Besides of flood retention effects, natural surface waters and floodplains have positive synergy effects on the surrounding ecosystems as new wetland habitats can be created through improved river-floodplain interaction.

Acknowledgements

We would first like to thank the Bavarian Environmental Agency ('Landesamt für Umwelt') and the Bavarian Ministry of the Environment and Consumer Protection ('Bayerisches Staatsministerium für Umwelt und Verbraucherschutz') for the cooperation as well as financial support of the ProNaHo-Project. We would further like to express our gratitude for the Hydrotec Ingenieurgesellschaft für Wasser und Umwelt mbH and the Leibniz Rechenzentrum for kindly assisting us with the simulations carried out within this project. Furthermore, we would like to thank Sandra Zimmermann.

Further Information

This article contains extracts from the conference article Neumayer et al. 2018 as well as from the journal article Neumayer et al. 2020.

References

Bayerische Vermessungsverwaltung (2014). Gewässernetz, Grundlage: ATKIS Basis-DLM25. URL: https://www.lfu.bayern.de/wasser/gewaesserverzeichnisse/fachlicher_hintergrund/index.htm.

Briem E & Mangelsdorf J (2002): Fließgewässerlandschaften in Bayern. Hg. v. Bayerisches Landesamt für Wasserwirtschaft. Wasserwirtschaftsamt Deggendorf.

Dahm V, Kupilas B, Rolauffs P, Hering D, Haase P, Kappes H, Leps M, Sundermann A, Döbbelt-Grüne S, Hartmann C, Koenzen U, Reuvers C, Zellmer U, Zins C & Wagner F (2014): Hydromorphologische Steckbriefe der deutschen Fließgewässertypen. Anhang 1 von „Strategien zur Optimierung von Fließgewässer-Renaturierungsmaßnahmen und ihrer Erfolgskontrolle". Hg. v. Umweltbundesamt. Dessau-Roßlau.

Jürging P (2001): Wasserbauliche Aspekte bei der Renaturierung von Fließgewässern, Fließgewässerdynamik und Offenlandschaften. In: Bayerisches Landesamt für Umwelt (Hg.). Fachtagung, 7–18.

Koenzen U (2005): Fluss- und Stromauen in Deutschland – Typologie und Leitbilder. Ergebnisse des F+E-Vorhabens "Typologie und Leitbildentwicklung für Flussauen in der Bundesrepublik Deutschland" des Bundesamtes für Naturschutz; FKZ: 803 82 100. Zugl.: Köln, Univ., Diss., 2005. Bonn-Bad Godesberg: Bundesamt für Naturschutz (Angewandte Landschaftsökologie, 65).

Neumayer M, Heinrich R, Rieger W & Disse M (2018): Vergleich unterschiedlicher Methoden zur Modellierung von Renaturierungs- und Auengestaltungsmaßnahmen mit zweidimensionalen hydrodynamisch-numerischen Modellen. – Forum für Hydrologie und Wasserbewirtschaftung 39.

Neumayer M, Teschemacher S & Disse M (2019): Modelling river restoration and floodplain measures in Bavaria on different scales. Poster. European Geosciences Union, Vienna.

Neumayer M, Teschemacher S, Merk F & Disse M (2020): Retentionspotenzialanalyse von Renaturierungsmaßnahmen an bayerischen Gewässern. Auenmagazin, Heft 18.

PAN (2016): Planungsbüro für angewandten Naturschutz GmbH. Entwicklung und Anwendung einer Methodik zur Analyse der innerhalb der Auenkulisse wirkenden Restriktionen (Restriktionsanalyse). Hg. v. Bayerisches Landesamt für Umwelt, Referat 64. München.

Pottgiesser T & Sommerhäuser M (2008): Beschreibung und Bewertung der deutschen Fließgewässertypen -Steckbriefe und Anhang. Hg. v. Umweltbundesamt, Bund / Länder-Arbeitsgemeinschaft Wasser (LAWA).

StMUV (2014): Hochwasserschutz: Aktionsprogramm 2020plus. München: StMUV.

The vegetation of water bodies in the floodplain of the Danube in Serbia – comparative analysis and assessment of water quality using existing evaluation methods

Johanna Weidendorfer: Student of BSc Geography, Catholic University of Eichstätt-Ingolstadt, Germany, e-mail: johanna.weidendorfer@gmx.de

Rather by chance I got the opportunity to participate in a research project between six universities from Serbia, Croatia and the Czech Republic. During the site surveys in July 2019 data on species communities occurring in 17 backwaters along the Danube were collected (fig. 1 and 2). Using the metacommunity concept influences such as environmental parameters or inter-species competition on the occurrence of individual species should be explored (see Árva et al. 2017; Alahuhta & Heino 2013). A subtask included the recording of macrophytes, about which I could write my bachelor thesis.

Evaluation of Serbian backwaters using aquatic macrophytes

Eutrophication is one of the main problems maintaining good water quality in open waters today (Laketić et al. 2013). Impacts such as structural impoverishment or the discharge of toxic substances also have far-reaching consequences for lakes and rivers (Schneider 2004). In order to implement targeted measures for the improvement of water quality a regular assessment of the status of a body of water is necessary (Stelzer 2003). The bioindication is a simple way to determine the nutrient content of a waterbody as far as possible without using chemical and physical measurements. With aquatic plants in particular, changes in the nutrient balance can be derived from growth behavior and species composition (Laketić et al. 2013). Over the past few years, many indices for the evaluation of rivers and lakes using aquatic macrophytes have been developed, ranging from a simple description of macrophyte distribution to a complete ecological evaluation of the water (Schneider 2004).

Within Serbia, which is traversed by the Danube for a length of 588 km (Takić et al. 2012), the Danube has a

Figure 1: A part of the research team while collecting the data of one of the evaluated back-waters. Own photograph

water quality level of III. The most important causes of this low class are urban agglomerations and industries that are concentrated along the Danube (Milanović et al. 2010). Because the water quality of a river also inevitably affects the adjacent floodplain areas and the backwaters in them, monitoring for these areas is also necessary. However, especially for the assessment of backwaters, which are smaller than lakes and subject to the natural dynamics of the floodplain during floods, there are no adequate assessment systems (Lüderitz & Remy 2009).

As part of my bachelor thesis, mapped macrophyte stocks in Serbian oxbows were assessed using various existing indices. One was the water quality class according to the WFD, despite the fact that Serbia is currently not part of the EU, calculated using two different methods referring to Schaumburg et al. (2011) and Stelzer (2003). A second method was the Lake Macrophyte Nutrient Index adapted for Serbia to assess the water status of lakes referring to Laketic et al. (2013). Since several bioindication methods were used, which were not developed in or for Serbia, the aim was to check whether good results can be achieved by transferring them to this region, which method is best and whether improvements need to be made.

The 17 bodies of water investigated as part of this research work are located within floodplain landscapes along the Danube in the northern Serbian province of Vojvodina near Novi Sad and extend over the river kilometers km 1,400 to km 1,250 (Ramsar Convention 2012, 2007). The sampled backwaters are with three exceptions within the Nature Reserves 'Koviljsko-Petrovaradinski Rit', 'Gornje Podunavlje', 'Begečka Jama' and 'Karadjordjevo'.

Comparison of the different indication methods

On the basis of the three indices used to determine just the nutrient load, it was not possible to clearly differentiate between the study sites. A more precise assessment was only possible when the recorded water parameters, the mapped hydromorphological parameters and the properties of the specific macrophytes were taken into account. When calculating the water quality class – with the method of Schaumburg et al. (2011) as well as the somewhat different calculation method according to Stelzer (2003) – the assessments of some water bodies are to be regarded as not certain, since the proportion of the species not taken into account there exceeds 25 %. While this is primarily due to the missing assessment of the behavior of *Azolla filiculoides* in the calculation according to the PHYLIB method, the species table in Stelzer (2003) lacks the necessary scope to be able to transfer the calculation safely to another data set. Only 54 species are listed here, of which 18 were mapped in the course of this work. Without

considering the helophytes excluded from the analysis, data on 12 species is missing, which is $^2/_3$ of the data set.

In a large-scale comparison of several indices to assess the condition of lakes and rivers in Europe, Schneider (2007) concluded that the greatest differences between the results lie in the assessed species composition instead of the index values themselves. When an index is used in a country other than that of its origin, important local indicators may be neglected, which may result in an insufficient proportion of indicative species. It is therefore recommended to adapt the list of indicator types to local conditions (Schneider 2007).

When calculating the water quality, it should also be noted that the used indices have only been developed for lakes with a size of 0.5 km² or more (Schaumburg et al. 2011; Stelzer 2003). In the course of the WFD, the existing procedures are not mature enough for the assessment of oxbows (Lüderitz & Remy 2009). Apart from that Serbia is currently not an EU member state, which is why the provisions of the WFD does not apply to this country. The implementation methods are also not adapted to this region and can potentially lead to sources of error. But since Serbia is surrounded by other EU countries, to which these requirements should also apply, the question is whether there are such large deviations that an application would have to be questioned. Instead of making a distinction based on purely political criteria, Serbia should be considered as part of a united Europe. In order to prepare for a possible membership in the EU, it is essential for Serbia to meet the necessary standards with regard to the WFD before they become mandatory (Takić et al. 2012).

In the overall picture, none of the indices used can be seen as sufficient to reproduce the actual condition of a backwater in Serbia accurately using a single calculation. Only a combination of all of them allows a good assessment. It is therefore necessary to adapt the survey methods for macrophytes and environmental variables on a Europe-wide scale and to extend the results of the various indices to include environmental parameters (Penning et al. 2008). And also with regard to the limited procedures for a macrophyte-based assessment of backwaters, a further adaptation of the existing bioindications to all types of water is a high priority.

Acknowledgments

A big thank goes to PhD Dušanka Cvijanović, who made my stay in Serbia possible and was always there for me with advice, such as with the introduction to the topic of aquat-

Figure 2: One of the evaluated backwaters within the 'Koviljsko-Petrovaradinski Rit' Nature Reserve with good water quality. Own photograph

ic plants, with which I have never had any contact before, as well as with questions about the evaluation and analysis of the data. Communication during the field work was not always so easy due to the mix of different nationalities and languages, but that was precisely why the collaboration with the many researchers was a great asset for me and I was able to get to know a wide range of working methods related to water.

I would also like to take this opportunity to express my gratitude to Prof. Dr. Bernd Cyffka, who convinced me to accept this wonderful offer and supported the application for the funding program BAYHOST, without which I might not have been able to undertake this trip, as well as to my supervisor Dr. Barbara Stammel, who accompanied me during this adventurous workflow. The stay in Serbia was an incredible experience for me and I wouldn't want to miss it!

References

Alahuhta J, Heino J (2013): Spatial extent, regional specificity and metacommunity structuring in lake macrophytes. J. Biogeogr. 40/8, 1572–1582

Árva D, Tóth M, Mozsár A, Specziár A (2017): The roles of environment, site position, and seasonality in taxonomic and functional organization of chironomid assemblages in a heterogeneous wetland, Kis-Balaton (Hungary). Hydrobiologia 787/1, 353–373

Laketić D, Radulović S, Živković M, Jurca T, Alford M (2013): Lake Macrophyte Nutrient Index of standing waters in Serbia (LIMNIS). Ecological Indicators 25, 200–204

Lüderitz V, Remy D (2009): Einleitung - Entstehung und Entwicklung von Altwässern. In: Lüderitz V, Langheinrich U, Kunz C (Eds): Flussaltwässer. Ökologie und Sanierung. Wiesbaden: Vieweg+Teubner, 13–18

Milanović A, Kovačević-Majkić J, Milivojević M (2010): Water Quality Analysis of Danube River in Serbia - Pollution and Protection Problems. Bulletin of the Serbian Geographical Society, Tome XC 2, 47–68

Penning WE, Dudley B, Mjelde M, Hellsten S, Hanganu J, Kolada A, van den Berg M, Poikane S, Phillips G, Willby N, Ecke F (2008): Using aquatic macrophyte community indices to define the ecological status of European lakes. Aquatic Ecology 2008/42, 253–264

Ramsar Convention (2007): Information Sheet on Ramsar Wetlands (RIS) – 2006–2008 version. Gornje Podunavlje

Ramsar Convention (2012): The Nomination of the "Koviljsko-Petrovaradinski Rit" Area for a Ramsar Site. Ramsar Site no. 2028

Schaumburg J, Schranz C, Stelzer D, Vogel A (2011): PHYLIB – Verfahrensanleitung für die ökologische Bewertung von Seen zur Umsetzung der EG-Wasserrahmenrichtlinie: Makrophyten und Phytobenthos. Bayerisches Landesamt für Umwelt

Schneider S (2004): Indikatoreigenschaften und Ökologie aquatischer Makrophyten in stehenden und fließenden Gewässern. Habilitationsschrift. Technische Universität München, Wissenschaftszentrum Weihenstephan, Limnologische Station Iffeldorf

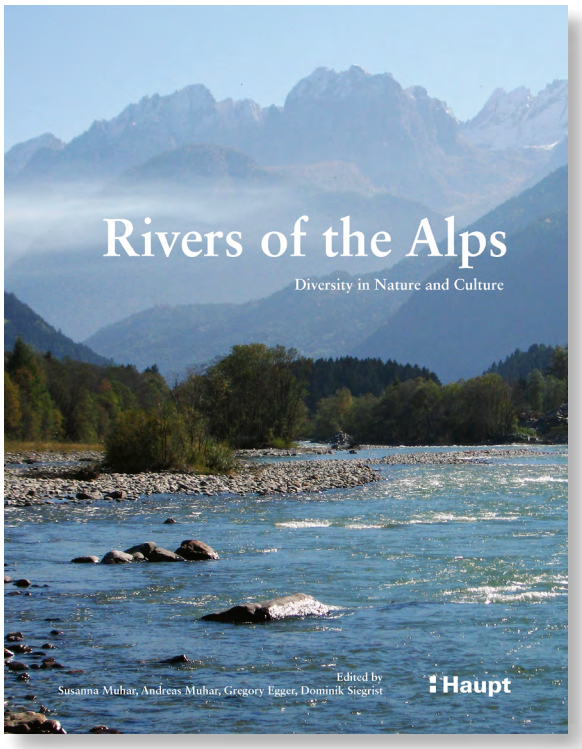
Schneider S (2007): Macrophyte trophic indicator values from a European perspective. Limnologica 37/4, 281–289

Stelzer D. (2003): Makrophyten als Bioindikation zur leitbildbezogenen Seenbewertung. Ein Beitrag zur Umsetzung der Wasserrahmenrichtlinie in Deutschland. Dissertation. Fakultät Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt der Technischen Universität München

Takić L, Mladenović-Ranisavljević I, Nikolić V, Nikolić L, Vuković M, Živković N (2012): The Assessment of the Danube Water Quality in Serbia. Advances technologies 1/1, 58–66

News and Notes

A new book dedicated to Alpine rivers



Thundering waterfalls, mysterious gorges, raging rapids, wide floodplains: The landscapes of the Alps are essentially shaped by flowing waters. Societal development in the Alpine region is closely linked to the rivers and their human uses. 'Rivers of the Alps' offers for the first time a comprehensive documentation of the importance of the Alpine rivers from numerous professional perspectives. From geology, water balance and morphology to flora and fauna, to mythology and artistic reflection, the book describes the origin and function of rivers, as well as their ecological, social and economic significance in history and the present.

The extent and consequences of human use are taken into account, as well as the need for coordination between protection and use interests. Portraits of more than fifty rivers provide a pan-Alpine overview, present the respective characteristics and invite visitors to visit the unique river landscapes of the Alps.

Susanna Muhar, Andreas Muhar, Gregory Egger, Dominik Siegrist (Eds., 2019): Rivers of the Alps - Diversity in Nature and Culture. Haupt Verlag Bern. 512 pages, hardcover

ISBN: 978-3-258-08114-4