

Lóczy, D. (ed.): **The Drava River: Environmental Problems and Solutions**. Cham, Springer, 2019. 399 p.

It is uncommon in Central Europe that an all-encompassing geographical monography addresses the entire catchment area of a 749 km long river. One obvious reason for this is the political fragmentation of the area the river runs through, and that, as a result, it required 100 years of international cooperation to prepare a book of this kind. We might also say that it took 100 years for the inclination to such a cooperation to be born.

The foreword of Mauro SOLDATI, the president of the International Association of Geomorphologists (IAG), is followed by a short introduction of the editor, Dénes Lóczy (University of Pécs). The editor emphasises the peripheral and, in terms of military strategy, sensitive location of the river, which explains the negligence of its scientific investigation before the border zones opened with the political transformations in 1989–1990, and the end of the Serbo-Croatian War in 1995. The introduction highlights the use of the river's power by hydroelectric power stations, but it also underlines the resulting environmental

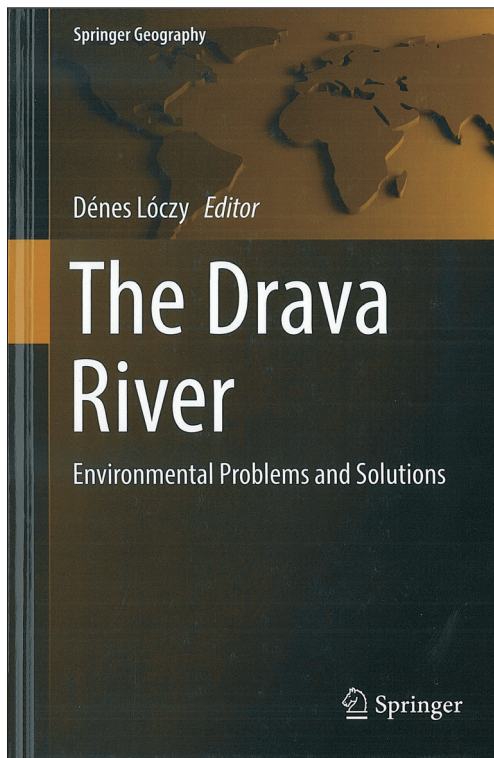
problems, and pointing at the importance of taking into consideration the environmental problems of the river channel and the floodplain area after channel construction and the regulation and harnessing of the river. In spite of the hydropower constructions the river channel and the cut-off meanders provide valuable habitats for wildlife, which the UNESCO Transboundary Biosphere Reserve as well as numerous Ramsar and Natura 2000 sites along the river prove. The introduction of the book discusses different aspects of the maintenance of this natural heritage, the improvement of its quality, and the rehabilitation potential of the river channel and the floodplain. The chapter also emphasises the need for international cooperation in solving environmental challenges in the area.

The second chapter by Dénes Lóczy describes the geological and geomorphological setting of the Drava Basin, dividing it into three major units: the Austro-Alpine Nappe System, the South-Alpine Nappe System and the southwestern margin of the Pannonian Basin. It concludes that the river catchment area is extremely varied and picturesque in terms of geological structure and surface forms. The chapter focuses on the geological and geomorphological description of the catchment area instead of geological units, which is a novel approach and perfectly fits the objective of the book.

The authors of Chapter 3, Gerhard Karl LIEB and Wolfgang SULZER, describe in detail the current land use and recent changes of the Drava basin based on the CORINE Land Cover database. They conclude that the land use pattern and the dominant classes of the western and eastern parts of the basin significantly differ not only for natural, but also for cultural reasons. Based on land cover data, the authors evaluate the environmental status of the area as satisfactory, not least because of the relatively big protected areas within the basin.

Chapter 4 by Dénes Lóczy discusses climatic conditions and climate change in the Drava Basin. There are remarkable differences within the catchment area, carrying characteristics of Atlantic, Mediterranean and continental climates as well as orographic influence. Due to climate change, the difference between these four types are expected to increase further. The spatial and temporal pattern of the river regime is definitely determined by snowmelt in upper sections of the river, and only moderately affected by continental climate along the downstream.

Ulrich SCHWARZ's chapter (Chapter 5) focuses on the hydro-morphology of the Lower Drava. At the downstream of the Mura confluence the river shows



anabranching characteristics, which transform to meandering type for the gradual decrease in the slope. The chapter describes the sediment types, the geomorphological character, and their evaluation from the perspective of the numerous upstream hydropower plants. It concludes that the long-term effects of hydropower dams on the interrupted sediment continuum and channel type call for the need for reconsidering river management and floodplain restoration.

Lidija TADIĆ and Tamara BRLEKOVIĆ summarise in Chapter 6 the hydrological characteristics of the Croatian section of the river. They point out that regulation and dam construction enable the control of high water levels, but the backwater effect of the Danube still affects the lowest section of the river. The authors find that drought periods and low discharge are becoming more and more frequent in the last decades.

Enikő Anna TAMÁS characterises in Chapter 7 the sediment transport of the river. She analyses in detail the bedload and bed material, the suspended load concentration, and their variability with the discharge. The study concludes that the typical processes of river morphology are reservoir armouring on the upstream, but rather riverbed erosion on the downstream.

Chapter 8 by Hrvoje PETRIĆ, Enikő Anna TAMÁS and Dénes LÓCZY describes the history of regulation and documented floods along the river. The authors summarise the major flood events in four countries with their estimated discharge, as well as early and modern time regulation history, the state of navigation, and the data of hydropower plants. Concerning future the authors point at the changes of river management, as it is turning from hard engineering to ecologically based restoration activities.

In Chapter 9 Ognjen BONACCI and Dijana OSKORUŠ connect to the previous chapter, and deal with human impacts on the water regime of the river, changing hydro-morphological characteristics, and sediment transportation of the river. The chapter shows that human activity substantially influences the water regime of the Drava River, even in downstream sections, and underlines that more efficient and interdisciplinary international cooperation is essential to preserve the still remaining, but very vulnerable, fluvial landscape and environment.

In Chapter 10 three authors (Alajos BURJÁN, Gábor HORVÁTH and László MÁRK) write about the river channel incision along the Hungarian section of the Drava. The study shows that the river channel not yet reached the hydro-morphological equilibrium due to relevant human interventions. Regulation increased the channel gradient, and the construction of hydroelectric plants reduced the sediment supply. Altogether these processes generated significant channel incision on the downstream sections.

Tímea KISS and Gábor ANDRÁSI analyse the evolution of the Drava floodplain during the last 100 years along the downstream section of the river. They find that the floodplain area has increased by several thousands of hectares, while the channel area has been decreasing simultaneously. Old abandoned channels lose their water conductivity due to incision of the channel and islands which have been merged to the floodplain. Meander development has accelerated and the stability of eroding banks has decreased. Lateral erosion can contribute to local sediment yield.

The following two chapters (Chapter 12 by Dénes LÓCZY, József DEZSŐ, Péter GYENIZSE, Szabolcs CZIGÁNY and Gabriella TÓTH and Chapter 13 by Adrienne ORTMANN-AJKAI) present the cut-off oxbow lakes along Drava River. The first study evaluates and classifies the oxbows based on their geographical position, their connection with the main channel, their water retention capacity and relation to the groundwater flow. This kind of analysis may prove very helpful while planning the rehabilitation or restoration of the floodplain. The second study addresses the vegetation and its development around the oxbows, which are regarded as valuable biodiversity refuges in an environment dominated by agricultural fields. The study asserts that the aquatic and riparian vegetation of the oxbows are relatively well-preserved due to the moderate intensity of land use, its location along national boundaries, and efficient nature conservation policy. It considers the terrestrialisation of habitats due to river incision an unavoidable treat.

József DEZSŐ, Dénes LÓCZY, Ali Mohamed SALEM and Gábor NAGY deal with floodplain connectivity in the next study. They consider the connectivity of cut-off oxbows to the main channel as the most relevant factor of maintaining biodiversity and other vital ecosystem services. Due to river regulation, disconnected or geographically isolated oxbows have become the most common in the Drava floodplain area. Hence, the authors consider the potential of subsurface water supply. For this reason, they calculate the effective porosity and hydraulic conductivity of floodplain deposits, and apply hydrological modelling to estimate groundwater streams. The authors regard subsurface water supply as a key factor in floodplain rehabilitation planning as well.

Chapter 15 by Anita DOLGOS-KOVÁCS, Gabriella TÓTH and Dénes LÓCZY analyses the water quality of the lower section of the river. Although the upper and middle sections of the river were assessed to have good water quality, the authors consider that many features of the river catchment area, like land use intensity and erosion, influence water quality at the downstream section. They evaluate water quality according to hydro-morphological, physio-chemical, biological and biochemical parameters. The study also discusses assessment according to the European Water Framework Directive. Not only the water qual-

ity of the river itself, but also the tributaries within the Hungarian part of the catchment area are depicted in colour maps. Compared to the major rivers in Hungary, the Drava proves to be one of the cleanest rivers and water bodies of the country. The chapter also employs a case study evaluating the water quality of an oxbow lake.

Chapters 16 and 17 provide an inventory of select-ed taxa of the river, and insofar macroinvertebrates and fishes are good indicators of water quality, they concentrate to them. From the macroinvertebrate fauna the *Mollusca*, *Annelida*, *Crustacea Chelicerata* and *Insecta* are listed in the river channel and from the floodplain in the chapter by Arnold MÓRA and Zoltán CSABAI. The authors conclude that the macroinvertebrate fauna of the river is one of the richest ones among Hungarian floodplains. Numerous Natura 2000, protected, and strictly protected species indicate the conservational significance of the region, whereas the large number of non-indigenous species signs the vulnerability of aquatic communities. Similarly, Péter SÁLY's study on the fish fauna of the river reveals the semi-natural status of fish assemblages. The ratio of native and non-native fish species reflects an overall good ecological status of the riverscape. Therefore, the actual good quality of the river along the Croatian-Hungarian section has to be maintained.

The relatively long Chapter 18 by Balázs KEVEY provides an excellent systematic overview of floodplain forest communities in the Drava Plain. Beyond describing willow shrubs, softwood and hardwood forests, and bog forest communities, it also discusses their interconnections. Numerous figures with cross sections show typical toposequences and the coupling of forest communities to micro-topography, pedodiversity pattern and microclimate. The analysis of these typical landscape patterns is a useful basis for ecological forest management and reforestation of deforested potential hardwood habitats.

Chapter 19 by Dénes LÓCZY and Rok CIGLIČ evaluates nature conservation in the Drava catchment area. The study deals not only with the variety and the extent of protected areas like national parks and nature parks, but also stresses that the restoration of riverine habitats, floodplains and river channels has become an integral part of nature conservation strategies. Rehabilitation of riverine landscapes not only increases the habitat diversity through establishing gravel and sand bars, but also facilitates the management of riverine landscapes, directing them into more and more self-sustaining conditions.

The last two chapters of the book (Chapter 20 by Tibor PARRAG and Dénes LÓCZY and Chapter 21 by Dénes LÓCZY and József DEZSŐ) present accomplished side-channel and floodplain rehabilitation projects, and also the largest-scale actual landscape rehabilitation project in Hungary. The authors critically present

the rehabilitation potential based on ecosystem services and landscape functions.

Two-thirds of the 29 authors who wrote the 21 essays of the book are from Hungary. Five contributors are from Croatia, three from Austria, one from Slovenia, whereas the Italian source of the river is symbolically represented by the inaugural lines of an Italian colleague. These contributions of course do not follow a strict thematic division, as the phenomena, attributes and qualities of the upper and lower reaches of a river are always close intertwined. It is not by chance that the subtitle of the volume is "Environmental Problems and Solutions", since there are significant hydrological, geomorphological and biogeographical consequences of the heavy anthropogenic impact along the upstream section of the river. This generates new, often political controversies, which cross-border nature conservation projects can only partly counterbalance. An important aim of the editor was with the detailed analysis of environmental issues to identify positive outputs and possible solutions to the problems. The volume presents several great examples of river restoration projects in Austria, Slovenia and Croatia. Another important element of this positive vision is the Hungarian 'Old Drava' landscape rehabilitation programme, which is implemented at the landscape level, and, at the same time, represents the most up-to-date approach to managing environmental problems as it is focusing on ecosystem services. Accordingly, the book intensively discusses topics like flood storage, local climate regulation, water-sport possibilities, and revitalisation of traditional forms of agriculture, including the reintroduction and local processing of old fruit species.

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