River bank restoration on the upper Danube between Vohburg and Neustadt/Donau for habitat enhancement and improvement of ecological status

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Status quo

Due to stream regulations implemented in the past 200 years, which allowed straightening of the river and the building of hydropower dams and dykes, the Danube lost its natural dynamics and its diversity in bed and bank morphology. Aside from the free flowing stretches between Straubing and Vilshofen (this reach is free flowing but has

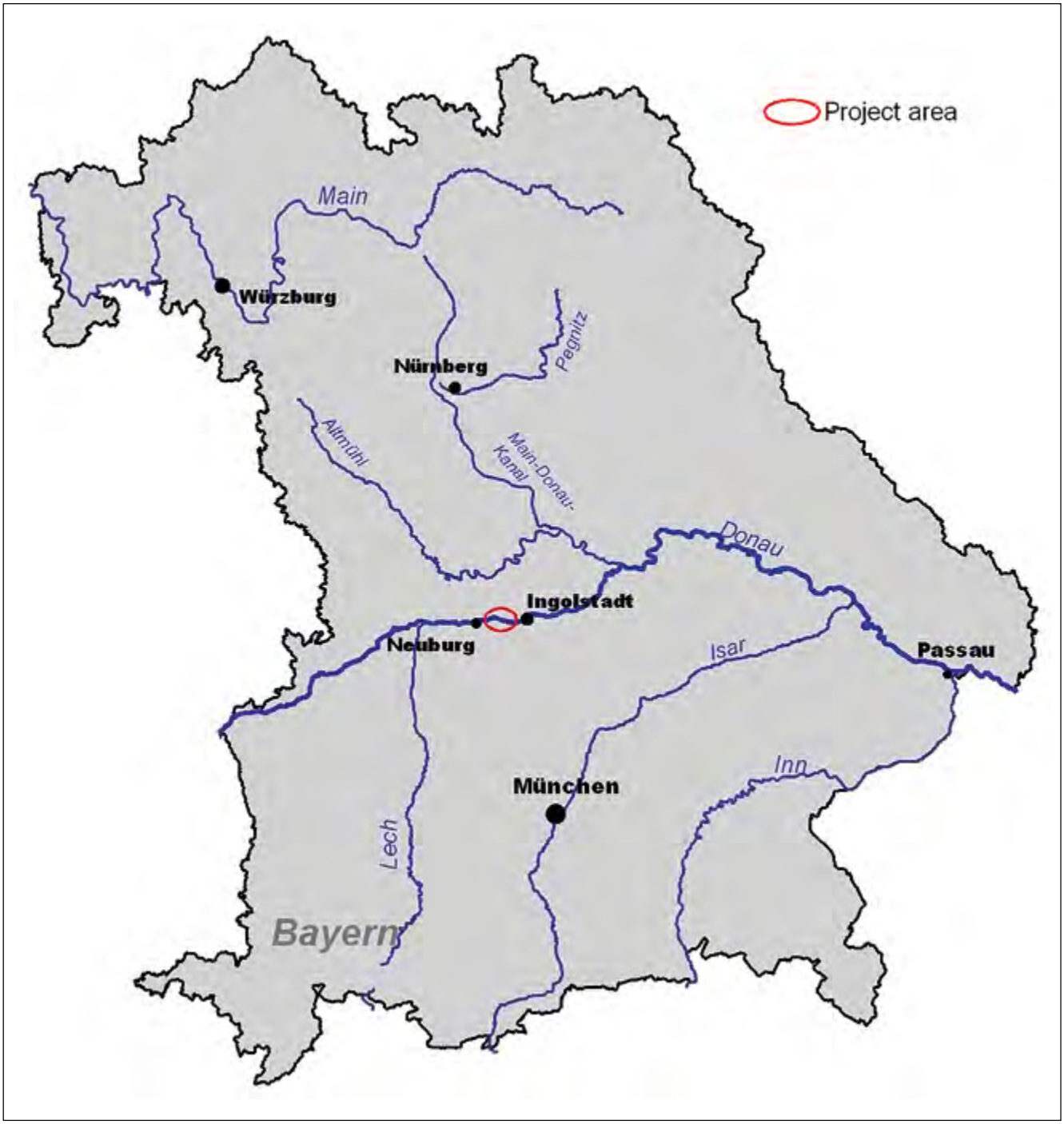

Figure 1. Project area

embankments due to shipping), the banks of the Danube are mostly fixed on both sides by heavy stone embankments squeezing the Danube in a "corset".

Environmentally, the consequences were the loss of flood plains and alluvial habitats and biodiversity. Additionally, because of the steep river banks and the monotonous stream bed, the Danube lost its recreational attraction. While the remobilization of flood plains is difficult to achieve, the restoration of river banks is simple and inexpensive.

Ten years ago the State Office for Water Management, Ingolstadt, in Bavaria started with the removal of the stone corset between Vohburg and Neustadt/Donau *(figure 1)*. On both sides a corridor of 50 m was available for stream bed dynamics and the connection between river and flood plain.

Goals of the project

The goal of the river bank restoration was to improve bank structure and bank habitat and to achieve better interactions between river, riparian zone and flood plain and also improved accessibility for the public.

Various measures were tried to gain a high diversity in habitat and bank morphology for the benefit of fish and macroinvertebrates. Bank restoration started with the removal of the silt depositions along the banks which had resulted from flooding, creating elevated bank structures. Consequently, the riparian zone and flood plains are more often inundated and new aquatic and semi-aquatic habitats can develop.

Implementation

Following are some examples of river bank restorations. The measures were undertaken as "maintenance" without the need for water permission actions.

- **Bank restoration at Vohburg/Gaden – Removal of embankments and construction of steer groins**

Starting in 2010, riprap was removed and the stones were used for building 8 to 10 m long triangular steer groins along the bank *(figure 2)*. The groins are slightly inclined with the current which created alternating overflowing and non-overflowing sections. They guide the water flow to the unprotected banks and initiate side erosion, bank and flow diversity (zones for rheophilic species with high flow and zones for more limnophilic species with low current) and create varying depths and little bays with various substrates. Dead wood *(figure 3)*, bundles of willow branches and trunks of trees were used sometimes to emphasize the effects and created new habitats.

- **Bank restoration at Pförring - Removal of embankments and construction of flow around steer groins**

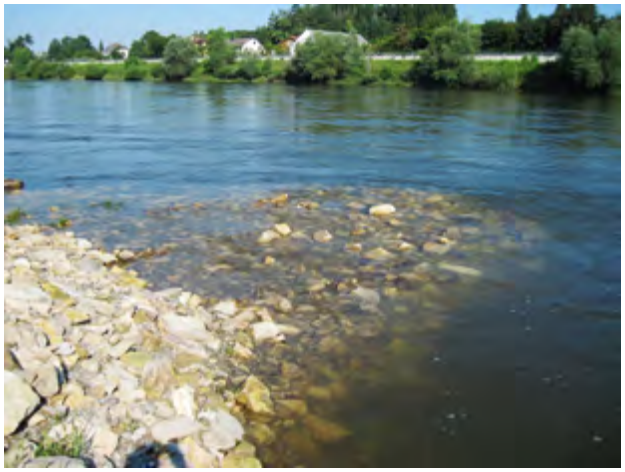

Figure 2. *Steer groins using rocks from embankments, covered during medium discharge*

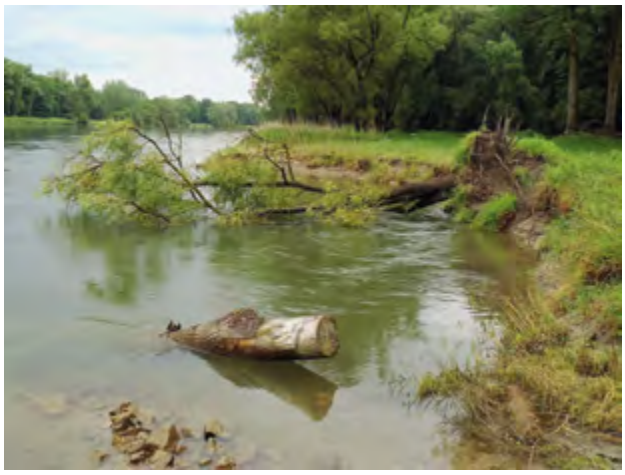

Figure 3. *Introduced dead wood from the riparian zone in the inter-groin field*

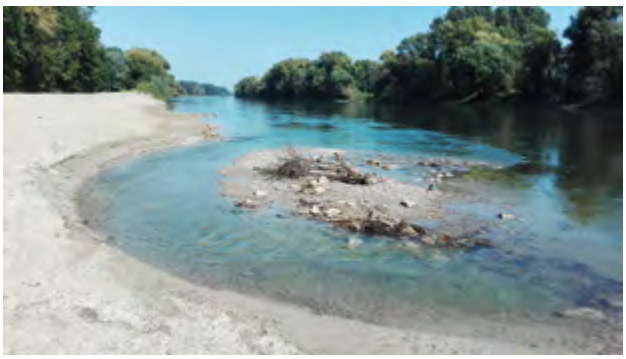

Figure 4. *"Island groins" with shallow gravel banks and side streams*

Similar to the groins described above, oval groins where the current has to circle around, were built within 5 m from the shore, 10 m long and slightly inclined to the current. They act like small islands producing high flow and substrate diversity with side streams *(figure 4)*. While the rocks from the embankment were used for building the groins, the silt depositions had to be removed by chain dredger and trucks *(figure 5)*. They were used for dyke construction nearby.

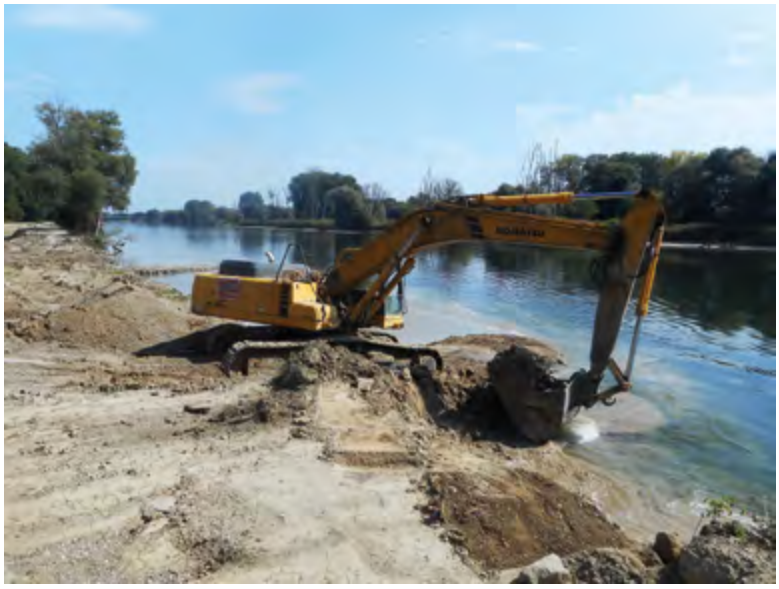

Figure 5. Removal of embankment and silt deposition by chain dredger

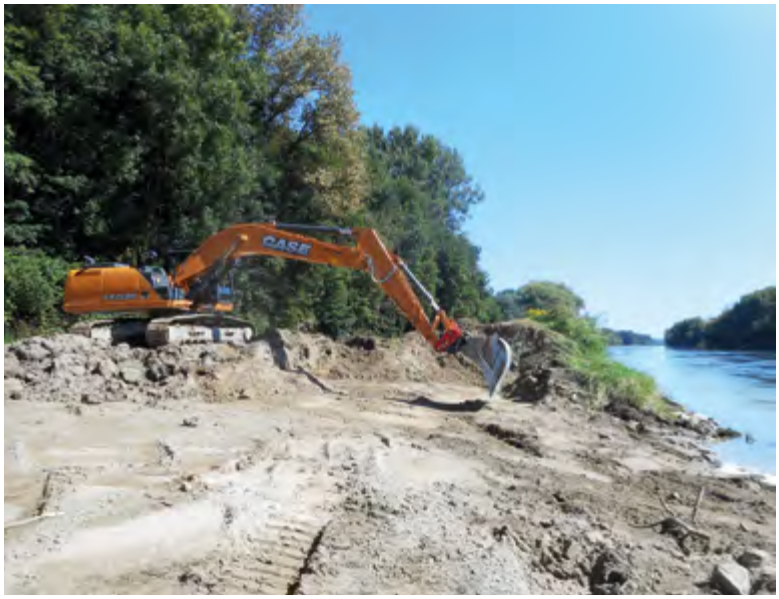

Figure 6. Shallow water zones with gravel banks

- **Bank restoration at Pförring - Removal of embankments and creation of shallow water zones with frequent overflows**

Shallow water zones allow good interaction between river and riparian zones through frequent flooding. These lenitic zones provide habitat for many macroinvertebrates and fish fry. The rocky-sandy beach offers pioneer species like sand pipers and ground beetles (Carabides) better habitats and provides recreational areas for humans.

At the start of restoration silt depositions were removed to the original level and the extracted material was used for dyke restoration. After clearing the foreshore, the embankment rocks were shifted towards the Danube. In this way aquatic and semi-aquatic zones were connected and accessibility for humans was made possible *(figure 6).*

- **Bank restoration at Pförring – Removal of embankments and creation of treed islands in the riparian zone**

In agreement with the Nature Conservancy, areas with silver willows on elevated banks were protected and not removed during restoration work. They remained as treed exposed islands surrounded by flowing water and supply with their "aquatic structure of disturbance" and dead wood greater habitat biodiversity for fish larvae and fry.

- **Bank restoration at Neustadt on the Danube – creation of a new adjacent water course**

A former arm of the Danube which was connected only downstream was opened upstream in order to create a 250 m long adjacent water course. Lateral connections in the channelized Danube are very important for habitat enhancement, especially for typical Danube fish species like Streber *(Zingel streber)* or Danube roach *(Rutilus pigus).* Also, when flooding occurs, which is now more frequent, it can more easily reach the plain. Flooded riparian zones which for example enhance soft wood development are very limited on the Danube River.

Conclusions

The hydro-morphological bank restorations and the combined aquatic and semi-aquatic habitat enhancements have produced good ecological results. With little economic expenditure, morphology of river banks and habitat diversity was improved in a short period of time. The Danube is now no longer just threatening due to flooding but a living river with a social function.

And, last but not least, the restoration measures are a further "brick in the wall" for the European Water Framework Directive (WFD) in order to improve the ecological status of the Danube. These measures are in compliance with the management plan required by the WFD and will be undertaken along other stretches of the Danube. Spawning beds for rheophilic fish species and new habitats for macroinvertebrates are the focus for further restorations.

References and further reading:

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