The Danube, a European cross-border alpine river: History, present status and future restoration needs.

Le Danube, un fleuve alpin Européen et transnational : histoire, situation actuelle et restaurations indispensables

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RÉSUMÉ

Le Danube est le fleuve européen ayant le statut international le plus affirmé avec 10 pays traversés le long de ses 2857 km, et un bassin versant de 817 000 km2 pour 85 millions d'habitants se répartissant entre 20 pays. Comme hydrosystème, il permet de multiples usages: voie de transport, source d'eau potable, récepteur d'effluents, élément nécessaire à l'agriculture et aux pêcheries, lieu de loisirs et plus généralement support de nombreux services écosystémiques. La grande diversité de ses paysages autorise une telle multiplicité d'usages. Cependant, ces derniers rentrent souvent en conflits avec les objectifs de conservation et de maintien d'un bon fonctionnement écologique. Dans ce contexte, cet article a pour objet de présenter l'évolution du Danube, des derniers siècles à nos jours. Une attention particulière sera portée aux caractéristiques de ce système tant des points de vue de l'hydromorphologie et de la connectivité que des conséquences des différents usages et modifications apportées par l'homme (apports de nutriments et rejets, équipements hydroélectriques, navigation et contrôles des crues,…). Dans le cadre de la Directive Cadre sur l'Eau et des lois de protections de la nature, l'article vise à mettre en évidence les besoins en termes de protection et de revitalisation, le potentiel de restauration et les projets-clés indispensables pour le développement et le maintien sur le long-terme d'un fleuve Danube et de ses paysages aquatiques intacts.

ABSTRACT

The Danube is the most international of rivers. Its 2 857 km course interconnects 10 countries, and its 817 000 km² catchment area encompasses a population of 85 million people from 20 nations. As a riverine system the Danube serves as a link, a transport route, a source of drinking water and receiver of effluents, the basis for agricultural production and fisheries, a recreation site and as a provider of many other ecosystem services. The great diversity of landscape types enables a full range of human uses. These, however, often conflict with ecological and conservation considerations. The present contribution provides an overview of the Danube's historical development and current situation. The focus lies on the different natural hydromorphological and connectivity conditions along its course, as well as their degradation through human interventions and uses (nutrient and sewage inputs, hydro-electric power stations, flood control measures and navigation). Against the background of the EU Water Framework Directive and relevant nature conservation laws, this paper outlines the protection and revitalization needs, restoration potential and key projects as the basis for the longer-term development of an intact Danube riverine landscape.

KEYWORDS

Danube River, Human Impacts, Hydro-Morphology, Restoration Demand, Restoration Projects.

1 INTRODUCTION

The Danube has a length of 2 857 km and an average discharge of 6 700m³/s in the Black Sea delta area. This makes the Danube, after the Volga, Europe's second longest as well as second largest river (ranked 41 worldwide). It flows through 10 countries, and its 817 000 km² catchment area serves twice as many nations, making the Danube the world's most international river basin (Germany, Switzerland, Austria, Italy, Czech Republic, Slovakia, Hungary, Slovenia, Croatia, Bosnia-Herzegovina, Serbia, Montenegro, Macedonia, Albania, Poland, Rumania, Bulgaria, Moldavia, Ukraine, Kosovo). Nearly 85 million people inhabit this catchment system.

A highly diverse international community has used the Danube and its large tributaries for centuries as a settlement area, cultural link, transport route, source of drinking water and agricultural production, fisheries, receiver of effluents and provider of many other ecosystem services. This is reflected in an equally diverse cultural landscape. The Danube can be subdivided into three sections – the Upper, Middle and Lower Danube (including the delta) – based on the highly variable geomorphological conditions, gradient, flow, and bed load regimes. This subdivision is also mirrored in the different human uses and impacts (hydro-electric power generation, flood control measures, agriculture, navigation, etc.), which often stand in conflict with ecology and nature conservation.

2 HUMAN USES AND THE RESULTING ECOLOGICAL PROBLEMS

The comparatively steep Upper Danube provides ideal conditions for producing electric energy. With a total of 76 hydro-electric power plants, the utilized capacity here is high (in the Middle Danube, Gabcicovo and Iron Gate provide two additional facilities). The same holds true for the large tributaries. This is accompanied by expansive flood protection and water engineering measures to improve navigation, some dating back to the mid-19th century. Together, these river engineering efforts have created a wide range of ecological deficits. The more important of these include: reduced river length, drastically reduced lateral connectivity and hydromorphological dynamics, reduced bed load input from tributaries, retention of bed load within impounded sections, and reduced actual bed load transport in free-flowing stretches, leading to river bed incision. The result is a decoupling of the river from its alluvial floodplains. Fragmentation of the Danube and its tributaries not only affects bed load transport but also severely impacts fish communities, in particular species with long-distance migrations such as sturgeons.

Altogether, the altered hydromorphological regime has caused far-reaching degradations of the Danube floodplain environment. Such habitat deficits, and therefore overall biodiversity loss, increase in severity and extent as the geomorphological framework conditions approach those of the especially broad alluvial areas in the lowland basins of the Middle and Lower Danube and its delta.

Another overriding problem is organic pollution, pollution with hazardous substances and especially nutrient pollution (mainly phosphorus and nitrogen inputs from point and diffuse sources). Nutrient pollution leads to eutrophication. The impacts of nutrient-induced eutrophication are particularly evident in the Middle and Lower Danube, especially in standing or slow-flowing stretches (floodplain water bodies, impoundments) as well as in transitional and Black Sea coastal waters. According to ICPDR (2007) the highest nutrient loads were discharged during the 1980s, causing eutrophication with widespread anoxic zones in the coastal waters. First signs of recovery were documented in the 1990s, reflecting both the economic decline and improved nutrient management.

3 DEMAND FOR RESTORATION, RESTORATION POTENTIAL

The above-listed impacts, uses and ecological deficits clearly underline the need for mitigation and restoration, especially with regard to hydromophology and nutrient pollution. The EU Water Framework Directive (WFD) provides an ideal basis for this endeavor. Beyond incorporating many new advances, it also introduced the river basin approach to promote the development of an integrated and coordinated river basin management. An important task for the future development of the Danube will be to implement a "River Basin Management Plan" – a comprehensive program of measures to improve current deficits over the long term. One focus should be on hydromorphology and nutrient pollution, whose comprehensive treatment specifically requires an interdisciplinary approach at the catchment level. The prerequisite is a leitbild (reference)-oriented approach whose

plans are based on type-specific processes and functions. It must target the causes rather than merely the symptoms. The “Joint Statement of Inland Water Navigation and Environmental Sustainability in the Danube River Basin” (ICPDR 2007) is one positive example of an agreement among all Danube range states for coordinated interdisciplinary planning (navigation, water engineering, ecology…) related to aquatic ecosystems.

The restoration potential of the Danube differs according to the specific conditions of the respective stretches but, overall, is exceptionally favorable. Over wide stretches, the floodplain forest areas along with the fish, amphibian and bird populations etc. continue to show a high potential for recolonization and range extension. In the Upper Danube of Germany and Austria, over long stretches characterized by chains of hydropower stations, numerous projects currently deal with restoring the longitudinal migration of fish populations, re-establishing the lateral connectivity of former floodplains, etc. The goal in most cases of such “heavily modified” water bodies is to attain “good potential” according to the WFD. In areas where free-flowing stretches and extensive floodplains with lateral exchange processes still exist (e.g. Alluvial Zone National Park in Austria, Gemenc National Park in Hungary, Kopacki Rit Croatia/Serbia), numerous activities and projects have been designed to pursue long-term restoration goals. Such future conservation, preservation and development strategies orient themselves according to “good status” (WFD), with a particular focus on the goals outlined in Natura 2000, FFH-D and Bird-D.

4 ECOSYSTEM SERVICES

Despite the many range states, the large human population in the catchment area and the abundant uses, impacts and deficits, the Danube continues to exhibit an astounding level of free-flowing stretches and ecologically intact areas. The key task is therefore to preserve a sustainably functioning “Danube-River-Cultural-Landscape”, thereby making its manifold ecosystem services available to future generations. The internationality of this aquatic ecosystem and of the WFD approach itself calls for a large-scale, catchment and river landscape perspective to successfully protect, restore and sustainably develop the overall system.

LIST OF REFERENCES

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