# Innovative river management – combining ecology, navigation and river engineering

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The Austrian Danube River is affected by several severe, conflicting processes and influences. Caused by the retention of bedload in the catchment (e.g. torrent control) and reservoirs of hydropower plants almost no bedload is entering the reach downstream of Vienna, leading to a deficit of bedload and consequently to river bed degradation. The prevented side erosion and braiding restricts the lateral input of bedload to the regulated river bed itself, where the transport capacity is enhanced by the reduced channel width. Observations (Donauconsult, 2006) demonstrate an average bed degradation rate of 2 - 3.5 cm $year^{-1}$, leading to a strong downcutting of the river into its alluvium, eventually causing a river bed break through into fine, marine deposits.

As the Danube river corridor is part of an international waterway (Pan - European Transport Corridor, class VII) a continuous availability for shipping is required. Actually during low flow periods the constraint of minimum water depth for navigation is not met especially in specific areas of fords. Yearly ford dredging and refilling of the material is performed to ensure ship passage, which is a not sustainable measure.

Furthermore, the free flowing Danube downstream of Vienna is part of a National Park, which in the long term is endangered by the lowering of the groundwater table in the Aue area. In the study reach the Danube River was characterised by a partially braided morphology, with a lateral extent of several kilometres and bank as well as side channel dynamics (Hohensinner et al., 2004). Due to channelization and bank protection measures the former morphodynamics have been prohibited and entail ecological deficits. Sedimentation of side channels and in the inundation area during floods leads to a lowering of habitat quality.

The complex and diverging interests of navigation and ecology as well as other groups like hydropower companies for decades prevented a sustainable solution, satisfying all interests in an acceptable way. Since river bed degradation has been continuing at an even enhanced rate the pressure of finding a compromise urged more and more, especially as the National Park suffers from the declining water level and the improvement of the international shipping way got increasing importance on an EU level.

**Integrated River Engineering Project on the Danube East of Vienna**

The Austrian Ministry for Transport, Innovation and Technology (BMVIT) and via donau initiated the “Integrated River Engineering Project on the Danube East of Vienna” with the three major, equally weighted aims:

- Stop of further riverbed degradation by a sustainable stabilisation of the mean bed level
- Improvement of minimum water depth for navigation
- Sustainable improvement of the ecological status, especially at shorelines and sidearms, based on necessities of the National Park

A steering group was formed by BMVIT and via donau, containing scientists and experts in river engineering, navigation, ecology, spatial planning and economics as well as representatives of the Ministries and the National Park. First, alternatives that were not at all agreeable were excluded during a general planning phase, where all stakeholders were involved both in the steering group and the interdisciplinary planning team. Then several

scenarios of the selected alternative were intensively discussed and improved over several years. The main reasons for discussion were the minimum water depth, required by navigation, the extent of river restoration and the procedure of measures implementation, either being uniformely realised along the whole project reach or in an adaptive process.

As a central outcome of this working phase planning principles were defined (aiming for an environmental impact assessment):

- application of the granulometric bed improvement for river bed stabilisation
- improvement of low water depth by dredging and defined refilling of material and construction of new and modification of existing groins
- implementation of measures according to given river morphological processes
- integrated design of regulation structures, equally regarding hydraulic, morphological and ecological criteria
- realisation of measures in an adaptive form, focussing on pool reaches
- definition of width and depth specifically for the central part of the navigation channel and areas with granulometric bed improvement
- optimal use of the potential for river bank restoration and side channel reconnection
- keeping or if possible reducing flood water levels

The planning principles were commonly agreed by stakeholders, politics, navigation and ecology, leading to a river engineering solution that creates a winning situation for ecology and navigation. Only via the accepted planning principles the designing of measures could be continued, leading to modified scenarios, which were assessed and improved by the steering group and planning team in very intensive and often controversial discussions. After a total planning and discussion period of over three years, where both, ecology and navigation were willing to find a compromise, hardly to be accepted by the individual groups, an agreed set of measures was defined, aiming for a win-win situation for ecology and navigation. On the way to this success river engineering played a central role in suggesting and designing suitable and technically sound measures.

**Set of measures**

*Granulometric bed improvement*
The main measure to solve the problem of bed erosion is the granulometric bed improvement (Donauconsult, 2006). Thereby a 25 cm thick layer of approximately 40 to 70 mm coarse gravel material will be added to the bed surface (approximately 450 kg $m^{-2}$) for a width of about 220 m. The granulometric bed improvement will not be covering the total river bed, instead being focussed to pool reaches, whereas ford reaches are staying natural within the first step. Calculations by bedload formulas and numerical models demonstrate that the bedload transport capacity can be reduced down to about 10 % of the existing yearly volume of around 400,000 $m^3$, thus minimizing bed degradation (Donauconsult, 2006).

*River restoration for improving the ecological status*
The main restoration measures consist of:

- Riverbank restoration
- Sidearm reconnection
- Stop of river bed degradation

The removal of bank protection at all inner bends, the allowance of side erosion and the reconnection of the former side channels will lead to a significant improvement for ecology (Reckendorfer et al., 2005).

*Low water regulation for increasing water depth - improvement of navigation*
The measures for the improvement of navigation are:

- Dredging and defined refilling of material
- Construction and modification of groins
- Granulometric bed improvement

The concept of dredging and defined refilling of material leads to a sediment balance. Together with modified form and length to distance relations of groins and a raise of the river bed by the granulometric bed improvement this will increase the water depth at low discharges and simultaneously reduce sedimentation processes in groin fields as well as increase side erosion tendencies in reaches with restored banks.

The realisation of these innovative measures implies the necessity of monitoring the success in Nature, based on an interdisciplinary monitoring team.

In order to reach this set of river engineering measures, being accepted by ecology and navigation and allowing to achieve the three major project aims, an interdisciplinary, integrative approach was developed. The from the beginning of the process given interaction between the steering group, BMVIT, via donau and the planning team, whereby each of the partners included experts from several fields, formed the key for being able to find a generally accepted solution for ecology and navigation. A prerequisite was a common language across disciplines, a common will to understand the problems of the “other” side and a special communication and discussion culture. The more than three years process of discussion and planning finally let to a win-win situation, thus stimulating future planning procedures with such complex boundary conditions to be handled in a similar way.

**References**

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