamic and floodplain forests, building several side channels and large pioneer habitats on gravel banks, CORONA satellite data 1968 (Credit: WWF)

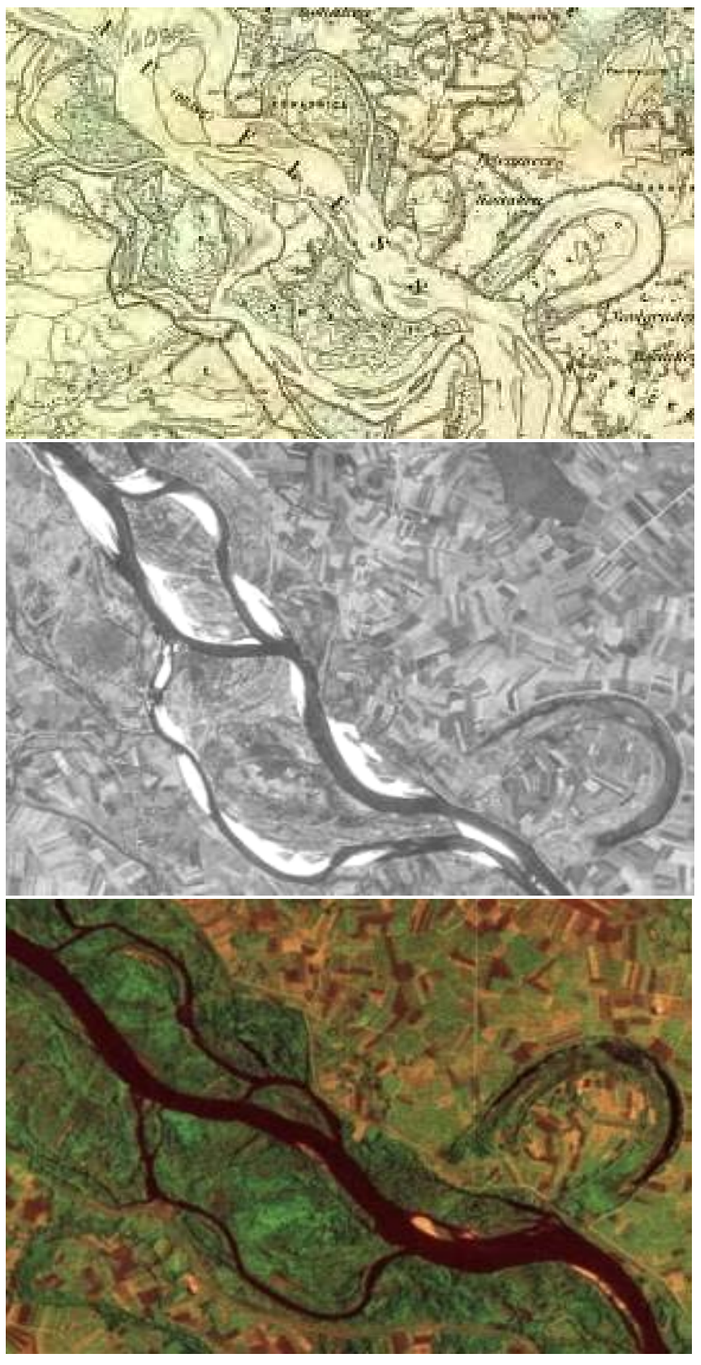


Fig. 14: Time series of a Drava River course at Jeskovo/ Croatia 1879, 1965, 1992) (Credit: WWF/EuroNatur)

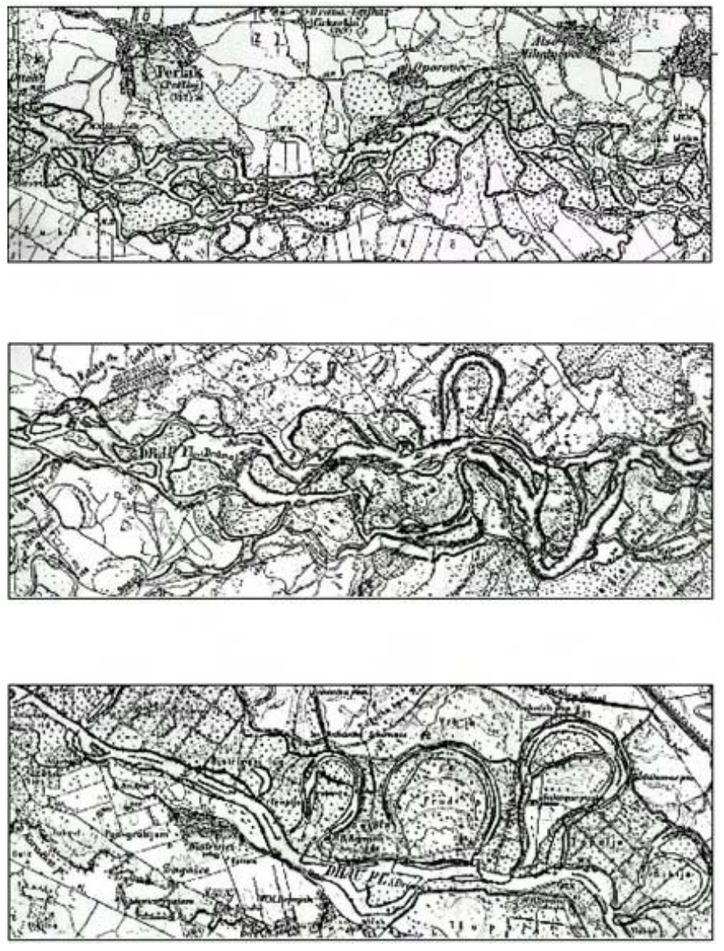


Fig. 15: The first map shows the braided river type near Varazdin, the second map shows the transition towards the meandering type downstream of the Mura confluence and the third map shows the already altered lower meandering river reach (all maps are from Austrian 3rd Landesaufnahme 1879-1902 1:75,000).

The analysis of morphological "reference conditions" such as the width-depth variability, the sinuosity (degree of meandering), substrate and habitat distribution should be based on historical data (in particularly maps), but also species lists and comparative studies with still intact river systems (compare Schwarz 2007). Those reference conditions are important for the proposal of restoration sites.

2.2. Pressures and impacts

The ecological values of the free-flowing Lower Drava and Mura Rivers in Croatia, Hungary and Slovenia are faced with considerable degradation, which results from various types of anthropogenic activities: river bed regulation, excessive gravel and sand extraction from the river bed, construction of flood protection dykes and hydropower dams in the upstream sections.

Though river bed degradation and river bed deepening along the free-flowing stretches has its origin in all types of activities, past and ongoing river regulation and sediment extraction activities has considerably multiplied and accelerated the impacts of the hydropower dams which are situated in the upstream sections (compare Biondic 1999).

River regulation

As similar to almost all northern and eastern Alpine rivers the Lower Drava and Mura were subject of different river regulation epochs and hydropower dam construction periods. In particularly the so called high and mean water regulation in the 19th and 20th centuries can be mentioned as the most significant impact on the river system.

The very early regulation works in the 17th century were mostly aimed for local flood protection by the building of small flood protection dikes close to settlements. Dike construction for protection of arable land and settlements started systematically in the second half of the 20th century. In this way about 70% of the former morphological floodplain within the natural lower terraces has been disconnected from the river and natural flooding regime. Whereas high water regulation has reduced the natural inundation areas, mean water regulation has considerably altered the natural river courses.

In the 18th and 19th century the mean water regulation (in particularly by cutting meander reaches) along the Lower Drava was mostly forced by the waterway transport (K&K Donaudampfschifffahrtsgesellschaft) but also by the drainage of agricultural land. Between 1784 to 1848 62 curves were cut and the river downstream of Barcs was shortened by about 40% of its natural length (see figure 17).

The typical sequence of meanders with point bars and steep banks (compare cover picture in right lower corner) disappeared over most of the reach and the degradation of the sandy river bed increased due to the concentration and the higher velocity of the flow in the straightened channel.

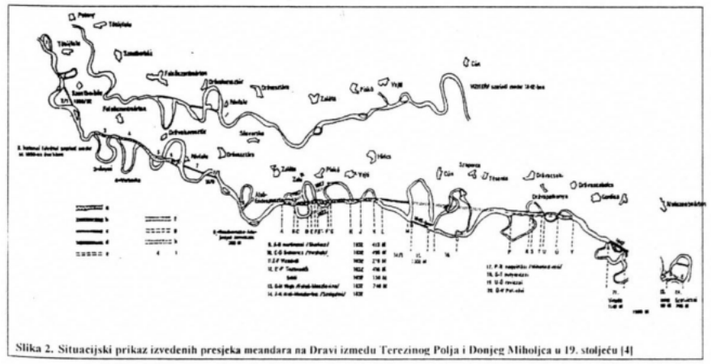


Fig. 16: Significant shortening of the Lower Drava since 1830 (after Bognar 1990).

In the 20th century the river bed degradation has increased considerably along the entire lower course of the Drava due to past impacts of regulation works and continued straightening of the rivers and the fixing of the natural banks with stones (bank reinforcement with rip-rap).

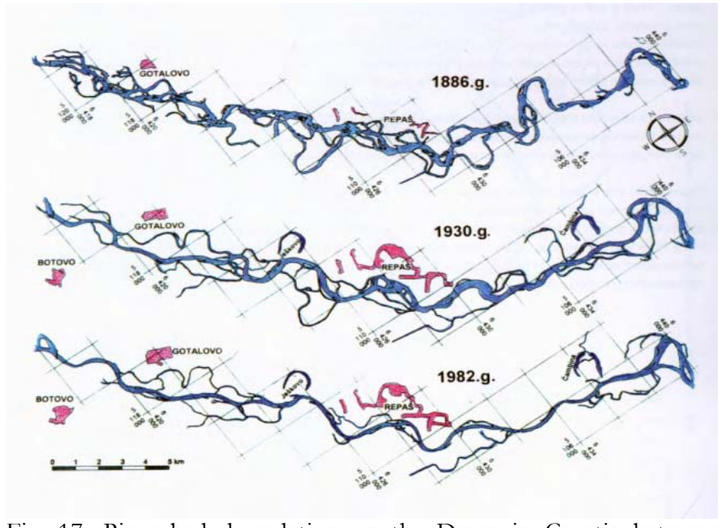


Fig. 17: River bed degradation on the Drava in Croatia between Botovo and Ferdinandovac in the last 120 years (Credit: Hrvatska Elektroprivreda 2000).

Gravel and sand banks as well natural steep river banks which one the most important dynamic river habitats, have been reduced to a large extend (see fig. 18 and 19).

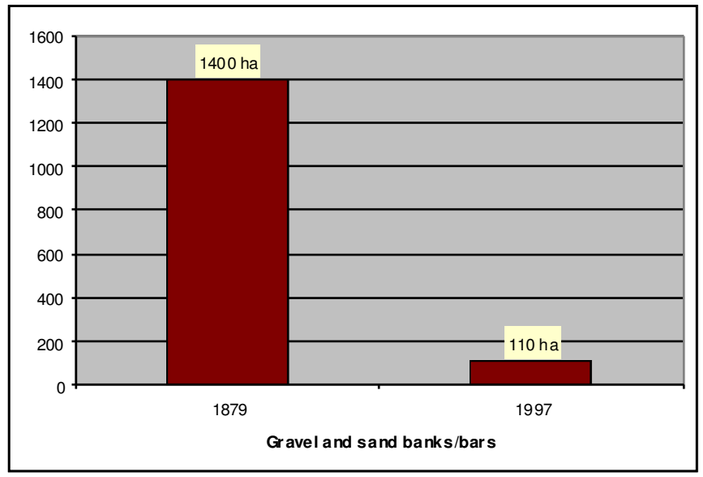


Fig. 18: Reduction of sand banks/bars in ha along the Drava (Botovo-Ferdinandovac) in the last 100 years (Credit: Mohl/Schwarz 1998).

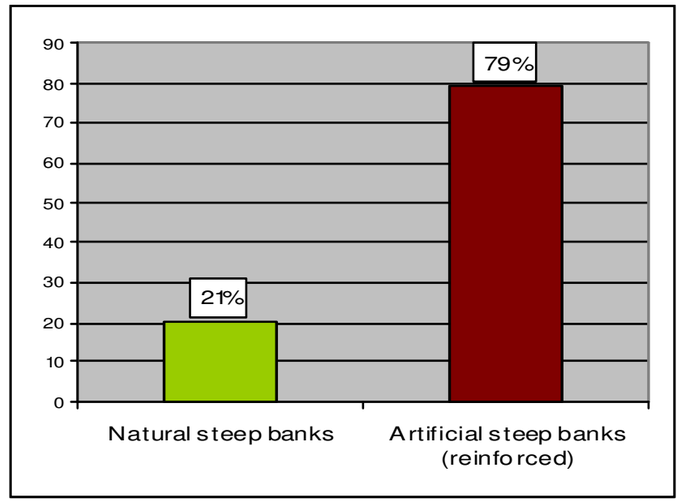


Fig. 19: Reduction of natural steep banks in % along the Drava and Mura (selected banks, Murska Središće-Osijek 2005) (Credit: WWF/EuroNatur)

In the second half of the 20th century, the Lower Drava and Mura Rivers along the Croatian-Hungarian border were well preserved for more than 40 years as part of the former "Iron Curtain". Only minor river regulation activities have taken place. However, after the political changes in the beginning of the nineteen nineties last century Croatia and Hungary has resumed the regulation of natural river stretches and the reinforcement of river banks in ecologically sensitive areas.

These activities last until today and the old principles of the Croatian-Hungarian water management strategy for the Drava from the 1980ties are still applied along the entire river. Its main aim is to create and maintain a uniform canalised river corridor free of side arms, gravel and sand banks and river islands with following width:

110 m width from Varaždin to Legrad
160 m width from Legrad to Barcs
170 m width from Barcs to Dravaszabolcs
180 m width from Dravaszabolcs to Osijek
220 m width downstream Osijek

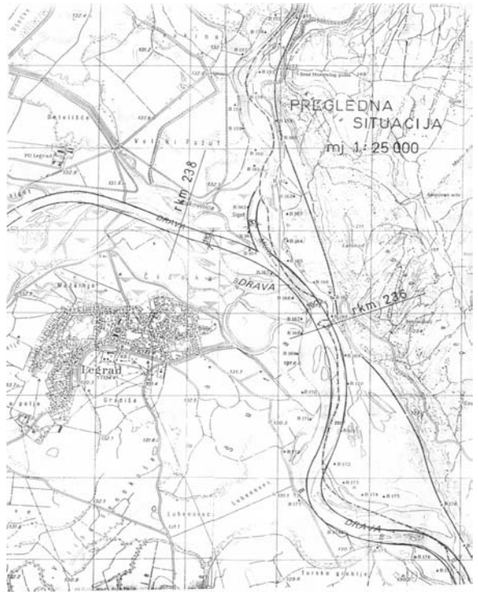


Fig. 20: Planned regulation of the natural riverbed of the Drava with a width of 160 m at the Mura confluence (Credit: Schneider-Jacoby 2005).

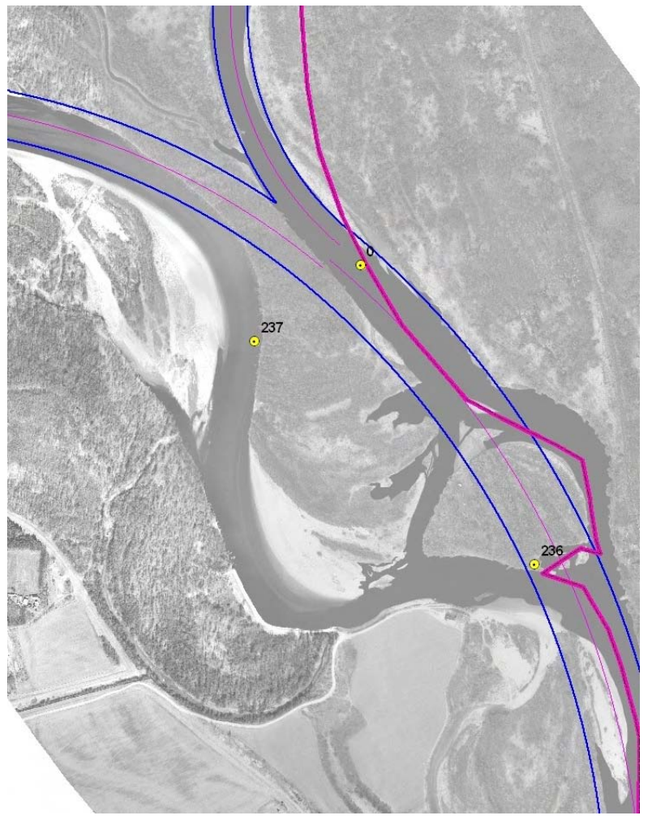


Fig. 21: In detail: Planned regulation of the natural confluence of the Mura into the Drava within the Special Zoological Reserve „Veliki Pažut" and the preliminary declared Croatian Regional Park "Drava-Mura"; blue line = regulation line (Credit: Croatian Waters 2008)

Fig. 22: Status and "Anti-Vision" in case of confluence rectification

As a consequence many natural river stretches along the Lower Drava such as between Legrad and Barcs have been destroyed. Valuable breeding areas for endangered bird species such as the Little Tern, Common Tern and Sand Martin have been lost or reduced significantly.

In 2008 a massive river regulation plan was issued by the Croatian Ministry responsible for Water Management aiming at regulating 56 km natural Drava river course at Osijek. This stretch had in fact experienced a unique self-restoration process in the last 100 years (see fig. 47 in chapter 5).

Fig. 23: Destruction of a natural river bank with a colony of Sand Martin at Sigetec/Croatia in 2007(Credit: A. Mohl/WWF)

Fig. 24: River regulation on the Drava at Repaš/Croatia in 2003 (Credit: A. Mohl/WWF)

The enhancement of navigation along this stretch with channel stabilisation and dredging measures endangers the richness of this intact lowland river ecosystem. Officially the Drava is navigable up to about rkm 180 near Ferdinandovac including all core zones of the Hungarian National Park which is also a Natura 2000 site. The river should be usable for ECE class I, II. Only the lower part from Osijek to Belišće falls into class III and from Osijek to the Danube in class IV. All those classes require specific depths, width and minimum radius which contradict the natural river course development (even the first two classes require regular maintenance, in particularly dredging). With a lack of industrial areas along the Drava the usage for navigation is strongly limited and questionable in particular upstream of Osijek.

In most cases the regulation works are being done without any appropriate environmental impact assessment. The studies are poor and are not meeting EU standards.

River regulation as well as sediment extraction along the free-flowing stretches in Croatia and Hungary has accelerated the river bed degradation and the deepening process and thus has considerably multiplied the impacts of hydropower dams.

Hydropower dam construction

A chain of 50 hydropower dams - 22 on the Drava and 28 on the Mura - has been established along the upper and middle courses of the Drava and Mura Rivers (see fig. 1 and 25-27) in Austria, Croatia and Slovenia.

Place	Power house	Year	Reservoir area removing natural river landscape
Maribor	Zlatolice (SI)	1969	< 1 km²
Ptuj	Formin (SI)	1981	4,2 km²
Ormož	Varaždin (SI/ HR)	1975	3,0 km²
Varaždin	Čakovec (HR)	1982	10,5 km²
Dubrava	Dubrava (HR)	1989	16 km²

Fig. 25: The hydropower dams in Slovenia and Croatia downstream from Maribor (Credit: WWF/EuroNatur)

Concrete plans for dams along the still free flowing lower courses of the rivers in Slovenia, Croatia and Hungary have existed since the 1960s. The last dam to date on the Drava River was finalised by former Yugoslavia in 1989, at Donja Dubrava, a few kilometres above the confluence of the Mura into the Drava close to the border to Hungary. The natural river course and its braided section have been completely changed into a series of five barrages and abstraction canals.

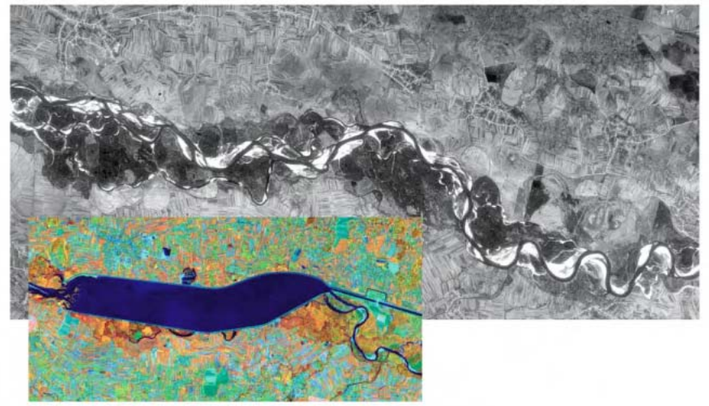


Fig. 26: Drava near Prelog before (1968) and after the construction (1989) of the hydropower dam "Donja Dubrava" (Credit: WWF).

Fig. 27: Typical situation of a diversion dam system on the Drava at Varaždin: The Dam reservoir covering the whole former riverine landscape; bypass canal to the power house (energy production) on the right side and release channel for flood situations on left side (Credit: WWF)

The political changes in 1989, after the fall of the "Iron Curtain", influenced the decision between former Yugoslavia and Hungary to build further dams on the Drava along their border section. The new government in Hungary decided to preserve the river and the natural resources as

drinking water reserve and natural areas. Although the law to create the Danube-Drava National Park passed Hungarian parliament in 1991 and the Park was established in 1996, Croatia, as the successor of Yugoslavia, continued to propose to build further dams, in particular the largest dam at Novo Virje. A trans-boundary environment impact assessment under the ESPOO Convention was conducted of this dam in 2000. The Hungarian government opposed the Novo Virje project. Finally in 2007 the Croatian Government decided against the dam project.

The last dam on the Mura was built at Spielfeld in Austria close to the border to Slovenia in the 1980s. However, in 2006 the Slovenian government has resumed earlier plans and has proposed further dams on Natura 2000 list areas of the Mura River including the border section with Austria.

Today the impacts of the existing chain of hydropower dams on the Drava and Mura in Austria, Croatia and Slovenia on the free flowing lower stretches of both rivers are everywhere evident with regards to changes in hydrology (hydropeaking, altered discharge regime) and morphology (river bed degradation and channel incision).

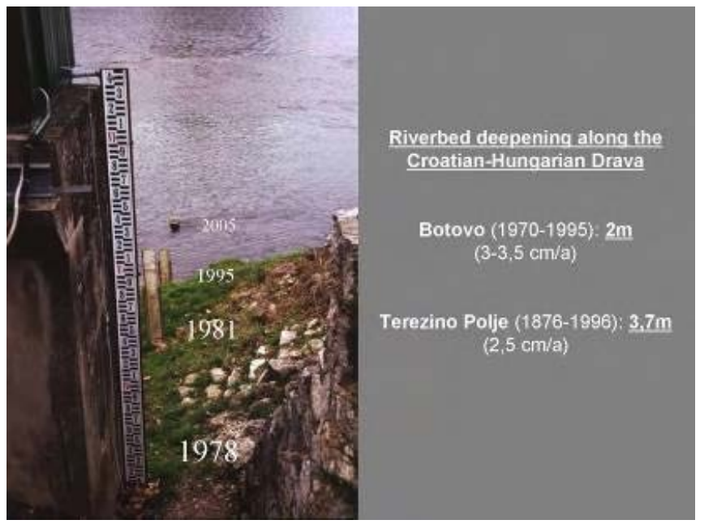


Fig. 28: The progression of new water level markers shows local river bed incision rates (Credit: B. Stumberger, Hrvatska Elektroprivreda 2000).

The free flowing river stretch of the Drava downstream of the last dam at Donja Dubrava in Croatia is suffering severe river bed erosion due to a much reduced load of sediments. The total amount of sediment transport has decreased significantly since 1975 by about 50%. The bed incision related to the low water stage is up to 3,5 cm/year. The groundwater table lowering within 120 years is up to 370 cm (Hrvatska Elektroprivreda 2000).

The channel incision mainly leads to the degradation of the natural river bed (unification of river course and loss of valuable habitats as gravel and sand banks, side arms) and to the lowering of adjacent groundwater tables with the degradation of floodplain areas (drying out of floodplain habitats such as forests, meadows and oxbows and loss of typical riparian species, raising floodplain levels due to fine sedimentation during floods). This in turn affects terrestrial vegetation structures and species compositions.

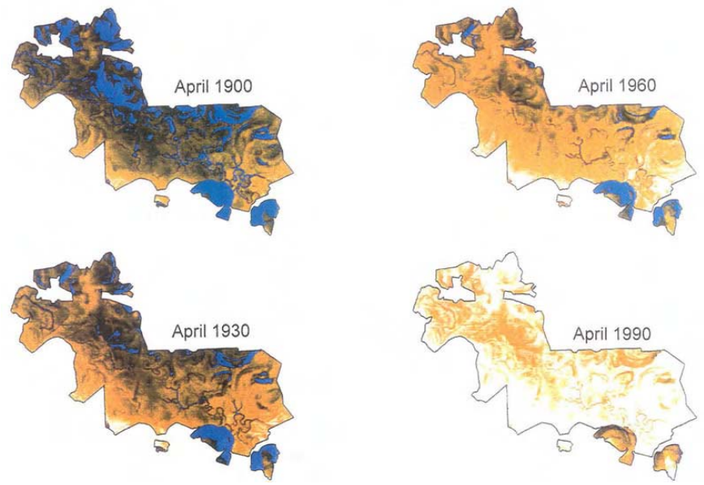


Fig. 29: Changed groundwater conditions in the 4,000 ha large lowland Repaš forest in Croatia between Botovo and Ferdinandovac in the last 100 years strongly correlates with river bed degradation of the Drava between Botovo and Ferdinandovac, stretching from blue and brown colour scale: from 0 m and less (surface water) in blue and dark brown to 3 m and more (out of the rooting zone) in light brown and orange (Credit: Hrvatska Elektroprivreda 2000).

Furthermore, the economic value of important lowland forest areas along the Drava River in the Podravina region has been affected. The 4000 ha large Repaš forest with Penincula oak, is highly impacted due to changed natural river bed and groundwater conditions (see chapter "ecological values").

In addition to the bed-load deficit, the hydrological and flooding regime along the Lower Drava between Croatia and Hungary has changed. In particular the amplitude and frequency of small flood events (1-5 year annual flood) decreased (evaluation of discharge data from 1970-2000). The water retention in the reservoirs upstream on the Drava River reduces the discharge peaks (high – with the exception of catastrophic floods - and low water situation). The last two Slovenian and the last three large Croatian power plants work in peak energy mode (see fig. 25). As a consequence the water level on the Lower Drava changes sometimes several times a day by between 0,6 –1,8 m. Also the unregulated discharge of Mura and flow retention in side channels downstream of the Mura confluence cannot greatly reduce the level fluctuations (compare also 14). The daily water oscillation by hydropeaking is evident more than 200 km downstream (Barcs up to 80 cm, few cm in Osijek close to the Drava mouth). In general the most natural parts of this stretch buffer the ecological impact due to reduced and retarded increase and decrease of water levels.

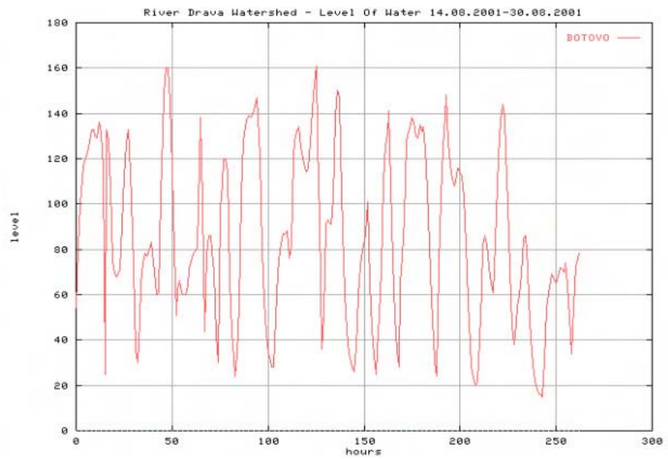


Fig. 30: Daily water level fluctuations in the Drava downstream of the Dubrava dam (Botovo gauge, 15 km downstream of Mura confluence) (Credit: Croatian Waters).

As a consequence of the peak power mode (pulse releases) fish populations along the Drava have declined considerably.

Fig. 31: Bélavár side arm during "low water peak" showing a clogging of the gravel by fine sediments due to the daily water oscillation (Credit: A. Mohl/WWF)

Further the residual water in the diverted stretch ("Stara Drava" in Slovenia and Croatia) is mostly insufficient and in particularly gravel excavation leads to a substantial degradation of this former rivers courses (compare fig. 38).

Sand and gravel excavation

The Drava and Mura alpine and sub-alpine valleys hold an enormous quantity of Holocene sediments. Gravel and sand layers reaches a thickness of more than 150 m. The commercial large-scale sand and gravel excavation along the Lower Drava and Mura Rivers in Croatia and Hungary in conjunction with the maintenance of the regulated river channel for flood protection and navigation has been focused on the recent floodplain and the main channel.

For over 30 years sediment extraction from the river bed has been taking place in various areas along the rivers in Hungary and Croatia and new plans for further massive extraction have been developed especially in Croatia in recent years. The impacts on the natural river bed are considerable.

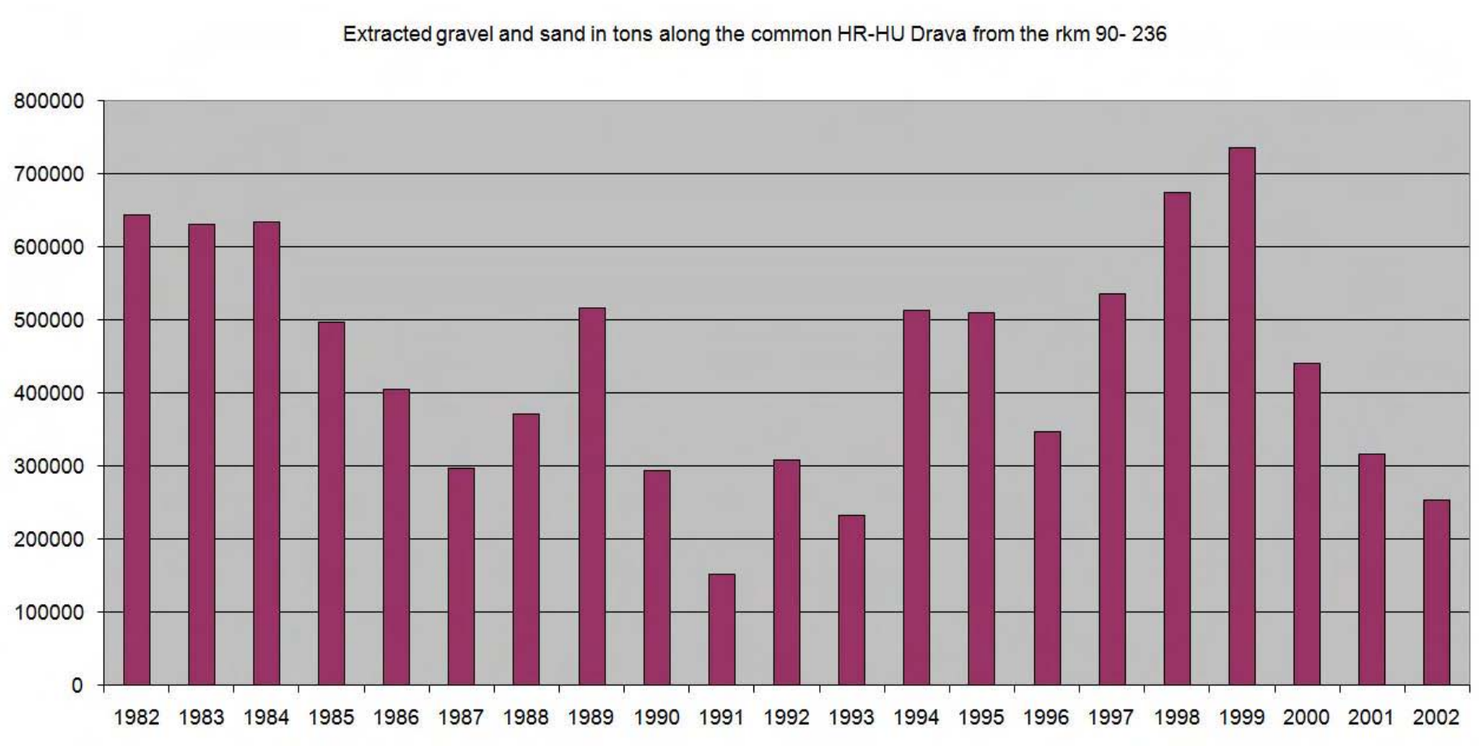


Fig. 32: The total amount of extracted material from the Drava during 1982-2002 is more than 9 million tons, which is equal to about 450,000 t/yr. The average annual bedload transport is only about 100,000 t for the corresponding river stretch (Rákóczi 2008).

Extraction along the Croatian-Hungarian border stretch of the Drava between Vizvar and Barcs has caused more than 90% of the riverbed deepening between 1970 and 2000 (compare chapter "river regulation" and "hydropower dams"). Furthermore, extraction leads to a loss of valuable dynamic habitats as gravel and sand banks, hosting several red list species and international endangered species of the FFH annexes such as Little Tern or Stone Curlew.

Fig. 33: Public tender in 2005 for extraction for 2,000,000 m³ gravel and sand from the Drava River (Ministry for Agriculture, Forestry and Water Management Croatia)


17. 3. 2005.

ASI Jutarnji LIST

REPUBLIKA HRVATSKA
MINISTARSTVO POLJOPRIVREDE, ŠUMARSTVA
I VODNOGA GOSPODARSTVA

JAVNI NATJEČAJ
za dodjelu koncesija za vađenje pijeska i šljunka bagerima ili drugim
sličnim napravama iz obnovljivih ležišta u koritu rijeke Drave

I. Javnom natječaju mogu pristupiti zainteresirane domaće fizičke i pravno osobe koje su registrirane za obavljanje djelatnosti vađenja pijeska i/ili šljunka.

II. Koncesija za vađenje pijeska i šljunka dodjeljuje se:

1. za ležišta obnovljivih količina sastavnog materijala (pijeska i šljunka) iz korita rijeke Drave na dionicama, uzevši korištenje (prema procjeni mineralnih sirovina u m3) i vrsti materijala:

a. "Zeleno Polje I"	km	15+500 do km 16+220	145.000 m³	pijesak;
b. "Zeleno polje II"	km	16+220 do km 16+500	60.000 m³	pijesak;
c. "Pampas I"	km	23+550 do km 23+980	60.000 m³	pijesak;
d. "Pampas II"	km	24+600 do km 25+330	85.000 m³	pijesak;
e. "Bokroš"	km	31+465 do km 31+835	200.000 m³	pijesak;
f. "Jelengrad"	km	35+300 do km 36+500	80.000 m³	pijesak;
g. "Nehaj I"	km	38+750 do km 39+200	200.000 m³	pijesak;
h. "Nehaj II"	km	39+200 do km 39+600	100.000 m³	pijesak;
i. "Nehaj III"	km	39+600 do km 40+300	100.000 m³	pijesak;
j. "Nehaj IV"	km	40+300 do km 41+000	100.000 m³	pijesak;
k. "Valpovačke plaže I"	km	49+230 do km 50+000	90.000 m³	pijesak;
l. "Valpovačke plaže II"	km	50+000 do km 51+080	90.000 m³	pijesak;
m. "Jamine"	km	157+300 do km 157+700	50.000 m³	šljunak;
n. "Darugijača"	km	161+200 do km 161+700	100.000 m³	šljunak;
o. "Križnica I"	km	166+500 do km 168+000	50.000 m³	šljunak;
p. "Križnica II"	km	168+800 do km 169+040	150.000 m³	šljunak;
r. "Duretina"	km	175+700 do km 176+950	70.000 m³	šljunak;
s. "Kingovo"	km	193+250 do km 196+300	100.000 m³	šljunak;
t. "Repaš-most"	rkm	204+400 do rkm 209+000	80.000 m³	šljunak;
u. "Botovo-most - nizvodno"	rkm	225	110.000 m³	šljunak;

Na svim ležištima područje se vađenje pijeska i/ili šljunka isključivo plovnom mehanizacijom osim za ležišta pod s., t. i u. gdje je moguće kopnenom opremom vađenje materijal vađenje šljunka i sukcesivnom mehanizacijom uz prethodno razrađene postupke u otkopnim za vađenje šljunka i pruna vodopravnoj dozvoli.

Na svim ležištima postoji mogućnost zaustavlja in isko eksploatacijskih sredstava te se preporučuje prije korištenja koncesija ista provjeriti u Centru za mine i MUP-u.

Fig. 34: Gravel extraction on the Drava at Botovo/Croatia in 2006 (Credit: A. Mohl/WWF)

Fig. 35: Sand extraction along the Lower Drava in 2004 (Credit: A. Mohl/WWF)

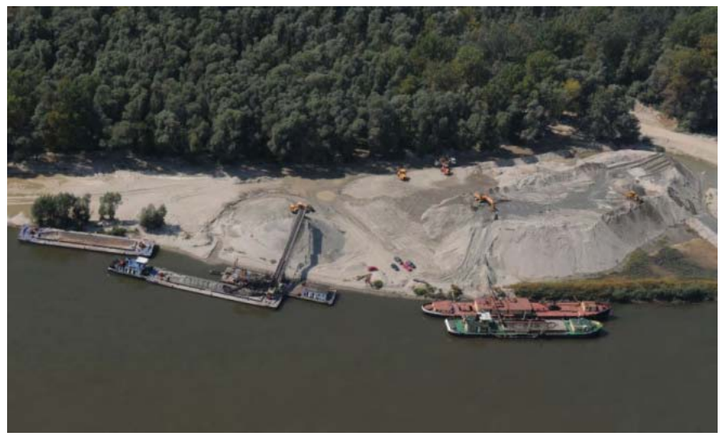


Fig. 36: Sand extraction along the Lower Drava at Osijek/Croatia in 2008 (Credit: D. Grlica)

The list of continuous dredging is long and licenses have been given even within the Danube-Drava National Park and Natura 2000 site.

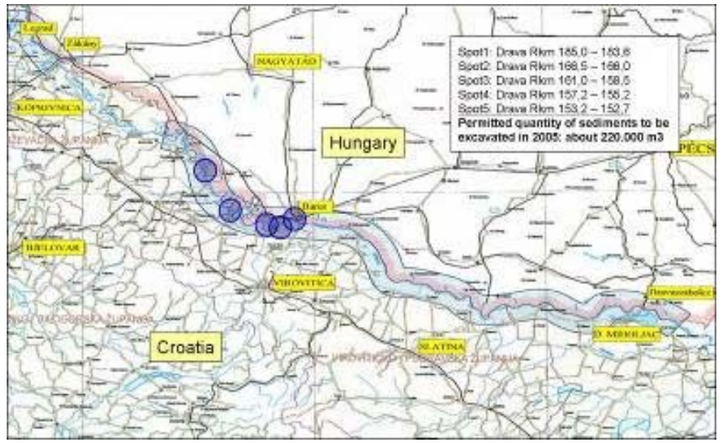


Fig. 37: Sediment extraction sites along the Drava in Hungary within the Danube-Drava National Park and the Natura 2000 site (Credit: South-Danubian Water Authority 2005)

Beside ongoing extraction on various spots along the rivers huge sediment extraction plans have been developed and partly implemented in Croatia in recent years:

2003: The old Drava river bed between Varaždin and Ormož was partly destroyed by systematic excavation to win and sell gravel for the construction of a highway (see fig. 38).

2005: A plan to extract 2, 000, 000 m³ on 20 sites along the entire Lower Drava was issued by the Croatian Ministry responsible for Water Management (see fig. 33 and 40).

2007: A further plan to extract 800,000 m³ along the 60 km Drava River stretch at Osijek was issued by the Croatian Ministry responsible for Water Management.

Sediment extraction as well as river regulation along the free-flowing stretches in Croatia and Hungary has accelerated the river bed degradation and the deepening process and has considerably multiplied the impacts of hydropower dams (compare chapter "river regulation" and "hydropower dams").

Fig. 38: Intensive gravel excavation and destruction of the former Drava river bed near Varaždin (Credit: ZEUS)

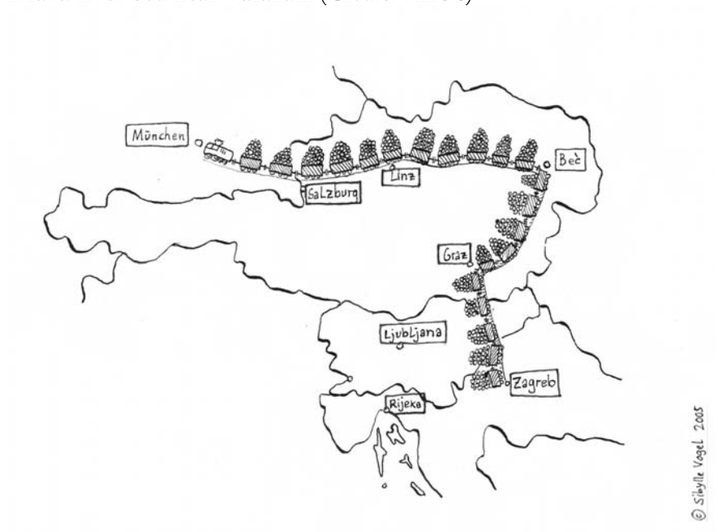


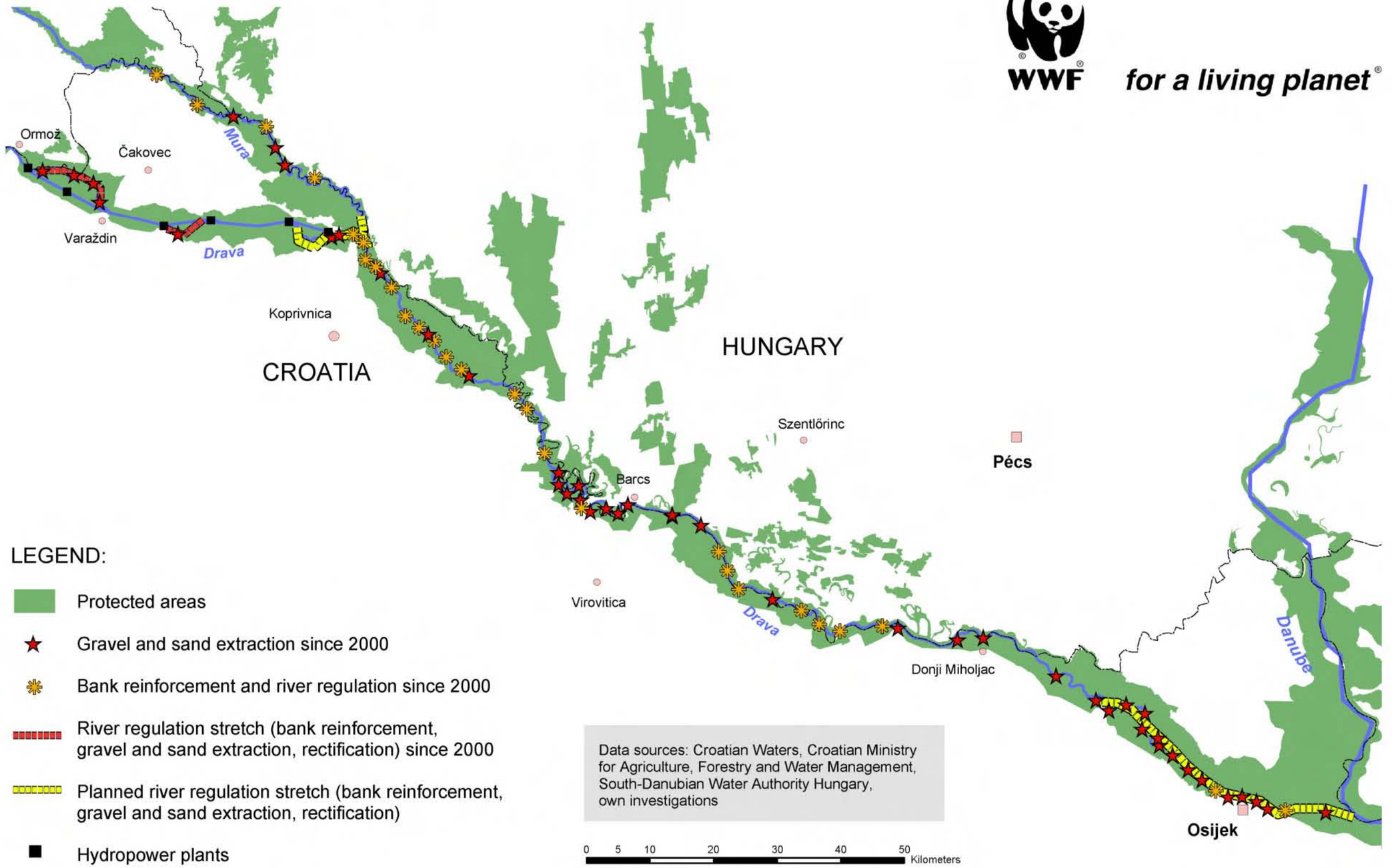
Fig. 39: 2,000,000 m³ planned 2005-2009 (Croatia) equals a 870 km long train from Zagreb via Beć to München (Credit: WWF)

Fig. 40 (next page): Water management impacts along the Lower Drava and Mura Rivers (Credit: WWF)

Water management impacts along the lower Drava and Mura Rivers in Croatia and Hungary

Preliminary investigation WWF, December 2008

WWF *for a living planet®*



LEGEND:

- Protected areas
- Gravel and sand extraction since 2000
- Bank reinforcement and river regulation since 2000
- River regulation stretch (bank reinforcement, gravel and sand extraction, rectification) since 2000
- Planned river regulation stretch (bank reinforcement, gravel and sand extraction, rectification)
- Hydropower plants

Data sources: Croatian Waters, Croatian Ministry for Agriculture, Forestry and Water Management, South-Danubian Water Authority Hungary, own investigations

3. Future perspectives

An International River Restoration Programme for the Drava and Mura Rivers

The ongoing degradation of the natural courses of the Drava and Mura Rivers is the major threat for the biodiversity values and natural resources of the region (Schneider-Jacoby 1998).

In order to halt and ideally reverse this process a joint trans-boundary "*River Restoration Programme*" (hereafter RRP) for the Lower Drava and Mura is proposed to be implemented between all countries involved.

Within such a RRP special focus should be given to the key problems caused by river regulation, excessive gravel and sand extraction from the river bed and the hydro-peaking mode of the last Croatian hydropower plant.

The common RRP should be developed and implemented by the competent Water Management and Nature Protection Authorities of the countries in cooperation with international institutions (e.g. EC, ICPDR) and experts.

A RRP will support the effective common implementation of EU environmental law, the Water Framework Directive, the Floods Directive and the Habitats and Birds Directives in the region.

A Trans-Boundary UNESCO Biosphere Reserve "Danube-Drava-Mura" (hereafter TBR "DDM") would create an appropriate international framework for the cooperation in the development and implementation of the RRP.

Trans-Boundary UNESCO Biosphere Reserve "Danube-Drava-Mura"

During the first EuroNatur Conference in Kaposvar in 1993, the idea of a Trans-Boundary Biosphere Reserve for the entire riverine landscape was born (Schneider-Jacoby 1996). It was clear that only an internationally recognised status for the region and a framework that could combine together the cluster of different protected areas would encourage trans-frontier cooperation for the protection and sustainable management of the area.

The overall goal would be: a large Trans-Boundary UNESCO Biosphere Reserve along the Danube, Drava and Mura, spanning Austria, Croatia, Hungary, Serbia and Slovenia (see fig. 42) and covering at least 400,000 ha (EuroNatur 1999, WWF 2006).

This goal including the creation of many new protected areas along the rivers. Most recently, the Croatian Ministry of Culture has preliminary designated about 145,000 ha along the Danube, Drava and Mura in Croatia as a Regional Park. The plan for a TBR including the delineation of core and buffer zones is already highly developed in Croatia and Hungary.

Trans-Boundary Biosphere Reserves (comp. www.unesco.org/mab)

As borders between states are political and not ecological, ecosystems often occur across national boundaries, and may be subject to different, or even conflicting, management and land use practices. Trans-boundary Biosphere Reserves (TBR) provide a tool for developing common management and protection.

A TBR is important in providing official recognition at an international level and by a UN institution of the political will to co-operate in conservation and sustainable use through common management of a shared ecosystem. It also represents a commitment of two or more countries to apply together the Seville Strategy for biosphere reserves and its objectives. And it reflects the increasing recognition of the appropriateness of the ecosystem approach, for conservation and sustainable use of biological diversity.

The recommendations presented below deal with the establishment of TBR, the measures which can be taken to respond to the Man and the Biosphere (MAB) principles and in particular the goals of the Seville Strategy and the means to ensure that a TBR is truly operational. However, it should be kept in mind that, although the biosphere reserve provides a general framework for action in a trans-boundary location, the real-world situations will vary very much from one place to another, and flexibility is needed even more than in a national context.

The process leading towards the official designation of a TBR can include many forms of co-operation and co-ordination among the existing areas on either side of a border. These serve as a basis for formalising the TBR proposal and should be encouraged

Procedure for the establishment of a TBR

Up until now, all existing TBR were established as separate biosphere reserves in individual countries before being designated as TBR. However, it could be envisaged in the future that a TBR would be established jointly by the countries concerned in one step. In both cases, the ultimate aim should be to have one *functional biosphere reserve*.

In these two different scenarios, the following respective procedures are recommended:

- Establishment of a biosphere reserve on each side of the border;
- or, when the TBR is established in one step, definition of the zoning of the area according to the general criteria for designation of biosphere reserves.
- Identification of local and national partners and establishment of a working group to define the basis and identify key issues for co-operation.
- Signing of an official agreement between governmental authorities regarding the TBR.
- Nomination of the various parts by the respective State authorities;
- or, when the TBR is established in one step, joint nomination for the whole area by the concerned State authorities.
- In both scenarios, indication of the main components of a plan for co-operation in the future.
- Official designation by ICC MAB of UNESCO.

Functioning of the TBR Among the measures recommended to make the TBR function effectively, priority should be given to:

- Preparation and adoption of a zonation plan for the whole area and implementation of the zonation by strict protection of core areas, delimitation of the buffer zones and co-ordinated objectives for the transition areas; this implies that the countries concerned have a common understanding of the characteristics of each of the zones, and that similar management measures are in place for each zone.
- When the zonation plan is defined, publication on a joint map of the zonation.
- Definition of common objectives and measures, work plan, time table, and required budget; this should be a demand driven process, based on perceived needs or management requirements. This work plan should take into account the elements listed under the goals of the Seville Strategy as suggested below.
- Identification of potential funding sources for the work plan and joint or simultaneous application for these funds.
- Establishment of a means of communication between the co-ordinators/managers of the different parts of the TBR, including electronic mail when feasible.
- Efforts towards harmonised management structures on each side.

Institutional mechanisms The TBR will not function without a joint structure devoted to its co-ordination. Although this structure can vary greatly from one TBR to another, the following points can be recommended:

- The co-ordinating structure is representative of various administrations and the scientific boards, as well as the authorities in charge of the protected areas, the representatives of local communities, interested and affected groups, including youth, and of the private sector.
- The NGO sector in the region should be also represented in the structure.
- This structure has a permanent secretariat, and a budget is devoted to its functioning.
- A person is designated on each side to act as a focal point for co-operation.
- General and regular meetings of the co-ordinating structure are complemented by thematic groups, on an *ad hoc* basis, in order to create a platform for discussion among stakeholders from the countries concerned, with a view to promote all opportunities for exchanging views and knowledge.
- Joint staff teams are operational for specific tasks.

An association is set up with the specific aim of promoting the TBR.

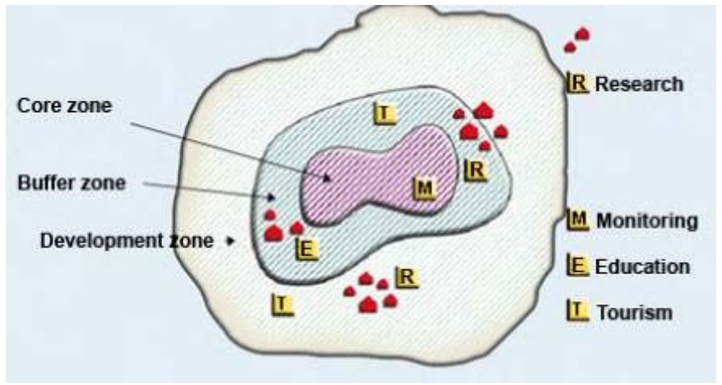


Fig. 41: Zoning concept of a Biosphere Reserve (Credit: UNESCO MaB)

Fig. 42 (next page): Protected areas along the Danube, Drava and Mura Rivers and proposed Trans-Boundary UNESCO Biosphere Reserve

Protected Areas along the European Lifeline Danube-Drava-Mura

Proposal for a Trans-Boundary Biosphere Reserve "Danube-Drava-Mura" within the framework of UNESCO's Programme on Man and the Biosphere (MAB)

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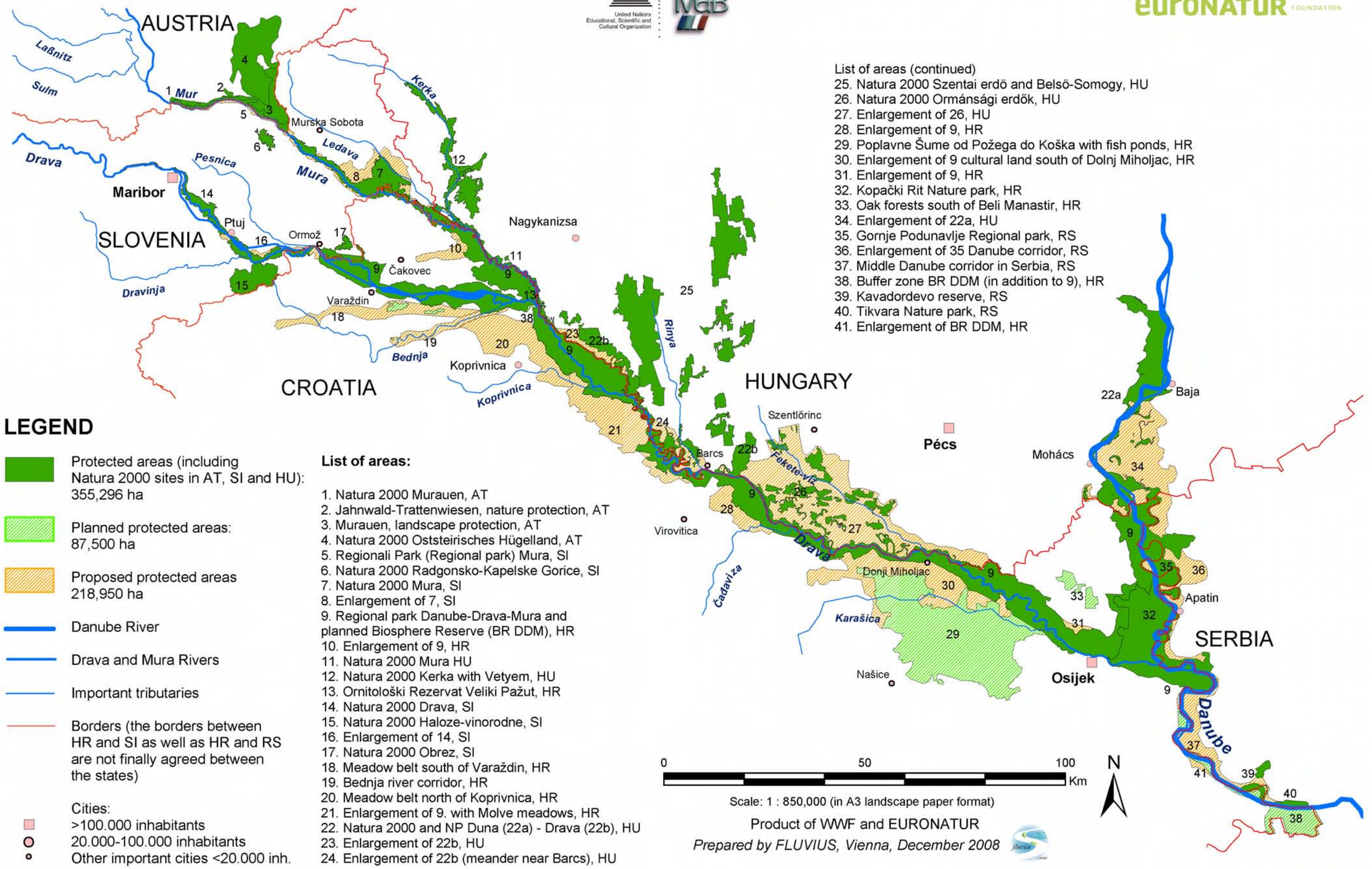


List of areas (continued)
25. Natura 2000 Szentai erdö and Belsö-Somogy, HU
26. Natura 2000 Ormánsági erdők, HU
27. Enlargement of 26, HU
28. Enlargement of 9, HR
29. Poplavne Šume od Požega do Koška with fish ponds, HR
30. Enlargement of 9 cultural land south of Dolnj Miholjac, HR
31. Enlargement of 9, HR
32. Kopački Rit Nature park, HR
33. Oak forests south of Beli Manastir, HR
34. Enlargement of 22a, HU
35. Gornje Podunavlje Regional park, RS
36. Enlargement of 35 Danube corridor, RS
37. Middle Danube corridor in Serbia, RS
38. Buffer zone BR DDM (in addition to 9), HR
39. Kavadordevo reserve, RS
40. Tikvara Nature park, RS
41. Enlargement of BR DDM, HR

LEGEND

- Protected areas (including Natura 2000 sites in AT, SI and HU): 355,296 ha
- Planned protected areas: 87,500 ha
- Proposed protected areas 218,950 ha
- Danube River
- Drava and Mura Rivers
- Important tributaries
- Borders (the borders between HR and SI as well as HR and RS are not finally agreed between the states)

Cities:
- >100.000 inhabitants
- 20.000-100.000 inhabitants
- Other important cities <20.000 inh.

List of areas:

1. Natura 2000 Murauen, AT
2. Jahnwald-Trattenwiesen, nature protection, AT
3. Murauen, landscape protection, AT
4. Natura 2000 Oststeirisches Hügelland, AT
5. Regionali Park (Regional park) Mura, SI
6. Natura 2000 Radgonsko-Kapelske Gorice, SI
7. Natura 2000 Mura, SI
8. Enlargement of 7, SI
9. Regional park Danube-Drava-Mura and planned Biosphere Reserve (BR DDM), HR
10. Enlargement of 9, HR
11. Natura 2000 Mura HU
12. Natura 2000 Kerka with Vetyem, HU
13. Ornitološki Rezervat Veliki Pažut, HR
14. Natura 2000 Drava, SI
15. Natura 2000 Haloze-vinorodne, SI
16. Enlargement of 14, SI
17. Natura 2000 Obrez, SI
18. Meadow belt south of Varaždin, HR
19. Bednja river corridor, HR
20. Meadow belt north of Koprivnica, HR
21. Enlargement of 9. with Molve meadows, HR
22. Natura 2000 and NP Duna (22a) - Drava (22b), HU
23. Enlargement of 22b, HU
24. Enlargement of 22b (meander near Barcs), HU

Scale: 1 : 850,000 (in A3 landscape paper format)

Product of WWF and EURONATUR

Prepared by FLUVIUS, Vienna, December 2008

4. International examples of good river restoration and ecological river management

Benefits for nature conservation and water management

Today, problems in river ecosystems for both nature conservation and water management have basically the same origin: a high degree of river engineering of natural water courses. The enormous decline of freshwater biodiversity has challenged nature conservationists, whereas the deterioration of natural flood retention capacity, the river bed deepening and the fall of groundwater tables has caused a paradigm shift in the Water Management Authorities. For the sake of both, conservation of valuable habitats and species and sustainable water management, numerous river restoration projects were or are already implemented on several rivers in Europe. Good examples with the aim of maintaining and restoring the natural river dynamic processes can be found on the rivers Drava in Austria, Loire/Allier in France or Elbe in Germany.

Loire/Allier (France)

Key measure: Land owner management to maintain and improve free river dynamics especially lateral erosion

Info: www.rivernet.org/loire/lifeloire/life_e.htm

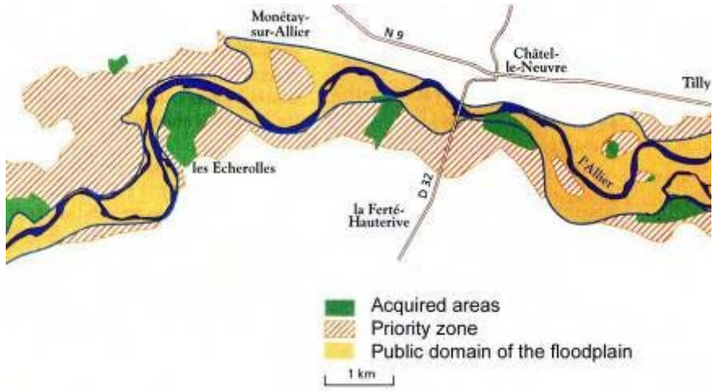


Fig. 43 and 44: Preserved and well managed dynamic natural river course of the Allier by an active land management (Credit: LN-CEPA-JS)

Upper Drava (Austria)

Key measure: Active River bed widening and re-connection and creation of side arms

Info: www.life-drau.at

Fig. 45: Drava River before and after restoration (Credit: Water Management Authority of Carinthia/Tichy)

International examples of good river restoration and ecological river management

To date there have been six finalised or ongoing large river restoration projects along the Drava and Mura Rivers. They have been mainly aimed at restoring the river dynamics by widening of the river bed and reconnection of the former side-arm system. Benefits encompass stopping of river bed deepening and improving natural flood protection and maintaining and restoring characteristic habitats and species populations. Around 20 Million Euros have been allocated in total incl. the support of the EU funds for work related to river restoration. Two projects have been funded under Interreg IIa and IIIa (border Mura between Austria and Slovenia), the others under LIFE Nature (upper Mura and Drava I + II in Austria, inner Mura in Slovenia) (Mohl 2004).
These projects have been carried out in partnership with water management and nature conservation bodies as well as other institutions and organisations such as NGOs. WWF Austria has supported several of them, either as a project partner such as for the Life project in Slovenia or as a facilitator in the project development. More information on the ongoing Life project in Slovenia available under: www.biomura.si

Elbe (Germany)

Key measure: Active removal of the dike system and creation of natural retention areas

Info:www.biosphaerenreservatmittlereelbe.de/contenido_468/cms/index.html

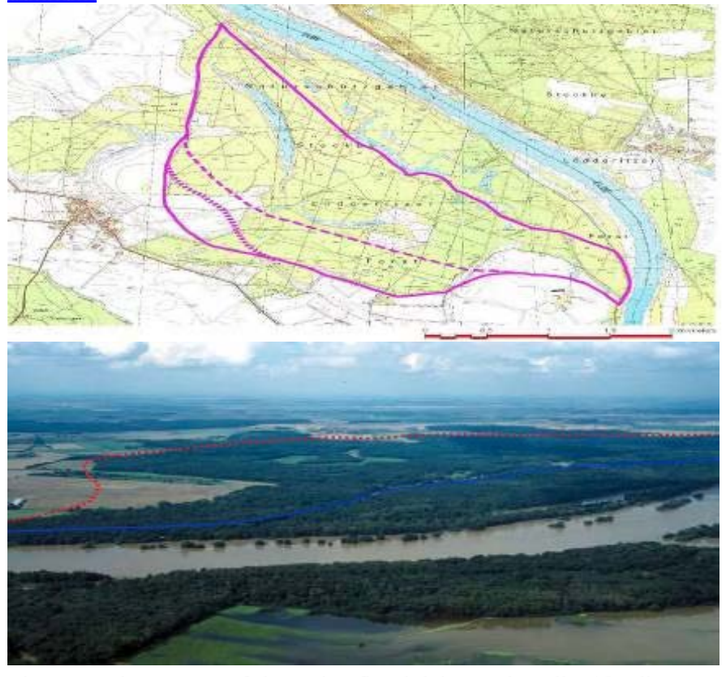


Fig. 46: Enlargement of the active floodplain on the Elbe (Credit: LHW Sachsen-Anhalt, 2006)

5. Action Plan

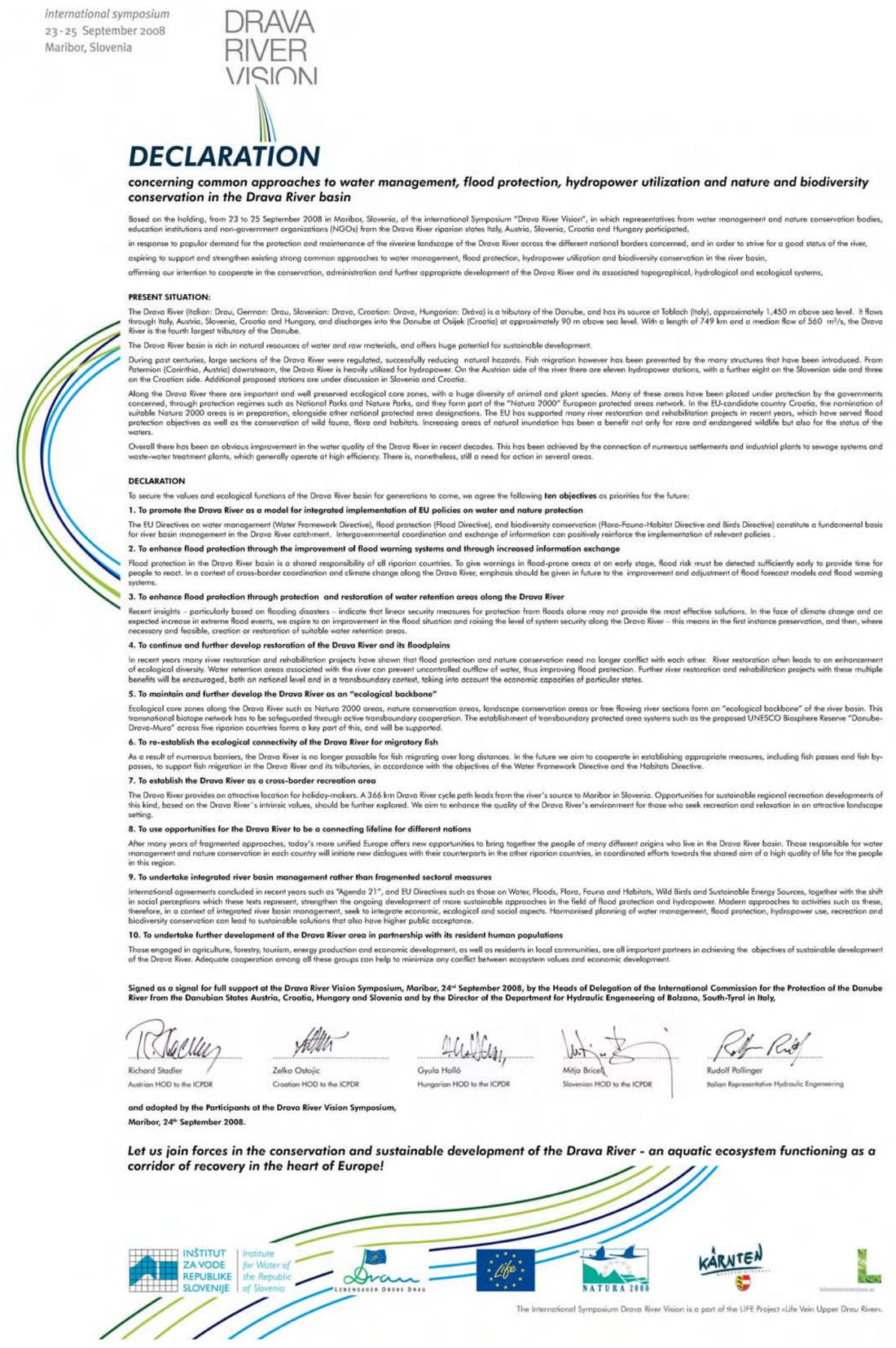
The Strategy and Action Plan provides the basis for a future RRP.

Objectives and Strategy:

A common approach to obtaining a valuable and ecologically functional Drava River has already been discussed between all Drava Basin countries on the International Symposium "Drava River Vision", which took place in Maribor in September 2008 (BMLFUW et al. 2008).

The Symposium was attended by representatives from water management and nature conservation bodies, educational institutions and non-government organizations (NGOs) from the Drava River riparian states - Austria, Croatia, Hungary, Italy and Slovenia - as well as from international institutions such as the European Commission, UNESCO and the International Commission for the Protection of the Danube River (ICPDR).

A joint Declaration, including ten key objectives, has been endorsed by representatives of the water management sector of all five Drava Basin countries and supported by the participants. This joint statement will support the future cooperation in the conservation and ecological management of the river and will help the countries to meet the challenging environmental objectives of the EU.



international symposium
23 - 25 September 2008
Maribor, Slovenia

DRAVA RIVER VISION

DECLARATION

concerning common approaches to water management, flood protection, hydropower utilization and nature and biodiversity conservation in the Drava River basin

Based on the holding, from 23 to 25 September 2008 in Maribor, Slovenia, of the international Symposium "Drava River Vision", in which representatives from water management and nature conservation bodies, education institutions and non-government organizations (NGOs) from the Drava River riparian states Italy, Austria, Slovenia, Croatia and Hungary participated,

in response to popular demand for the protection and maintenance of the riverine landscape of the Drava River across the different national borders concerned, and in order to strive for a good status of the river,

aspiring to support and strengthen existing strong common approaches to water management, flood protection, hydropower utilization and biodiversity conservation in the river basin,

affirming our intention to cooperate in the conservation, administration and further appropriate development of the Drava River and its associated topographical, hydrological and ecological systems,

PRESENT SITUATION:

The Drava River (Italian: Drau, German: Drau, Slovenian: Drava, Croatian: Drava, Hungarian: Dráva) is a tributary of the Danube, and has its source at Toblach (Italy), approximately 1,450 m above sea level. It flows through Italy, Austria, Slovenia, Croatia and Hungary, and discharges into the Danube at Osijek (Croatia) at approximately 90 m above sea level. With a length of 749 km and a median flow of 560 m^3/s, the Drava River is the fourth largest tributary of the Danube.

The Drava River basin is rich in natural resources of water and raw materials, and offers huge potential for sustainable development.

During past centuries, large sections of the Drava River were regulated, successfully reducing natural hazards. Fish migration however has been prevented by the many structures that have been introduced. From Paternion (Carinthia, Austria) downstream, the Drava River is heavily utilized for hydropower. On the Austrian side of the river there are eleven hydropower stations, with a further eight on the Slovenian side and three on the Croatian side. Additional proposed stations are under discussion in Slovenia and Croatia.

Along the Drava River there are important and well preserved ecological core zones, with a huge diversity of animal and plant species. Many of these areas have been placed under protection by the governments concerned, through protection regimes such as National Parks and Nature Parks, and they form part of the "Natura 2000" European protected areas network. In the EU-candidate country Croatia, the nomination of suitable Natura 2000 areas is in preparation, alongside other national protected area designations. The EU has supported many river restoration and rehabilitation projects in recent years, which have served flood protection objectives as well as the conservation of wild fauna, flora and habitats. Increasing areas of natural inundation has been a benefit not only for rare and endangered wildlife but also for the status of the waters.

Overall there has been an obvious improvement in the water quality of the Drava River in recent decades. This has been achieved by the connection of numerous settlements and industrial plants to sewage systems and waste-water treatment plants, which generally operate at high efficiency. There is, nonetheless, still a need for action in several areas.

DECLARATION

To secure the values and ecological functions of the Drava River basin for generations to come, we agree the following **ten objectives** as priorities for the future:

1. To promote the Drava River as a model for integrated implementation of EU policies on water and nature protection

The EU Directives on water management (Water Framework Directive), flood protection (Flood Directive), and biodiversity conservation (Flora-Fauna-Habitat Directive and Birds Directive) constitute a fundamental basis for river basin management in the Drava River catchment. Intergovernmental coordination and exchange of information can positively reinforce the implementation of relevant policies .

2. To enhance flood protection through the improvement of flood warning systems and through increased information exchange

Flood protection in the Drava River basin is a shared responsibility of all riparian countries. To give warnings in flood-prone areas at an early stage, flood risk must be detected sufficiently early to provide time for people to react. In a context of cross-border coordination and climate change along the Drava River, emphasis should be given in future to the improvement and adjustment of flood forecast models and flood warning systems.

3. To enhance flood protection through protection and restoration of water retention areas along the Drava River

Recent insights – particularly based on flooding disasters – indicate that linear security measures for protection from floods alone may not provide the most effective solutions. In the face of climate change and an expected increase in extreme flood events, we aspire to an improvement in the flood situation and raising the level of system security along the Drava River – this means in the first instance preservation, and then, where necessary and feasible, creation or restoration of suitable water retention areas.

4. To continue and further develop restoration of the Drava River and its floodplains

In recent years many river restoration and rehabilitation projects have shown that flood protection and nature conservation need no longer conflict with each other. River restoration often leads to an enhancement of ecological diversity. Water retention areas associated with the river can prevent uncontrolled outflow of water, thus improving flood protection. Further river restoration and rehabilitation projects with these multiple benefits will be encouraged, both on national level and in a transboundary context, taking into account the economic capacities of particular states.

5. To maintain and further develop the Drava River as an "ecological backbone"

Ecological core zones along the Drava River such as Natura 2000 areas, nature conservation areas, landscape conservation areas or free flowing river sections form an "ecological backbone" of the river basin. This transnational biotope network has to be safeguarded through active transboundary cooperation. The establishment of transboundary protected area systems such as the proposed UNESCO Biosphere Reserve "Danube-Drava-Mura" across five riparian countries forms a key part of this, and will be supported.

6. To re-establish the ecological connectivity of the Drava River for migratory fish

As a result of numerous barriers, the Drava River is no longer passable for fish migrating over long distances. In the future we aim to cooperate in establishing appropriate measures, including fish passes and fish by-passes, to support fish migration in the Drava River and its tributaries, in accordance with the objectives of the Water Framework Directive and the Habitats Directive.

7. To establish the Drava River as a cross-border recreation area

The Drava River provides an attractive location for holiday-makers. A 366 km Drava River cycle path leads from the river's source to Maribor in Slovenia. Opportunities for sustainable regional recreation developments of this kind, based on the Drava River's intrinsic values, should be further explored. We aim to enhance the quality of the Drava River's environment for those who seek recreation and relaxation in an attractive landscape setting.

8. To use opportunities for the Drava River to be a connecting lifeline for different nations

After many years of fragmented approaches, today's more unified Europe offers new opportunities to bring together the people of many different origins who live in the Drava River basin. Those responsible for water management and nature conservation in each country will initiate new dialogues with their counterparts in the other riparian countries, in coordinated efforts towards the shared aim of a high quality of life for the people in this region.

9. To undertake integrated river basin management rather than fragmented sectoral measures

International agreements concluded in recent years such as "Agenda 21", and EU Directives such as those on Water, Floods, Flora, Fauna and Habitats, Wild Birds and Sustainable Energy Sources, together with the shift in social perceptions which these texts represent, strengthen the ongoing development of more sustainable approaches in the field of flood protection and hydropower. Modern approaches to activities such as these, therefore, in a context of integrated river basin management, seek to integrate economic, ecological and social aspects. Harmonised planning of water management, flood protection, hydropower use, recreation and biodiversity conservation can lead to sustainable solutions that also have higher public acceptance.

10. To undertake further development of the Drava River area in partnership with its resident human populations

Those engaged in agriculture, forestry, tourism, energy production and economic development, as well as residents in local communities, are all important partners in achieving the objectives of sustainable development of the Drava River. Adequate cooperation among all these groups can help to minimize any conflict between ecosystem values and economic development.

Signed as a signal for full support at the Drava River Vision Symposium, Maribor, 24rd September 2008, by the Heads of Delegation of the International Commission for the Protection of the Danube River from the Danubian States Austria, Croatia, Hungary and Slovenia and by the Director of the Department for Hydraulic Engeneering of Bolzano, South-Tyrol in Italy,

Richard Stadler	Zelko Ostojic	Gyula Holló	Mitja Bricelj	Rudolf Pollinger
Austrian HOD to the ICPDR	Croatian HOD to the ICPDR	Hungarian HOD to the ICPDR	Slovenian HOD to the ICPDR	Italian Representative Hydraulic Engeneering

and adopted by the Participants at the Drava River Vision Symposium,
Maribor, 24th September 2008.

Let us join forces in the conservation and sustainable development of the Drava River - an aquatic ecosystem functioning as a corridor of recovery in the heart of Europe!

INŠTITUT ZA VODE REPUBLIKE SLOVENIJE | Institute for Water of the Republic of Slovenia

Drau LEBENSADER OBERE DRAU

Life

NATURA 2000

KÄRNTEN

The International Symposium Drava River Vision is a part of the LIFE Project »Life Vein Upper Drau River«.

Restoration measures

Based on the international Drava Declaration and its objectives (see above) key measures can be defined for the Lower Drava and Mura Rivers which would lead to ecological and sustainable river management. These measures should be included in the proposed RRP.

Initial management measures, particularly in Croatia and Hungary should prevent further damage to the river landscape:

- Any further extraction of sediments from the riverbed and banks and therefore from the river system should be prevented.
- Free river dynamics (bank erosion, channel changes) of the Lower Drava and Mura should be allowed where no infrastructure is endangered. Instead of further river training structures, alternative measures of river management should be applied (e.g. compensation of land owners, removal of dikes).
- In case further river training structures have to be established to protect infrastructure (bridges, roads, dykes) or settlements and if this cannot be achieved by other means, ecological compensation measures should be implemented in other sections of the river in order to recognise the changed management approach from "river regulation" to "ecological river management and river restoration".
- New hydropower dams along the rivers should be banned e.g. the planned dams on the Mura in Slovenia or further dams on the Drava in Croatia.
- The operation of the last hydropower dam on the Drava at Donja Dubrava in Croatia should be adapted to the ecological needs of the free-flowing 230 km long downstream section, in particular by stopping hydro-peaking and restoring the natural river flow.
- The creation and improvement of the Lower Drava in particular the entire river stretch upstream Osijek as an inland water way should be abandoned.

River restoration projects need to be developed and implemented for impacted river sections and funded e.g. through EU programmes.

Major river restoration measures shall include:

- Removal of bank reinforcement (rip-rap) and other river training structures
- Re-connection of oxbows and former side channels
- Restoration of floodplains including the re-location of flood protection dykes
- Restoration of tributaries

Example: Self-restoration of the Drava river bed

As sediment management of the Lower Drava and Mura is a key issue to stop the further river bed degradation, river restoration measures should always make use of the self-restoration capacity of the rivers and should promote the re-mobilisation of sediments from lateral erosion.

A very good example for self-restoration due to lateral erosion is the Drava River in Croatia upstream of Osijek.

The trend of bed degradation has been reduced considerably, after a 90 years long "self-restoration" process and re-meandering. This Drava stretch was completely straightened 100 years before (flood protection, navigation) by the Austrian K&K monarchy. As the river was not strongly impacted by hydro-engineering measures since World War I, the Drava has started to re-meander again (compare fig. 47). This part of the Drava could serve as a good reference for sustainable river management and for individual restoration measures.

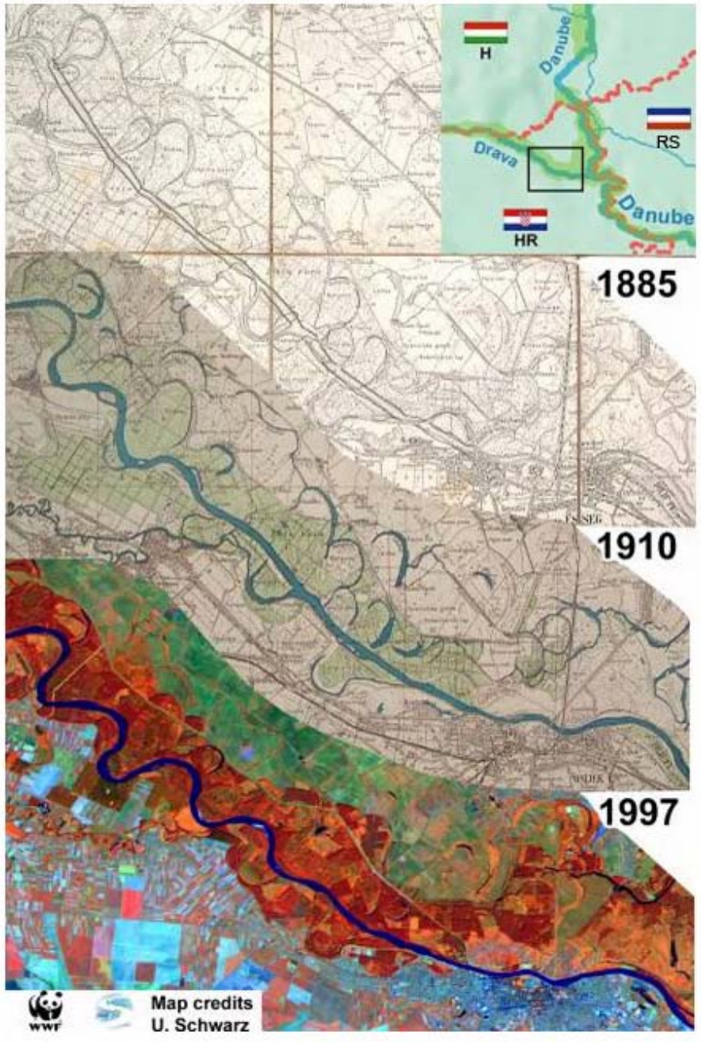


Fig. 47: Time series of river course development upstream of Osijek (1885: complete straightening for navigation purposes under the K&K monarchy; 1910: abandoned maintaining measures allow re-meandering; 1997: further re-meandering of the river course) (WWF 2002b).

Fig. 48: Meandering Drava River upstream Osijek/Croatia (Credit: M. Romulic/ www.romulic.com).

5.1. Restoration spots with status, development and proposed restoration measures

Eight initial action spots were selected to show examples for possible restoration projects. All together the action spots have a potential project size of nearly 16,000 ha (about 12,200 ha in the active floodplain (between the existing flood protection dykes) and 3,800 ha outside, requiring local dyke re-location).

They involve the removal of about 20 km of bank protection and side channel closures, the reconnection of 45 kms of side-channels, the management or reconnection of 10 oxbows and the floodplain restoration of about 3,000 ha.

Which spots where selected?

The spots were selected based on:

- The presence of floodplain remnants and partial connectivity
- The presence of larger areas without intensive landuse (settlements)
- The location of the flood protection dykes (and space for re-location)
- The general hydromorphological situation (mostly along altered river stretches)

What was evaluated for each spot?

The following parameters were evaluated:

- Historical and current landscape and landuse comparison
- Proposal and map for the restoration measures in the main classes of:
  1. Removal of bank reinforcement (rip-rap) and other river training structures
  2. Re-connection of oxbows and former side-channels
  3. Restoration of floodplains including the re-location of flood protection dykes
  4. Restoration of tributaries (where applicable)
- Photo documentation

What is needed for the further detailed planning of restoration sites?

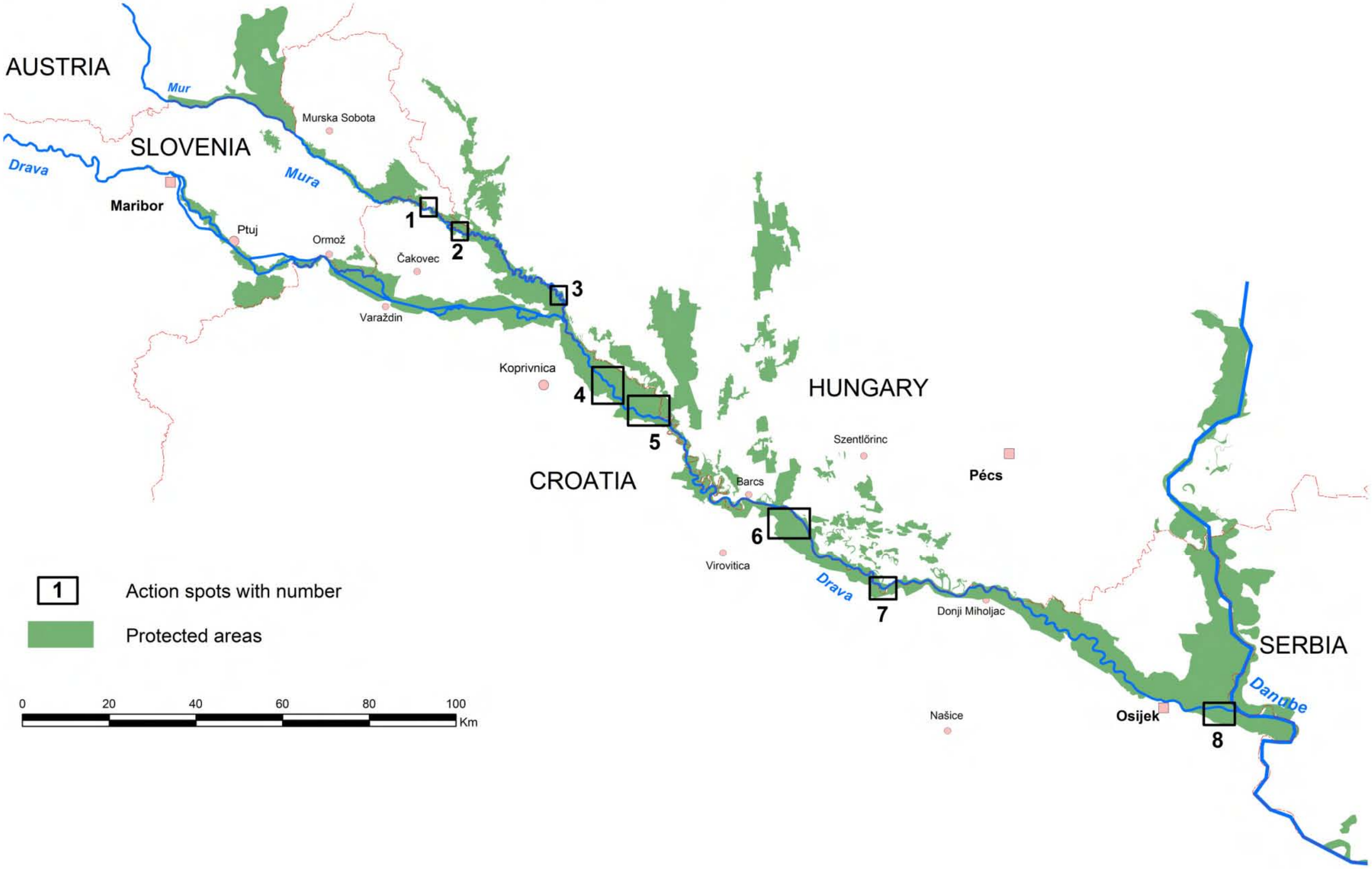
For the detailed suitability and project planning the following floodplain evaluation for proposed areas for reconnection can be given:

1. Landuse assessment (do flood tolerant forests, or meadows already exist or is the landuse unsuitable)
2. Water level dynamics (duration, frequency and amplitude)
3. Flow velocity and diversity (critical for vegetation - standing water conditions - and fine sediment accumulation)
4. Floodplain relief (status)
5. Connectivity (status)
6. Floodplain habitat diversity and management of existing FFH habitats

Further aspects of land availability and ownership or compensation for farmers and flood protection (flood retention efficiency) are important. Without the acceptance and awareness in the local population, restoration measures are difficult to realise.

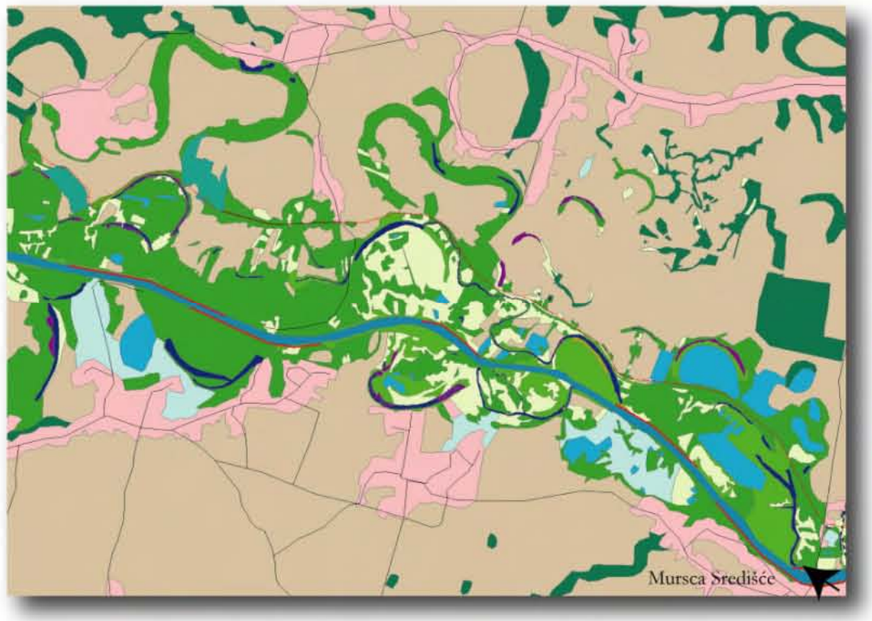
Fig. 49 (next page): Location of the eight action spots

Action spots along the lower Drava and Mura Rivers

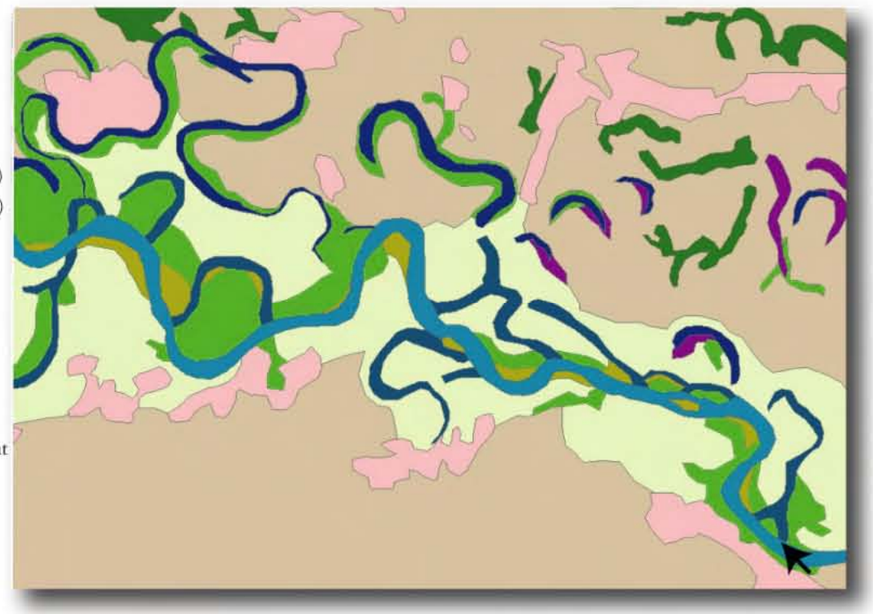


Action Spot Nr. 1 Mura River upstream Mursca Središće (HR), rkm 75

The spot is situated upstream of Mursca Središće and can be seen as the last recent engineering stretch in the strongly regulated upper Mura in Slovenia and Austria. The straightening of the main river and closure of all side channels was done after the second world war.



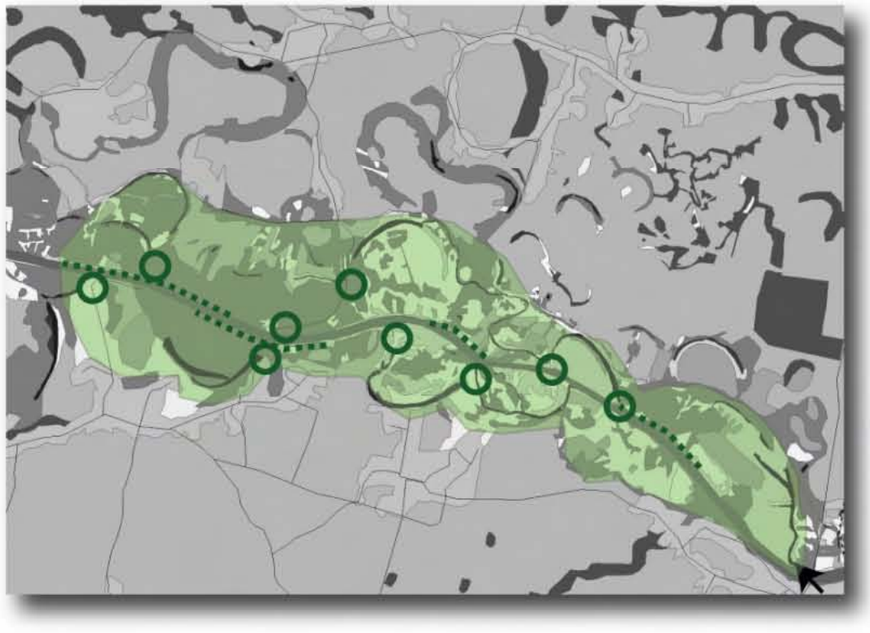
Current habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike



Historical habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map based on maps after the second world war originally mostly sinuous to meandering charcteristics

Picture: Current situation with monotonous and sectoral enforced banks (compare vision picture 1 on page 32).



Restoration measures:

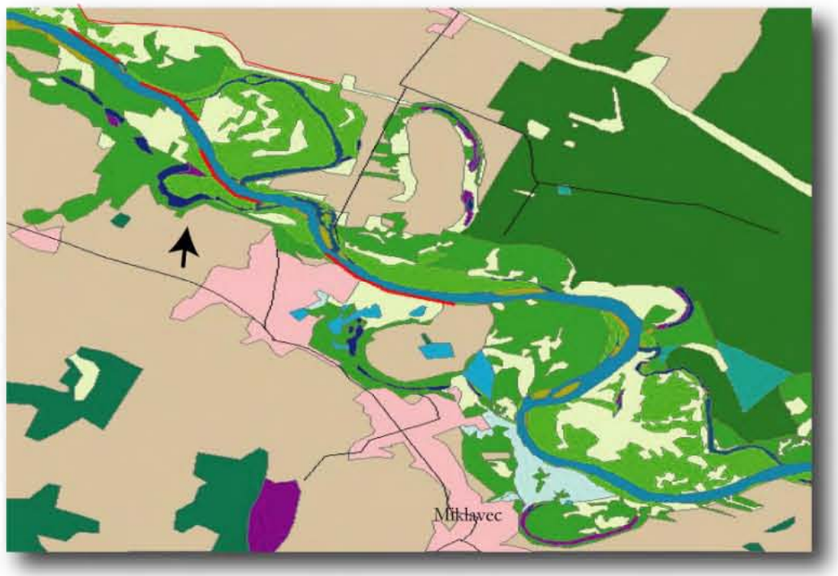
Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

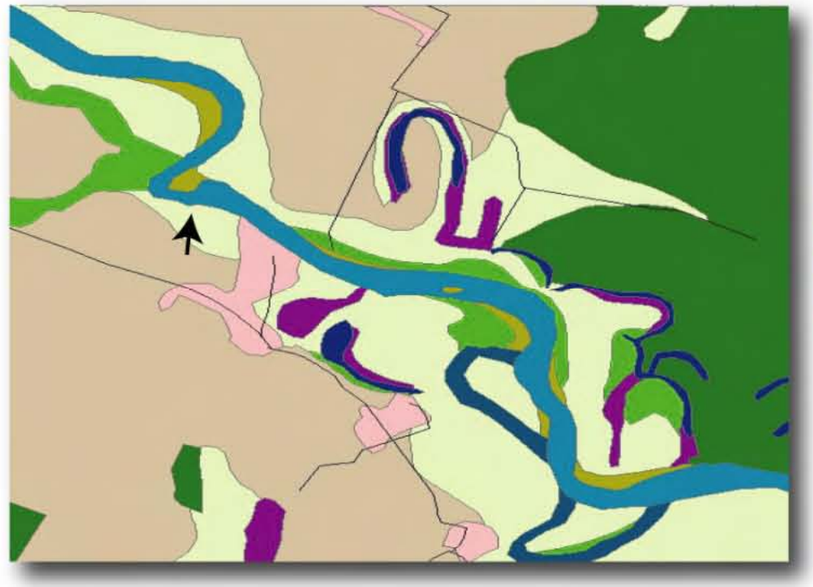
Restoration of floodplains including the re-location of flood protection dykes

Action Spot Nr. 2 Mura near Miklavec (HR), rkm 55

This spot is situated about 15 rkm downstream from Mursca Središće and illustrate in its upper part a very recently straigthened reach and in its lower course a reach with still good hydromorphological conditions. The engineering works in the upper part include a typicall meander short cut by closing the former channel.



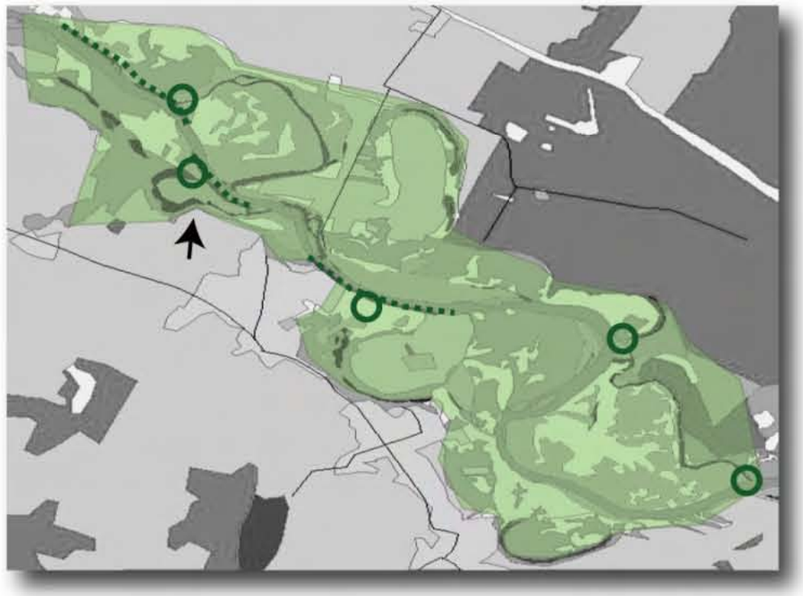
Current habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike



Historical habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map based on maps after the second world war originally mostly sinuous to meandering charcteristics.

Picture: Current situation with meander cut-off (compare vision picture 1 and 2 on page 32).



Restoration measures:

Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

Restoration of floodplains including the re-location of flood protection dykes

Action Spot Nr. 3 Mura near Murakeresztür (HU), rkm 15

This spot is about 15 rkm upstream of the Mura mouth into the Drava. The menaders were not straigthened but fixed by bank protection (rip-rap) in the steep banks.

Current habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike

Picture: Current situation with fixed meander bends by rip-rap (compare vision picture 2 on page 32).

Historical habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 with unprotected steep banks and strong meander dynamics.

Restoration measures:

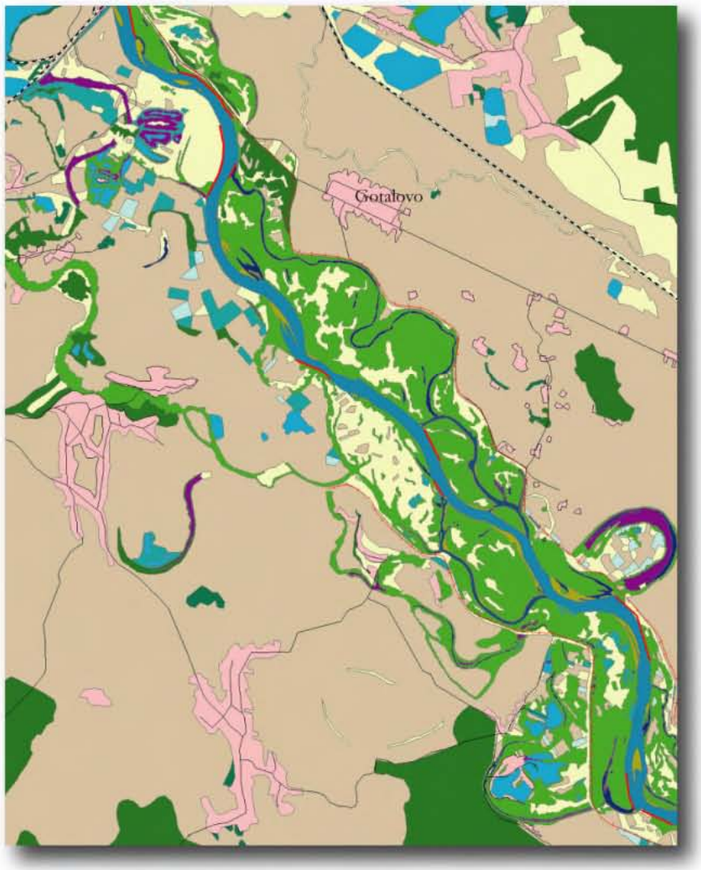
Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

Restoration of floodplains including the re-location of flood protection dykes

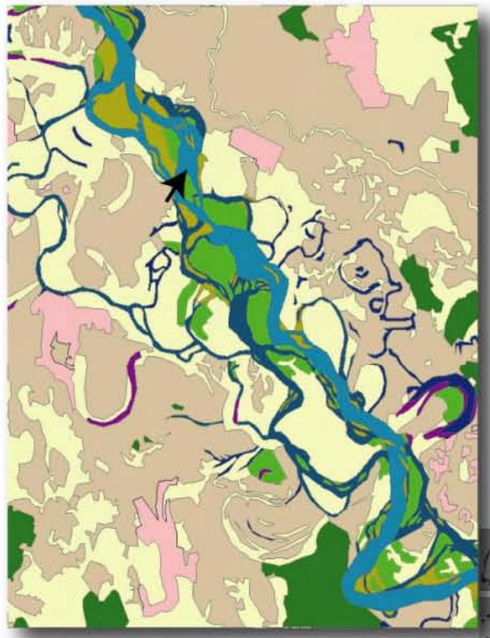
Action Spot Nr. 4 Drava near Gotalovo (HR), rkm 215

This spot is about 20 km downstream from the Mura confluence and characterised by various mixed gravel and sand habitats and decreasing slope. The transition zone is characterised by anabranching and meandering. The river width is today considerably reduced due to strong incision effects.



Current habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike



Historical habitats

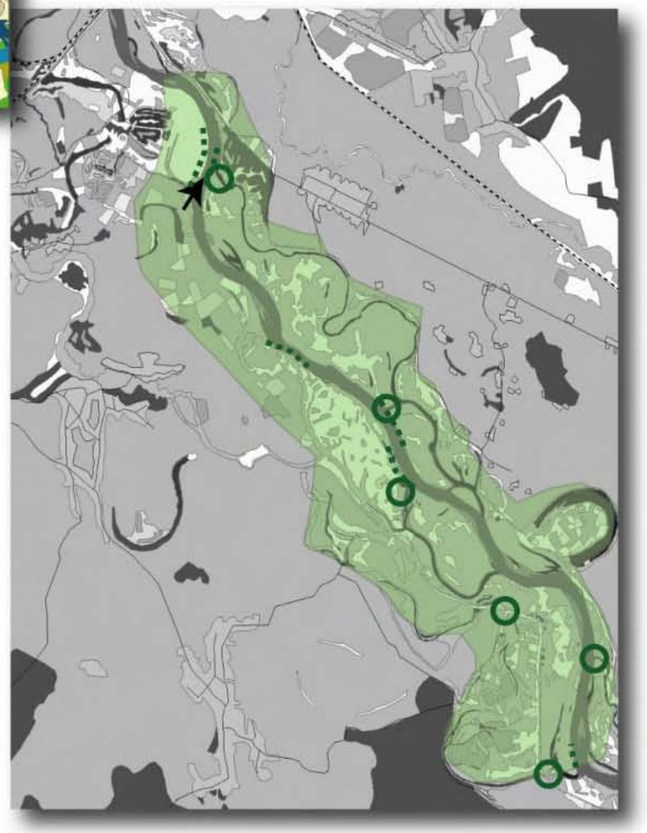
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 with many side channels in the upper part and transition towards meanderinf channel in the lower part.

Picture: Current situation with fixed banks and closed side channels (compare vision picture 3 on page 32).

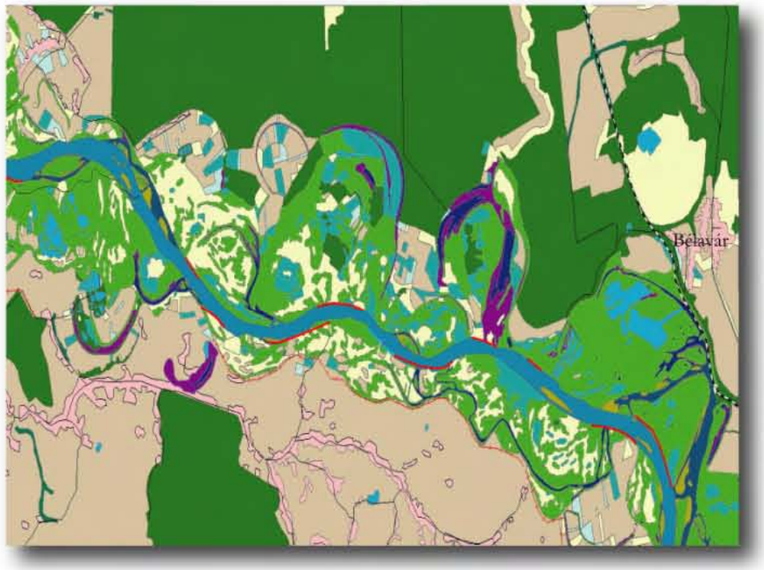
Restoration measures:

- Removal of bank reinforcement (rip-rap) and other river training structures
- Re-connection of oxbows and former side-channels
- Restoration of floodplains including the re-location of flood protection dykes



Action Spot Nr. 5 Drava near Bélavár (HU) and Novo Virje (HR), rkm 200

This spot is spread over 15 km close to the villages of Bélavár and Novo Virje (the dam "Novo Virje"was planned within this reach) and is characterised by straightening and meander shortening (in particularly the bend south of Bélavár which was cut-off in the 1980ties and which is one of the core zones of the Danube-Drava national park) increase the ongoing channel incision of this reach.

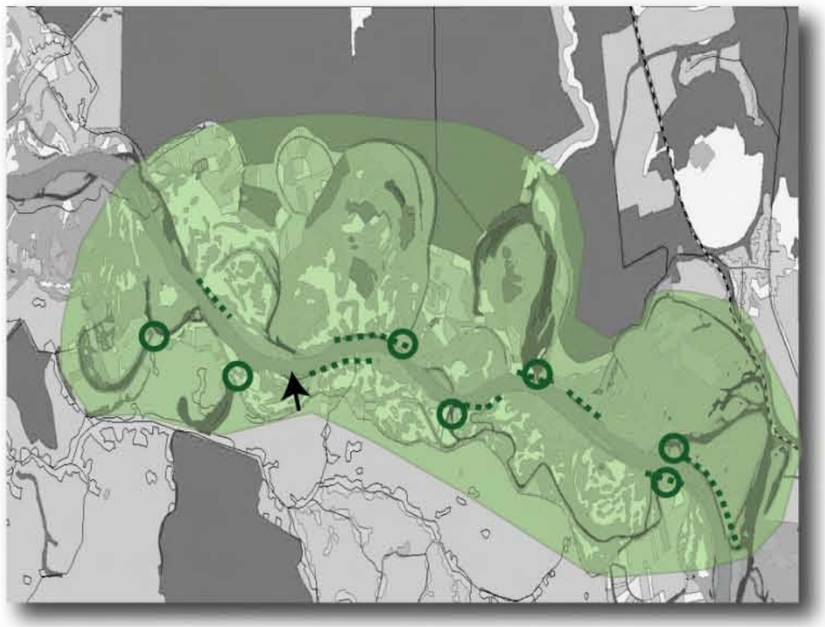


Current habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike

Historical habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 showing the meander reach connected to the large lowland forest in the north.

Picture: Current situation with regulated channel but still large and diverse floodplain area in the north (compare vision picture 3 and 4 on page 32).



Restoration measures:

Removal of bank reinforcement (rip-rap) and other river training structures

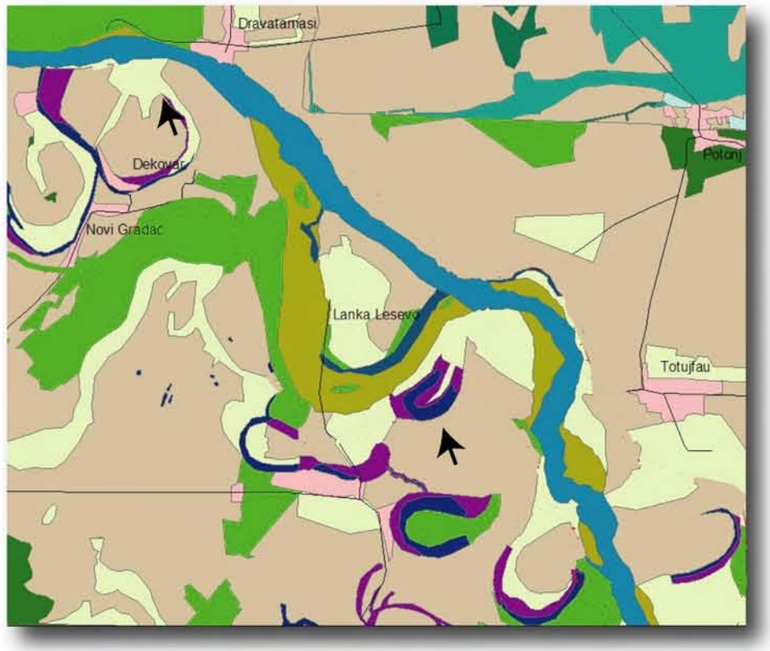
Re-connection of oxbows and former side-channels

Restoration of floodplains including the re-location of flood protection dykes

Action Spot Nr. 6 Drava near Detkovac (HR), rkm 138

This spot is situated about 10 rkm downstream from Barcs and was strongly straigthened in the past. Due to the relativly far flood protection dikes on the Croatian side a lot of possibilities for the reconnection of side-channels are given. The whole are is inside of the proposed landscape protection area.

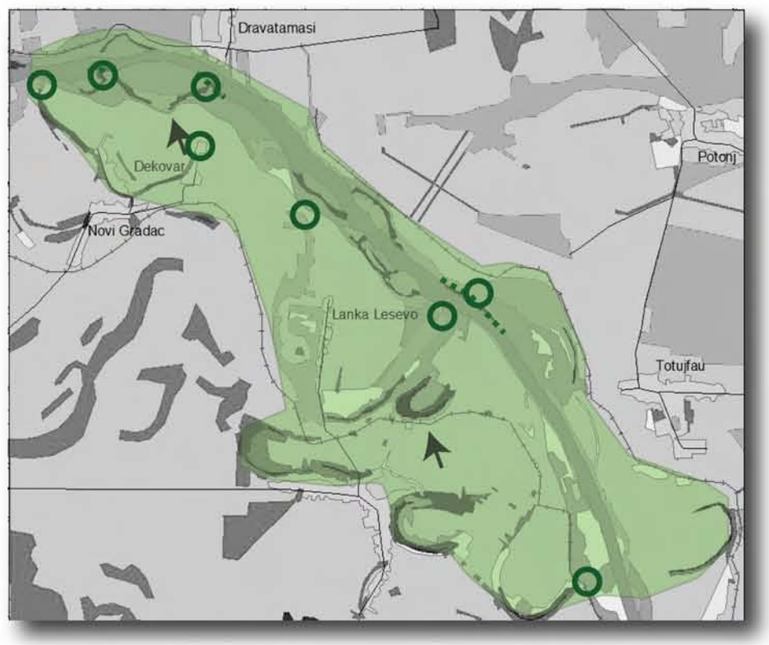
Current habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike



Historical habitats
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 showing already several meander cut-offs.

Aerial images: Current situation with regulated channel and isolated oxbows (compare vision picture 4 on page 32).



Restoration measures:

Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

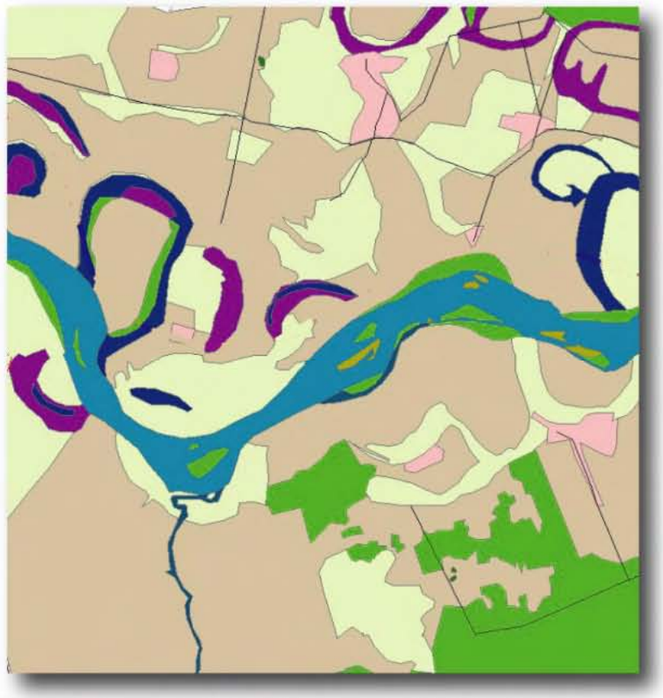
Restoration of floodplains including the re-location of flood protection dykes

Action Spot Nr. 7 Drava near Zaláta (HU), rkm 108

This spot is about 40 rkm downstream from Barcs (HU) and was subject of river engineering works such as the narrowing of the flood protection dike in the 1970ties in Hungary and the meander cut-off in Croatia within the last decades. However the main regulation works go back to the 17th and 18th century (similar for spot 6) making restoration efforts more complicated due to the substantial channel incision.

Current habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike



Historical habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 indicating already many river shortening works.

Satellite image (GoogleEarth): Current situation with cut meander and closed side channel (compare vision picture 4 on page 32).

Restoration measures:

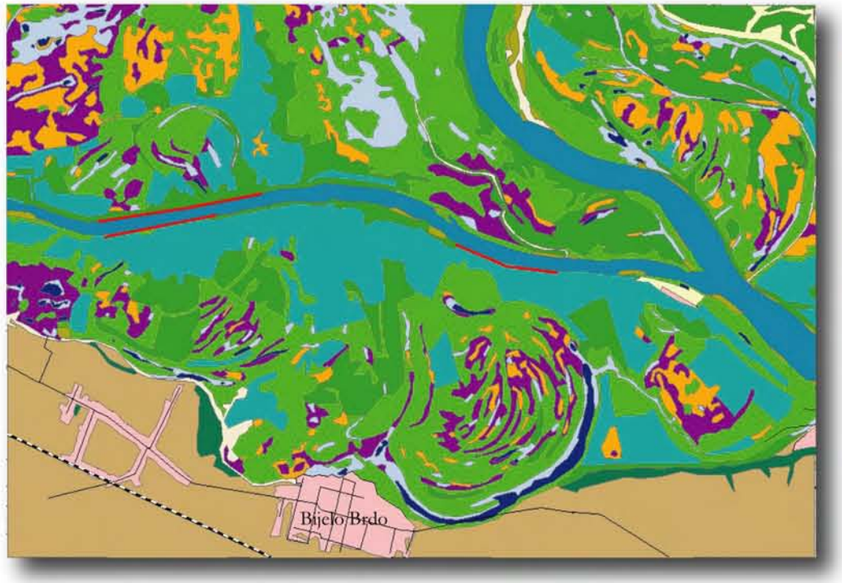
Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

Restoration of floodplains including the re-location of flood protection dykes

Action Spot Nr. 8 Drava near Ajmas (HR), rkm 3

This spot includes the very last Drava reach towards the confluence with the Danube. As the river is used as waterway to Osijek the river was straigthened in the 19th century. The area is integral part of the Kopački Rit floodplain complex strongly influenced by Danube but also by a hydromorphological intact Drava.



Current habitats

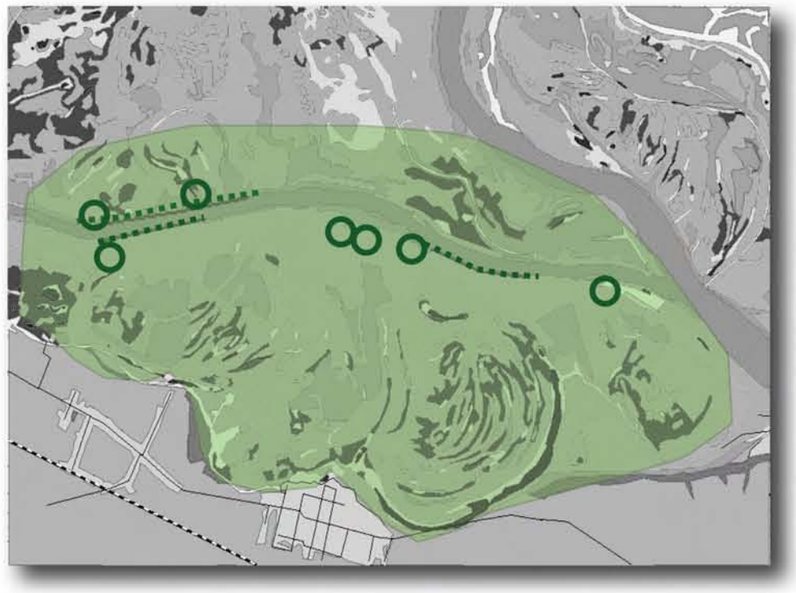
- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Lowland hard wood (oak)
- Reed
- Meadows
- Intensive meadows
- Filled gravel pits
- Poplar plantations
- Arable land
- Settlements
- Major bank reinforcement
- Flood protection dike

Historical habitats

- Main channel
- Side channel
- Oxbow
- Gravel and sand bars
- Softwood (willow, poplar)
- Hard wood
- Reed
- Patures, meadows
- Arable land
- Settlements

Historical map from 1880 showing the fluvial landscape of the Danube confluence.

Satellite image (GoogleEarth): Current situation with fixed banks and abandoned oxbows which are regularly flooded (compare vision picture 4 on page 32).



Restoration measures:

Removal of bank reinforcement (rip-rap) and other river training structures

Re-connection of oxbows and former side-channels

Restoration of floodplains including the re-location of flood protection dykes

5.2. Drava and Mura from above: The living Vision

The following images (three of them are marginally changed by photomontage) give an impression of restoration targets for both the Lower Mura (left) and Drava (right) showing existing short stretches which could serve as reference sites. Both upper images belong to stretches with more islands side-channels and gravel and sand bars and the lower images represent the typical meander rivers of lower stretches with large point bars and steep banks (Credit: A. Mohl/WWF).

1

2

3

4

6. Photo gallery: Nature and people along the Drava and Mura Rivers

Credits: Jiri Bohdal, Arno Mohl/WWF, Mario Romulic (www.romulic.com)













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