IDES

Improving water quality in the Danube river and its tributaries by integrative floodplain management based on Ecosystem Services

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O.T1.2: National training courses for key actors in the water sector on IDES application

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with support of the entire IDES partnership

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Summary

We performed training courses on the application of the novel IDES Tool (Output T1.1) in the participating countries and in their respective national languages, following a joint design. The trainings aimed at developing expertise among the participants to apply the IDES Tool in order to foster an integrative floodplain management based on ES. The target groups included staff of water administrations and other key actors dealing with water quality-, ecosystem-, or floodplain-management. In the training courses, we provided capacity building and information on the Ecosystem Service (ES) approach in general, the selection of suitable ES in specific floodplain areas, their evaluation methods on the basis of available data, and on options to visualize and analyze the ES evaluations. We created national protocols of the training courses and eventually synthesized the discussed key topics. This output supports the implementation of the IDES Tool and therefore contributes to the Specific Objective 1 and 3 of the IDES project.

Common structure of the national training courses

The training courses and their protocols followed a common structure using a joint presentation which was translated into the respective national languages. The English version of the presentation is provided in the final chapter. The following topics were presented to the participants:

- Background about floodplains and ES
- What is the IDES Tool?
- Why use the IDES Tool?
- How to use the IDES Tool?
- Delineation of floodplains
- Evaluation of ES (based on data availability)
- Prioritization of water quality functions
- Visualization
- Analysis: ES and water quality
- Integration of stakeholder perceptions

During the courses, there were two guided discussions about the following topics:

1. The stakeholders' experiences:
    a. with the ES concept and its application,
    b. in the floodplain and water quality management.
2. The application of the IDES Tool and feedback:
    a. Potential applications in the respective fields
    b. Implementation in concrete measures
    c. Additional requirements for sustainable floodplain management
    d. Other profiteers/beneficiaries of the IDES Tool
    e. Policies benefitting from the tool
    f. Ways to visualize ES
    g. Additional feedback

In all national protocols, general information about the type of training (in person or online), anonymized information about the participants (number, institute names, and stakeholder types only), and the results of the two stakeholder discussions were summarized.

List of participating institutions

Country	Institution	Stakeholder type	Number of representatives
AT	Austrian National Waterway Authority (viadonau GmbH)	sectoral agency	2
	Austrian Federal Forestry (Bundesforste AG)	sectoral agency	1
	National park Donau-Auen (GmbH)	Interest groups including NGOs	1
	Austrian Federal Ministry for Agriculture, Regions, and Tourism (BMLRT)	national public authority	1
	Municipal Department for Climate, Forestry, and Agriculture Vienna (MA 49)	local public authority	2
BG	District Administrations in the town of Veliko Tarnovo	regional public authority	5
	Gorna Oryahovitsa Municipality	local public authority	10
	Danube River Basin Directorate	regional public authority	4
	Regional department of agriculture	regional public authority	1
	Sedmicata News Paper	local public authority	1
	Polski Trambesh Municipality	local public authority	1
	Water supply and sewerage "Yovkovtsi" - WWTP Gorna Oryahovitsa, Dolna Oryahovitsa and Liaskovets	local public authority	1
	Dolna Oryahovitsa City Hal	local public authority	1
	Shumen Water Supply and Sewerage Association	regional public authority	1
	Bulgarian Water & Sewerage Holding EAD	national public authority	1
	Sugar factories JSC	SME	2
	Yantra Village City Hall	local public authority	1
	Krusheto Village City Hall	local public authority	1
	Balkanka Association	Interest groups including NGOs	1
	District Administrations in the town of Gabrovo	regional public authority	1
	Pravda Village City Hall	local public authority	1
	Draganovo Village City Hall	local public authority	1

	Veliko Tarnovo Water Supply and Sewerage Association	regional public authority	1
	G.D. Trambesh Village City Hall	local public authority	1
	District Administrations in the town of Veliko Tarnovo	regional public authority	1
	Regional Inspection for Environment and Water - Veliko Tarnovo	regional public authority	2
	Parvomaytsi Village City Hall	local public authority	1
	Regional Health Inspectorate Veliko Tarnovo	regional public authority	2
DE	Water Management Authority Munich	Local public authority	3
	Water Management Authority Rosenheim	Local public authority	3
	Department for Food, Agriculture and Forestry Deggendorf-Straubing	Local public authority	1
	Regional Authority of Tübingen	Regional public authority	1
	Regional Authority of Swabia	Regional public authority	1
	Federal Waterways and Shipping Administration (WSV)	National public authority	4
	German Federal Institute of Hydrology (BFG)	Sectoral agency	5
	National Association for Bird Protection, Upper Bavaria	Interest groups including NGOs	1
	Bavarian farmers' association	Interest groups including NGOs	1
	Ludwig-Maximilians-University Munich	Higher education and research	3
	IWW Water Centre	Higher education and research	1
HU	ATIVIZIG	Regional public authority	3
	DDVIZIG	Regional public authority	2
	University of Debrecen (DE)	Higher education and research	4
	ÉMVIZIG	Regional public authority	2
	FETIVIZIG	Regional public authority	1
	KDVVIZIG	Regional public authority	3

	KÖVIZIG	Regional public authority	2
	General Directorate of Water Management (OVF)	National public authority	1
	Pázmány Péter Catholic University (PPKE JÁK)	Higher education and research	1
	István-Széchenyi-University (SZE)	Higher education and research	1
	Szféra-Tisza Kft	Sectoral agency	3
	TIVIZIG	Regional public authority	3
HR	Kopački Rit Nature Park Public Institution	National public authority	1
RO	National Agency for Fisheries and Aquaculture - Moldova Branch	Regional public authority	2
	National Agency for Protected Natural Areas, Braila	Local public authority	2
	Environmental Protection Agency, Braila	Local public authority	3
	National Environmental Guard, Braila	Local public authority	1
	Romanian Waters National Administration, SGA Braila (3)	Local public authority	3
	Forestry Guard, Braila	Local public authority	1
	Regional Development Agency, South-East	Interest groups including NGOs	1
	EcoAlpex 024 Asociation	Interest groups including NGOs	1
	ARIN	Interest groups including NGOs	1
	Obiectiv, Vocea Brailei	Interest groups including NGOs	1
	National Institute of Hydrology and Water Management	Higher education and research	2
	Braila Agricultural Development Research Station	Higher education and research	3
	Research & Development Institute for Aquatic Ecology Fisheries and Aquaculture	Higher education and research	3
	Danube Delta National Institute for Research and Development	Higher education and research	1
RS	Public Enterprise for Water Management “Srbijavode”	National public authority	1

	Public Water Management Company Vode Vojvodine	Sectoral agency	1
	Institute of Nature Conservation	Regional public authority	1
	Public Company Vojvodinašume	National public authority	1
	Provincial secretariat for urbanism and environmental protection	Regional public authority	1
	University of Belgrade, Faculty of Civil Engineering, Department of Hydraulic and Environmental Engineering	Higher education and research	1
	University of Belgrade, Institute of Chemistry, Technology and Metallurgy	Higher education and research	1
	University of Novi Sad, Faculty of Sciences	Higher education and research	1
	Civil Society Association Dunav 1245	Interest groups including NGOs	1
	Pokret Gorana	Interest groups including NGOs	1
	City of Novi Sad Administration for Environmental Protection	Local public authority	1
SI	Slovenian Water Agency	Sectoral agency	1
	LUTRA, Institute for Conservation of Natural Heritage	Interest groups including NGOs	1
	University of Maribor, Faculty of Natural Sciences and Mathematics	Higher education and research	1

Protocols of the national training courses

1 Austria

1.1 Type of Training and Stakeholders

The national training course in Austria took place on May 31st from 9:00 to 11:45. As preferred by the participating stakeholders, the course was held as an online event.

Two participants attended from the national waterway authority (viadonau GmbH; sectoral agency), which is in charge of the preservation and development of the Danube waterway for navigation, including the hydro-engineering maintenance, and the river-floodplain restoration measures in the Austrian pilot area (national park Donau-Auen). Two participants represented Vienna's municipal department for Climate, Forestry, and Agriculture (MA 49; local public authority), assigned to the management of the Viennese part of the national park. There was one representative of the organization in charge of the overall management of the national park Donau-Auen (Nationalpark Donau-Auen GmbH; interest groups including NGOs). One person represented the Federal Ministry for Agriculture, Regions, and Tourism (BMLRT; national public authority). The ministry covers a variety of thematic fields, including agriculture, forestry, torrent control, water management, hydraulic engineering, water management, tourism, and regional policies. The Austrian Federal Forestry (Bundesfortse AG; sectoral agency), in charge of the maintenance and management of fisheries in the national park, was represented by one associate. Thomas Hein, Elisabeth Bondar-Kunze, Silke-Silvia Drexler, and Martin Tschikof participated on behalf of BOKU-IHG. Thomas Hein welcomed the course participants, Martin Tschikof held the course, Elisabeth Bondar-Kunze led the discussions and Silke-Silvia Drexler took the minutes.

1.1 Discussions

Experiences of stakeholders

All participants were familiar with the general concept of (ES) and presented the significance and applications in their respective fields:

MA 49 shared that ES are crucial in forests, in floodplains and elsewhere, especially in the light of climate change. For 2-3 years, the ES concept has gained importance in the management of forests in Vienna to increase resilience against climate change. However, the management of nutrients is currently not an issue for the department. MA 49 is concerned with ES about groundwater, cold-air filtration, and cold-air depressions. Also, the ES concept has been used for the topics of drinking water supply, flood protection, and environmental education, topics of great value to MA 49. Finding ways to define and monetarize ES would help them and probably others to better gain resources from contracting entities.

National park Donau-Auen GmbH mentioned that every aspect of their management in the national park is linked to ES, even though not always visible at the first glance. There are direct and indirect uses of ES in the national park ranging from grassland management to the improvement of air quality. However, there is a lack of awareness about the function and the value of the national park in the wider society. It was raised that in protected areas, a monetary evaluation would be useful to compare it with anthropogenically influenced systems or alternative management scenarios. These economic comparisons of systems might facilitate a better understanding among the society and support decision-making.

Viadonau GmbH quoted a joint study with BOKU, where ES in different implementation scenarios of planned restoration measures in the national park were evaluated (BEDOM, University of Natural Resources and Life Sciences, Vienna (BOKU) - Research portal). Because significant amounts of tax money have been used for river engineering and restoration projects, these evaluations are crucial to justify these large investments. Besides the traditional evaluations of the measures' impacts on navigation and the national economy, a more comprehensive representation can be given using ES. The resulting transparency for decision- and policy-makers helps to further argue the investments for navigation and ecological improvements.

On the part of the Austrian Federal Forestry, ES have been evaluated qualitatively, not monetarily. Flexible approaches are needed to comprehend the extensive measures required for the protection of floodplain forests.

The BMLRT ministry was interested in the IDES project, in particular in the roles of cultural ES for the development of aquatic ecosystem- and risk management concepts.

Feedback and applications of the IDES Tool

Viadonau could imagine applying the tool in current projects along the Austrian Danube. It would find its way to show changes in ES to support the communications with local stakeholders and municipalities, among others. There are possible scientific applications of the IDES Tool by the National Park Donau-Auen GmbH and options for its further development. Other participants had no concrete suggestions to implement the tool in their respective fields.

MA 49 suggested that population density is also an important indicator for the potential use of ES and information about it can be used to reach a wider population via educational institutions. Therefore, population density should be included in the IDES database and ES evaluations.

MA 49 reported that their colleagues from the departments Environmental Protection (MA 22), Vienna Water (MA 31), and Water Management (MA 45) (invited but not present) are also working closely with ES and would profit from the IDES Tool. In this context, working examples of matter fluxes in groundwater and biodiversity were mentioned.

There would be potential applications of the tool in the spatial planning packages on the regional or state level. National Park Donau-Auen GmbH raised the point that it is helpful to develop strategies on the Danube-wide level (e.g. Danube Parks). However, there was skepticism about a successful application on the local level, because on these levels the priorities are rather on the specific uses of floodplains.

The stakeholders announced their interest in various visualization approaches. Both, the spatial explicit visualizations on a larger scale and the charts to show the distribution and diversity of ES are crucial. Their opinion was that large-scale visualizations support the transnational administration of waterways or the designation of protected natural goods, whereas a more local approach might be relevant for nature conservation purposes. Overall, it was agreed, that a web-based and interactive map of ES in floodplains would be of great value for most of the participating stakeholders.

As has been mentioned by several stakeholders that a monetarization of ES would represent a useful extension of the IDES Tool to directly argue about the costs and benefits of floodplain management and to better reach a wider audience.

2 Bulgaria

2.1 Type of Training and Stakeholders

The Bulgarian IDES national training course was held in Gorna Oryahovitsa on June 8th, 2022. 42 stakeholders participated representing national, regional and local public authorities, SMEs, and interest groups, including NGOs.

2.2 Discussions

Experiences of stakeholders

The stakeholders involved did not have the competence for ES concept and its application, with the exception of those who attended the first work meeting in Veliko Tarnovo town on June 23rd, 2021. A small number of the participants in the completed Interreg DTP project "Danube Floodplains" were aware of the measures for managing the floodplains. For example, the participants from the Danube River Basin Directorate, city of Pleven. Only the participants from the Regional Environmental Inspection and the Regional Health Inspection in Veliko Tarnovo town in the Yantra River Basin were aware of the monitoring of water quality, and the participants from the Water & Sewerage Company "Yovkovtsi" were aware of the conventional ways in removing nitrogen and phosphorus.

Applications of the IDES Tool and feedback

For all participants, the training course was of great benefit. Especially the representatives of the agricultural organizations and the mayors of settlements in the floodplains expected in the developed IDES Manual good practices and methodologies for compensating farmers after flooding their arable lands. There was special interest in the treatment of wastewater using innovative technologies and facilities including natural systems -reeds, etc. In response to the interests of the participants, a presentation with good practices for the use of wetlands and innovative approaches to the removal of nitrogen and phosphorus compounds was also presented at the course. The main message of the participants in the training course in the Yantra River Basin was to have specific legal and technical solutions for the implementation of ES in the floodplains. Particular attention was paid to the wetland of the Danube River near Ingolstadt in Germany. The description of such good examples would be useful.

3 Croatia

3.1 Type of Training and Stakeholders

The national training organized for invited Croatian stakeholders (via WWF Adria), from the Sava River Basin Commission and ICPDR, was held online via Zoom on 23rd of June, from 9:00 to 12:00. Besides IGB, only one person, representing the Kopački Rit Nature Park Public Institution, participated.

3.2 Discussions

Experiences of stakeholders

The participant was experienced in the floodplain management sector but had no experience in the water quality management and the application of the ES concept.

Applications of the IDES Tool and feedback

The participant was interested in having the Kopački Rit Nature Park Public Institution included in projects applying IDES Tool.

4 Germany

4.1 Type of Training and Stakeholders

The German national training was held online via Zoom on 22th of June, from 9:00 to 12:00.

7 participants represented the 3 local public authorities Water Management Authority Munich (WWA München), Water Management Authority Rosenheim (WWA Rosenheim), and the Department for Food, Agriculture and Forestry Deggendorf-Straubing (Amt für Ernährung, Landwirtschaft und Forsten Deggendorf-Straubing).

The regional public authorities Regional Authority of Tübingen (Regierungspräsidium Tübingen) and the Reginal Authority of Swabia (Regierung von Schwaben) were represented by 2 participants.

The Federal Waterways and Shipping Administration (national public authority) and the German Federal Institute of Hydrology (BFG; sectoral agency) were represented by 4 and 5 participants, respectively. 2 people represented the interest groups the National Association for Bird Protection of Upper Bavaria and the Bavarian Farmers' Association. In the field of higher education and research, 3 participants from the Ludwig-Maximilians-University (LMU) Munich and one from the IWW Water Centre were attending. From the IDES Partnership, 3 persons from CUEI and 2 persons from FVB.IGB were present.

4.2 Discussions

Experiences of stakeholders

In the German training, the experiences of the stakeholders were inquired using the online survey tool „Mentimeter". The results are summarized below:

Do you work in/with floodplains?

- Yes, often (5)
- Yes, sometimes (5)
- No (6)

Do you work with water quality?

- Yes, often (2)
- Yes, sometimes (7)
- No (7)

How familiar are you with the concept of ES?

- Ranking 1 to 10 (1= not familiar; 10 = very familiar)
- Average = 5.1

Have you already used ES calculations in your work?

- Yes, calculated by yourself (2)
- Yes, existing evaluations used (2)
- No (12)

How have you used ES calculations in your work?

- Research and development
- Communication
- Has not been used so far

Applications of the IDES Tool and feedback

WWA Rosenheim asked whether it is possible to quantify areas of "high relevance" for nutrient retention using concrete values. FVB.IGB replied that class boundaries were calculated automatically and are not shown in qualitative form but it could be observed which rank has been assigned to which absolute value. CUEI added that the difficulty lies in the different scales (Danube-wide vs. local measures). The ranking enables an overview, but of course it is interesting to see the absolute values at the local level especially for practical applications.

WWA Rosenheim asked if the model MONERIS can be also applied at the regional level on sub-catchments or smaller catchments. For example: What would the increase of water retention volumes with high flood frequency in a small catchment do for water quality? How much retention volume needs to be created to achieve a certain reduction in nutrient levels? FVB.IGB replied that the MONERIS approach could reach its limits for very small-scale applications. This approach is probably too imprecise for the local complexity. But in principle, there are other models that work with detailed input data, e.g. for scenario calculations. If data availability is not a limiting factor, other approaches would be used. CUEI mentioned that instead of the MONERIS approach, the IDES calculation can be used for nutrient retention. This has already been successfully tested on 1 km segments. It is still quite coarse, but with good data availability, a smaller segmentation can be carried out. Scenario building is also possible with this approach.

LMU had experiences with the INVEST model (for quantifying and validating ecosystem services) and asked whether it played a role in IDES or it is too data-intensive in the Danube River Basin. FVB.IGB stated that the idea was to continue with the RESI approach, as it was very successful in Germany. The Danube Region is very important for different countries, therefore RESI was implemented for the Danube Region. The challenge was the data - from this the IDES approach was developed and good results for different ecosystem services were achieved. In part, new approaches within the framework of IDES, e.g. for the ecosystem services Timber, Fishing, Hunting were developed. LMU mentioned that INVEST has a very modular structure and it is also possible to calculate only individual ES (e.g. phosphorus retention) and perhaps tools like INVEST are more suitable at the local level than the IDES approach. CUEI answered that there were several reasons against the use of INVEST. For example, the cultural ES were not represented at all, and RESI also wanted to pursue a uniform approach. IDES is the continuation of RESI. FVB.IGB added that INVEST has also not been developed specifically for floodplains, but for other ES. RESI and also IDES focus specifically on floodplains and the ES they provide. LMU agreed that INVEST also often works at the catchment level and not, for example, in relation to a floodplain.

LMU inquired whether the IDES approach is a snapshot or it considers a longer period and if it is expected that climate change or other developments will make reclassifications necessary. CUEI answered that the time period was dependent on the most recent available data. A lot of it relates to land use data, for the floodplains there is the Copernicus Riparian Zones dataset. These are updated regularly. I.e. different time steps can be considered. A big unsolved issue has been floods and the regularities in which they occur. For nutrients, for example, the most recent data at the best resolution were used. In Germany, the data situation is generally very good. LMU further asked about the stability of these classifications. Will there be a reclassification necessary? In which direction would this go? CUEI replied that climate change, even if it is no longer a scenario, must of course be considered as a scenario to assess what is important for planning and decisions. It might concern flood protection, nutrient retention, settlement development, or agriculture. Of course, there may be a shift in the near future, so that we realize that flood protection is no longer so important, but that we have to think about the

retention of water in the landscape. This is an opportunity for decision-makers to focus on drought regulation, for example.

5 Hungary

5.1 Type of Training and Stakeholders

The national training course was held in Szolnok, Hungary on June 29th, 2022.

Most of the participants belonged to two groups:

- Water Directorates (regional public authority), 15 participants (excl. KÖTIVIZIG)
- Universities (higher education and research), 6 participants

In addition, one participant representing the General Directorate of Water Management (OVF; national public authority) and 3 representatives of Szféra-Tisza Kft (sectoral agency) attended.

5.2 Discussions

Experiences of stakeholders

The participants from the Water Directorates had a general knowledge about the ES. Each of them deals with the maintenance and management of floodplains in their respective river sections. A few of them have already known about ES assessments. The Floodplain Research Institute had just been established in Hungary and their goal is to adapt the RESI/IDES methodology in Hungary. All those who came from universities have dealt with ES assessments and are also part of the Research Institute.

Applications of the IDES Tool and feedback

In general, the training was well attended by the participants. Several people were trying to adopt the applied methodologies (e.g. Hungarian Floodplain Research Institute). One of the comments was that it would be worthwhile to test the methods in smaller areas. The importance of possibilities for measurements and sampling was mentioned to have adequate data access.

The colleagues of the University of Debrecen (DE) wanted to test the RESI and IDES methodology on a short section of the Hernád River. They also wanted to measure some data for the analysis.

The innovative ES evaluation methodology could bring the interested sectors (water management, nature protection, agriculture etc.) closer together. However, the participants missed assessments from the biological side of the methodology. The web visualization won the approval of the participants. It was recommended that as much of the input data as possible should be also displayed there.

6 Romania

6.1 Type of Training and Stakeholders

The Romanian national training course was held on 10th of June, in Braila, from 10:00 to 12:00. All the participants were present in person at the event.

25 participants from 15 institutions attended the training: two representatives from the National Agency for Fisheries and Aquaculture - Moldova Branch; two representatives from the National Agency for Protected Natural Areas, Braila; three representatives from the Environmental Protection Agency, Braila; one participant from the National Environmental Guard, Braila; three representatives from the

Romanian Waters National Administration, SGA Braila; one participant from the Forestry Guard, Braila; one participant from the Regional Development Agency, South-East; one participant from EcoAlpex 024 Asociation; one participant from ARIN NGO; one participant from Obiectiv, Vocea Brailei; two representatives from the National Institute of Hydrology and Water Management; three representatives from the Braila Agricultural Development Research Station; three representatives from the Research & Development Institute for Aquatic Ecology Fisheries and Aquaculture; and one participant from the Danube Delta National Institute for Research and Development.

Nicoleta Geamana, Relu Giuca, Mihai Adamescu, Constantin Cazacu, Tudor Racoviceanu and Valentin Dinu participated on behalf of UB-RCSES, and Corina Gheorghiu participated on behalf of WWF Romania. Mihai Adamescu welcomed the participants and presented the IDES project (its aim, goals, and activities), while Constantin Cazacu held the course.

6.2 Discussions

Experiences of stakeholders

Most of the 21 participants were familiar with the concept of ES, having different levels of knowledge and understanding about it.

Applications of the IDES Tool and feedback

Stakeholders mentioned that the IDES Tool can be used in the decision-making process, in order to sustainably manage the natural habitats specific to wetlands. It can be used by specialists for decision support regarding public policies and also for cost-benefit analyses. The IDES Tool can provide information on the current situation of a study area, including on anthropogenic pressures. It can thus provide support for decision makers to identify the appropriate measures / solutions that can be implemented so as to ensure both an improvement in ES and an approach accepted by all stakeholders and decision makers.

Furthermore, the tool could be used by the authorities in the field of water management, authorities with responsibilities in the management of protected areas, especially along the Danube or its tributaries, education, research and development institutions and in the environmental assessment process. The assessment of ES can be integrated into environmental policies, especially those concerning the fisheries, forestry, hydrological, and biodiversity management sectors.

The visualization of ecosystem services should be publicly accessible on an interactive online platform and easy to analyze, using maps with different layers.

7 Serbia

7.1 Type of Training and Stakeholders

The national training course in Serbia was held on the 23rd of June 2022 in Eko-centar Radulovački in Sremski Karlovci as a face-to-face event. The training started at 9:30 with the registration of participants and finished at 13:00.

Invitation for the training was sent to 16 organizations (national stakeholders) dealing with water quality management, water administration, water management, and other stakeholders. The invitation was also distributed to WWF ADRIA and the International Sava River Basin Commission.

The training was attended by the representatives of the Public Enterprise for Water Management “Srbijavode” (national authority responsible for all aspects of water management in Serbia); Public

Water Management Company Vode Vojvodine (sectoral agency responsible for the water management in Vojvodina Province); Institute of Nature Conservation (Serbian ASP, regional public authorities); Public Company Vojvodinašume (national authority) ; Provincial secretariat for urbanism and environmental protection (regional public authority); University of Belgrade, Faculty of Civil Engineering, Department of hydraulic and environmental engineering (higher education and research); University of Belgrade, Institute of Chemistry, Technology and Metallurgy (higher education and research); University of Novi Sad, Faculty of Sciences (higher education and research); civil society association Dunav 1245 (NGO); non-governmental organization Pokret Gorana (NGO); City of Novi Sad Administration for Environmental Protection (local public authority), and the Faculty of Agriculture, University of Novi Sad.

The course was divided into three parts. Within the first part, Jasna Grabić presented the IDES project, its aim, goals, and activities. What is the IDES Tool and why it should be used was presented by Milica Ilic. This part included also definitions of the ES, for the participants new in the field. How to use the IDES Tool was presented by Pavel Benka, explaining in detail the whole IDES Tool methodology including delineation of floodplains, evaluation of ecosystem services, and prioritization of water quality functions, as well as the visualization options (in use, and under development). After the short break, Miloš Ćirić presented the project BIOLAWEB (HORIZON-WIDERA-2021-ACCESS-03 - Twinning) - 'How we can improve biomonitoring in Serbia, neighboring countries and the EU?', a highly relevant issue for water quality management and its improvement. In the final presentation, Zorica Srđević gave an overview of the application of the IDES Tool in the Serbian pilot area Special Nature Reserve Koviljsko-petrovaradinski rit (KPR): the analysis of relevant ES, their relation to water quality, results of the first and second stakeholder workshops in KPR, integration of stakeholders' perceptions in the visualization of optimal water management scenarios. The third part of the training included the guided discussions.

7.2 Discussions

Experiences of stakeholders

Seven stakeholders took part in the discussion. Participants representing national and provincial public enterprises in the water and forestry sector, urban inspections, institute of environmental protection, NGO, and academia (Novi Sad and Belgrade) informed the audience about the generally insufficient understanding of the ES concept and its potential concerning further developments in Serbia. There are already actions for improving provisioning and cultural ES, but a more organized approach is needed at the institutional level to promote these services as societal interest and to reduce identified pressures such as unauthorized land changes and the absence or insufficient communication between sectorial representatives (stakeholders) in the KPR on two sides of the Danube (Kovilj area at the left side, and Sremski Karlovci on the right side). Stakeholders from the civil sectors believe that management of floodplain (responsibility of Vojvodina Šume - public forest enterprise), should be more concerned with the ES-related interests of citizens, e.g. outdoor activities such as recreation, camping, fishing, kayaking, etc. Although floodplain management was not discussed in detail, it appears that stakeholders in the KPR are not satisfied with the present situation. The adopted strategy for rural development of the broader KPR area includes measures for improvements of floodplain management, however without detailed treatment of water quality issues. The focus is more on the public, private, and civil infrastructure (roads, bridges, local transport). In the stakeholder's opinion, the 'state' and 'province' are late in implementing procedures and more actions are needed to push the implementations forward.

The potential of ES is not yet exploited at a local scale. Many people still do not know about the concept at all, better to say, there is a feeling about the ES's potential but not in an articulated way. More information and motivational actions (media promotions) are needed to prepare the ground for improvement.

The audience is informed that on June 17th, 2022, the workshop has been organized at the FAUNS premises in Novi Sad under the title 'Ecosystems services, pressures, payments, and actions – motivation required in south-eastern and central European countries (ESS - MotSE)'. More than 40 attendees from 11 countries actively discussed the ES concept and possibilities for implementation in their countries. Six speakers from Italy (2), Croatia, Serbia, Hungary, and Slovakia presented a general overview of the ES concept, existing pressures, and complex institutional global and local measures to ease implementation, and payment for ES services schemes in different European countries.

Applications of the IDES Tool and feedback

About 2/3 of the participants were informed about the Tool for the first time. There were no particular comments about the level of understanding. Discussion indicated that a possible approach could be to demonstrate the application at small test examples with several ES, few pressures, few measures, and several scenarios. FAUNS informed stakeholders that they may easily use fuzzy cognitive models (FCM) on the internet because it is publicly available. To initiate the IDES Tool application, a local approach was advised, to work with FCM on a trial basis to become familiar with the tool, and then to proceed with real problems, again on a local scale. The dissemination of experience to stakeholders could be the most appropriate strategy after all. Decision-makers, or staff close to them, are recognized as the most important actors in this process. It was jointly stated that the most important part of the usage of the IDES Tool is that user(s), e.g. decision-maker(s), understand the concept and get familiar with the importance of the tool. That is, the acquisition of sufficient knowledge and data to evaluate real opportunities and benefits from selected ES. FAUNS team offered its help (on request) in this regard.

Regarding the issue of sustainable floodplain management, it was jointly concluded that public participation will be the most efficient way to emulate societal interest in making better management decisions, especially in the light of ES provision. Even where legislation exists, the problem is still its implementation, and in a way, it is indicated by the discussion that the state and provinces exhibit significant delays in the real implementation of legislative rules and strategies.

The decision-making process might be significantly improved if it is based, at least to a certain extent, on the usage of the IDES Tool to simulate scenarios and seek solutions to be implemented in management plans, strategies, and operational actions in situ. KPR can be the perfect area to demonstrate the capabilities of the tool by analyzing what-if scenarios of implementing the ES concept and gaining benefits from nature. Further promotion of the ES concept and IDES Tool will be best achieved by the application to a real study area.

Regarding different sectors and policies that might profit from the integration of ES assessments and use of IDES Tool, it was stated from the sector of urban planning and inspection that there is a lack of relevant data: Certain important datasets are 10 years outdated, data are dispersed among sectors and there are no mechanisms for data interchange, monitoring exists but is not connected with measures, etc. There is an obvious need for creating short-term programs of implementation of measures, not to leave most of the activities in this relation to the urban sector.

In the discussion, it was also mentioned that old people dominate in decision-making which is explainable if a political framework is concerned, as well as the migration of qualified young staff to western countries. This process is not considered as a Serbian problem only.

Visualization of ES did not receive the particular attention of stakeholders. It seems that the representation as a matrix was well understood.

Additional Feedback:
From the water sector: There is not enough water of high quality in Serbia, although the national perception is the opposite. Decision-makers often demonstrate in-competence due to their politically-motivated posts at high institutional positions. Most decision-makers do not know the meaning of ES. ES should be more involved in the education at all levels (basic, middle, and university). At the university level, subjects treating ES should be implemented, besides environmental engineering, in faculties of law, agriculture, engineering, and social sciences.

From the civil sector: Enhance public participation in developing rural and urban development strategies. Take care of infrastructure (public, private, and others). Apply for EU funds by developing (with EU partners) projects related to ES concept implementation, networking, and especially exchanging and educating the youth.

From other sectors (forests, agriculture, academia, ...): Identify enthusiasts (pioneers!) in a different sector to jointly help to implement the ES concept and enable the usage of the IDES Tool and other scientific and technological tools and instruments.

8 Slovenia

8.1 Type of Training and Stakeholders

The training course was organised on 9th of June 2022 as a face-to-face event. It was organised in Ljubljana (in the conference hall of the Slovenia Forest Service, Central Unit) since most national stakeholders are located in Ljubljana. The training started at 9:15 and ended around 11:45.

18 organisations (national stakeholders) that are dealing with water quality management and water administration were invited. Also several other stakeholders and individuals were invited. The invitation for the national training was also distributed over different channels from the Slovenia Forest Service as well as the Institute for Waters of the Republic of Slovenia. Unfortunately, most of the stakeholders did not express the desire to participate. The main reason was that few days before the event, the new national government started with work, so most of the stakeholders were highly occupied with the new reorganisation and at the same time could not get the approval to participate in this event. Nevertheless, 10 people in total (together with project team from Slovenia) participated in the event.

One participant came from Slovenian Water Agency – SWA (sectoral agency). This is the agency of the Ministry of the Environment and Spatial Planning tasked with the implementation of water-related EU and national policies. There was one representative from the Institute for Waters of the Republic of Slovenia - IWRS (sectoral agency). This is national research and policy institute that is dealing with water policy issues in Slovenia. One representative was from LUTRA, Institute for Conservation of Natural Heritage (Interest group - NGO). LUTRA is focusing on the conservation of the otter and beaver and has been previously involved in various projects on the Mura River. One representative was from the University of Maribor, Faculty of Natural Sciences and Mathematics-FNM UM (higher education and research). They are dealing with education, research, and applicatory developing centers in the region, studying the fields of biology, ecology, physics, and mathematics.

Several participants (3) also came from the Slovenia Forest Service (SFS, sectoral agency). SFS is the national authority responsible for planning the management of all Slovenian forests, regardless of their ownership.

8.2 Discussions

Experiences of stakeholders

The discussion mostly evolved around the ES concept and its application. All participants were familiar with the ES concept and its application, but they had a different level of knowledge and understanding of ES. Participants from IWRS and SFS have been working with ES already for some time and have used this concept on different levels.

FNM UM wanted to learn more about ES and their application, and the integration of IDES results into their lectures. They have knowledge about ES, but they did not know how ES can be calculated, visually interpreted and presented.

In LUTRA, they have not yet worked with ES, but they understood the value and importance of it. They were exploring the options on how to integrate this concept into their activities. They are currently mainly working with beavers. Since the beaver is also an important element on the Mura River, they are especially interested how beavers interact with specific ES (e.g. wood production). We were also discussing the proposition of widening the forest area at riparian areas of the Mura and leaving it to natural development - this way, the negative impact on wood production and on agriculture would be lower. At SWA, they have included the ES concept in their work, but the full potential of ES has not been exploited yet.

Most participants did not have any real experience in floodplain management and water quality management. SWA and IWRS have the most experiences with these two topics and are highly involved into floodplain and water quality management. However, floodplain and water quality management are two very important topics also for the other stakeholders as they are indirectly concerned with these two topics through their activities.

Applications of the IDES Tool and feedback

This discussion was for the participants a bit trickier since it was the first time IDES Tool was explained to them. For a first-time listener it is quite complicated/confused to understand all the steps on how to reach the final outcome from the IDES Tool. Participants in general understood the process, but for any concrete ideas and feedback they needed a bit more time to think about it. The participants agreed that the IDES Tool can be adopted and used for their work - at least to some extent. But to better understand the IDES Tool and to see how it can be used in their work, they needed some more time to rethink it. The IDES Manual will be a great asset to this, since they will be able to compare the IDES approach more directly with their work.

Nevertheless, participants agreed that the IDES Tool can be a very useful asset when planning some activities, actions or measures in the area of concern (e.g. floodplain area, riverbed). With the IDES Tool, they can calculate how these actions will influence on ES. Most importantly, the graphical visualization of ES changes has a great impact on the stakeholders to take actions.

Participants pointed out that everyone who dealt with water management or the management of ES that are impacted by water, can profit from the IDES Tool. In any case, adaptations are needed, but they are confident that the IDES Tool can be used also in other fields besides water management. LUTRA suggested concrete ideas to apply the tool by using ES to assess the conditions for the appearance of the beaver.

Participants pointed out that by assessing ES all policies in this area can profit. Knowing the value of an individual ES is a starting point for the planning and negotiation of spatial development. In general, policies that have the least measurable results profit most from ES assessments such as nature conservation and landscape perception.

Participants agreed that the presented visualization of the IDES Tool and approach is suitable. They pointed out that they need some more time to be better acquainted with the tool to think of some better visualization options.

One of the main points participants raised was how to use the IDES Tool on smaller streams and if we can use it also for local rivers. The question was if the tool can be also used for alpine rivers or only for floodplain areas. In Slovenia, many rivers have an alpine character so participants agreed it would be an added value if the IDES Tool can be modified and used also outside floodplain areas.

Synthesis

In the participating countries, the level of familiarity with the ES concept varied widely. In part, this was due to the very different stakeholder compositions at the training courses. For example, in Austria, Hungary and Slovenia, where most participants had an academic background and worked on a larger scale, the knowledge of ES was wide spread, whereas in e.g. Bulgaria or Serbia, where also more local stakeholders attended, there have been limited competences for the ES concept and its application. It has been stated by multiple stakeholders, that a proper understanding of ES (and the underlying data) is crucial prior to the application of the IDES Tool from which institutions working on the local level would benefit most.

The greatest potential for the application of the IDES Tool was mentioned in the fields of communication and education, management of protected areas and species, river and floodplain restoration, spatial planning, environmental impact assessments and as support to identify suitable legal and technical solutions. There have been wishes to deliver best practice examples for specific issues. However, many stakeholders mentioned that for concrete local realizations of measures the IDES tool would require a higher spatial and temporal resolution. Some stakeholders offered to test the tool in smaller areas and collect more local data.

It has been stated that there is a need for better communication between sectors and more stringent implementation of strategies. In addition to the IDES Tool, media promotions and the monetarization of ES might support the communications and the acquisition of funds. Another suggestion to improve the IDES Tool was to integrate data about the population density, as it indicates the demand and flow of ES. Overall, there was great interest in the visualization of ES on all scales and the use of publicly available web-based and interactive maps.

Joint Presentation

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WELCOME to the training course on the

IDES Tool

Improving water quality in the **D**anube river and its tributaries by integrative floodplain management based on **E**cosystem **S**ervices

Title, **Name**, email

Logo of the respective institutions

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Programme

15:00-15:30
Background
What is the IDES Tool?
Why use the IDES Tool?

Break

15:30-16:00
How to use the IDES Tool?
- Delineation of floodplains
- Evaluation of ecosystem services
- Prioritization of water quality functions

16:00-16:30

Break

- Visualization
- Analysis: ecosystem services and water quality
- Integration of stakeholder perceptions

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Background

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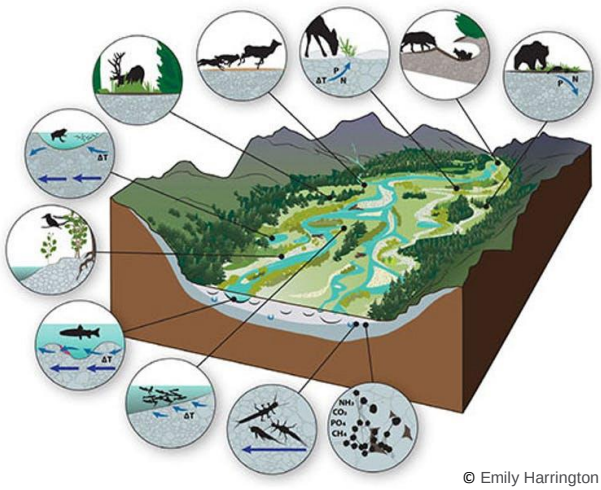
Floodplain Ecosystems

- Land alongside rivers
- Periodically flooded
- Biogeochemical and biodiversity “hotspots”



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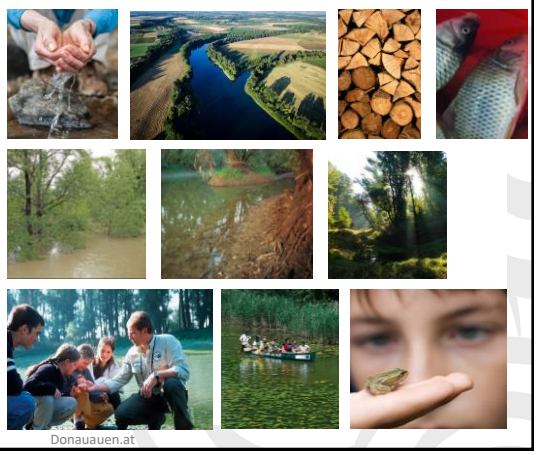
Floodplains provide vital Ecosystem Services (ES)

ES are direct and indirect contributions to human well-being by ecosystems and comprise:

- **Provisioning services**
  - Drinking water
  - Food
  - Raw materials
  - …
- **Regulative services**
  - Flood/drought regulation
  - Nutrient retention
  - Climate regulation, CO_2-storage
  - …
- **Cultural services**
  - Recreation and landscape aesthetics
  - Education and research
  - Spirituality

& navigation, hydropower…



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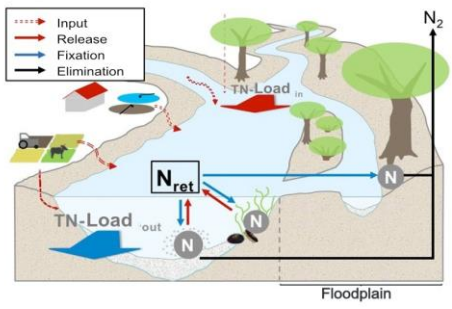
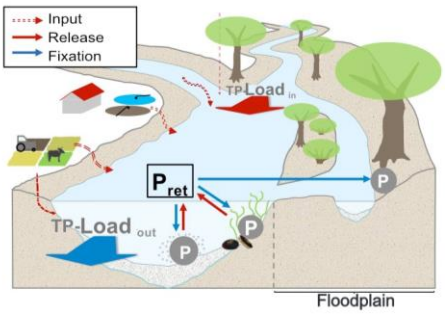
Water quality functions of floodplains:
Nutrient retention

Nitrogen retention



Phosphorus retention



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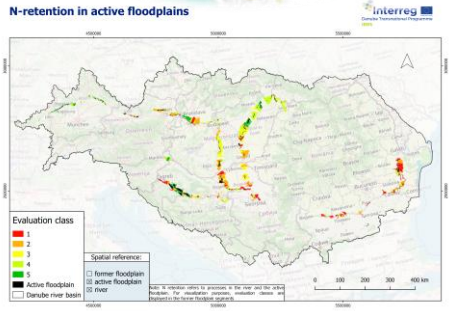
Water quality functions of floodplains:
Nutrient retention

N-pollution

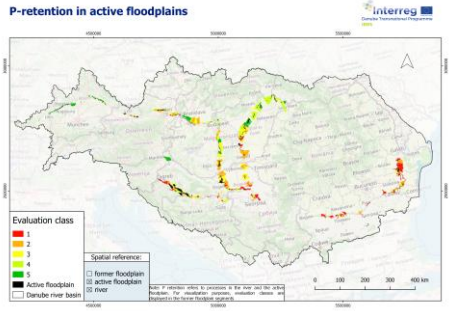
P-pollution

ICPDR 2015

N-retention in active floodplains



P-retention in active floodplains



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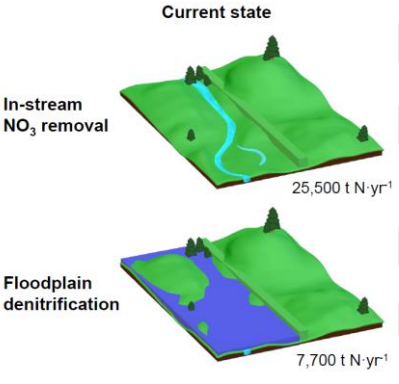
Nutrient retention in the Danube River Basin

Example Nitrogen (N):

Currently, floodplains are able to **remove ~33.000 t of N** from the river water

But the functions of floodplains are impaired!
(Dyking, channelization, land use …)



Tschikof et al. (submitted)

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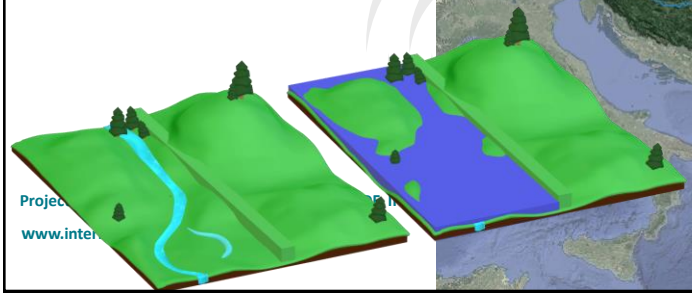
Pressures

In the Danube River Basin (DRB):

- Elevated nutrient levels
- Eutrophication of the Black Sea
- 70-80% of floodplain area is converted/disconnected
- Ecosystem services impaired/lost



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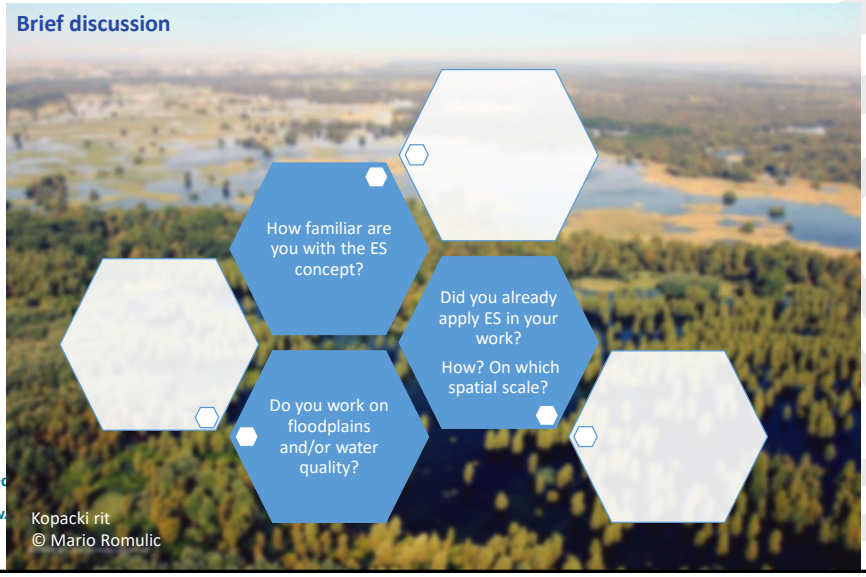
Brief discussion



Kopacki rit
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What is the IDES Tool?

A methodological approach to **harmonize the evaluation and visualization of ES** in floodplains

And to **link ES evaluations with water quality** improvement

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Why use the IDES Tool?

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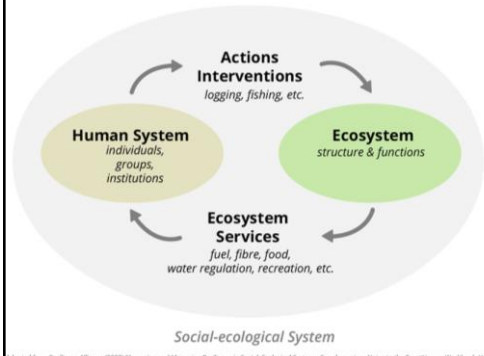
Multiple ES – multiple actors…



Adapted from Resilience Alliance (2007) "Assessing and Managing Resilience in Social-Ecological Systems: Supplementary Notes to the Practitioners Workbook, Vol. 2"

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Multiple ES – multiple actors…

in multiple countries

Actions
Interventions
logging, fishing, etc.
Human System
individuals,
groups,
institutions
Ecosystem
structure & functions
Ecosystem
Services
fuel, fibre, food,
water regulation, recreation, etc.
Social-ecological System

Adapted from Resilience Alliance (2007) "Assessing and Managing Resilience in Social-Ecological Systems: Supplementary Notes to the Practitioners Workbook, Vol. 2"

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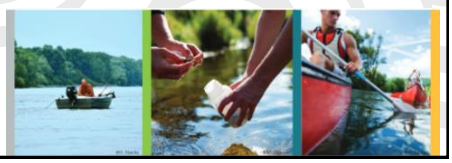
Aim

Improve water quality through **integrative** floodplain management

Needs

- **Water quality issues** of river systems need to be solved by multiple countries
- **Promoting communication** and discussion between individual stakeholders in floodplains on an equal footing
- Demonstrating **synergies and trade-offs** in the planning and implementation process
- **Acceleration of objective decision-making** and implementation in water (quality) management

-> Harmonize existing ES evaluation methods in the Danube region with a focus on water quality issues



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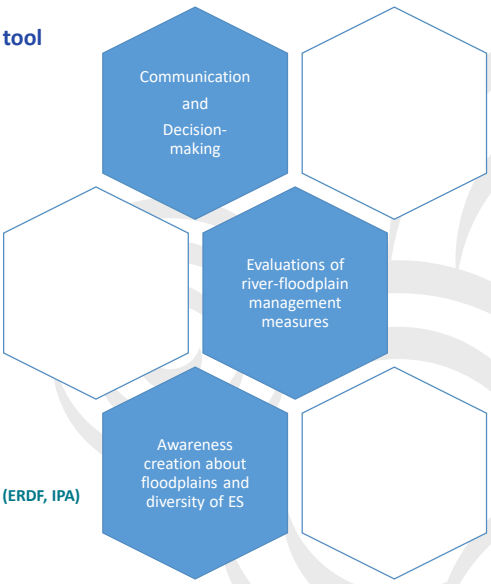
Some applications of the IDES tool



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How to use the IDES Tool?

Mapping ES

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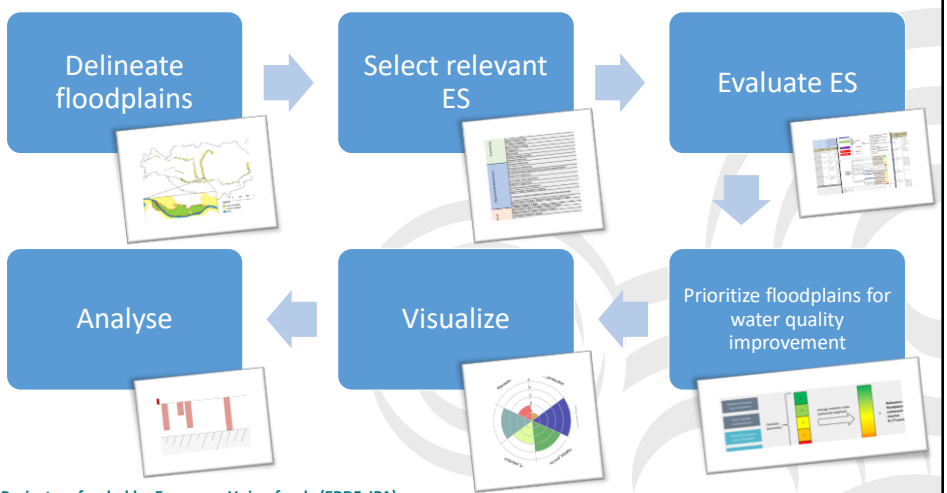

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Requirements

Software and skills in GIS (e.g. ArcGIS, QGIS), data analysis (e.g. R), fuzzy cognitive mapping (FCM)

Geodata: Floodplain areas (hydr. model), land cover / land use, hydro.-morph. mapping, soil maps, protected areas, DTM, meteorological data, nutrient fluxes …

Optionally specific data on: Fishing, hunting, forestry, hydropower, groundwater, drinking water wells …

In the following, we will provide methods and data to assist successful ES evaluations

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Delineate floodplains

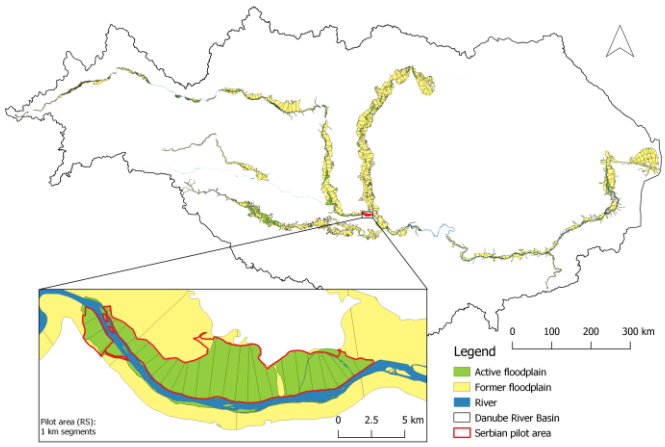
Active floodplain:
Area of a 100-year flood
> 500 ha

Data source:

Former floodplain and **river**:
Copernicus riparian zones

Data source:

Segmentation on 2 spatial levels of detail:
1 km in pilot areas
10 km Danube-wide



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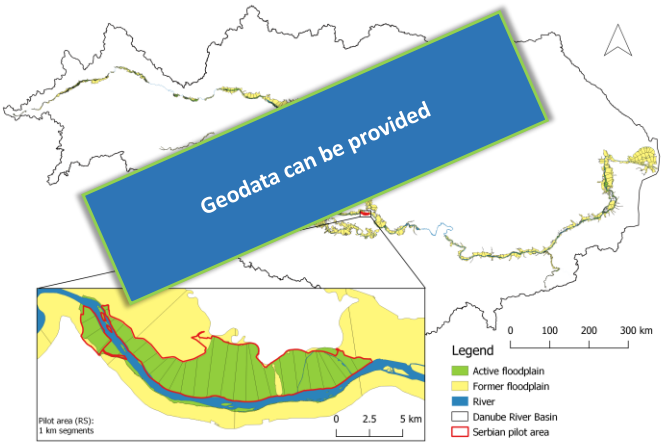

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Select relevant ES

Class	Ecosystem Service
Provisioning	Arable crop production
	Plant biomass grassland
	Commercial fishing
	Timber production
	Commercial hunting
	Freshwater
	Wild foods
	Abiotic energy sources
	Mineral resources
Regulation & Maintenance	Nitrogen Retention
	Phosphorus Retention
	Greenhouse gas regulation and carbon sequestration
	Flood risk regulation
	Low water level regulation
	Sediment regulation
	Soil formation in floodplains
	Local climate regulation/ cooling
	Habitat provision/simplified assessment (Danube-wide)
	Habitat provisioning / detailed assessment (pilot area)
	Habitat provision / river
Cultural	Opportunities for non-water-related activities
	Opportunities for water-related activities
	Landscape aesthetic quality
	Natural Heritage
	Cultural Heritage
	Knowledge systems

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Select relevant ES

Class	Ecosystem Service
Provisioning	**Arable crop production**
	Plant biomass grassland
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	Natural Heritage
	Cultural Heritage
	Knowledge systems

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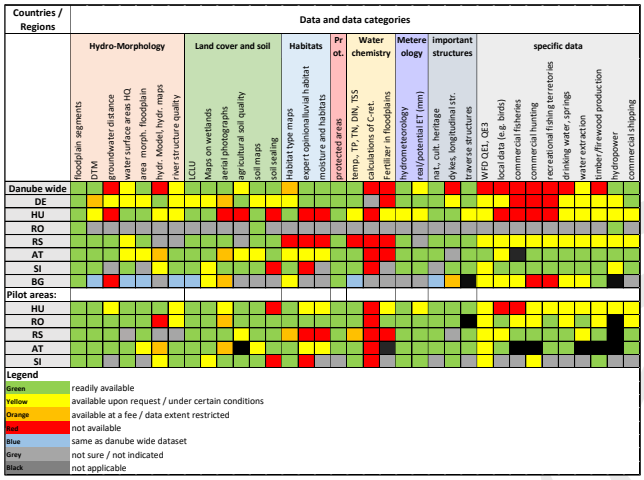
RESI
River Ecosystem Service Index

Diverse data – what to do?



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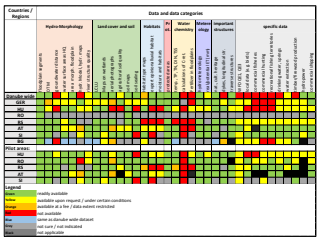
RESI
River Ecosystem Service Index

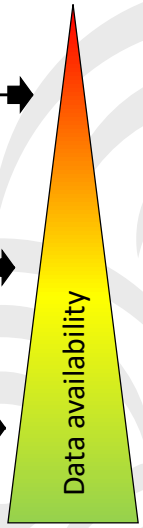
Harmonization of existing ES evaluation methods – 3 approaches for the IDES tool



Capacity matrix:
Estimates of ES potential in landscapes (Burkhard et al. 2009, Stoll et al. 2015)

IDES approach:
Adapted ES evaluation using indicators

RESI approach:
Indicator approach developed in Germany (Podschun et al. 2018)



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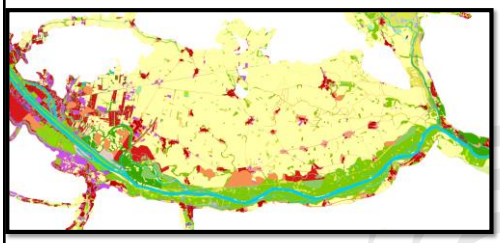
Evaluate ES: Capacity matrix



Land cover / land use
(COPERNICUS riparian zones)

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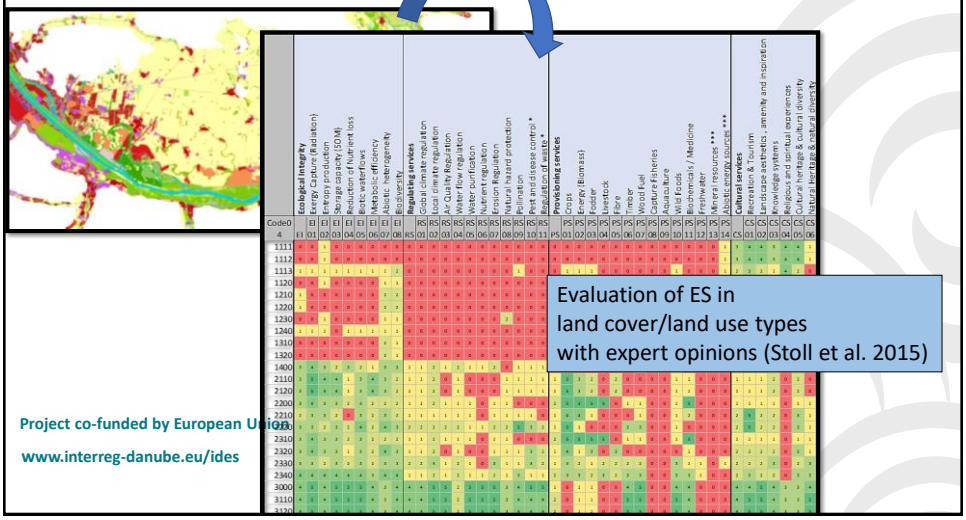
Evaluate ES: Capacity matrix



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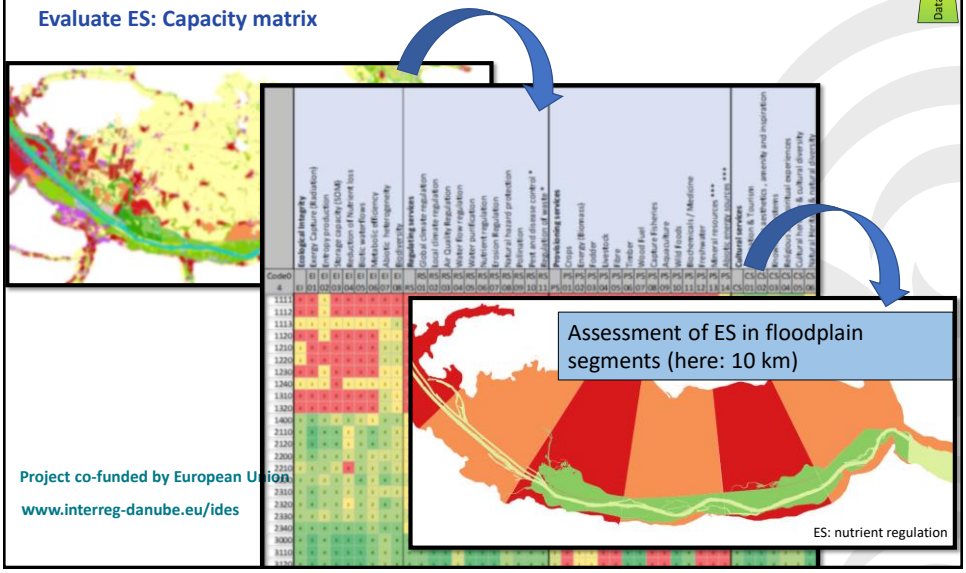
Evaluate ES: Capacity matrix



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Evaluate ES: IDES approach, Example Crop production (provisioning ES)

Data availability

■ **Adaption for Danube-wide application**

Class	Abbr.	Description		Spatial reference	
Provisioning	ACI	Used arable crops (e.g. cereals, root crops, vegetables, fruit)		Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☐ river	
Variable	**Abbr.**	**Unit**	**Variable description**	**Data basis**	**Comment**
Reference areas (Segment- or compartment)	A_{Seg} A_{Comp}	ha	Calculation of the area	- Floodplain segment - Floodplain compartment	
Arable land in the floodplain segment (separated into active and former floodplain)	AL_{act} AL_{for}	ha	Calculation of area: Arable land within the reference areas	- Corine Landcover Classification (CLC)	
Site-specific yield potential for agricultural use	YP_i	Ordinal (1-5)	Weighting of arable land according to yield potential	- Agricultural site mapping (describing the value of the site for agricultural use, mainly depending on soil type)	Classification might differ between countries
Flood-induced yield loss	YL_{Fl}	constant	Yield loss in the active floodplain to flooding	- Flood hazard maps HQ_5, HQ_{10}, HQ_{20}	Estimate

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Evaluate ES: IDES approach, Example Crop production (provisioning ES)

Data availability

■ **Adaption for Danube-wide application**

Class	Abbr.	Description		Spatial reference
Provisioning	ACI	Used arable crops (e.g. cereals, root crops, vegetables, fruit)		Floodplain segment or compartment
Variable	**Abbr.**	**Unit**	**Variable description**	
Reference areas (Segment- or compartment)	A_{Seg} A_{Comp}	ha	Calculation of the area	
Arable land in the floodplain segment (separated into active and former floodplain)	AL_{act} AL_{for}	ha	Calculation of area: Arable land within the reference areas	
Site-specific yield potential for agricultural use	YP_i	Ordinal (1-5)	Weighting of arable land according to yield potential	
Flood-induced yield loss	YL_{Fl}	constant	Yield loss in the active floodplain to flooding	

■ **Data sources**

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
A_{Seg}, A_{Comp}	polygons			river-floodplain segments (1-10 km)	2021	
AL_{Act}, AL_{For}	polygons	International		CLC_2018		
YP classes	polygons			National soil datasets for Austria, Slovenia, and Serbia, SGDB for the other countries		YP is a relative value based on the official fertility classification of soils, which ranges from 1 = very low to 5 = very high Classification based on soil expert opinion and https://esdac.jrc.ec.europa.eu/public_path/shared_folder/dataset/45_biomass_prod/SoilProd_model_soiltype_tables.xlsx
YL_R classes	polygons			National datasets (Romania, Austria, Germany, Hungary, Slovenia), http://www.geo.u-szeged.hu/dfgis/ for Serbia		YL_{Fl} is defined as the averaged annual yield loss due to flooding. Calculation was not performed for AFP where is missing data about flooding probability (Croatia, Bulgaria, Slovenia (Sava))

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Evaluate ES: IDES approach, Example Crop production (provisioning ES)

Data availability

■ Adaption for Danube-wide application

Class	Abbr.	Description	Spatial reference
Provisioning	ACI	Used arable crops (e.g. cereals, root crops, vegetables, fruit)	Floodplain segment or compartment

Variable	Abbr.	Unit	Variable description
Reference areas (Segment- or compartment)	A_{Seg}, A_{Comp}	ha	Calculation of the area
Arable land in the floodplain segment (separated into active and former floodplain)	AL_{act_i}, AL_{for_i}		
Site-specific yield potential for agricultural use	YP_i		
Flood-induced yield loss	YL_{FI}		

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
A_{Seg}, A_{Comp}	polygons			river-floodplain segments (1-10 km)	2021	
AL_{act_i}, AL_{for_i}						
YP_i						YP is a relative value based on the official fertility classification of soils, which ranges from 1 = very low to 5 = very high Classification based on soil expert opinion and https://esdac.jrc.ec.europa.eu/public_path/shared_folder/dataset/45_biomass_prod/SoilProd_model_soiltype_tables.xlsx
YL_{FI}						YL_{FI} is defined as the averaged annual yield loss due to flooding. Calculation was not performed for AFP where is missing data about flooding probability (Croatia, Bulgaria, Slovenia (Sava))

Calculation

Calculation steps	Indicator
1. Determination of the reference area size for each segment or compartment j (GIS) 2. Identification of all arable land i within the reference areas j from land use data (GIS) with differentiation according to location (active or former floodplain) 3. Intersection of arable land with data on yield potential (GIS) 4. Determination of the relevant flood probability for the active floodplain from flood hazard maps (simplified procedure) (GIS) 5. Calculation of the indicator for each reference area 6. Classification of the resulting arable crop index into 5 classes	Calculation of potential yields of meadows and pastures within the river-floodplain segments (for j =river-floodplain segments) $ACI(j) = \sum_{i=1}^{n}(i)\frac{AL_{for_i} * YP_i}{A_{seg_j}} + \frac{AL_{act_i} * YP_i}{A_{seg_j}} * YL_{FI}$ j = 1, 2, ...m Floodplain segments/compartments i = 1, 2, ...n Partial area within segments/compartments

ACI	> 0.8 of max (ACI)	0.8-0.6 of max(ACI)	0.6-0.4 of max(ACI)	0.4-0.2 of max(ACI)	< 0.2 of max (ACI)	0
Evaluation Class	5	4	3	2	1	0
Qualitative Evaluation	Very high yields	High yields	Average yields	Low yields	Very low yields	No agriculture

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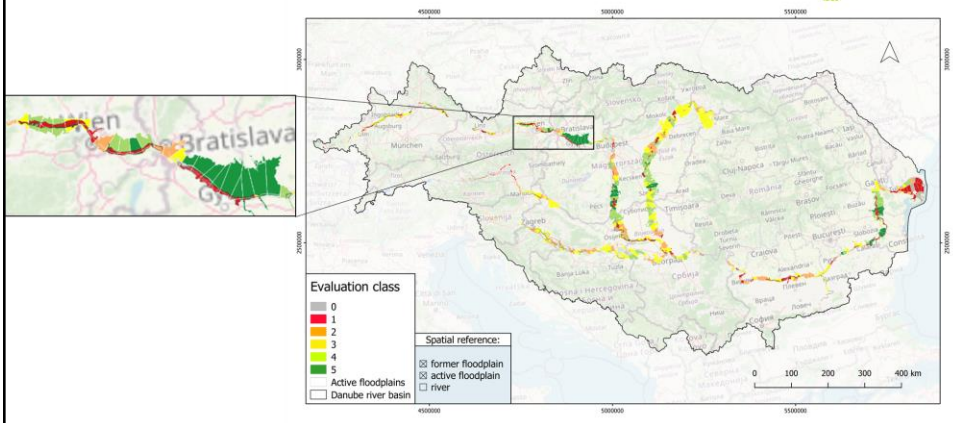
Arable crop production



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Evaluate ES: IDES approach, Example Habitat provision (regulating ES)

Data availability

■ Adaption for Danube-wide application

Class	Abbr.	Description			Spatial reference
Regulating	HPI_{sample}	"Habitat Provision covers the functional and structural quality of habitats and their communities as a basis for multiple human uses. In this case, habitats provide a diversity of animal and plant communities typical for rivers and floodplains both of natural and cultural landscape." (Fischer et al. 2019)			Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☐ river
Variable	**Abbr.**	**Unit**	**Variable description**	**Data basis**	
Natura 2000 areas	Nat2000	Ordinal (1-5)	Proportion of Natura 2000 areas in the river-floodplain segment	Natura 2000 areas, in non-EU countries protected areas and habitats	
Land use intensity	LUI	Ordinal (1-5)	Intensity of land use	Corine Landcover Classification (CLC)	
Wetland habitats	WH	Ordinal (1-5)	Proportion of wetland habitats and protected biotopes	Wetland habitats of Copernicus riparian zones LCLU (MAES_4)	
Backwater influence	BI	Nominal (yes/no)	Influence of hydrologic flow alteration by hydropower dams and traverse structures (impoundment)	Hydrological Alterations – Impoundments, Danube River Basin Management Plan (DRBMP)	
Former floodplain	FFP	Nominal (yes/no)	Former Floodplain where regular flooding is inhibited by anthropogenic structures	Active floodplain delineated by Danube Floodplain Project	

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Evaluate ES: IDES approach, Example Habitat provision (regulating ES)

Data availability

■ Adaption for Danube-wide application

Class	Abbr.	Description			Spatial reference
Regulating	HPI_{sample}	"Habitat Provision covers the functional and structural quality of habitats and their communities as a basis for multiple human uses. In this case, habitats provide a diversity of animal and plant communities typical for rivers and floodplains both of natural and cultural landscape." (Fischer et al. 2019)			Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☐ river
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Former floodplain	FFP	Nominal (yes/no)	Former Floodplain where regular flooding is inhibited by anthropogenic structures	Active floodplain delineated by Danube Floodplain Project	

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
Nat2000 Natura 2000 areas, protected areas in RS	Polygon	International/ segments		https://www.eea.europa.eu/data-and-maps/data/natura-12	2020	5: <75%, 4: >50%-75% 3: >25%-50% 2:>0%-25% 1: 0%
LUI Corine land cover (CLC 2018)	Polygon	International/ Active FP	Minimum Mapping Unit (MMU): 25 ha	https://land.copernicus.eu/pan-european/corine-land-cover/clc2018	2018	For assessment see LUI decision tree
WH Copernicus riparian zones LCLU (MAES_4)	Polygon	International/ Active FP	Minimum Mapping Unit: 0.5 ha Minimum Mapping Width: 10 m	https://land.copernicus.eu/local/riparian-zones/land-cover-land-use-lclu-image	2012	MAES 4 codes: 3111, 3121, 3211, 3221, 3311, 3321, 7111, 7121, 8111, 8113, 8211, 8221, 9111, 9112, 9121, 9211
BI Hydrological Alterations - Impoundments from DRBMP	Line shape file	international/ river		https://www.danubegis.org/	2015	
FP Active floodplain delineated by Danube Floodplain Project	Polygon	international/ Former FP		http://www.geo.u-szeged.hu/dfgis/	2020	Optional, for the segments which contain active floodplains from the Danube Floodplain Project only

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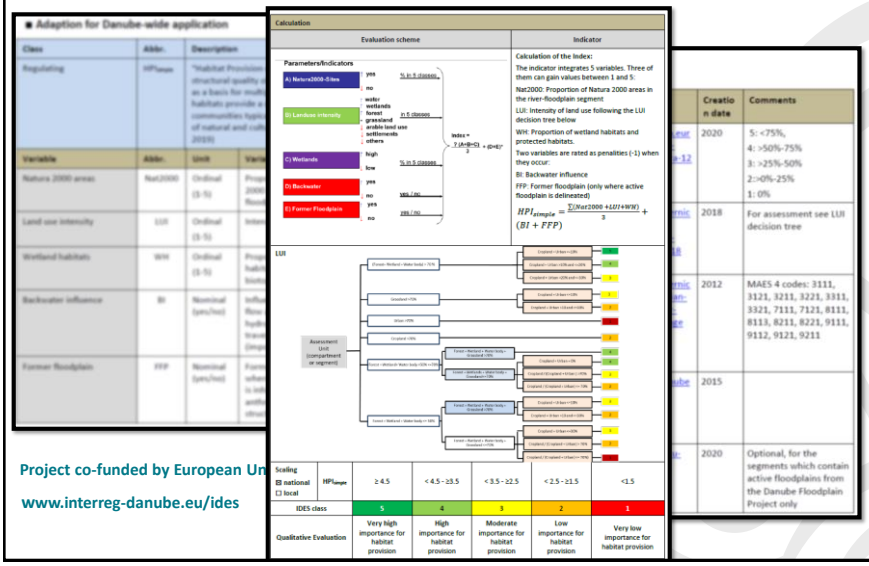
Evaluate ES: IDES approach, Example Habitat provision (regulating ES)

Data availability



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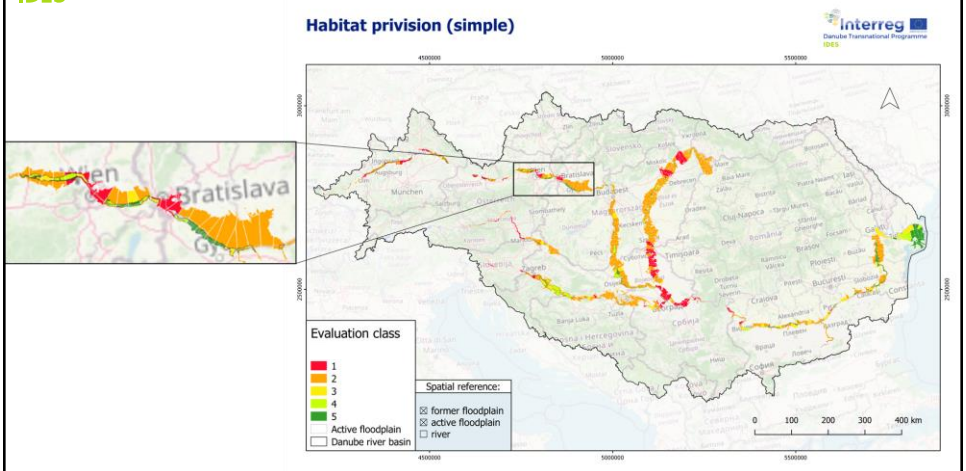

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Evaluate ES: IDES approach, Example Non-water related activities (cultural ES)

Data availability

■ Adaption for Danube-wide application

Class	Abbr.	Description	Spatial reference
Cultural	NWA	Experiencing animals, plants and landscapes (e.g. nature observation, cycling, walking) for the purpose of non-specific recreation	Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☒ river

Variable	Abbr.	Unit	Variable description	Data basis	Comment
Bank and water body availability	BWA	categorial	People's preference to perform various activities next to water are calculated as the length of banks per area unit within a 1000 m radius using Line Density tool, then normalized per segment length	land cover model	
Possibility to experience the terrain	EoT	categorial	Different categories of land use land cover are converted into ordinal data using a lookup table revealing the pedestrian accessibility between 0 and 95 (Thiele 2020)	land cover model	
Number of overlapping protected area categories	NPA	categorial	Presence of protected areas per segment	National parks, biosphere reserve, nature parks, nature reserves, landscape conservation areas, Natura 2000 areas	

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Evaluate ES: IDES approach, Example Non-water related activities (cultural ES)

Data availability

■ Adaption for Danube-wide application

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
BWA, EoT Copernicus riparian zones LCLU (MAES_4)	Polygon	International / Active FP	Minimum Mapping Unit: 0.5 ha Minimum Mapping Width: 10 m	https://land.copernicus.eu/local/riparian-zones/land-cover-land-use-lclu-image	2012	
NPA e.g. Natura 2000 areas, protected areas	Polygon	International / Segments		https://www.eea.europa.eu/data-and-maps/data/natura-12	2020	

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Evaluate ES: IDES approach, Example Non-water related activities (cultural ES)

Data availability

■ Adaption for Danube-wide application

Class	Abbr.	Description	Spatial reference
Cultural	NWA	Experiencing animals, plants and landscapes (e.g. nature observation, cycling, walking) for the purpose of non-specific recreation	Floodplain segment or compartment ☒ former floodplain

Variable	Abbr.	Unit	Variable
Bank and water body availability			
Possibility to experience the terrain			
Number of overlapping protected area categories			

■ Data sources

Data set	Data	Spatial	Spatial	Source	Creation date	Comments
				opernicus, ran-ver-land-e	2012	
				ea.europ e-tura-12	2020	

Calculation

Indicator

$$f_{(NWA)} = \sum BWA,\ EoT,\ NPA$$

→ normalize raster between 0-100 (Rabe et al. 2018):

$$\frac{max_{new} - min_{new}}{max_{old} - min_{old}} \cdot (v - max_{old}) + max_{new}$$

v is the resulting raster generated by $f_{(NWA)}$

Scaling						
☒ national ☐ local	Quintiles	> 33.0 – 73.0	> 23.4 – 33.0	> 17.9 – 23.4	> 14.7 – 17.9	0 – 14.7
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		Very high provision	High provision	Moderate provision	Low provision	Very low provision

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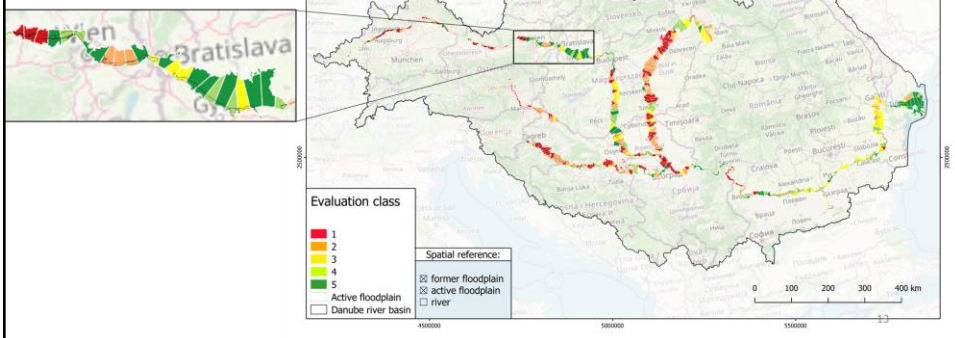
Non-specific interactions with the riverine landscape



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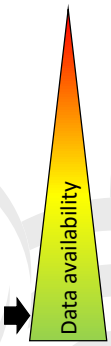
Better data available?

Indicator approach developed in Germany
(Podschun et al. 2018)

RESI
River Ecosystem Service Index



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Better data available?

Indicator approach deve
(Podschun et al. 2

Detailed description of how to evaluate 17 ES (IDES & RESI approach) available in fact-sheets

River Ecosystem Service Index

Original RESI Manual (in German)

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How to use the IDES Tool?

Prioritization of water quality functions

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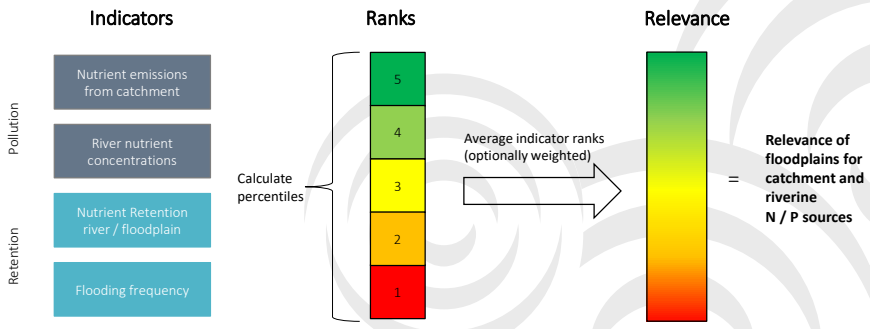
Prioritize floodplains for water quality improvement (Scheme)



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Prioritize floodplains for water quality improvement

Floodplains

Indicators

Scale (basin, national)

Assessment of relevance for water quality

	A	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL
1	DFGIS_ID	ConcNO3	ConcTP_n	Denit_Cor	Denit_Wa	TPret_me	Flooding_	Emission_	Emission_	TPret_rive	DINret_riv	scale	NO3_emis	NO3_conc	P_emissio	P_conc_re	all_rel
2	BG_YN_AFP_02	3	3	3	3	2	3	3	3	1	3	basin	3	3	2.5	2.25	2.6875
3	AT_DU_AFP04	2	1	3	2	3	3	3	3	2	3	basin	2.5	2.5	3	2.25	2.5625
4	BG_YN_AFP_09	3	3	3	2	2	3	3	3	2	3	basin	2.5	2.75	2.5	2.5	2.5625
5	HR_SA_AFP_01	1	3	3	3	2	3	3	2	3	3	basin	3	2.5	2	2.75	2.5625
6	DE_DU_AFP01	3	1	3	3	1	3	3	3	3	3	basin	3	3	2	2	2.5
7	RO_DU_AFP04	1	3	3	3	3	3	1	2	3	3	basin	2	2.5	2.5	3	2.5
8	BG_YN_AFP_01	1	3	3	2	3	3	3	3	1	1	basin	2.5	1.75	3	2.5	2.4375
9	BG_YN_AFP_03	3	3	3	3	1	2	3	3	2	3	basin	3	2.75	2	2	2.4375
10	BG_YN_AFP_08	3	3	3	1	2	3	3	3	3	3	basin	2	2.5	2.5	2.75	2.4375
11	AT_DU_AFP05	2	2	3	2	3	2	3	2	2	3	basin	2.5	2.25	2.5	2.25	2.375
12	RO_DU_AFP03	1	3	2	3	3	1	2	3	2	2	basin	2.5	1.75	3	2.25	2.375
13	HU_DU_AFP07	2	3	1	2	3	1	2	3	2	3	basin	2	2	3	2.25	2.3125
14	RS_DU_AFP02	1	2	2	1	3	3	3	3	2	2	basin	2	1.75	3	2.5	2.3125
15	SI_MU_AFP01	1	1	2	1	3	3	3	3	2	3	basin	2	2	3	2.25	2.3125
16	BG_YN_AFP_07	3	3	2	1	1	3	3	3	3	3	basin	2	2.5	2	2.5	2.25
17	HU_DU_AFP08	2	3	2	2	3	2	2	3	1	1	basin	2	1.75	3	2.25	2.25
18	BG_RO_DU_AFP03	1	2	2	2	3	2	2	3	2	1	basin	2	1.5	3	2.25	2.1875
19	BG_RO_DU_AFP04	1	2	2	3	2	2	2	2	3	2	basin	2.5	2	2	2.25	2.1875
20	BG_YN_AFP_04	3	3	2	2	1	1	3	3	3	3	basin	2.5	2.25	2	2	2.1875
21	BG_YN_AFP_05	3	3	2	2	1	2	2	3	3	3	basin	2	2.5	2	2.25	2.1875
22	DE_DU_AFP02	3	1	3	2	1	3	3	3	2	2	basin	2.5	2.5	2	1.75	2.1875
23	HU_DU_AFP03	3	3	3	3	2	2	1	1	3	3	basin	2	2.75	1.5	2.5	2.1875
24	HU_DU_AFP06	2	2	2	3	3	2	1	1	3	2	basin	2	2.25	2	2.5	2.1875
25	HU_SK_DU_AFP05	3	2	3	3	1	3	2	3	1	1	basin	2.5	2.5	2	1.75	2.1875
26	HU_TI_AFP03	2	1	3	3	1	3	2	2	3	3	basin	2.5	2.75	1.5	2	2.1875
27	BG_RO_DU_AFP02	1	2	1	3	3	1	2	2	2	1	basin	2.5	1.5	2.5	2	2.125

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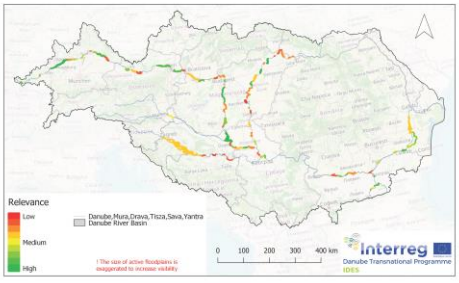
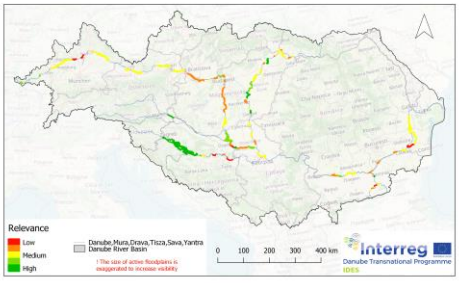
Prioritize floodplains for water quality improvement
Nitrogen

D.T1.1.1: Prioritization of active floodplains for N retention from river sources on river basin scale



D.T1.1.1: Prioritization of active floodplains for N retention from catchment emissions on river basin scale



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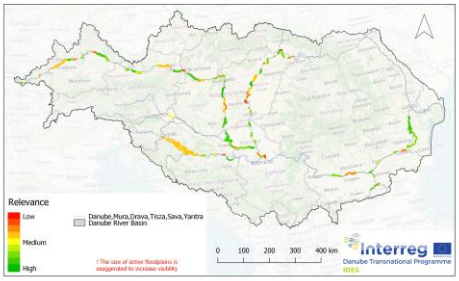
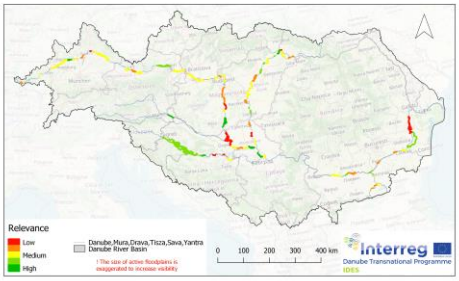
Prioritize floodplains for water quality improvement
Phosphorus

D.T1.1.1: Prioritization of active floodplains for P retention from river sources on river basin scale



D.T1.1.1: Prioritization of active floodplains for P retention from catchment emissions on river basin scale



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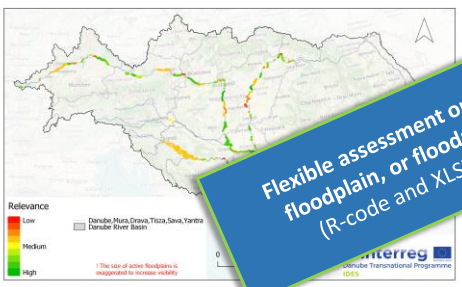
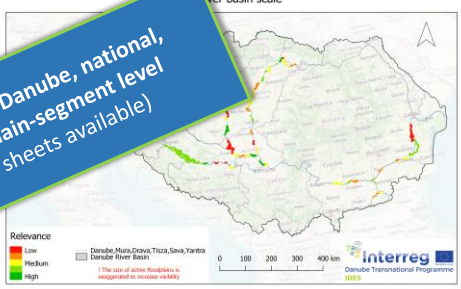
Prioritize floodplains for water quality improvement
Phosphorus

D.T1.1.1: Prioritization of active floodplains for P retention from river sources on river basin scale



D.T1.1.1: Prioritization of acti…dplains for P retention from catchment emissions …ver basin scale



Flexible assessment on Danube, national, floodplain, or floodplain-segment level
(R-code and XLSX sheets available)

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How to use the IDES Tool?

Visualization

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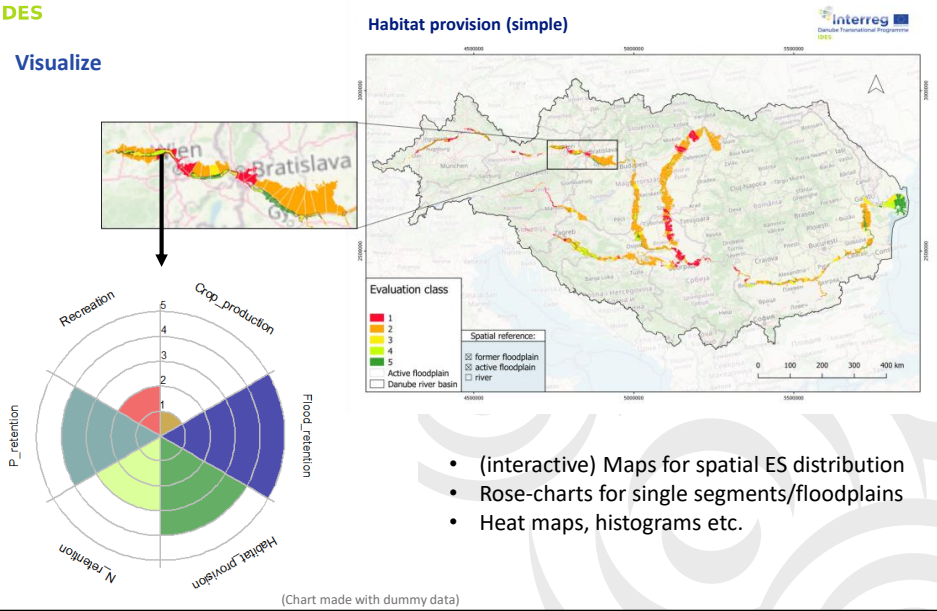
Visualize



- (interactive) Maps for spatial ES distribution
- Rose-charts for single segments/floodplains
- Heat maps, histograms etc.

(Chart made with dummy data)

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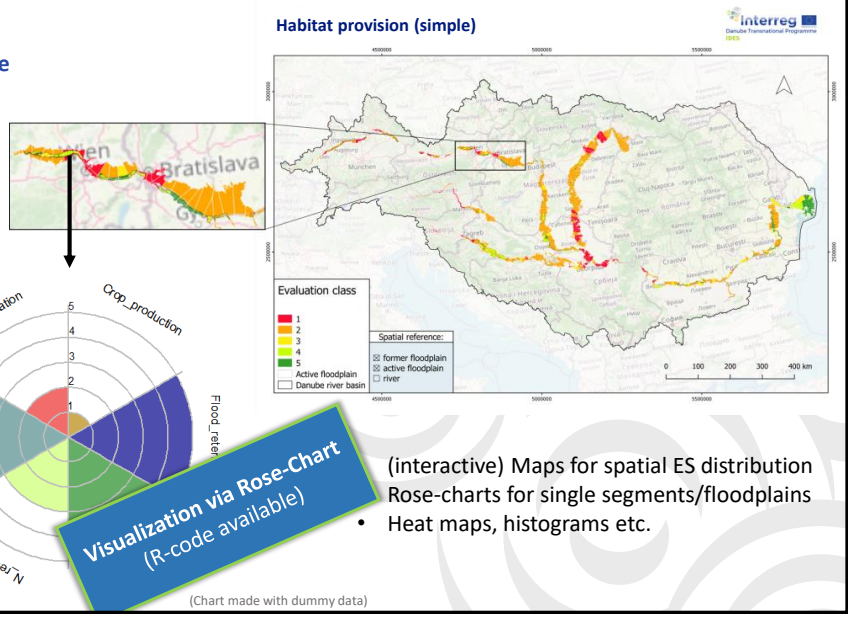
Visualize



(Chart made with dummy data)

- (interactive) Maps for spatial ES distribution
- Rose-charts for single segments/floodplains
- Heat maps, histograms etc.

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Visualize

Web ES visualization:
(example capacity matrix)

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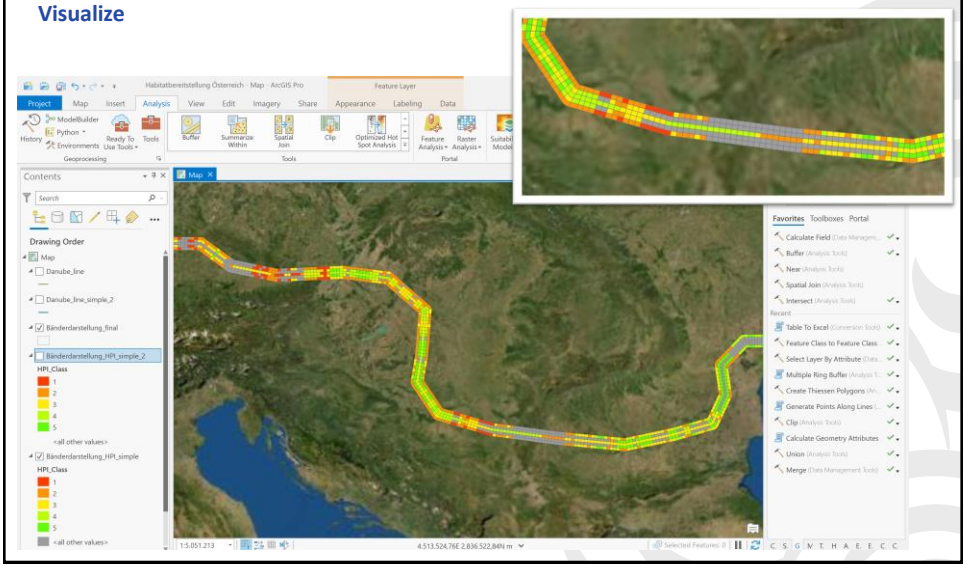
Visualize



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How to use the IDES Tool?

Analysis and integration of stakeholder perceptions into ES mapping

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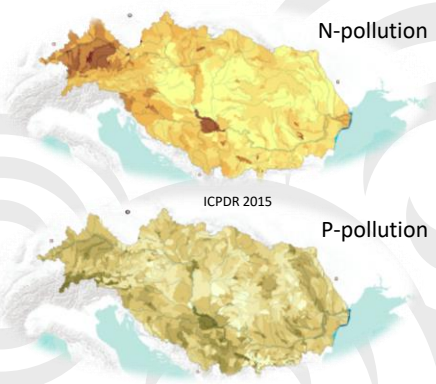
Interactions between ES and water quality functions

On the basin-scale:

- Basin-driven effects on water quality (agriculture, wastewater discharge etc.)
- Active floodplains and their ES represent a small share of the DRB
- Evaluation of interactions on basin-scale not meaningful -> **evaluations on the local level with specific scenarios**



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Case study:
Local interactions between ES and water quality functions

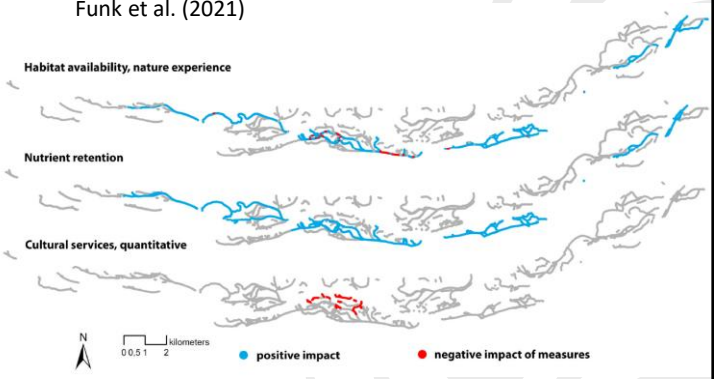
Pilot area in Austria (Donau-Auen national park)
Funk et al. (2021)

Floodplain reconnections:

→Synergies of nutrient retention, rheophilic habitat, nature experience

→Local trade-offs with hiking/cycling, stagnotopic habitat

→Overall increase in multi-functionality



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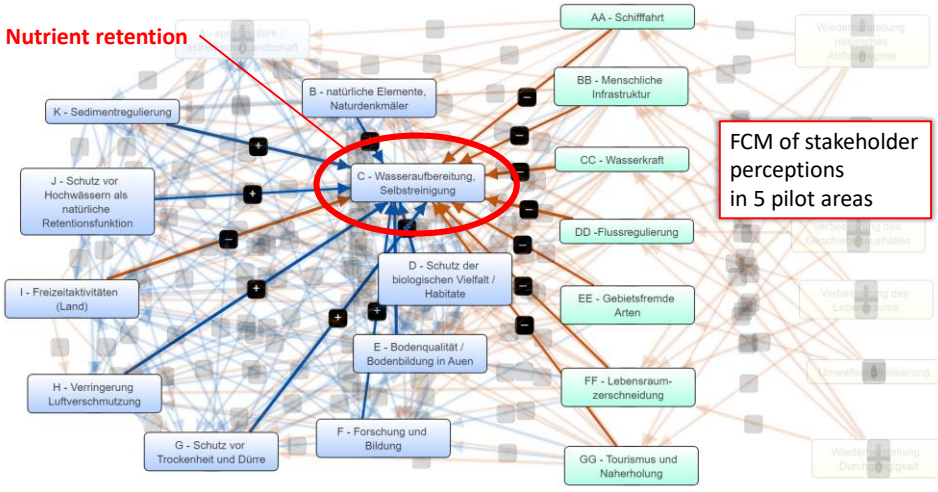
Local interactions between ES and water quality functions:
Stakeholder perception using Fuzzy Cognitive Mapping - FCM



FCM of stakeholder perceptions in 5 pilot areas

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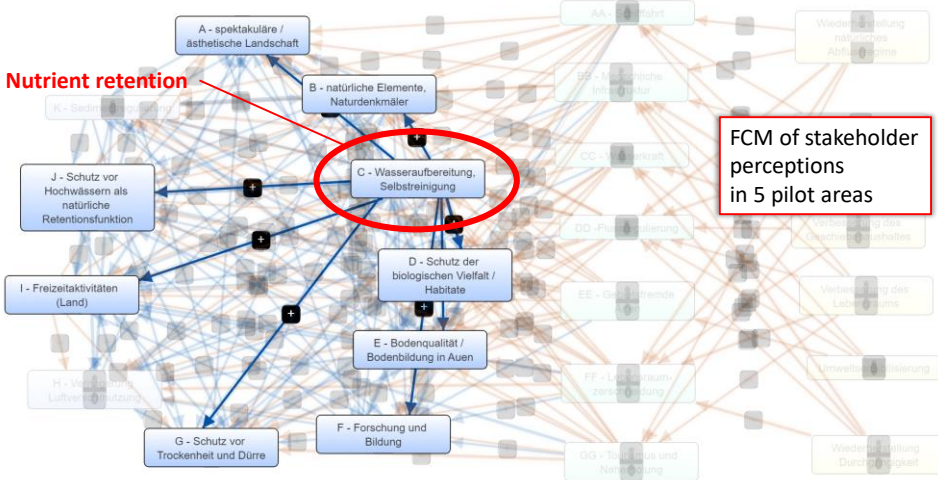
Local interactions between ES and water quality functions:
Stakeholder perception using Fuzzy Cognitive Mapping- FCM



FCM of stakeholder perceptions in 5 pilot areas

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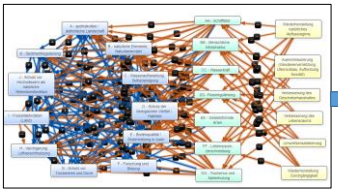
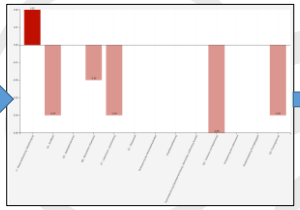
Derive scenarios

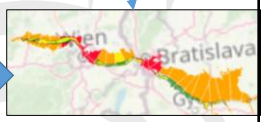
ES Mapping



Stakeholder perception (in the Austrian pilot area)



Implementation of measures (scenarios)



Updated ES pattern (scenarios)

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Benefits of the IDES tool

Harmonized ES evaluations for international and national applications

Linking water quality management with ES

Better **inclusion of stakeholders** into the decision-making process

Provision of a range of **methods, data files, and scripts** to facilitate integrative floodplain and water quality management

Promote and advocate nature-based solutions and sustainable development of (floodplain) ecosystems in policies

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Future outputs of the IDES Project

National Stakeholder Workshops

Jointly develop scenarios using Fuzzy Cognitive Mapping in 5 pilot areas

IDES Manual

Detailed manual for the evaluation of ES and water quality functions (IDES Tool) Danube-wide and in pilot areas

IDES Strategy

Integration of ES for water quality management in public planning processes of the participating Danube countries

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THANK YOU FOR YOUR ATTENTION!

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Discussion

How could I make use of the IDES Tool?

Who else might profit from it?

What else is needed for sustainable floodplain management?

Do you have concrete measures in mind to apply the tool?

How would you visualize ES?

Which policies might profit from the integration of ES assessments?

Any other feedback to us?

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