

# Realistic restoration of the Gemenc region of the Danubian floodplain based on hydroecological priorities

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## General characteristics of the region

The Gemenc floodplain lies between 1498 and 1470 stream km of the River Danube, 160 km south of Budapest (Fig. 1). The main discharge of the river is 2200 m<sup>3</sup>/sec, the gradient is 5 cm/km and the water level fluctuation is near 9 m along that section. This Danubian floodplain covering 18 000 hectares is unique in Central-Europe due to the great diversity of side arms and backwaters in different stages of succession. Data bases on different habitats and their communities have been created. Due to water engineering manipulation (cut-offs), the river bed of the Danube is 150 cm deeper than 100 years ago (Fig. 2). The negative regional effect of this increase in depth can be compensated only with a highly-sophisticated and specialised revitalization strategy based on sound principles (KALOCSA 2002).

**Key words:** restoration, Danube River, floodplain, river regulation

## Necessity of restoration

Information on hydroecological conditions, aquatic organisms (especially pro- and eukaryotic algae, mosses and invertebrates) and their interactions in protected inland waters (lakes, wetlands, running waters) is quite limited, even in countries with advanced nature conservation. In other words, it is not clear what we protect in a relatively closed water body where sophisticated processes occur. At the end of the 19<sup>th</sup> and the beginning of the 20<sup>th</sup> century, conservation principles were not taken into consideration along rivers (BUZETZKY 2002). Today, however, they can not be neglected, and the general protection of the whole affected water course as well as the special consideration of protected areas must be realised both in the planning phase and during river regulation works. This statement is valid even if the original conditions are impossible to reconstruct with present river regulation.

Without knowing aquatic conservation values and limnological processes, however, reconstruction or

revitalisation can not be planned and realised successfully. Understanding of sophisticated metabolic processes has developed considerably over the past decades. In recent years the importance of biodiversity also gained new interest. These developments increased the need for large scale, basic limnological surveys in our protected waters to provide a firm basis for maintenance and restoration (BERCZIK 2003).

## Former and present state

In addition to flood control, the aim of river regulation in the Gemenc region of the Danube was to shorten the duration of floods, to fight ice drift and to provide an adequate navigation channel since the second half of the 19<sup>th</sup> century. Among other interventions, meandering stretches were cut (i.e. the river was shortened), side arms were blocked to keep the entire water discharge in the main arm, and banks were stabilised causing a nearly 1.5 m deepening of the river bed. As a direct effect on the floodplain, both the depth of surface waters and the water table lowered and sedimentation sped up.

Today the two opposing processes (deepening of the river bed, sedimentation of floodplain waters) have decreased the frequency of floods in the region and the mean annual water level of surface waters, and the water table has dropped. River regulation is unfavourable for conservation goals to maintain communities and (semi)natural ecosystems long-term. The Gemenc floodplain is also a wetland where river regulation caused drying, even under greatly fluctuating water levels (Fig. 3). Large floodplain areas that are dry for long periods can be under several metres of water during floods, increasing current velocity change from 0 to 5 m/s.

At mean water level in the River Danube has wetlands, several-metre-deep lakes, slow or fast flowing waters in the Gemenc floodplain with large areas completely dry. At low water level, wetlands dry out, standing waters shrink or even dry out. As the water level and discharge decreases, the current slows down or stops, and the floodplain becomes considerably isolated from the main arm. At high water level

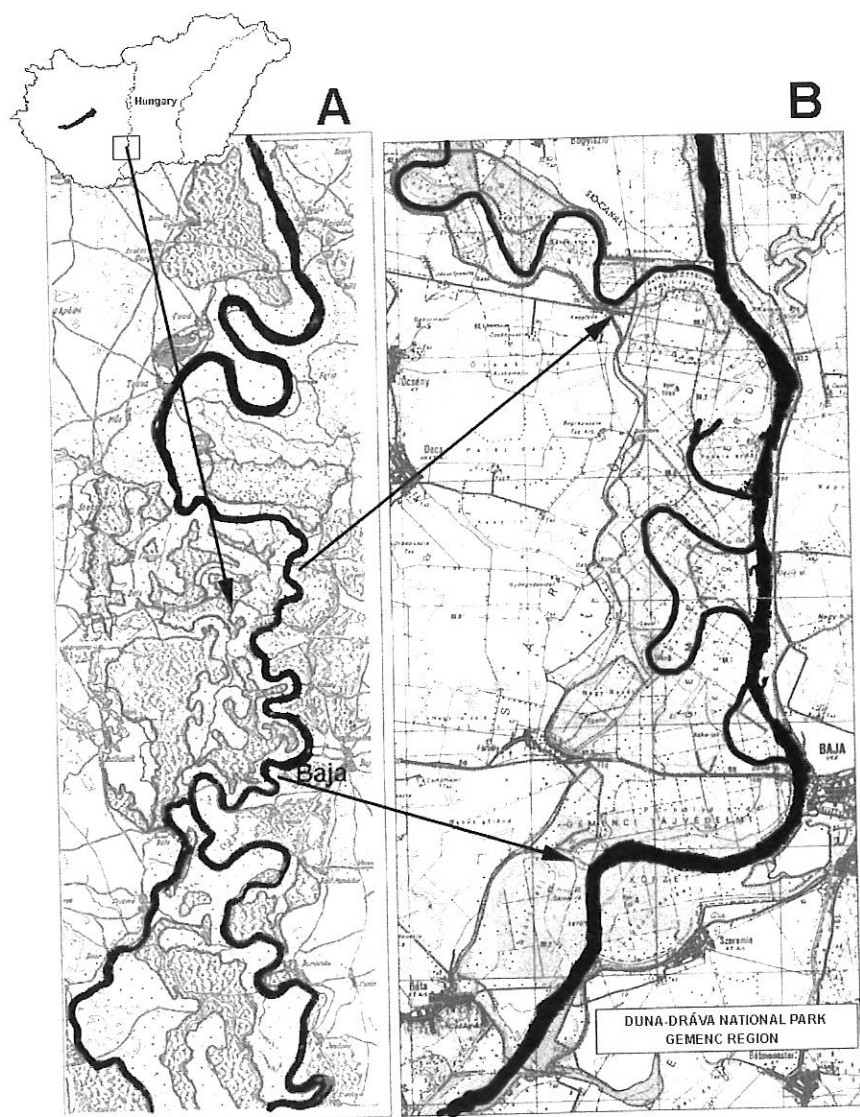


Fig. 1. Map of Gemenc floodplain (BUZETZKY 2002). **A:** before the regulation; **B:** after the regulation.

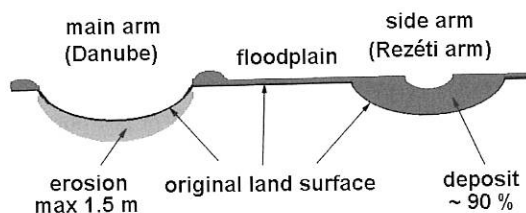


Fig. 2. Consequences of the regulation (KALOCSA 2002).

even standing waters flow. During high floods the whole floodplain is covered, uniting separate water bodies resulting in water exchange.

In addition to floodplain dynamics, other factors unrelated to water-level fluctuation must be considered. Seasonal and daily weather changes affect volume, current, sediment, light and heat conditions of floodplain waters, along with solution characteristics, species composition and abundance of aquatic communities (DINKA 2003, SCHÖLL 2003).

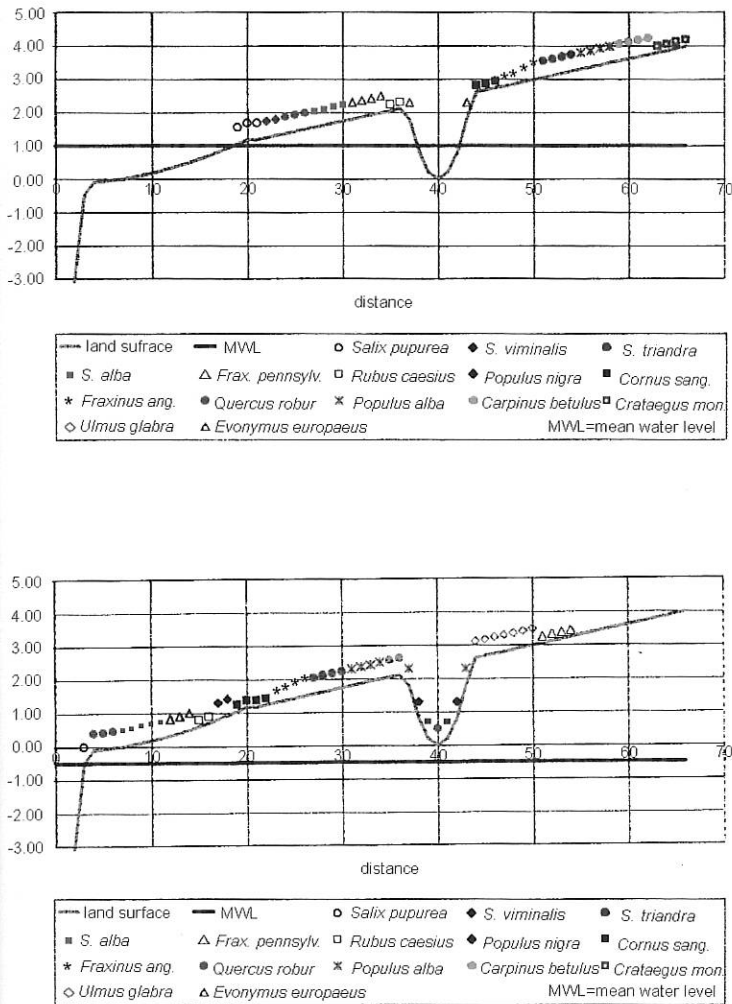


Fig.3. Floodplain vegetation after an average 1 m decrease of the water table (ZELLEI-BUZETZKY unpubl.).

## Fundamental conditions for revitalization

To plan an ecologically and biologically effective revitalization, a scientific data base describing the spatial and temporal diversity and variability of ecological conditions and communities is necessary to evaluate changes. On the basis of our 4–8-year studies, an appropriate data base (not fully published; STETÁK 2000a and b, CSÖRGITS & HUFNÁGEL 2000), is available for a considerable part of the Gemenc region. Findings which elucidated ecological conditions and differences between communities (e.g. chemistry, plankton) were especially

important in the determination of revitalization conditions.

Results of many water chemistry data series repeatedly proved that several characteristics, such as oxygen and nitrate concentrations and total dissolved solid content, indicate how water of the main arm changes in the side arms (DINKA 2003, DINKA et al. 2006).

Species composition and abundance of Rotatoria planktonic communities were studied in 3 neighbouring but hydrologically different side arms for 3 years (2002–2004). The Grébec side arm, a 5-km arm formed by the fusion of several smaller branches at its upper part, is charac-

Table 1. Taxa and individual number of planktonic Rotifer communities in different water bodies in the Gemenc floodplain

|                 | total number<br>of taxa | number of taxa<br>only detected<br>at this site | number of taxa<br>in different<br>sampling periods | ind./10 l  |
|-----------------|-------------------------|---|--|------------|
| Duna rkm 1497   | 20                      | 0   | 1–9  | 0–14.000*  |
| Grébec side arm | 36                      | 4   | 5–11   | 700–19.000 |
| Rezét side arm  | 40                      | 1   | 5–11   | 150–37.650 |
| Vén side arm    | 36                      | 3   | 1–11   | 200–8.000  |

\* No Rotatoria was found at extremely high water level and at 1–2 °C water temperature, while once 14.000 ind./10 l was recorded after a long, low water period, when there was no direct connection between the River Danube and the side arms.

terised by a continuous current if water discharge in the main arm is higher than average. Unless water discharge is low, a current flows in the Rezét side arm, which does not bear further side arms or large inlets (length: 15 km). The Vén side arm, a 4.5-km stretch with one large inlet, has a continuous current. Side arm samples were compared with main arm data collected at the same time. Rotatoria communities were clearly affected by the hydrological differences between the main arm and the side arms (Table 1; SCHÖLL 2004).

The average number of Rotatoria individuals was 2500/10 l and 3000–5000/10 l in the Danube and the three side arms, respectively.

## Opportunities for revitalization

The revitalisation action plan outlined below takes into consideration two basic facts: (1) Conditions before river regulation began (130–150 years ago) can not be reached today. The correction of the 1.5-m deepening of the river bed due to river regulation is also unrealistic. (2) Revitalising formerly diverse habitats and species composition by providing longer water cover to areas now dry most of the year is a realistic aim. Goals of the revitalisation plan are:

- Construct adequate regulation measures in water retention areas to provide longer water cover and shorten dry periods caused by water level decreases.
- Determine habitat types most affected by water engineering manipulations (e.g. small wetlands, diverse littoral structures) to ensure they can be formed during revitalisation interventions.

- Select dead arms and dry river bed sections to reconstruct by connecting water bodies of different depth and articulation. This sophisticated side arm network would provide refugia, even during low water periods.
- Use gravity to supply water from the higher elevation Sió canal at the northern end of Gemenc to improve river bed deepening caused by declining floodplain water supply.
- Store water from floods in the Sió canal, which might also be used to improve conditions during extremely dry periods (Fig. 1; Buzetzký 2002).
- Build a monitoring system to study basic conditions, continuously follow the realisation of stated goals, mathematically describe ongoing processes and provide feedback information for future corrections.

## Acknowledgements

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