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RIVERS UNDER THREAT – CHALLENGES FOR BIODIVERSITY CONSERVATION IN THE DANUBE RIVER

Thomas HEIN[*,**], Andrea FUNK[*,**], Florian PLETTERBAUER[*], Daniel TRAUNER[*]

A b s t r a c t. – Rivers are key ecosystems providing a multitude of ecosystem services that are vital for human well-being. Moreover, rivers have a high strategic importance for global ecological functions and biodiversity, as key ecological corridors. The Danube River and its basin – as many other large river systems in the world – have experienced severe changes and alterations due to multiple human-induced pressures over long times, highly threatening the system's ecological integrity. These threats also impair the provision of a variety of ecosystem services that build the basis for human well-being in the entire Danube Region. In turn, the mitigation of human-induced pressures is a key issue for river basin management, aiming to improve the ecological status and integrity, and to guarantee the sustainable provision of ecosystem services. In this paper, we extend the view for future management aspects especially considering combined effects on biodiversity conservation.

Keywords: biodiversity, Danube, DPSIR, linkage framework, Bayesian network

BACKGROUND

All over the world, large rivers have undergone massive alterations due to infrastructure development, such as engineering structures, land use changes due to urbanisation and intensification of agricultural production, various

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forms of pollution, and biotic changes such as invasive alien species [17]. In some European river basins, these pressures have been lasting over decades and even centuries, often causing environmental legacies, irreversible ecological impacts, system adaptions or shifts [8, 9]. Different stressor interactions may increase the problem, as there are various, often hardly predictable additive, synergistic or antagonistic effects on river ecosystems [14]. In the Danube River the temporal dimension, especially long-term interventions, is also of importance. Resulting human-induced pressures are a key issue for river management, aiming to improve the ecological conditions and guarantee the provision of ecosystem services, while considering the long-term changes.

SPECIFIC CHALLENGES IN DANUBE RIVER BASIN MANAGEMENT

Since 1998, 14 Danube River Basin (DRB) countries have been cooperating on aquatic ecosystem and water resource protection and conservation issues coordinated by the International Commission for the Protection of the Danube River (ICPDR). The ICPDR implements the "Convention on Cooperation for the Protection and Sustainable Use of the Danube River" from 1994, known as the "Danube River Protection Convention" (DRPC). This is specifically challenging, as the DRB is the most international river basin in the world, shared by 19 nations and draining a catchment of 807,827 km^2 in Central and South-Eastern Europe [5]. The Danube River flows from the Black Forest Mountains in Germany to the Black Sea and has a total length of almost 2,900 km, divided into three sections: the Upper, Middle, and Lower Danube [16]. Exceptionally diverse ecological and socio-economic properties characterize the DRB [16]. Its unique biodiversity and high ecological potential make the DRB one of the Earth's 200 most valuable ecoregions [13]. Still, the Danube River Basin faces multiple threats. With regard to the Danube River Basin Management Plan [11], several significant water management issues have been identified related to different aspects of pollution and hydro-morphological alterations.

The river network of the DRB has been progressively constrained for flood protection, navigation, and, during the last 100 years, for hydropower generation and other uses, resulting in 78 barriers located in the Danube and further 1610 barriers along the major tributaries [10]. Point and diffuse pollution, as well as the effects of land use changes, have aggravated the ecological impacts of barriers, river channelization, and navigation. In the Upper Danube, most floodplains and fringing wetlands have been converted into agricultural and

urban areas or have been isolated by dams and artificial levees, and are, thus, hydrologically and functionally decoupled. However, along the Middle and the Lower Danube, large, near-natural floodplain areas still exist [7].

In this context, we target key aspects for future biodiversity management by analyzing the main human activities and pressures that are related to the decline of aquatic biodiversity. In regard to this, potential synergies and barriers of current targets and environmental policy frameworks will be investigated.

LINKING DIFFERENT ASPECTS FOR RIVER MANAGEMENT

As highlighted by Hein et al. [7], complex linkages and interactions within and among different ecosystem components and between different policy targets and assessment approaches require more attention in an integrated management of the DRB.

When focusing on biodiversity targets (EC Biodiversity Strategy), two EU policies are especially relevant for the protection and restoration of the hydromorphological conditions of aquatic habitats – the Water Framework Directive (WFD) and Habitats and Birds Directives (HBD) [7]. As the Danube ecosystem is irreversibly altered and biodiversity targets interact with multiple targets of sectoral policies related to hydropower, navigation and/or land use, modified targets for key ecosystems are required [6]. Those should focus on balancing these different goals and require knowledge about interactions, potential synergies and antagonisms between the various management targets.

To examine and visualize such relations, we applied a linkage framework. Such a framework [12] follows a Driver-Pressure-State-Impact-Response (DPSIR) approach [2]. The so-called impact chains form a network of human activities, pressures they introduce, and ecosystem components which they affect. This leads to a complex network, which depicts the connectance of these activity-pressure-ecosystem component linkages in the study area. The linkage framework, with its overview of interactions, is helpful for management decision making, as it enables us to identify important and influential activities within the Danube Basin. In case of the DRB the activities with the highest connectance are hydropower and agriculture. Additionally, the impact chains were weighted into categories according to the spatial extent of each activity, the frequency, severity, persistence, and dispersal of the pressures.

However, while giving us a qualitative overview of various impacts on ecosystem components (such as habitats), it does not tell us the actual and potential future situation of biodiversity in these areas as a result of present activities.

Therefore, we use data collected as indicators for the different policy targets and include them into one quantitative spatial explicit analysis focusing on the river-floodplain systems along the navigable stretch of the Danube. Those data include a continuous hydro-morphological assessment compliant with WFD requirements [15] as well as land cover/land use (LCLU) data developed by the local component of Copernicus Land Monitoring Services (land.copernicus.eu). Furthermore, data collected on the status of the waterway, critical locations for navigation [3, 4] and navigation class [1], as well as information on the position and impacted river length by hydropower plants (JDS2, https://danubis.icpdr.org/) were included. Finally, information on the conservation status of widely distributed protected species was added (www.eea.europa.eu).

Using a Bayesian network approach, we showed multiple interactions of the indicators concerning activities related to sectoral policies and other human demands, hydro-morphological pressures and state of biodiversity indicators along the Danube. Further, we quantified the relative importance of main human activities and pressures that determine the status of different aquatic species and their habitats. Coupled with a GIS approach, we finally identified zones of potential synergies and conflicts for the different policy targets along the navigable stretch of the River Danube. Whereas the land use pattern in the floodplain is more important for stagnophilic species, rheophilic species are more intensely impacted by navigation. Zones of the highest biodiversity value but also with a high conflict potential are found in the lower section of the Danube.

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РЕКЕ У ОПАСНОСТИ – ИЗАЗОВИ У ОЧУВАЊУ БИОДИВЕРЗИТЕТА У ДУНАВУ

Томас ХАЈН, Андреа ФУНК, Флориан ПЛЕТЕРБАУЕР,
Даниел ТРАУНЕР

Р е з и м е

Реке представљају кључне екосистеме који пружају низ услуга екосистема које су од виталног значаја за благостање људи. Штавише, као кључни еколошки коридори, реке имају велики стратешки значај за глобалне еколошке функције и биодиверзитет. Река Дунав и њен слив, као и бројни други велики речни системи на свету, претрпели су озбиљне промене због многоструких дугорочних притисака које је изазвао човек и који озбиљно угрожавају еколошки интегритет система. Те претње такође нарушавају пружање различитих услуга екосистема које представљају основ за благостање људи у целокупном региону Дунава. С друге стране, ублажавање притисака које ствара човек представља кључно питање за управљање речним сливом, с циљем унапређења еколошког статуса и интегритета и гарантовања одрживог пружања услуга екосистема. У овом раду износимо становиште у смислу будућих аспеката управљања, нарочито узимајући у обзир комбиноване ефекте на очување биодиверзитета.

Кључне речи: биодиверзитет, Дунав, приступ „водећа сила – притисак–стање – утицај – одговор (*DPSIR*)“, оквир веза, бајезијанска мрежа