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Restoration of the urban oxbow lake Alte Donau – a case study

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With the settlement in the Danube river floodplain and the growth of Vienna to a big city, the Danube River ecosystem health has been degraded by anthropogenic impacts (e.g. Schiemer and Waidbacher 1992, Chovanec et al. 2002, Janauer and Kum 1996, Hein et al 2006, Janauer et al. 2008). In the long-term the river basin close to Vienna has been changed and became heavily modified (long-term socio-economical aspects of Danube basin history see DN31, Schmid and Haidvogel 2015).

Alte Donau was cut off from the Danube River for more than 160 years (Dokulil et al. 2010). Over decades, this urban oxbow lake had attracted people living in the capital of Austria, Vienna, for many reasons. Besides the economic use of Alte Donau such as for boating, fishery, and poultry farming (goose husbandry), this groundwater-seepage lake has also a long tradition of serving as a popular recreational area *(Figure 1).* In the eighties, Löffler (1988) summarized ecological surveys ranging from phytoplankton and water plants to fish and water birds. He described this shallow lake as a mesotrophic ecosystem. About five years later the ecosystem changed as the nutrient loading increased coinciding with the strong reduction of the submerged vegetation cover (Donabaum et al. 1999, Dokulil et al. 2000, 2006, 2011). At that time Alte Donau was shifting from a macrophyte clear-water state to the state of a turbid water body with heavy phytoplankton blooms (Scheffer and van Nes 2007, Jeppesen et al. 2010). The lake's situation became particularly critical as the phytoplankton bloom was largely due to *Cylindrospermopsis raciborskii* (Mayer et al. 1997, Dokulil 2015). This

Figure 1: *Alte Donau comprises two large main basins, the so called 'Obere Alte Donau' and 'Untere Alte Donau'. The elongated shape of these two basins with an area of 1.5 km² refers to the former river branch of the Danube River. The lake and its surrounding parks and restaurants serve as a popular recreational area in the city of Vienna. (Photo: Untere Alte Donau, 2015, www.lakeriver.at)*

cyanobacterium, which is mainly occurring in sub-tropical shallow lakes after nutrient enrichment (Dokulil and Teubner 2000), is well known for potentially producing cyanobacterial toxins.

The awareness of the degraded state of the ecosystem Alte Donau in the nineties took action in urban planning by shifting the focus from water exploitation to ecosystem health (Figures 2-4) satisfying both nature conservation and the use for recreation and cultural values. Various management measures and concepts for reducing the nutrient load, biomanipulation and sustainable landscape planning were used as lake restoration tools to improve the ecosystem health of Alte Donau (e.g. Donabaum et al 1999, Teubner et al. 2003, Dokulil et al. 2000, 2006, 2011).

The book about the restoration of Alte Donau (in preparation) provides a synthesis of the many facets of urban lake restoration and ecosystem observations. It mainly comprises the period 1993-2014. More than 20 authors describe the hygienic situation, the hydrological and biotic conditions and landscape planning measures during the long-term development when Alte Donau was shifting back from an ecosystem state of an algal-turbid water body to a clear water state. This long-term urban lake description covers thus the eutrophication period before the first chemical treatment in April 1995, the 'restoration' period of chemical treatment and related measures (1995-1999), the period of the re-introduction of macrophytes (2000-2005), and the period of 'stable conditions' of the clear-water state (2006-2014).

These four main lake management periods are described from the perspective of environmental constrains (hydrological to chemical conditions), i.e. the ecosystem response mirrored by biota (from primary producers such as macrophytes and phytoplankton to aquatic bacterial assemblages, primary and secondary production, assemblages of ciliates and larger zooplankton and macrozoobenthos, assemblages of fish and water birds) to the management sustainability (restoration management and re-planting of the littoral zone, concepts of urban landscape planning) and future perspectives. Finally, the summary chapter extracts the following information: What were the keystone management actions improving the ecosystem health? Which biotic shifts were most responsible for the success of the sustained lake restoration that is superimposed by global warming?

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Figure 2: Size comparison between the freshwater jellyfish (Craspedacusta sowerbii, Fritz et al. 2007) and the submerged water plant Spiked Water-milfoil (Myriophyllum spicatum). The frequency of warm summer days with water temperature exceeding 22°C has increased by 10.5 days per decade from 1994 to 2014. Extreme hot summers favour the development of neobiota (Moog et al. 2007, Pall et al 2013) in Alte Donau as e.g. this jellyfish. (Photo: Untere Alte Donau, 2015, www.lakeriver.at)

Figure 3: Recreational areas such as public baths and beaches are in the close neighbourhood of habitat zones for animals and plants in the open water and banks. The small space patchiness of alternate zones satisfying both the recreational use and nature protection of urban wild life is most probably one of the greatest challenges of urban landscape planning (e.g. Hozang, in prep; Pall in prep). (Photo: Obere Alte Donau, 2015, www.lakeriver.at)

Figure 4: The Canada Goose (Branta canadensis) is one of 44 species of water birds found in Alte Donau. Field surveys of water birds were carried out in 1997/98 and 2000/01 (Raab, in prep). Other biota, as e.g. the assemblages of the many microorganisms in the water, for example the algae and water fleas (phytoplankton, zooplankton), were studied in biweekly or monthly sampling intervals for more than 20 years (1993 to 2015) and used for assessing the water quality. (Photo: Kaiserwasser, 2015, www.lakeriver.at)

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Obituary for Miklós Puky, PhD (1961–2015)

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Figure 1: Miklós Puky (Photo: zVg: IENE)

Miklós Puky was born in Budapest, on 10 March 1961. Even as a child he showed a particular interest in, and was attracted to the beauty and wonders of nature. He soon learnt to love the world of amphibians and reptiles, and he wanted to become a veterinary assistant or surgeon, or an animal tamer. In secondary school, he specialized in Biology, and took his final exams with excellent results. In 1986, he graduated as a biologist and professional translator in English from the Eötvös Loránd University in Budapest. As of September that year, he started work as a researcher at the Hungarian Danube Research Station of the Hungarian Academy of Sciences (today, Danube Research Institute of the HAS Centre for Ecological Research). He remained in this post till the day of his death. As a young researcher, for six years he had the opportunity to attend postgraduate courses mostly in conservation biology in the United States of America, England, Belgium, Cyprus and Scotland. In 1992, he defended his doctoral thesis, titled "Heavy metal accumulation in Anura populations". He got his PhD in 2005, with his work "Conservation of amphibians in Hungary".

His work as a scholar involved mostly conservational topics. He was concerned with the fragmentation, colonization and invasion issues of endangered amphibians, reptiles and also Decapods. Recently, he had broadened his aspects of study so as to include the possible effects of climate change. The conservation of the above mentioned species groups and their habitats formed a great part of his activity.

Apart from his work in Hungary, he took part in the conservation programmes of several countries from England to Nepal and the United States. He held lectures, titled "Conservation Ecology", at the Eötvös Loránd University for fourteen years, awakening the interest of many students. He also regularly gave lectures at international conferences and universities of other countries, such as – apart from the ones mentioned above – Mexico, China, South Africa and New Zealand.

His special vocation led him to environmental education, the recognition and protection of the treasures of nature, mainly those of the Hungarian wetlands, lakes and running