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Editorial

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Dear readers,

Our association is continuously developing. A change in the General Secretary of IAD took place leading to new and strengthening already established activities. Also, IAD members have been very active, as shown in this issue presenting results from ongoing projects and an outlook on starting projects related to IAD activities on invasive alien species and Danube sturgeons. Beginning of 2018, Doru Bănăduc informed us that he has to step back from his position as general secretary of IAD as he was offered a new position in the US. Being permanently outside the Danube River Basin, we fully understand that Doru will have to concentrate on his new challenges. Nevertheless, we regret to lose his support for IAD and we would like to thank him for his efforts as general secretary, not to forget the successful organization of the IAD conference in Sibiu in 2016. We wish him all the best and success for his new tasks and we hope to meet him during one or the other IAD conference in the future. At the IAD-General Assembly in July 2018, Katrin Teubner, University of Vienna, was elected as new General Secretary. Katrin joined IAD in 2008 and as a specialist for algae, she was particularly active as leader of the expert group on phytoplankton and phytobenthos. We are pleased to welcome a dedicated and active new general secretary. In the few months of her new position, Katrin initiated a relaunch of the IAD-webpage (https://en.wikipedia.org/wiki/International_Association_for_Danube_Research), she started to support activities of the association and she has proven her motivation to enlarge the IAD-network addressing especially young scholars.

From July 2–6, 2018, the 42nd IAD-conference took place in Smolenice, Slovakia, in the beautiful castle of the town. Altogether, 26 talks discussed different aspects dedicated to the overall conference theme «Danube – A lifeline governed by multiple uses, pressures and a multitude of ecosystem services». Katrin Teubner offered a seminar on freshwaters as sentinels for tracking global environmental change and Andrea Funk from BOKU Vienna organized a workshop on «Impact of hydromorphological alteration and restoration in the light of biodiversity and ecosystem services – exploring synergies for the WFD» in the frame of the EU H2020 project AquaCross. On Friday, July 6, the participants had the opportunity to visit the Váh River and the Danube at Gabčíkovo. Milan Lehotsky and the local organizing committee made this conference a memorable event. We thank him, the organizing committee, the Institute of Geography, Slovak Academy of Sciences, and the Slovak Limnological Society.

New General Secretary – Katrin Teubner CV

Katrin Teubner: *Limnology and Biological Oceanography, University of Vienna, email: katrin.teubner@univie.ac.at*

Katrin Teubner, born in Leipzig 1964, East-Germany, is a freshwater ecologist mainly focussing on algae in lakes. She received her PhD in ecology from Humboldt University Berlin in 1996 (Germany), and did her habilitation degree (Privatdozent, PD) as a university lecturer in limnology at the University of Vienna, Austria, in 2004. Katrin Teubner was involved in several national and international projects about restoration and climate change in Austria and neighbouring countries. She has been a member of the IAD since 2008 and contributed as a member of the expert group leaders on the field of algal ecology, phytoplankton and phytobenthos. Katrin Teubner is experienced in international science collaboration, merging ideas with colleagues on fresh-water ecology.

My personal mission statement

Rivers connect freshwaters around the globe, and I believe that connecting people that are involved in river

science is the only way to contribute to a better ecological understanding of running waters along a long river journey over huge distances from its source to its mouth. I am convinced that both nature and people benefit from exchanging ideas from their expertise about field surveys, nature conservation, ecosystem health assessment, sustainable ecosystem service management, landscape planning or implementation of environmental policy rules. IAD has a long tradition in scientific collaboration between 14 countries of the Danube River Basin. The mission of IAD is to serve as a platform for a better understanding for saving this second largest river in Europe. This mission reflects a still ongoing attempt in today's changing world. From this perspective, I would like to support the Danube Research collaboration by contributing as general secretary of the IAD.

No doubt about it – the Danube River Ecosystem is changing

When I first joined an IAD meeting, which was held in Bratislava, in my function as expert group leader for algae, another expert group leader said that he would soon retire from his job in the south of Germany, Bavaria, and he continued by saying that something had happened to the Bavarian stretch of the Danube River over time. What had happened, we wanted to know – he didn't look amused and told us that he had had a look at the list of fish species in recent days. He realised that no single fish species, which was recorded in the year when he started with his work on the Bavarian stretch of the Danube River about 30 years ago could now be found in the recent species list. All the previous fish species he had found have been lost?! Lost forever there? Are there more such stories about the Danube River? I am not a good story teller but what I realized then is that there is a silent vanishing of impressions and species I have had in my mind from childhood or as young researcher – and I was thinking: is this really all gone or is it because I have just changed my perspective in observing my environment?

We are experienced in advanced methods for monitoring the environment – so far the knowledge is much larger than that in the years before – but is this satisfying, is this enough? To reclaim Stephen Covey's saying adjusted to Danube Science: to learn about the Danube system but not to act is really not to learn! IAD has a 63-years tradition. Its foundation relied on the wish from people in the Danube riparian countries to study the Danube river not country by country but along the whole stretch and to build standard methods and exchange ideas after Danube surveys. Many things have changed meanwhile – lots of countries linked to about two thirds of the length of the Danube River have remarkably changed their policy – now we are all together on a round table, can openly and knowledgeably discuss the recent environmental issues for the whole Danube River Basin. This may sound good but the recent awareness about habitats in and around the Danube River together with a new critical understanding of nature conservation, sustainable ecosystem management and use of ecosystem services in recent days brings us again together on a round discussion table. The strongest arguments for IAD can be derived from its statutes, being a scientific network observing the Danube River and its main tributaries. I thank the presidium and the members for their confidence to vote for me as general secretary in June 2018. In this function, I will help to support the manifold activities of the IAD-presidium, of the IAD-expert group leaders and also of the IAD-members in the IAD-countries – so that we learn and accordingly also act – as there is no doubt – the Danube River Ecosystem is changing.

Katrin Teubner

Comparison between long-term monitoring data and «snap-shot» data from investigative monitoring of Joint Danube Surveys – Case study for nutrient forms along the Romanian stretch of the Danube River

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Abstract

Assessment of nutrient forms in the Danube River has a well-known and long-term history at the basin-wide level, especially in view of the link between the nutrient loads of the Danube and the eutrophication of the Black Sea. According to the Water Framework Directive (WFD), investigative monitoring is primarily a national task, but at the basin-wide level, ICPDR launched the concept of Joint Danube Surveys (JDS), carried out every six years, starting from 2001. One of the specific objectives of the investigative monitoring surveys is to increase the comparability between a homogenous data set produced by a single sampling procedure and laboratory analysis (JDS measurements) and data generated by long-term surveillance type of monitoring (Trans-National Monitoring Network/TNMN data) carried out by the basin-wide network of TNMN laboratories from each Danube country. In this paper, we provide a comparative view of nutrient levels along the Romanian stretch of Danube River. The analysis showed similar spatial and temporal nutrient dynamics

obtained in the frame of TNMN-Program and JDS measurements. Low concentrations of nitrogen forms were found, with a minimum of the average values of the entire stretch of 0.14 mg/L N-NH_4. Phosphorous forms present a decreasing spatial profile from upstream to downstream monitoring sections, from 0.077 mg/L P-PO_4 and 0.122 mg/L P upstream to 0.027 mg/L P-PO_4 and 0.072 mg/L P downstream.

Introduction

One of the major objectives of the comprehensive monitoring activity carried out by the Danube countries within the frame of TNMN of the International Commission for the Protection of the Danube River (ICPDR) is to monitor the pressures given by nutrients in the Danube River Basin District and the extent to which the nutrient loads into the Black Sea are being reduced. Tailored as a long-term surveillance monitoring, TNMN provides a general overview of the selected water quality parameters in terms of concentrations and loads, mainly in transboundary context.

In recent years, the nutrients issue at district level is underlined in the Danube Basin Analysis - WFD Roof Report (ICPDR 2004). The results of this preparatory analysis for the River Basin Management Plans according to the WFD showed that relatively significant proportions of the river Danube River were at «risk of failure» or «possibly at risk» of the WFD environmental objectives due to four types of pressure. In total, 58 % of the length of the Danube River was classified at risk because of organic pollution, 65 % due to nutrient pollution (especially the lower river section, 74 % due to dangerous substances and 93 % due to hydro-morphological changes. Subsequently, according to the Danube River Basin District Management Plan (ICPDR 2015), the four types of pressures identified in 2007 and confirmed in 2013 by the Update of the Danube Basin Analysis (ICPDR 2014) as Significant Water Management Issues (SWMI) can directly or indirectly impact the status of both surface water and transboundary groundwater. Results presented in the DRBM Plan (ICPDR 2015) show that nutrient pollution still represents an on-going pressure for 20 % of the length of waterbodies (catchment size larger than 4000 km^2) being at risk of failure to achieve good surface water status by 2021. Therefore, the nutrients problematic at the basin wide level still represents an issue of concern.

In this respect the present case study aims to provide a comparative view of the nutrients levels along the Romanian stretch of the Danube main course.

Data source

The study is based on national data collected in the frame of long-term surveillance TNMN-Program of the ICPDR during 1996 – 2015 in comparison with investigative data obtained during the three monitoring programmes known as Joint Danube Surveys (JDS) 1, 2 and 3, coordinated by ICPDR in 2001, 2007 and 2013 respectively. In order to have an optimal way of data comparison and given the survey timing of the different JDSs (August – September), the momentary results obtained during the three investigative surveys are compared with TNMN data set from each September from the above-mentioned time period.

We used monitoring data for four nutrients forms: N-ammonium, N-nitrates, P-orthophosphates and Total Phosphorous. They were obtained within the TNMN-program during 1996 – 2014, for eight monitoring stations located along the Romanian stretch of the Danube River, between river km 1071 and the end of the three arms in the Danube delta (km 18 and 0): Bazias (km 1071), Pristol (km 834), upstream Arges (km 434), Chiciu (km 375), Reni (km 120), Valcov (km 18), Sulina (km 0) and Sf. Gheorghe (km 0) (www.icpdr.org). In addition, nutrients concentrations measured during the three investigative monitoring surveys JDS 1, 2 and 3 were compiled. According to the TNMN-Yearbooks and JDSs (1 and 2) Technical Reports, analytical methods used for determination of nutrients forms within the TNMN-program are EN ISO standardized methods based on molecular spectrophotometry. The JDS3 data set was obtained using ion chromatography. Detailed information on the analytical methods used for determination of the investigated nutrients forms in water samples as well as performance characteristics are presented in TNMN Yearbooks and the JDSs corresponding technical reports from 2002, 2008 and 2015 respectively (ICPDR 1999–2016, Lazlo 2002, Hamchevici & Craciun 2008, Hamchevici et al. 2015).

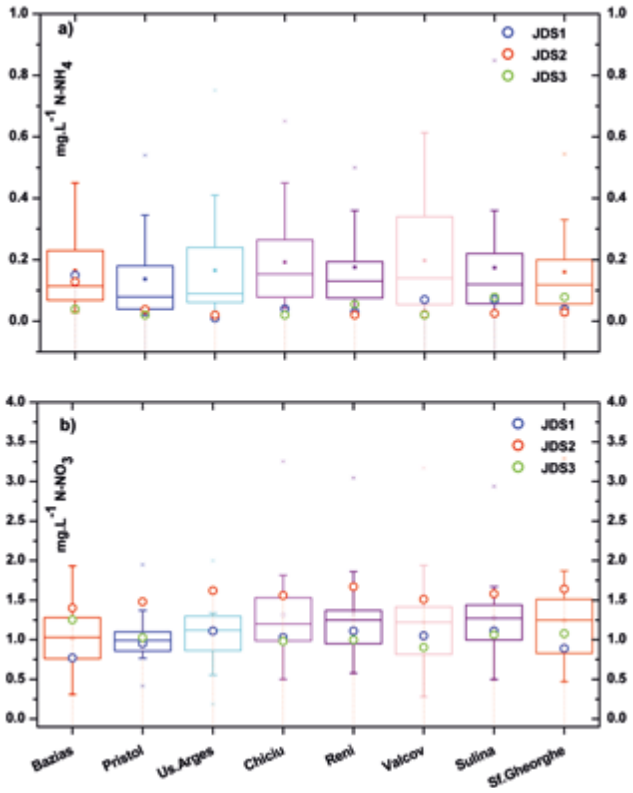

Figure 1. Comparison of selected nitrogen forms (a) N-ammonium and b) N-nitrates) between surveillance monitoring (each September from 1996–2015) and investigative monitoring (JDS1, JDS2 and JDS3) along the Romanian stretch of the Danube River (box is determined by the 25th and 75th percentiles, whiskers are determined by the 5th and 95th percentiles, also minimum, mean, median and maximum values are plotted)

Results and discussions Spatial variation

Longitudinal profiles of N-ammonium and N-nitrates concentrations *(fig. 1a and b)* show a decreasing shape at monitoring section Pristol, as a direct consequence of denitrification occurring in the Iron Gates reservoir from upstream area. This is especially described by the TNMN concentrations: a mean of 0.14 mg/L N-NH_4 is the minimum of the average values of the entire stretch; also during JDS1 and JDS3, low N-ammonium and N-nitrates were measured in this section (0.02 mg/L N-NH_4 and 0.95 and 1.03 mg/L N-NO_3 respectively). The rest of the stretch shows relatively elevated profiles of TNMN N-ammonium concentrations at monitoring sections Chiciu and Valcov – 0.19 mg/L N-NH_4, partially confirmed by the concentrations measured in JDS1 (0.07 mg/L N-NH_4). During JDS2 and JDS3, low values were measured for both nitrogen forms along most of the river.

Phosphorous forms *(fig. 2a and b)* present a decreasing spatial profile from upstream to downstream monitoring sections when TNMN averages concentrations from 1996–2015 are considered: from 0.077 mg/L P-PO_4 and 0.122 mg/L P at Pristol section to 0.027 mg/L P-PO_4 and 0.072 mg/L P at Sf. Gheorghe section. This decreasing tendency is noticed also during JDS2 in the case of P-ortho-phosphates, while during JDS1 the decreasing profile was present between Bazias and Reni, followed by a slight increase along the rest of the river stretch. For JDS3, P-orto-phosphates presented a more constant variation range in the lower Danube, between 0.046 mg/L P-PO_4 at section Chiciu and 0.062 mg/L P-PO_4 at section Sf. Gheorghe. A distinctive situation is present for Total Phosphorous at section upstream Arges, with very high concentrations measured during both JDS1 and JDS2 (0.61 and 0.41 mg/L P respectively). These concentrations are not confirmed by the long-term surveillance monitoring during which the most elevated concentrations from September (above 0.200 mg/L P) were measured in 2002, 2005 and 2011.

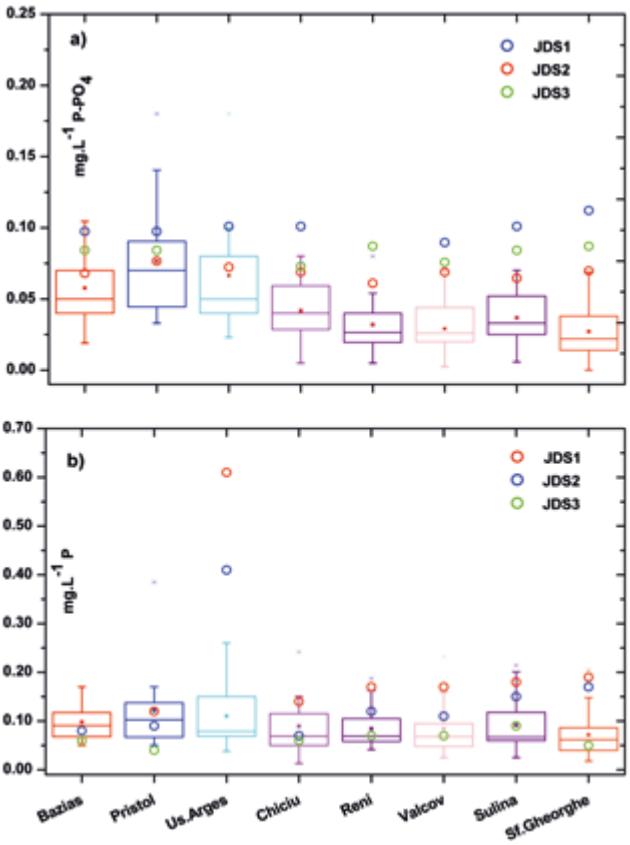

Figure 2. Comparison of phosphorous forms (a) P-ortophosphates and b) Total Phosphorous) between surveillance monitoring (each September from 1996–2015) and investigative monitoring (JDS1, JDS2 and JDS3) along the Romanian stretch of the Danube River (box is determined by the 25th and 75th percentiles, whiskers are determined by the 5th and 95th percentiles, also minimum, mean, median and maximum values are plotted)

JDS snap-shot data in the temporal dynamic of surveillance monitoring

Although one single measurement (as the JDSs measurements are) does not give fully reliable information on the temporal dynamic of concentrations, yet the nutrients forms investigated during the three JDSs could be put in comparative view with the monthly data provided by the long-term TNMN programme. This comparison is given here for only one monitoring station only – Bazias, additional information will be given in a more comprehensive future paper dealing with nutrients temporal variations in the lower Danube (Postolache et al., under preparation). In figure 3a and b selected nitrogen forms concentrations monthly measured in each September during 1996–2015 are compared with the «snap-shot» data

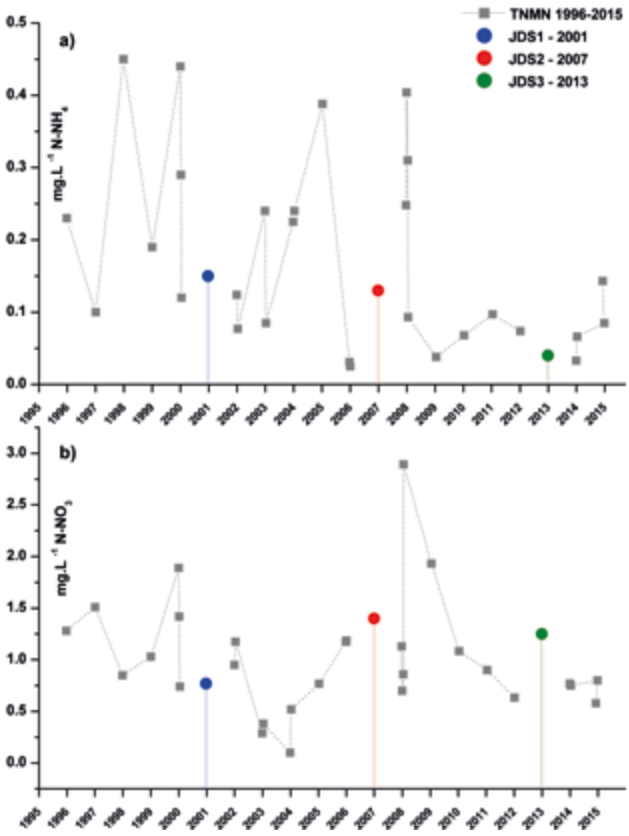

Figure 3. Comparison of selected nitrogen forms (a) N-ammonium and b) N-nitrates) from monthly measurements in each September during 1996–2015 within the long-term TNMN programme with the JDSs measurements from September 2001, 2007 and 2013 along the Romanian stretch of the Danube River

from JDS1, JDS2 and JDS3 measured in 2001, 2007 and 2013 respectively. As it can be noticed, the general view is that the concentrations from the three JDSs are highly comparable with the surveillance monitoring of the TNMN for both nitrogen forms. For instance, N-ammonium concentration from JDS1 (0.15 mg/L N-NH_4 is very close with the value recorded in 2000 and 2002 (0.12 mg/L N-NH_4) the concentration from JDS2 (0.13 mg/L N-NH_4) is higher than the average of 2006 (0.03 mg/L N-NH_4) but much lower than the average of 2008 (0.26 mg/L N-NH_4). The N-ammonium concentration from JDS3, much lower than the ones from previous surveys (0.046 mg/L N-NH_4) is close to the average value from September 2014 (0.050 mg/L N-NH_4). The N-nitrates concentration measured in 2001 (0.77 mg/L N-NO_3) was lower than the averages of 2000 and 2002 (1.35 mg/L N-NO_3 and 1.06 mg/L N-NO_3 respectively); the value recorded in JDS2 (1.40 mg/L N-NO_3), slightly higher than the average of 2006 (1.18 mg/L N-NO_3) was equal to the average of 2008 (1.40 mg/L N-NO_3) while the value measured in JDS3 (1.25 mg/L N-NO_3), which was higher than the concentrations from September 2012 and 2014 respectively (0.63 mg/L N-NO_3 and 0.76 mg/L N-NO_3).

For phosphorous forms, from figure 4a and b the same high comparability of investigated data can be noticed. P-orthophosphates from JDS1 (0.074 mg/L P-PO_4) is close to the average from September 2000 and one concentration from September 2002 (0.077 mg/L P-PO_4 and 0.071 mg/L P-PO_4); slightly different is the situation from 2007, when

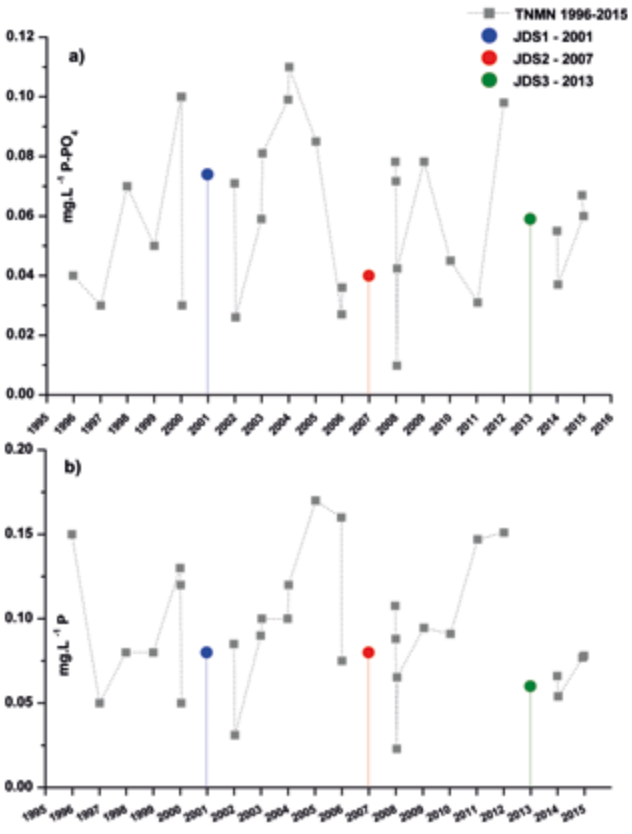

Figure 4. Comparison of phosphorous forms (a) P-ortophosphates and b) Total Phosphorous) from monthly measurements in each September during 1996–2015 within the long-term TNMN programme with the JDSs measurements from September 2001, 2007 and 2013 along the Romanian stretch of the Danube River

the JDS2 value (0.040 mg/L P-PO_4) was higher than the average of 2006 (0.032 mg/L P-PO_4), but lower than the average of 2008 (0.051 mg/L P-PO_4). In JDS3, the P-orto-phosphates concentration (0.059 mg/L P-PO_4) was lower than the one from 2012 (0.098 mg/L P-PO_4), but similar with the average between 2014 and 2015 (0.055 mg/L P-PO_4). Total P in JDS1 (0.08 mg/L P was similar with the average between 2000 and 2002 (0.083 mg/L P), while the value measured in JDS2 (0.080 mg/L P) was lower than the average of 2006 (0.118 mg/L P) but similar with the average of 2008 (0.071 mg/L P). In JDS3, Total P concentration (0.060 mg/L P) was much lower than the one from 2012 (0.151 mg/L P), but equal to the average of 2014 (0.060 mg/L P).

Conclusions

One of the specific objectives of the investigative monitoring surveys is to increase the comparability between a homogenous data set, produced by a single sampling procedure and laboratory analysis (JDS measurements), and data generated by long-term surveillance type of monitoring (TNMN data) carried out by the basin-wide network of TNMN laboratories from each Danube country. In this respect, the present paper briefly compares these two types of data sets corresponding to four nutrient forms measured along the Romanian stretch of the Danube River. Both in terms of spatial variation and temporal dynamic, analysis of monitoring data showed a highly comparable degree, with JDSs values generally lower than the ones given by the monthly TNMN values. Therefore, as regards the general physico-chemical parameters (and nutrients among them), the future investigative monitoring survey from 2019 (JDS4) will fully rely on the national monitoring data provided by the TNMN laboratories at the basin-wide level.

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With RESI towards a more integrative management of large rivers and floodplains

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Abstract

Rivers and floodplains are the most intensely used elements of European landscapes, while in some places they still fulfil important functions of «green and blue infrastructure», and represent hotspots of biodiversity of national importance. The multiple societal uses of rivers and floodplains are reflected by various sectoral legal frameworks and political objectives that apply to rivers and floodplains. Regrettably, the implementation of these legal objectives has hardly been harmonized or prioritized. In addition, water management needs to consider local socio-economic interests e.g. urbanization, tourism or agriculture. In order to establish a rationale for inter-sectoral decision making, the research project «River Ecosystem Service Index» (RESI) has developed an integrated approach quantifying multiple ecosystem services (ES). A first practical application of the RESI has been performed for an 80 km long section of the Danube River in Bavaria (Germany), where the RESI is used as additional support for decision-making in regional planning aiming to increase flood retention in floodplain areas.

Figure 1. General illustration of ecosystem services available in water-related ecosystems. Please note that supporting services are now often included into regulating services.

Introduction

River banks have always been preferred sites for human settlements, as river corridors provide a wide array of ecosystem services (ES) supporting human livelihoods and wellbeing *(Fig. 1)*. Most rivers have thus been used for fisheries as well as travel, transport and trade along the river, and the floodplains for agriculture, which benefitted from accumulation of fine sediments and nutrients in soils during floods (Nützmann et al. 2011). In order to intensify some of these uses, rivers and their floodplains have been historically profoundly modified (Tockner et al. 2010, Stammel et al. 2018). In Central Europe, most rivers have been channelized, which means that the river channel was narrowed and straightened and river banks were artificially stabilized. This facilitated navigation, the construction of hydropower plants, as well as agriculture in the floodplain areas which were then flooded less frequently or even protected by dykes. In many places this transformation has resulted in undesirable ecological effects over time, as river incision, sagging of floodplain surface due to peat decomposition, decrease and pollution of groundwater resources, increase of flood probability, decline of fisheries, and disappearance of biodiversity (Tockner et al. 2011).

Hence, rivers and floodplains represent sites that offer a broad array of benefits for humans but have been thoroughly modified in many places. The combination of high ES availability and strong human uses and alterations has made historic shifts in the availability of abiotic and biological resources especially apparent in river corridors (Postel & Carpenter 1997; MEA 2005, Collen et al. 2014).

Thus, recently more balanced and sustainable ways were sought to manage rivers and floodplains (e.g. Pusch & Hoffmann 2000). Such integrative approaches should serve the objectives of several important legal frameworks, as the Habitats Directive, the EU Water Framework Directive, the EU Flood Risk Management Directive, and at the same consider major economic interests, as e.g. hydropower or agriculture. Thereby, management practitioners are often faced with the challenge of harmonizing and prioritizing these various societal goals (Schindler et al. 2014, 2016).

The RESI approach

In order to establish a rationale for inter-sectoral decision making in complex management planning in river corridors, the collaborative research project 'River Ecosystem Service Index' (RESI) has developed an integrated approach quantifying multiple ecosystem services (ES). For the assessment, a catalogue of ecosystem services provided by rivers and floodplains has been elaborated including all three categories of ES according to CICES (Common International Classification of Ecosystem Services; Haines-Young & Potschin 2013), such as provisioning services (e.g. food production), regulating services (e.g. flood regulation) and cultural services (e.g. water related activities). All ES are assessed using spatial data which is processed in Geographical Information Systems (GIS), as e.g. the value for the provisioning services of agricultural land and pastures is calculated combining land use, soil quality and flooding frequency data. Hydromorphological data were used to calculate indicators for several ecosystem services. For river channels, hydromorphological data are relevant as well as water quality data for assessing the retention of organic carbon, phosphorus and nitrogen capacity of a river section, as retention is particularly associated with sediments (Fischer & Pusch 2001). Retention processes, which result in the so-called self-purification of rivers, are favoured by diverse hydromorphology at all scales in the river channel (Wilczek et al. 2004, Gücker & Pusch 2006), in the riparian zone (Pusch et al. 1998) and in the floodplain (Craft et al. 2002). Cultural ES were assessed e.g. based on available surface waters, experienceable parts of landscape, and the number of protection categories present. All ecosystem services included are assessed in a non-monetary way by scoring them from 1 (very low) to 5 (very high). Scores are assigned for 1-km segments of the morphological floodplain, separated into river channel, active parts and non-active parts of the floodplain. This uniform scaling of ES availability allows the elaboration of uniform maps for various ES, and an integration of various ES through the River Ecosystem Service Index (RESI) *(Fig. 2)*. The development steps of the RESI were accompanied by repeated interaction with stakeholders in several case studies, which helped to optimize the final RESI design.

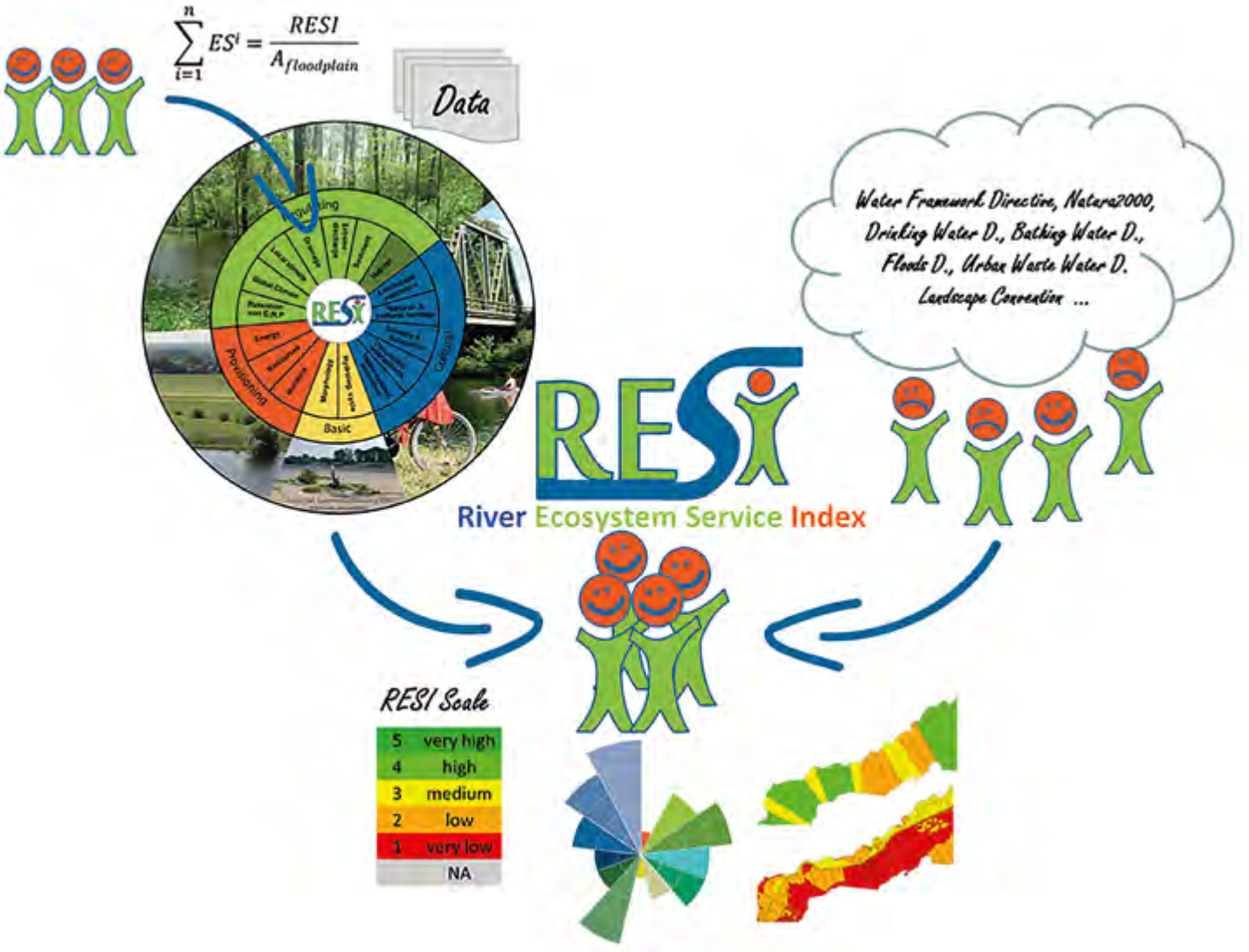

Figure 2. Conceptual approach of the River Ecosystem Service Index (RESI)

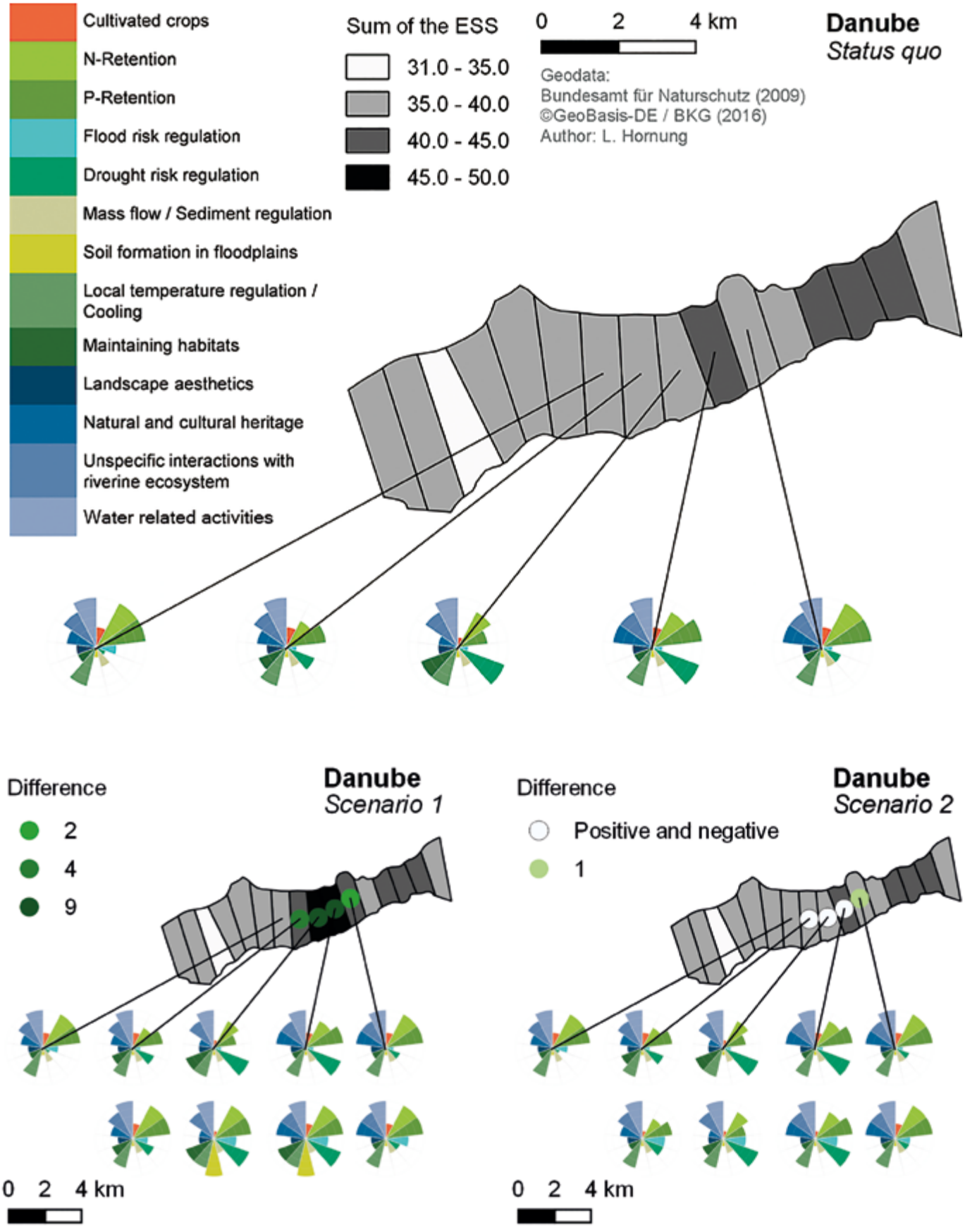

Figure 3. Exemplified representation of the RESI for a 16-km long section of the Danube river and floodplain area for the status quo and two scenarios of improved flood management. The grey shading of the 1-km segments of the Danube floodplain (incl. inactive floodplain area) represents the RESI as sums of assessment scores for 13 ecosystem services, as listed in the legend. In the scenarios, coloured dots indicate the changes of the RESI per segment compared to the status quo. Assessment scores (levels 1 very low - 5 very high) for individual ecosystem services are shown as polar graphs for selected 1-km segments, with colours referring to the respective ecosystem services in the legend. Thereby, upper polar charts refer to the status quo, lower ones to the respective scenario.

Results for the Danube section downstream of Ulm

Being one of the case studies of the RESI project, this assessment approach has been applied to an 80-km long section of the Danube River located downstream of the city of Ulm (Germany). For this section, as for the whole Bavarian section of the Danube, the Bavarian State Ministry of the Environment and Consumer Protection (STMUV) strives to increase the flood retention capacity of the river section, since the 2013 century flood of the Danube has shown significant need for improvement of flood protection. Therefore, a concept to establish three regulated polder areas and up to six unmanaged flood retention areas was developed. However, such plans will always interfere with other key uses of the river and its floodplains, as hydropower, forestry or agriculture, and in this case with a planned national project of floodplain restoration and nature conservation.

In such a complex decision-making situation, the RESI concept was appreciated by the regional water management agency (WWA Donauwörth) to contribute to a cross-sectoral and transparent comparison of planning options for the design and site prioritization for new flood retention areas. Hence, two different management options (scenarios) were defined and compared with each other and with the status quo. By the use of available data, 13 ecosystem services could be assessed for every floodplain segment of this 80-km long section. Thereby, scenario 1 reflects an integrated planning where especially the requirements of nature conservation and of agriculture were respected: the flood retention areas, which will be flooded by a 100-year flooding event, cover only the land use types forest, wetlands and water bodies, but no agricultural fields; following requests of nature conservation these areas will be additionally flooded regularly, approximately 3 times per year, which is comparable to natural floodplain conditions. In contrast, scenario 2 maximizes flood protection in a larger area also including crop fields, which will be flooded solely at extreme flooding events (> 100 years return time) without further ecological compensation. For both scenarios, ES assessments were performed for all affected 1-km segments.

Results for the individual ecosystem services in the five score levels were presented both in maps and in polar charts *(Fig. 3)*. As a first result, the status quo of each of the 13 ES was represented so that the location of high and low value sites could be identified. Second, the effects of the two scenarios for individual ES were compared, as illustrated in *Tab. 1* for three different ES in one retention area.

For a more integrative assessment of scenarios, the sum of available ecosystem services was calculated, too, and this River Ecosystem Service Index (RESI) was visualized by different shades of the respective 1-km segments of the river corridor *(Fig. 3)*. Dark segments represent areas with high values for many ES (maximum sum in the area 50 out of 65). Based on the assessment scores, planning scenarios could be additionally assessed in terms of their multifunctionality, in terms of ES improvement, and of the minimization of trade-offs between several major uses in the area. For the given example, improvements up to 9 points could be observed for scenario 1. In contrast, scenario 2 showed some deterioration or improvements of ES, while in total no effect was noticed. Hence, the more multifunctional scenario1 appears as the better planning option. These results of the RESI were introduced into the planning process of the flood retention program of the regional water management agency (WWA Donauwörth). The agency used them as a communication tool between agencies, planners, stakeholders and the general public, in order to provide adequate and comparable insights in the various effects of specific measures to be implemented.

Conclusions

Our experiences show that the ecosystem service concept may establish a uniform platform for the communication and cooperation among stakeholders from various sectors. Accordingly, the newly developed River Ecosystem Service Index (RESI) may be used as a transparent cross-sectoral communication and visualization tool for the management of riverine landscapes, which enables an integrative comparison of several management scenarios, as e.g. for flood retention along a river section. The RESI summarizes data from various sources, integrating methods from different disciplines and shows effects on the whole array of ecosystem services. Based on this, RESI supports the identification and decision-making for more balanced and sustainable planning and management options.

Acknowledgement

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Nine countries unite for a common purpose: the protection of migratory fish in the Danube River Basin

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This year nine countries along the Danube (Germany, Austria, Slovakia, Slovenia, Hungary, Croatia, Serbia, Romania and Bulgaria) join forces in an international project to conserve endangered migratory fish species in the Danube river basin by identifying and improving access to habitats and promoting the establishment of ecological corridors. Ukraine experts support the project to enlarge the spatial scope to the northern part of the Danube Delta.

The project under which these states will work over the next three years to achieve the objectives is called MEASURES (Managing and restoring aquatic ecological corridors for migratory fish species in the Danube river basin) and officially started in October 2018. Financial support is provided by the Interreg Danube Transnational Program.

Figure 1. *Between 17 and 22 September 2018, the Danube Delta National Institute organized a training workshop to discuss and harmonize sampling methods (© D. Trauner)*

The Danube is home to some of the most important sturgeon and other migratory fish populations (e.g. shads, barbel, nase etc.). Bulgaria and Romania hold the only – still – viable populations of wild sturgeon species in the European Union. The remaining populations have faced a dramatic decline in the past decades due to man-made barriers that prevent their migration and their ability to spawn, such as dams or hydropower plants. These barriers fragment the natural habitats of migratory fish, making it impossible for fish to move up or downstream to spawn or reach feeding grounds. In the long term, these barriers, along with other anthropogenic human activities such as overfishing, pollution and habitat destruction, will lead to the extinction of the species unless action is taken now.

In order to address the problem of migratory fish reaching their habitats, MEASURES will lay the foundation to establish ecological corridors by identifying key habitats and by initiating transboundary protection measures along the Danube and its main tributaries. The main actions through which the project aims to achieve all the objectives are:

- developing and testing a methodology for mapping and identifying habitats for migratory fish species;
- design a harmonized strategy for restoring ecological corridors and supporting implementation in future management plans;
- restocking of two native species to conserve their genetic pool in Hungary *(Acipenser ruthenus)* and Romania *(Acipenser gueldenstaedtii)*, in order to establish a network for concerted repopulation of the target species and to compose a manual for the operation of broodstock facilities that will provide the offspring needed for future re-population efforts;
- implementation of the MEASURES Information System will facilitate the access of relevant information to experts, decision-makers and the general public. Concrete input into future drafts of policy- and man-

agement plans will secure the consideration of our project outcomes into sustainable measures aimed to restore the function of ecological corridors.

The Danube and its tributaries are key migration routes for sturgeons and other migratory fish, such as barbel and nase. These species are excellent bio-indicators of the effectiveness of ecological corridors due to their specific needs during their long lifecycles. This is especially true of sturgeons, which typically migrate long distances and are an important part of the natural heritage of the entire Danube Region. Their dramatic decline in the last few decades has become an issue of basin-wide importance, documented by the Danube countries and the European Commission.

2. The participants of the Kick-Off Conference in Vienna (© R. Becsi)

Training workshop on assessment of migratory fish habitat and behavior

The MEASURES project began with two important activities. The first one dedicated to the NGO environment and for specialists of academic and relevant institutions in the partner countries was the training workshop on assessment of migratory fish habitat and behavior.

Experts from seven Central and Eastern European countries gathered in Tulcea from 17 to 22 September, in the framework of a course supported by specialists from the Danube Delta National Institute for Research and Development. The purpose of the six days was to exchange experience(s) and share good practices along the Danube and its tributaries, in order to better study and understand sturgeons, the emblem species of this river. Discussions were focused on the identification of sturgeon species´ habitats, ways to identify breeding, wintering or resting areas, behaviors of sturgeon species, and good practices and examples from all participating countries.

The Kick-off Conference took place this autumn in Vienna

On the first two days of October the Kick off Conference organized in Vienna officially launched the MEASURES project. Together with the project partners, also representatives from the relevant institutions for the conservation of sturgeons in Europe were present. Among them were: Gusztáv Csomor, Project Officer, Joint Secretariat – Danube Transnational Programme, Karl Schwaiger, Austrian Ministry for Sustainability and Tourism, Ivan Zavadsky, Executive Secretary, International Commission for the Protection of the Danube River and Jörn Gessner, Leibniz Institute of Freshwater Ecology and Inland Fisheries.

Important topics have been reached to achieve the project's objectives, a series of opinions have been set out to support work on the conservation of migratory fish in the Danube River Basin. And the solution is the synergy of all projects of the partner institutions and their work, the exchange of experience and expertise, the cooperation to maximize work for migratory fish of the Danube.

MEASURES is a project co-funded by the European Union (ERDF, IPA), www.interreg-danube.eu/measures

Strategies for restoration and conservation of aquatic biodiversity in the Danube River Basin – Findings from the H2020 AQUACROSS project

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The AQUACROSS project in a nutshell

Knowledge, Assessment, and Management for AQUAtic Biodiversity and Ecosystem Services aCROSS EU policies (AQUACROSS, https://aquacross.eu) is a Horizon 2020 project (June 2015 – November 2018) aiming to support EU efforts to protect aquatic biodiversity and ensure the provision of aquatic ecosystem services. Besides water quality problems, hydro-morphological alterations, such as disconnection of floodplains, threaten riverine ecosystems and their biodiversity, and are a particular challenge along the Danube. Multiple human activities, including the construction of hydropower plants, expansion of agriculture, and large-scale river regulation measures related to navigation and flood protection are resulting in an ongoing loss of habitat and biodiversity. In the Danube River Basin case study, the AQUACROSS Assessment Framework (Gómez et al. 2016) thus was applied to identify how management of river-floodplain systems along the Danube can

be improved to jointly conserve and restore biodiversity and maximise provisioning of ecosystem services i.e., conserve or restore the high multi-functionality of the natural system.

The importance of floodplain restoration to conserve biodiversity

Throughout the basin, hydro-morphological restoration of river-floodplain systems is important to conserve biodiversity (in line with the EU Biodiversity Strategy to 2020 and the EU Habitats and Birds Directive/HBD) and ensure that river stretches achieve at least «good status» according to the EU Water Framework Directive (WFD). Restoration also supports other societal and policy objectives: flood protection, as called for by the EU Flood Risk Directive (FD), pollution reduction to improve the Black Sea marine environment under the EU Marine Strategy Framework Directive, and climate adaptation. However, the complexity and heterogeneity of the environmental problems, lack of data, strong differences in socio-economic conditions, as well as complexity and inconsistencies in legislation along the Danube significantly hampers planning of restoration sites. Only a few countries of the Danube region have already implemented or planned restoration activities, due by 2021. Thus, a prioritisation strategy of the river-floodplain systems for restoration and conservation was established by AQUACROSS (Funk et al., accepted), using a novel integrative modelling approach that considers multiple targets related to biodiversity, ecosystem services and socio-economic benefits, in line with Ecosystem-based management (EBM).

Models and factors relevant for conservation and restoration planning of river-floodplain systems

Biodiversity models (Bayesian networks) and Ecosystem service models (ARIES - ARtificial Intelligence for Ecosystem Services, http://aries.integratedmodelling.org) were jointly applied and resulted in a spatial priorization to select sites for restoration and conservation. This selection was compared with the restoration priorization at member state level and a cost-benefit analysis was conducted. To target restoration goals adequately, three main factors relevant for conservation and restoration planning of river-floodplain systems, i.e. i) the remaining multi-functionality of the systems, ii) reversibility (potential to restore multi-functionality) related to multiple drivers and iii) the availability of remaining semi-natural land for restoration versus agricultural area were calculated.

Better performance of ecosystem-based management and multifunctionality of restoration measures

Unlike the current baseline, where each country selects their own restoration sites, the AQUACROSS method classified sites with conservation and restoration potential across the whole of the Danube based on their multi-functionality (i.e. restoration sites where habitats for multiple species as well as multiple ecosystem services can be enhanced, *fig. 1)*. Additionally, it systematically prioritizes sites for floodplain restoration within different compromise scenarios based on the three main factors relevant for restoration planning. The AQUACROSS evaluation further suggests that the ecosystem-based management approach is more cost-effective than the baseline scenario.

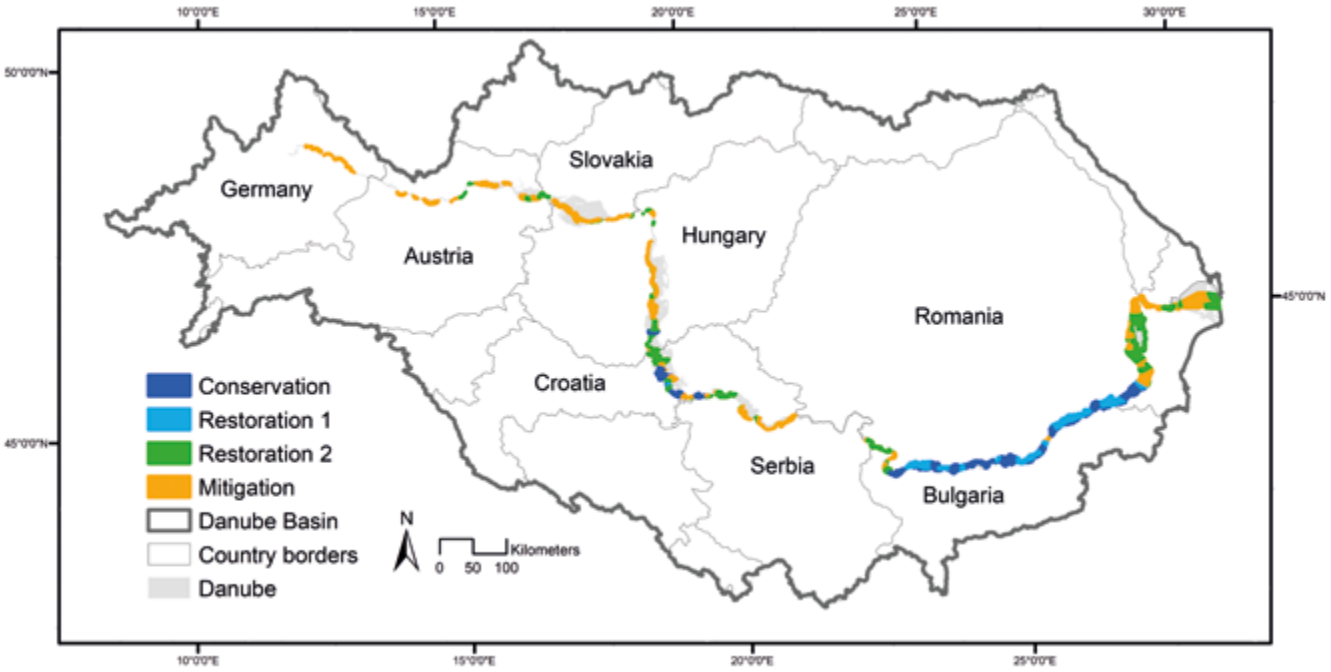

Figure 1. Classification of river-floodplain areas along the navigable Danube. Conservation: high multi-functionality across species and ecosystem services and therefore defined as having the highest conservation potential. Restoration 1: high remaining potential for only a dominantly rheotopic/river community and therefore defined as requiring restoration. Restoration 2: remaining potential for only a dominantly stagnotopic/floodplain community as well as ecosystem services and therefore defined as requiring restoration. Mitigation: overall reduced biodiversity potential across all species and ecosystem services except for increased flood regulation potential and therefore defined as having potential for mitigation measures related to flood regulation and possibly parts of the species community. Adapted from Funk et al. (accepted).

AQUACROSS results thus can promote successful implementation of river-floodplain restoration. The proposed EBM approach supports the joint selection of restoration sites including prioritisation of protected areas (HBD), and site selection for the next River Basin Management Plans (WFD) or Flood Management Plans (FD).

With this, AQUACROSS links available multi-disciplinary information in an innovative way and creates a basis for a more integrated management and restoration planning of river-floodplain systems in the Danube River Basin, in line with the principles of EBM.

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News and Notes

The most complete inventory of water plants along the Danube's entire course and of related water bodies in the Basin

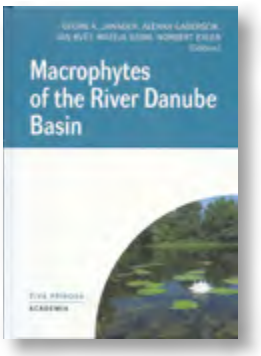
An attractive book for scientists as well as common readers interested in the aquatic plant life recorded in the «Most international Large River of the World».

This book covers the topic of «Aquatic Macrophytes» in the Danube River, starting at the source-rivers in the Black Forest of Germany and leading the interested reader directly along the whole river course, to where it ends in the channels of the Danube Delta. Also covered are other rivers and human-made canals in the river basin, as well as some related topics with relevance to aquatic plant life, e.g. contributions from Slovenia, the Czech Republic and Slovakia.

«Macrophytes of the River Danube Basin» has recently been published by ACADEMIA (Prague), with the support of the Academy of Sciences of the Czech Republic. The results reported in this book are based on the support of the Federal Ministry of Education, Science and Culture (Vienna, AT), the Austrian Committee of IAD (International Association for Danube Research), the Bavarian Government/Niederbayern, and the Provincial Authority for Environmental Protection and the Governmental Presidency of Baden-Württemberg.

Important contributions were provided by the Slovenian team, which took care of the first layout-structuring activities and the formidable graphic work on maps by Mateja Rihtaršič. Neither should one forget the outstanding support provided by regional and local organisations in the member countries that facilitated the essential work of the teams during the field campaigns a priori. Finally, more than 50 persons had been involved in different work phases of the whole project and 34 authors had prepared the 21 contributions of this book.

The Danube is one of the «Large Rivers of the World», ranking No.18 by length worldwide, and only second to the Volga River in Europe. The Danube is also the most 'international' river, as its basin reaches into 16 national states, and includes very small areas in another three countries (source: ICPDR maps).



Starting with earlier work of the Expert Group Macrophytes of IAD, and following a thorough Pilot Study period of two years, the main project lasted for five years until all reports had been delivered to the supporting authorities.

Regarding its content this book is quite unique, presenting a scale of detail never achieved previously in the documentation of the aquatic vegetation recorded in a large river. During the surveys along the whole length of the Danube, and with only a few exceptions (e.g. inaccessible reaches in the source-rivers), the 2850 kilometres in the main channel, and additional lengths in main river branches, were sampled for macrophytes, as well as for environmental parameters in the river and its corridor. Based on this dataset the individual contributions were composed to highlight different aspects of interest as seen by the authors of each chapter.

The source streams reflect the change in macrophyte composition from mountains, in which they start, towards the adjacent lowlands, where they merge to create the Danube. Its Upper, Middle and Lower Reach, and the Delta, clearly show the diverse character in macrophyte species composition along the whole Danube. This is also true for water bodies in other parts of the basin, which include e.g. karst-rivers, canal systems, and some types of impoundments, too. One contribution also deals with carnivorous aquatic plants, cultivated and studied in the Czech Republic.

This book also contains a complete species list of all macrophytes recorded during the surveys. Individual chapters show the plant names in the respective national language, too.

Figure 1. Overview map of the Danube catchment (top), indicating the Bavarian reach (rectangle); Detail map of the Bavarian Danube (bottom, © M. Rihtaršič, 2018).

The authors, the editors and ACADEMIA Publishing House look forward to a friendly reception of this book,

Figure 2. Dense and species-rich aquatic plant growth in a long and narrow channel of the Danube Delta (© G. A. Janauer, 2012)

which should contribute not only to an increase in scientific knowledge, but may also be a source of information for governmental agencies or stakeholders responsible for the Danube River, as well as for individual readers with interest in aquatic plant life in one of the large rivers in Europe.

Book Reference: Janauer, G.A., Gaberščik, A., Květ, J., Germ, M., Exler, N. (Eds.) 2018. Macrophytes of the River Danube Basin. ACADEMIA, Praha. ISBN 978-80-200-2743-6.
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The Editors

Joint ESENIAS and DIAS Scientific Conference

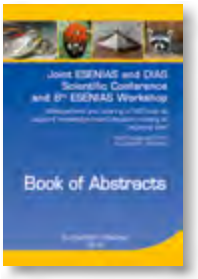
The Joint ESENIAS and DIAS Scientific Conference entitled «Management and sharing of IAS data to support knowledge-based decision making at regional level» was held on 26–28 September 2018, in Bucharest, Romania. It was organised by the Research Institute of the University of Bucharest (UB), Faculty of Biology, and the Botanic Garden «Dimitrie Brandza» of the UB, ESENIAS, and DIAS, in collaboration with the IBER-BAS. The conference covered the following topics:

1) Invasive alien species traits and trends;
2) Vectors and pathways for IAS introductions;
3) The Danube River as invasive alien species corridor;
4) Invasive alien species impact;
5) Invasive alien species prevention and management;
6) Management sharing IAS data.

The Danube Region Invasive Alien Species Network (DIAS) was presented in the conference introductory keynote lecture with its mission, recent activities and achievements. This lecture focused also on the DIAS data sources, including recent projects, types of data collected and future

Figure 1. Group photo of the participants of the Joint ESENIAS and DIAS Scientific Conference

challenges in the IAS data flow and management within the Danube countries. Furthermore, an update on the DIAS strategy development was made. Another keynote lecture given by Prof. Dr. Marius Skolka provided a review of the newly recorded invasive alien species in Dobroudja region and the Danube Delta area. Several contributions presented under the Topic 3 discussed IAS new records, pathways of introduction and spread, biological traits, as well as results from the testing of a smartphone application for recording new sightings of invasive alien species of EU concern in the Danube Region.



More than 100 participants from 12 countries (Bulgaria, Croatia, France, FYR Macedonia, Georgia, Greece, Italy, R. Moldova, Romania, Serbia, Turkey, and Ukraine) attended the conference. A total of 83 contributions were presented and published in a Book of Abstracts.

Teodora Trichkova, *Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences (IBER-BAS), email: trichkova@gmail.com*

Obituary for Prof. Dr. Hellmut Fleckseder M.S.

Prof. Dr. Hellmut Fleckseder, M.S. has unexpectedly passed away on February 20, 2018. His whole professional career was closely linked to the development of water quality management in the Danube region. The Austrian and the International Water Quality Management has lost one of its most visionary and innovative experts.

Born in 1943 in Vienna/Austria, Hellmut Fleckseder acquired his master degree in Civil Engineering at Vienna University of Technology in 1967, after having finished his secondary education in Basel/Switzerland. After his master degree he was immediately invited by famous Professor Wilhelm von der Emde, chair of the Institute for Water Quality Management at his university, to start a scientific career as researcher. The first great research area was to find solutions for the protection of Austrian rivers from heavy pollution by pulp and paper mill waste water discharges. This topic became the essence of his doctoral thesis, which was already closely linking pollution reduction technologies with river quality management with a focal point on Danube River Basin.

In 1969/70, Helmut Fleckseder acquired a post graduate master degree in Environmental Health Engineering at the University of Austin/Texas. In 1978, he was chairing a research team on Lake Neusiedl shared between Austria and Hungary with the goal to limit phosphorus discharge to this shallow lake in a semi-arid catchment. In 1985, Fleckseder was promoted to associate professor for water quality management. Beyond his outstanding scientific achievements and his teaching activity, this promotion was based on his habilitation “Water Protection Through the Ages”.

Prof. Fleckseder was one of the main initiators of a successful interdisciplinary post graduate, master course called ‘Environmental Protection Technology’. He implemented material management methodologies into river basin management starting with the first nitrogen balance for Austria. This methodology was later very successfully applied for research on nutrient balances for the Danube River and Black Sea Basins and has become a major research tool at the institute until today still with emphasis on Danube River Basin.

From the beginning of ICPDR Fleckseder was involved into the activities of the Ministry for Agriculture, Forestry, Environment and Water. He played an important role in establishing the ICPDR program and to bring the headquarter to Vienna. In 1984, he was invited to continue his career at the international water department and as a strategy consultant for the Austrian water management section of the Ministry. In 1995, he was appointed as permanent representative of the Ministry at the ICPDR. From 2001 until his retirement in 2008, Fleckseder represented the Austrian interests regarding the implementation of the EU Water Framework Directive.

Fleckseder was one of the first scientists having recognised and analysed the role of agriculture and human nutrition habits on diffused sources of pollution affecting eutrophication control, area and water requirements for food production in the context of River Basin management. He was one of the first scientists analysing the air transport of nitrogen and phosphorus even beyond river catchments. He was a pioneer in quantifying the natural and anthropogenic nutrient flows as basis for decision making on the most cost effective way to reduce point and diffused sources of pollution for improved water quality in surface and ground water. He clearly showed that for some problems changes in human behaviour are as important as technology.

More than 80 scientific publications and a great number of studies and expert reports have markedly contributed to the advancement of scientific knowledge and the progress in improving the quality of national and international rivers and lakes. He also investigated the great variety of geographical, historical, political and religious background of the 19 Danube countries joining this most international river basin in order overcome the barriers for a long-term fruitful co-operation in ICPDR and beyond.

His strength was to communicate with a large but limited number of national and international experts and friends who realised the high scientific and personal level of commitment of Hellmut and his visionary talent. He has inspired many researchers and friends to follow his footsteps and continue his ambition to create a sustainable coexistence of human and natural development even beyond water management.

We have lost a great personality but have inherited his achievements and inspiring ideas. *Helmut Kroiss*

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danube news

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Hydrological catchment of the River Danube

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