

## Biodiversity and water quality management in one of the most strategic international watercourse in Europe: The Danube River Basin

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### Abstract

The Danube flows southeastward for a distance of 2,872 km, passing through four Central European capitals before emptying into the Black Sea via the Danube Delta in Romania and Ukraine. The river passes through or touches the borders of ten countries which are Romania (29.0% of basin area), Hungary (11.6%), Serbia (10.2%), Austria (10.0%), Germany (7.0%), Slovakia (5.9%), Bulgaria (5.9%), Croatia (4.4%), Ukraine (3.8%) and Moldova (1.6%). Its drainage basin extends into nine more countries which are Bosnia and Herzegovina (4.6%), the Czech Republic (2.9%), Slovenia (2.0%), Montenegro (0.9%), Switzerland (0.2%), Italy (<0.1%), Poland (<0.1%), the Republic of Macedonia (<0.1%) and Albania (<0.1%). This waterway is being exploited for Drinking water, Navigation and maritime transport, Fishing, Tourism and other income generating activities. The water quality in the Danube River Basin is largely influenced by the anthropogenic inputs of particularly excessive quantities of nutrients, organic material, trace, and hazardous substances. These industrial and domestic activities release wastewater that contaminates the hydro-system, thereby initiating water diseases that place the life's of the riverside population into acute health related problems. The richness in habitats, flora and fauna qualifies the Danube River to be a focus of biodiversity conservation in the Central and South-Eastern parts of Europe. The complete river basin, including tributaries, is home to around 2,000 plant and 5,000 animal species, including numerous endangered or nearly extinct species. However, the scientific knowledge of the richness of biodiversity and the systematic complexity in this graded ecosystem is only at the initial stage of optimization, making it to be considered as the major hotspots for the protection of aquatic and pedological organisms. The types of ecological niches encountered place the area as the home to flora such as algae and cormophytes. The fauna species includes, protozoan, metazoan, vertebrates (Fish, Amphibians, Reptiles and Birds) that are being exploited for purposes of the various trophic webs.

**Keywords:** Danube River Basin, flora, fauna, hydro-ecological management

### 1. Introduction

The Danube River Basin is Europe's second largest river basin, with a total area of 801,463 km<sup>2</sup>. It is the world's most international river basin as it includes the territories of 19 countries. The ecosystems of the Danube River Basin are highly valuable in environmental, economic, historical and social terms, but they are subject to increasing pressure and serious pollution from agriculture, industry and cities. The Danube River Basin is home to 83 million people with a wide range of cultures, languages and historical backgrounds. But the increasing [human impacts](#), pressure and serious [pollution](#) from [agriculture](#), [industry](#) and [municipalities](#) affect the water supply for communities, irrigation, hydropower generation and industry, as well as opportunities for transportation, tourism and fishing. The Danube River and many of its [tributaries](#) form the spawning grounds for many fish, but they receive variously treated wastewater from many sources, which ultimately ends up in the [Black Sea](#), affecting a large area of its waters. In this way the River Danube is the single most important contributor to nutrient pollution in the Black Sea. The Danube River Basin can - based on its gradients - be divided into three sub-regions: the upper basin, the middle basin, and the lower basin (including the Danube Delta). The [Upper Basin](#) extends from the source of the Danube in Germany to Bratislava in Slovakia. The [Middle Basin](#) is the largest of the three sub-regions, extending from Bratislava to the dams of the Iron Gate Gorge on the

border between Serbia and Romania. The lowlands, plateaus and mountains of Romania and Bulgaria form the [Lower Basin](#) of the River Danube (Figure 1). Finally, the river divides into three main branches, forming the [Danube Delta](#), which covers an area of about 6,750 km<sup>2</sup>. The Upper Danube has a rapid current of between 8 and 9 km/hour, due to the pronounced gradient of the river bed. Its tributaries bring flow from the northern side of the Alps as well as out of the southern side of the Central European Highlands. In its middle reaches, the Danube looks more like a flatbed river, with around half the speed of the Upper Danube, with low banks and a bed that reaches a width of more than 1.5 km. Only in two stretches at Visegrad (Hungary) and at the Iron Gates does the river flow through narrow, canyon-like gorges. The Danube enters the Little Alföld Plain immediately after emerging from the Hungarian Gates Gorge near Bratislava. There the river slows down abruptly and loses its transporting capacity, leading to the deposition of enormous quantities of gravel and sand on the riverbed. This deposition has formed two large islands, one on the Slovakian side of the river and the other on the Hungarian side, which have a combined area of about 1,869 km<sup>2</sup>, and are home to some 190,000 inhabitants in more than 100 settlements. The Danube then flows past Budapest and across the vast Great Alföld Plain until it reaches the Iron Gate Gorge. The riverbed is shallow and marshy, and low terraces stretch along both banks. Deposition has formed a large number of islands along these reaches, including Csepel Island near Budapest. In this stretch the Danube is joined by the waters of

three major tributaries - the Drava, the Tisza and the Sava - which nearly triple its flow. Lower Basin beyond the Iron Gates, the Lower Danube flows across a wide plain; the river becomes shallower and broader, with several major islands, and the current slows down considerably.



Figure 1: Map of the Danube international River Basin

### Results and Discussion

The Danube River is Europe's backbone of biodiversity. The richness in habitats, flora and fauna qualifies the Danube River to be a focus for conservation of biodiversity in Central and South-East Europe. Experts from different Protected Areas weigh in on the wise use of this natural heritage. The Danube is the major river of Europe, connecting Central Europe to the South-Eastern parts. Because of its large area and very diverse habitats, gravel islands on the Upper River, large remaining forest floodplains, extended wetlands on the Lower River. It provides suitable living conditions for a large number of different species. The complete river basin, including tributaries, is home to around 2,000 plant and 5,000 animal species, including numerous endangered or nearly extinct species. However, our knowledge of the richness of biodiversity and the complexity in ecosystems is only beginning. The Danube Delta is a natural gene bank with inestimable value for the world's natural heritage. "The mosaic of habitats developed here is the most various in Romania, hosting a great variety of communities of plants and animals that number around 5,429. In 30 types of habitats, the area is home to 1,839 flora species, 678 algae species and 1,016 cormophytes. The 3,590 fauna species include 2,244 species of insects, 91 species of molluscs, 135 fish species and 331 different bird species. For biodiversity, the longitudinal continuity of a river should include more than just fish ladders and bypasses for hydro power dams, it must also take into consideration semi-aquatic and terrestrial habitats. To ensure re-colonisation, specific habitats have to be connected with source populations by suitable stepping stones. So the protection of specific habitat structures like gravel islands, steep dynamic river banks or gallery forests in Protected Areas can conserve sustainable populations of characteristic species only if source populations and

a coherent habitat network including numerous stepping stones along the whole river section is developed (APHA, 1992; 1998, Balanch et al).

The improvement of connectivity and communication systems and the re-inforcement of the socio-economic development, the preservation of the environment including the conservation of biodiversity has been identified as one of the main pillars for this strategy. The inspiration of a living river including all flora and fauna, the richness in habitats and structures as well as human culture linked to nature integrates Central and South-East Europe. Implementing corridor concepts will emerge as the key role of Protected Areas for the conservation of these natural values.

The Danube River Network of Protected Areas was established in 2009 to start facing these challenges on the field of nature conservation. The EU Strategy for the Danube Region is expected to underline the importance of transnational. But rivers can serve as biological corridors, such as for Danube sturgeons migrating from the Black Sea upstream to their spawning areas in the Upper Danube region. The EU Water Framework Directive, as well as the Danube River Basin Management Plan, highlights the importance of the corridor function of rivers and longitudinal continuity. Even the best human habitat management will not be able to compensate for the loss of river dynamics. The diversity along the river is threatened, many dynamic habitats have nearly disappeared due to river engineering, hydropower plants and navigation projects (Figure 2 - 4). Growing cities have made flood protection measures necessary, which in turn cut off large floodplain areas from the river system. For these and many other reasons, the extinction rate of species is currently around 1,000 times faster than it should be. Mammals are especially threatened - 1% of the nearly 6000 species worldwide is extinct, with another 22% endangered in varying degrees. The group of animals under highest pressure are generally vertebrates. The beluga sturgeon is the largest freshwater fish and can live to 100 years. All native sturgeon species are under pressure in the Danube Basin, due to their over-exploitation for caviar (eggs), the pollution and degradation of spawning grounds, and the interruption of migration routes. The Danube streber is yellow-brown in colour and has several dark bands crosswise along its body. The average length is approximately 15 centimetres, but they can grow to over 18 centimetres long. The Danube streber is found in fast-flowing river stretches. It becomes active after sundown when it goes searching for food. A remarkable characteristic of the Danube streber is its ability to hold itself on the riverbed, despite even the strongest currents. The Danube streber feeds almost exclusively on organisms that are driven near it by

the water. The **Danube salmon (Hucho hucho)** has an elongated body, a large head and mouth, and strong teeth. The back of the Danube salmon is grey-brown to red-brown in colour and patterned with numerous dark spots; the sides are reddish grey with a copper-coloured gloss, and the belly is silvery-white. It prefers cool, oxygen-rich water. The **Sterlet (Acipenser ruthenus)**. The sterlet has a narrow, pointed snout with four long, fringed barbels. It has a tail like that of a shark, where the backbone continues into the top lobe, which is longer than the bottom lobe. Sterlets grow to a maximum length of 70 centimetres. The sterlet inhabits rivers and their tributaries, living in brackish freshwater at depths of around one metre. The sterlet uses its sensitive barbels to locate food, preferring insect larvae, worms and snails. The unexpected spread of duckweed is observed in the main river channel. Duckweed is any of various small, free-floating, aquatic flowering plants of the genus *Lemna*, growing in close, often carpet-like colonies on the surface of quiet water. These simple plants, lacking a stem or leaves, but consisting of a small blade-like structure, absorbing Nitrogen and Phosphorus from the aquatic medium.

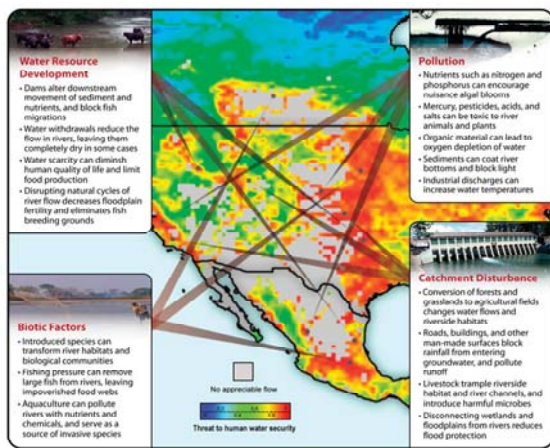


Figure 2: An illustration of integrated water quality management in the River Basin

The longitudinal continuity of the river includes more than just fish ladders and bypasses for hydro power dams, but also semi-aquatic and terrestrial habitats. Diversity along the river is threatened: Many dynamic habitats have nearly disappeared due to river engineering, hydropower plants and navigation projects (Besemer et al., 2000, Kelsey, 2004, Kirschner et al., 2009). To ensure recolonisation, specific habitats have to be connected with source populations by suitable stepping stones (Figure 2-6). The protection of specific habitat structures like gravel islands, steep dynamic river banks or gallery forests in Protected Areas can

conserve sustainable populations of characteristic species.

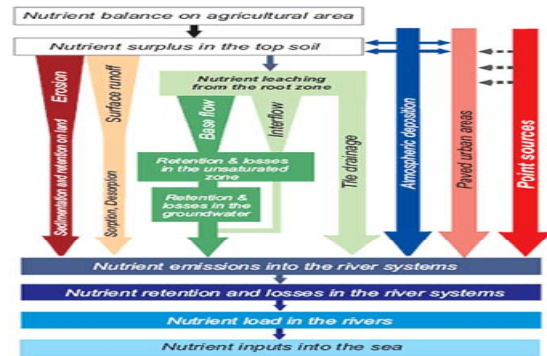


Figure 3: Nutrient emissions and retention in the Danube River Basin

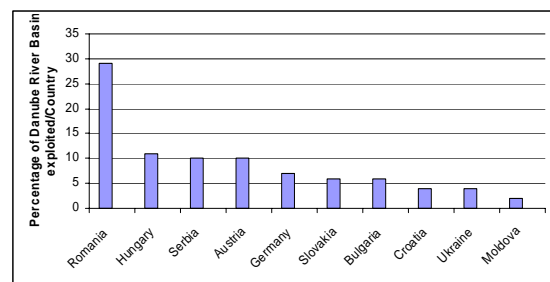


Figure 4: Exploitation of aquatic resources by the riparian states of Europe

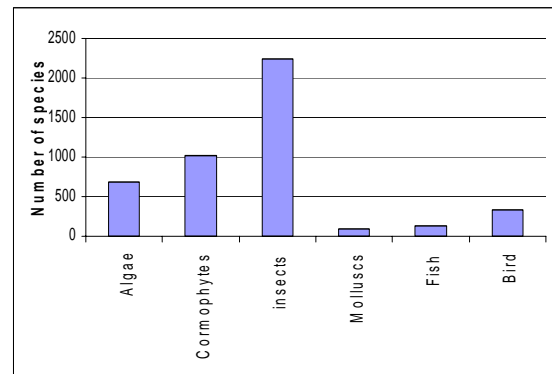


Figure 5: Repartition of plants and animals in the Danube River Basin

Riverain states have implemented legislation that seeks to increase the resilience of biodiversity in aquatic ecosystems by balancing sustainable water use with the long-term protection of available resources (Figure 4 and 5). Danube Day is celebrated on June 29 throughout the Danube River Basin, along small creeks and large streams to protect the biological and physico-chemical quality of the aquatic system (Micic and Hoffman, 2009, Sanja et al., 2009). The celebration pay tribute to the vital

role of providing water, food, power, recreation and livelihoods. According to WHO and UNICEF, 2004, the appropriate management of the water quality in this ecosystem is important in handling any upcoming challenges (Figure 3-5).

### Conclusion

The flora and fauna integrates Central and South-East Europe. Implementing corridor and parks concepts emerge as the key role of Protected Areas for the conservation of these natural values. The conservation, improvement and rational use of surface waters and groundwater. Preventive measures to control hazards originating from accidents involving floods, ice or hazardous substances, domestic and industrial pollution. Measures to reduce the pollution loads entering the Black Sea from sources in the Danube River Basin. This is a functional river system in which the various aspects of the ecosystems are incorporated into the management of the hydro-system.

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