Interreg
Danube Transnational Programme
IDES

Better water quality using integrative floodplain management based on ecosystem services

Extended Summary of the IDES Manual and the IDES Strategy

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

Project co-funded by the European Union (ERDF, IPA)

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Extended Summary of the IDES Manual and the IDES Strategy

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Cover photo

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Print
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December 2022

Bucharest, Berlin, Szolnok, Eichstaett,

INTRODUCTION

Ecosystems were modified and degraded by a multitude of pressures from agriculture (e.g. changes in land use, excessive use of fertilisers and pesticides, and soil degradation) and other sectors (e.g. energy, transport and tourism). At the same time, the quality of our lives depends on the functionality of these ecosystems through the services they provide (provisioning, regulation and maintenance, cultural). It is officially recognised through the Danube Basin Management Plan, that the Danube River Basin (DRB), including the Danube floodplain, is facing such challenges. Mapping and assessing the ecosystem services (ES) of the floodplains in the DRB is one way to provide an overview of the current status and to offer the fundament for science-based/informed decision-making.

Seven countries (Austria, Bulgaria, Germany, Hungary, Romania, Serbia and Slovenia), out of all 19 DRB countries covering about 75% of the entire basin area, were partners in the IDES project "Improving water quality in the Danube River and its tributaries by integrative floodplain management based on Ecosystem Services" (https://www.interreg-danube.eu/approved-projects/ides). Although there are multiple methods to evaluate ecosystem services, there was no harmonised method applicable to the entire DRB to evaluate ecosystem services of floodplains. Therefore, the IDES project developed a new approach (IDES Tool) for an ecosystem service-based integrative floodplain management that is presented in the IDES Manual (Stäps et al. 2022) and in the IDES Strategy. All English outputs can be downloaded from https://www.interreg-danube.eu/approved-projects/ides/outputs. This document is briefly summarising the main aspects described in the two main project publications. The IDES Manual presents the methods recommended for assessing the floodplain ecosystems services while the IDES Strategy brings a broader perspective on the use of the IDES Tool, especially in policies. Both publications provide a process overview, necessary for a science-based and evidence-based decision-making using mapping and assessing of ecosystem services.

CHAPTER 1

AIMS OF THE IDES PROJECT

The main aim of the IDES project funded by the Danube Transnational Programme (DTP funding number DTP3-389-2.1) is to improve the water quality along the Danube and its major tributaries by developing approaches for an ecosystem services-based integrative floodplain management. This approach had to consider all relevant societal interests and objectives and by this will accelerate the implementation of water management measures. The IDES Tool enables water quality management to demonstrate synergies of nutrient retention with a wide range of other ES provided by the Danube and its floodplains (e.g. flood protection, recreational values, and provision of drinking water). IDES thus contributes to an enhanced implementation of water quality management in the entire DRB by identifying optimum sites for reducing nutrient loads of rivers with nature-based solutions, stimulating discussions to mitigate conflicts among stakeholders and demonstrating synergies among different societal interests on floodplains.

CHAPTER 2

FLOODPLAINS AND ECOSYSTEM SERVICES

Current challenges for water quality and floodplain managment

For thousands of years, humans used river floodplains for hunting, fishing, agriculture and building their settlements, but did not severely affect this ecosystem. After the industrial revolution in Europe and North America, increasingly larger engineering projects transformed the river systems and their ecosystem processes. Consequently, many river floodplains are now disconnected, either directly by flood control levees or indirectly by altering the hydrology and hydraulics of rivers, and used for other purposes. These anthropogenic changes of the riverine and floodplain landscapes were identified as a significant cause of the decline of key ecological functions, including the loss of biodiversity.

For example, human development in the DRB over the past two centuries has seriously damaged the floodplains and their ecosystems (ICPDR 2021):

- Channelization and straightening of the rivers for transport and flood protection confined and shortened the rivers
- Dykes disconnected rivers from floodplains (less than 20% of the floodplains remain connected to the river).
- Dams for energy production block the flow of the rivers (e.g., 37% of the Danube is affected by impoundments)
- Land use alterations including the draining of wetlands changed the natural vegetation
- Pollution from point and diffuse sources changed water quality

As for the DRB, the management plan (DRBMP) has revealed that c. 70% of the water bodies are not in a

good ecological status or do not have a good ecological potential (ICPDR 2021) as a result of river straightening, dyke construction and land-use intensification in the former floodplains.

In the DRB, around 80 million inhabitants depend on surface waters, groundwater and productive floodplain soils for drinking water, energy production, transport and agriculture. The human activity in the DRB has an extensive impact on water as a resource, including intensive land use, nutrient emissions, and structural changes to the river systems affecting the ecological and chemical status of surface waters. Only 15% of the about 29,000 km evaluated by the Water Framework Directive achieved the good ecological status or potential whereas for the chemical status 36% were rated as "good" (ICPDR 2021), but there is a significant difference between the countries. By improving the floodplains and the state of their ecosystem services, there is a good chance to reach the goals of the WFD.

What are ecosystem services?

Ecosystem services are defined as the direct and indirect contributions of ecosystems to human well-being (TEEB 2010), and have an impact on our survival and quality of life. Currently, the standard in categorisation of the manifold ecosystem services at European level is the Common International Classification of ecosystem services (CICES, Haines-Young & Potschin 2018), which was also used in the IDES project. Accordingly, ES can be divided into the three main categories "provisioning", "regulation and maintenance" and "cultural" ecosystem services.

CHAPTER 3

THE IDES TOOL

The IDES Tool was developed to support science-based and evidence-based evaluations of river-floodplain management measures, communication between stakeholder groups, creating awareness about the diversity of provided ES, and hence, to improve effective decision-making. This tool represents a methodological approach to harmonise the evaluation of ES on floodplains, and to link it with water quality improvement. It has been developed and implemented in the DRB, but the concept is generally applicable elsewhere.

Five working steps (Figure 3.1) cover the scope of ES evaluations and floodplain water quality assessments. A successful implementation requires GIS skills and is facilitated by the IDES Manual including links to data files and scripts.

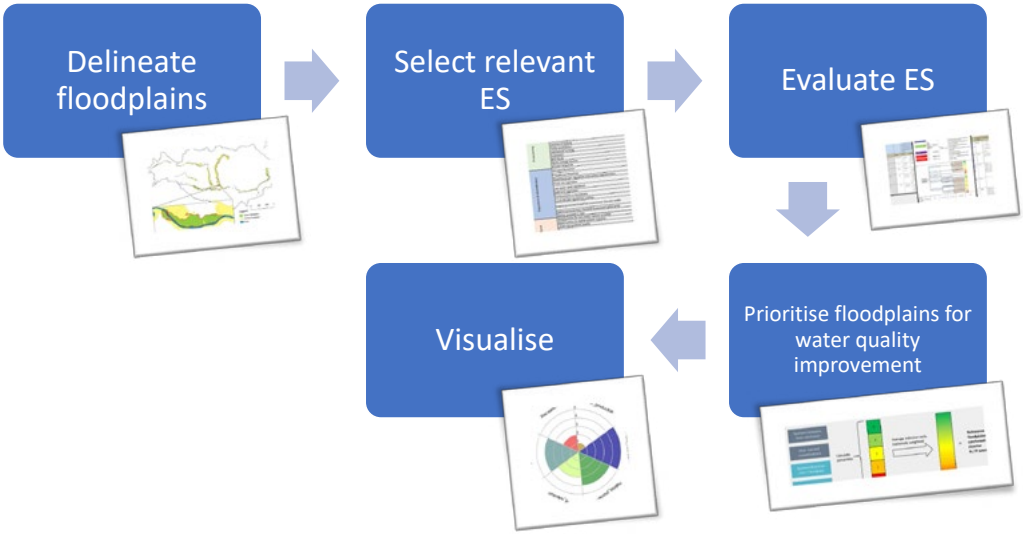

Figure 3.1 Work steps covered by the IDES Tool

Step I.
Delineation of floodplains

To ensure a spatially explicit assessment of ES for comparable spatial units, and to facilitate their visualisation, the IDES Tool differentiates between three compartments (river, active floodplain and former floodplain) and longitudinally divides them into equally sized segments considering the spatial variability of ES. The entire DRB was divided into 10 km segments and the 5 pilot areas were divided into 1 km segments.

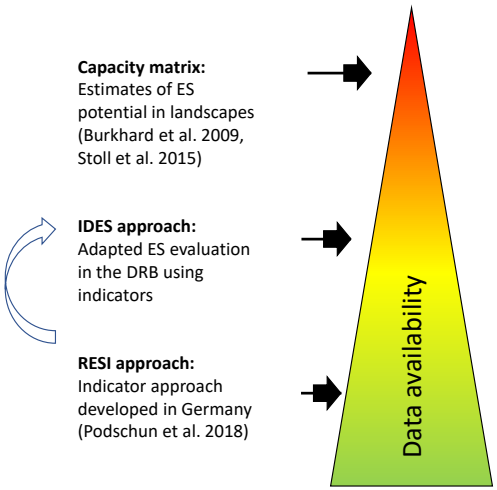

Figure 3.2 Selection scheme of ES evaluation approaches based on the quantity and quality of the required data in the DRB

Step II.
Selection of relevant ES

26 relevant ES, typically provided by river-floodplain systems in the DRB, were selected and evaluated on basin-level, and also tested at local level, in 5 pilot areas (Austria, Hungary, Romania, Serbia and Slovenia).

Step III.
Evaluation of ES

The IDES Tool is a spatially explicit, non-monetary approach to evaluate ES in an easily intelligible way. Due to the heterogeneous data situation in the DRB, two complementary methods are applied as part of the IDES Tool.

The comprehensive indicator-based approach RESI (River Ecosystem Service Index, Podschun et al. (2018)) was adapted to the DRB and can be applied if suitable data is available. Otherwise, a capacity matrix can be applied which was adapted from Burkhard et al. (2009), Stoll et al. (2015) (Figure 3.2). It is a simple, widely applicable method that makes use of expert evaluations on the capacity of landscape features to provide ES. Both, the original and adapted indicator-based approach use a set of indicators to calculate an

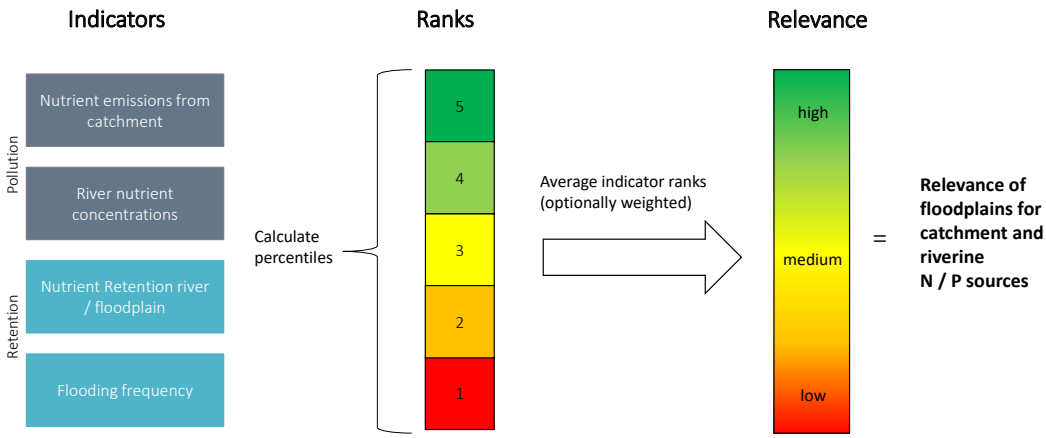

Figure 3.3 Evaluation scheme for estimating the relevance of rivers and active floodplains for water quality

index (0-5) and are described in the detailed factsheets of the IDES Manual.

Step IV: Prioritisation of areas with high potential for water quality functions

The IDES Tool can also evaluate the relevance of active floodplains for water quality improvement. A combination of indicators is ranked and aggregated to prioritise areas for their water quality improvement on basin-wide and national levels (Figure 3.3). The approach allows for user-specific prioritisation through different criteria with the material provided in the IDES Manual.
The IDES application focused on nitrogen (N) and phosphorus (P) retention from upslope or riverine sources. The selection and combination of indicators can be adapted to the specific of other applications.

Step V: Visualisation

Data visualisation should be accurate and convincing. Depending on the target group, the ES assessment

can be presented as text, charts of different complexity, maps or any combination of them. The readability of maps can be constrained by the limited spatial extent of rivers and active floodplains, especially for large-scale assessments. In such cases, interactive or generalised maps can be helpful but require additional resources.

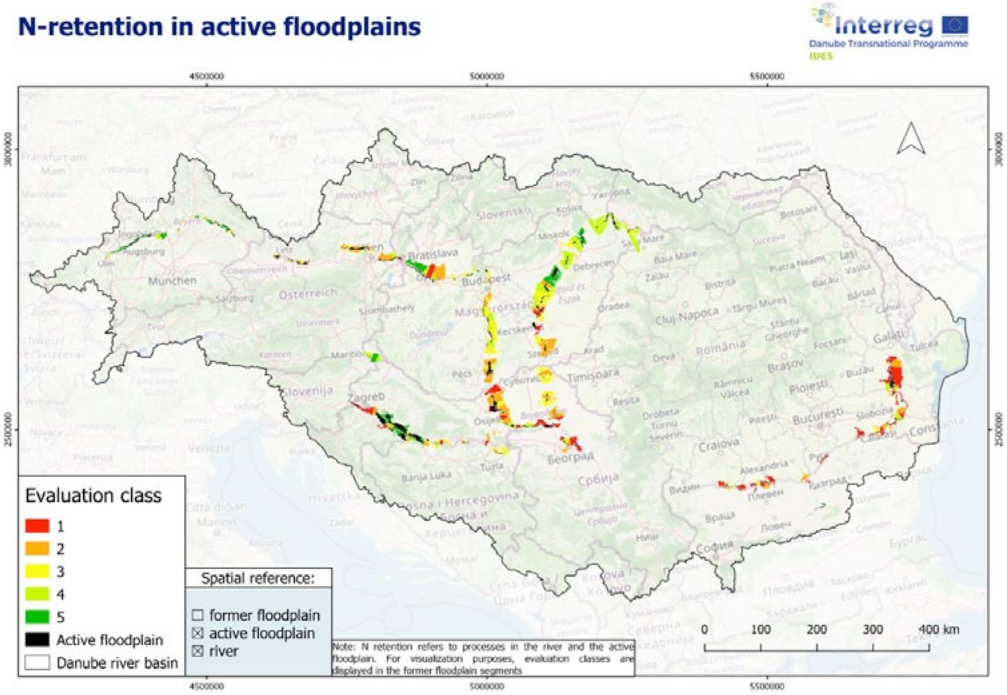

Figure 3.4 Nitrogen retention (NRI): The NRI indicator represent the retained fractions of the N load in the active floodplains and the river.

CHAPTER 4

MEASURES FOR IMPROVING THE STATE OF FLOODPLAINS IN THE DANUBE RIVER BASIN

In order to improve the ecological and socio-economic conditions of floodplains it is necessary an ecosystem services-based floodplain management. However, it is impossible to make a general ranking of measures for the entire DRB. In contrast, the local characteristics of the river sections strongly influence the selection of suitable measures for implementation.

In the IDES project a set of 21 measures discussed with the stakeholders were collected which aim either directly to improve water quality or indirectly as synergy with other water management measures. These indirect synergies are demonstrated by the fact that the ES “N retention” and “P retention” will also be improved. The collection was carried out at national level and combined into one list for the entire Danube River floodplain. Measures were searched by reviewing management plans (river basin, flood risk, Natura2000) on national and international level.

The measures found could be grouped to the following main pressures addressed:

- Pollution: organic or hazardous pollution, and by nutrients or plastic waste
- Loss of river connectivity: interruption of river continuity and morphological alterations, disconnection of adjacent wetlands/floodplains,
- Hydrological alteration, including altered quality and quantity of groundwater
- Climate change: flood, drought and water scarcity

The example of measures to reduce flood risk demonstrates that nature-based solutions are providing the most synergies. The

restoration of healthy ecosystem, for example by reconnecting former floodplains, is often a very effective way of preventing and mitigating floods, but also to improve nutrient retention, sediment regulation or carbon sequestration. Even when grey measures for flood risk mitigation, such as dykes, are necessary to protect communities, those measures should be complemented with long-term nature-based solutions such as floodplain restoration. By 'greening the grey' and creating a network of green infrastructures, the necessary protection levels can be reached with a minimum loss of habitats and ecosystems services..

CHAPTER 5

IMPLEMENTATION OF IDES TOOL IN PILOT AREAS

Five pilot areas were selected in Austria, Hungary, Romania, Serbia and Slovenia (Fig. 5.1) in order to test, calibrate and improve the IDES Tool under different natural and socio-economic conditions. Besides the better quality of data in the pilot areas, a large number of stakeholders were involved in the co-creation of optimum scenarios to improve water quality in their areas.

Various meetings and two workshops in each pilot area helped to integrate stakeholder perspectives already during the early tool development. Starting from

Figure 5.1. Location of the five pilot areas: 1) The Donau-Auen National Park, Austria; 2) Mura River, Slovenia; 3) Tisza River Floodplain near Szolnok, Hungary; 4) Koviljsko-petrovaradinski rit Special Nature Reserve, Serbia; 5) Brăila Islands, Romania

Figure 5.2. Fuzzy Cognitive Model of the pilot area

the list of 26 ES, the stakeholders individually selected only those ES they considered important in their area and prioritised them. In the end, a joint list of the most important ten ES was created and agreed upon. From a pre-defined list of 30 pressures, stakeholders selected the pressures that have an (negative) impact on the ES present in the pilot areas. They selected and prioritised a list of five pressures. This step reflects the status quo, the state of the ES and the pressures in the pilot area.

Possible measures were introduced in the co-creating process in order to identify scenarios to improve the state of ES and in the end the water quality in the area. The stakeholders discussed among themselves the most appropriate measures to reduce certain pressures and agreed on a list of five measures. Based on the Drivers-Pressures-State-Impact-Response (DPSIR) approach, the three elements: "ecosystem services", "pressures" and "measures" and their intercorrelations were the starting points for a Fuzzy Cognitive Model (FCM) for each pilot area that reflects the synergies and trade-offs between ES, pressures and measures. All relevant stakeholders in each pilot area co-developed and mapped such a model (Figure 5.2), showing their agreed perception of the status quo in their area.

By changing the intensity of the pressures, different scenarios were created: "business as usual", "ideal" (reduction of all pressures to minimum) and "optimal" (measures jointly agreed by the stakeholders). In this manner stakeholders were able to see the way pressures affects different ES and how the absence of one or all pressures will improve the status of the ES.

5.1 Brăila Islands, Romania

In this publication, the results of the Romanian pilot area are exemplarily given. Brăila Islands (Figure 5.3) are a group of islands on the Danube

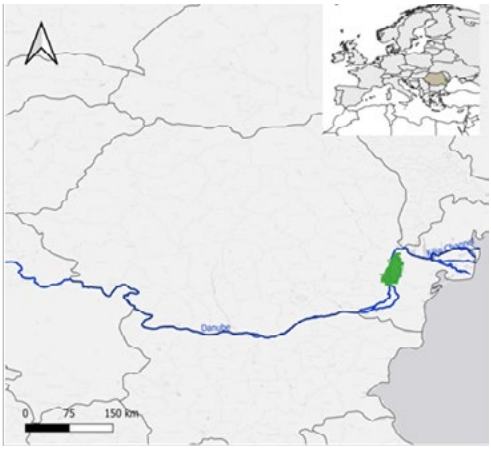

Figure 5.3 Location of the pilot area.

River, located in the South-East of Romania with a total surface area of over 2,600 km^2. The pilot area stretches 78 km along the Danube River, between the cities of Hârşova and Brăila. It covers four counties and comprises 20 administrative territorial units. It also contains nine EUNIS level 1 habitats, including aquatic, terrestrial and socio-ecological systems.

Brăila Islands are divided into two major components: the Big Island of Brăila and the Small Island of Brăila. Once a wetland, the Big Island of Brăila consists of heavily modified ecosystems where more than 95% of the area were converted into agricultural land. Prior to the conversion to agricultural land, the Big Island of Brăila contained large numbers of lakes, ponds, and marshes that were linked to each other and connected to the river. In contrast, the Small Island of Brăila still maintains ecosystems under a natural functional regime and has preserved its natural hydrological conditions. It is the main remnant of active floodplains in the area, making its conservation crucial. The Small Island of Brăila is a protected area, both at national (Natural Park - 06/03/2000) and international level (Ramsar Convention - 15/06/2001, Natura 2000).

5.2 The selection of Ecosystem Services and Pressures

During a face-to-face workshop, 19 relevant stakeholders from local, regional and national public authorities, research institutions, and NGOs selected the ES provided by the Brăila Islands. The stakeholders identified the **regulating and maintenance group of ES** as the most important. The following five ES were selected: 1) habitat provisioning; 2) reduction of air pollution; 3) local temperature regulation/ cooling; 4) water purification/water quality improvement; 5) flood risk regulation.

Among the **provisioning ES**, the stakeholders identified the following three ES as having high importance in the pilot area: commercial fishing, drinking water/water for animals and water for cooling or irrigation (household or industrial use).

The stakeholders identified two **cultural ES** as important for this area: contribution to research and education as well as opportunities for water-related activities (fishing, swimming and boating). They

also identified the following pressures due to the different economic activities with negative impacts on the ES: intensive fishing, solid waste (plastics, dredging waste), nutrients inputs, intensification of agriculture and waste water.

5.3 Matching the stakeholders view with the ES maps

The evaluation of the Brăila Islands pilot area with the IDES Tool (Figure

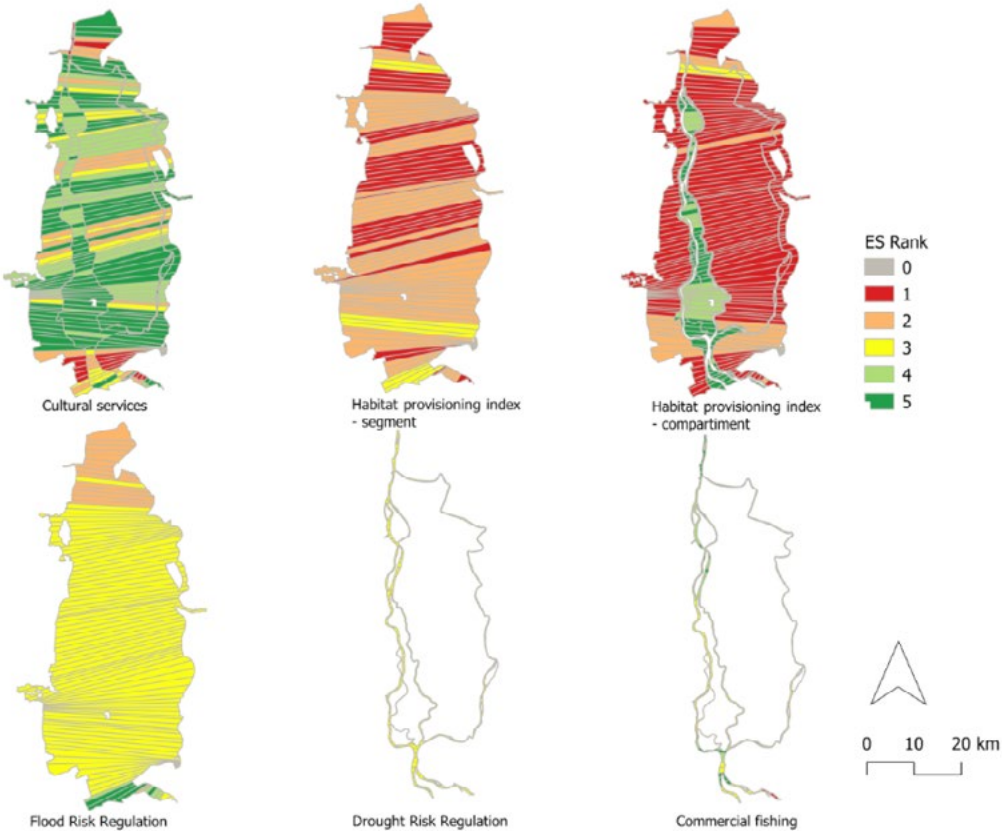

Figure 5.4 Selection of ES evaluated with the IDES Tool for Brăila Islands. The evaluation classes range from 0 (= no ES provision) to 5 (= very high ES provision).

5.4) revealed, that its potential for flood risk regulation decreased due to the conversion of natural land to agricultural land. Thus, the area has now a medium potential of flood risk regulation. Additionally, the Big Island of Brăila has a very low habitat provisioning potential, while the Small Island of Brăila has a high to very high potential.

The Big Island of Brăila only offers a few cultural ES, but the presence of several Natura 2000 sites on the surrounding Danube arms increases its cultural ES potential to mostly high and very high. The Small Island of Brăila has a very high potential for supplying cultural ES.

As another consequence of the conversion to agricultural land, the Big Island of Brăila provides higher provisioning services to human communities. Even if the primary production of the Small Island of Brăila is consistent, this service is not entirely available to human populations but is rather consumed within the system. It maintains a high biodiversity and different ecological processes, allowing also other groups of ES to be sustained (e.g., regulating ES such as carbon retention, nutrient and sediment retention, flooding regulation as well as cultural and habitat provisioning).

5.4 Optimal scenario for the Brăila Islands pilot area

The local stakeholders agreed on and recommended a set of five measures as management options. The discussions regarding the optimal scenario for Brăila Islands focused on reducing the use of nutrients, anticipating an increase in intensive agriculture in the near future. To make this scenario more concrete, additional tailored measures were proposed by the stakeholders: subsidising/stimulating nitrogen-fixing crops (soybeans, peas, beans, alfalfa), adapted crop rotation, cover crops to reduce the use of mineral fertiliser, the use of organic fertilisers, bio-herbicides, permaculture, the use of new technologies, improving learning curricula in universities and vocational schools, changing the habit of consumption. The stakeholders also agreed that simply complying with waste and wastewater legislation would lead to a reduction of the impact on water quality. Given the current situation, upgrading of existing wastewater treatment plants is also needed to improve water quality.

Applying all the IDES Tool steps, the visualisation of the changes in the values of the ES between the 'status

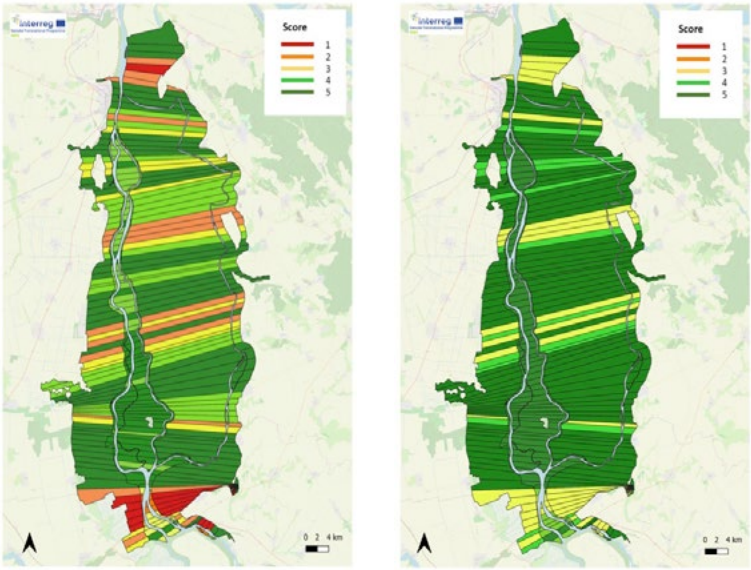

Figure 5.5. Status quo (left) and "optimal" scenario (right) for the habitat provision in Braila Islands.

quo' and the 'optimal scenario' is possible (Figure 5.5).

5.5 Conclusions

Using pilot areas facilitated a better harmonisation of the concurring societal interests, and led to the building of a conceptual framework (management options, ideas, values, visions) that was co-created together with the local stakeholders.

The IDES Project demonstrated that different communities on the Danube floodplain have the same understanding of ES regardless of the country, but the relative importance of ES is different from place to place. The level of importance of an ES is considered mostly based on the interest of the local communities. So, even if the pressures are the same throughout the DRB, the specificity of the values that local communities are placing upon the ES are locally defined. Consequently, the scenarios for improving water quality must take into consideration not only other ES, but also the specific local needs.

CHAPTER 6

THE INTEGRATION OF THE ECOSYSTEM APPROACH INTO EU AND NATIONAL POLICIES

The good state of the ecosystems in the DRB and in particular the quality of its water bodies, depend on the successful design and implementation of public policies. Ecosystem services and natural resources are addressed and/or influenced by a wide set of sectoral EU policies - and related instruments - dealing with the use of natural resources. Different policy sectors affect ES in different ways. Some policy sectors regulate economic activities that have negative impacts on biodiversity, ecosystems and their services (e.g. agriculture, energy production, transport and tourism). Other EU policy instruments support the conservation and sustainable use of ES and natural resources. First and foremost, the Birds and Habitats Directives protect the biodiversity underlining all ES. Furthermore, a range of sector-specific instruments – such as the common EU policies for agriculture and fisheries (CAP and CFP), policies for the management of inland, coastal and marine areas (Water Framework Directive – WFD, Marine Strategy Framework Directive – MSFD), and policies supporting the EU-wide cohesion and regional development – provide measures relevant for maintaining and sustainably using ecosystem services (Kettunen et al. 2014).

Using the analytical framework developed in the OPERAs project, the IDES project has looked at the level of conceptual and operational integration of the Ecosystem Approach into the national policies of Austria, Germany, Hungary, Bulgaria, Romania, Serbia and Slovenia. The conceptual level refers to the integration of ecosystem services and natural capital into the overall premises and objectives of different policy areas, and the operational level to the uptake of ES and natural capital in the

practical policy implementation. The assessment refers to the most recently approved policies, mainly related to the EU programming period 2014-2020, and covers the following policy sectors: biodiversity, water, forestry, agriculture, fisheries & aquaculture, climate change, energy, transport, territorial planning and tourism.

When analyzing documents covering the EU, the Ecosystem Approach is stronger at the conceptual level compared to the operational level. Moreover, ecosystem services appear in general at both conceptual and operational levels, except for tourism and transport sectors. The integration of ES into these two sectors is far weaker than the other policy sectors at EU level.

In case of water policies, it is important to make a concrete step from conceptual to operational integration. The EU's current policy framework for water – outlined in "A Blueprint to Safeguard Europe's Water Resources" – recognises and addresses ecosystem services explicitly. It recognises the current threats to water ecosystems and the services they provide and highlights the importance of green infrastructure in cost-effective water management. The Blueprint also acknowledges water as valuable natural capital and provider of numerous valuable provisioning ecosystem services, as it highlights the value of water to humans, nature and the economy.

Analysing documents covering the EU, the implementation of the Ecosystem Approach is stronger at the conceptual level compared to the operational level.

When analysing documents covering the national level, the integration of the Ecosystem Approach is still a work in progress for all countries, but keeping the same trend of better integration at the conceptual level compared to the operational level.There is a need for improvement on both levels in terms of preventing possible negative impacts of sectoral policies on ecosystem services and also proactively supporting the uptake of ecosystem services through nature-based solutions that support both biodiversity and inter-sectoral policy objectives.

CHAPTER 7

RECOMMENDATION FOR AN ES-BASED INTEGRATIVE FLOODPLAIN MANAGEMENT

The improvement of the Danube's water quality in recent years has shown that it is possible to reverse (under certain limits) the negative impacts of human activity. Nature-based solutions such as restoring a morphologically diverse river channel, reconnecting floodplains, or managing more sustainably areas adjacent to the water offer the opportunity to not only targeting a singular issue, (e.g. water quality), but also to look for solutions integrating several societal demands. Thus, these types of solutions aim at improving the ecological status of rivers and floodplains and at the same time enhancing services the ecosystem provides for human well-being. In this regard, the IDES Tool has shown in the pilot areas that the functional approach of ES assessment facilitates integrating the various interests in a multidimensional view. This enables stakeholders to better understand and appreciate the perception of others, and to jointly develop site-specific integrative concepts.

Availability of a new, common assessment procedure, as it is the IDES Tool that takes almost all relevant ES into account, is favouring incorporating the ES concept into spatial and socio-economic planning and decision-making. The IDES approach harmonised between the DRB countries will enable water managers and planers of different levels designing ES-based, integrative and transparent decision-making processes. This will foster the application of the ES approach and result in multi-purpose and sustainable solutions.

At the **local and regional levels**, where water management projects are realised, the detailed assessment of ES based on the available local data may help to convince land users and land owners as well as all relevant stakeholders to apply measures in order to increase the ES availability in their floodplain territories. Chances for a successful implementation of restoration projects increase when

stakeholders and their ideas and perceptions are integrated into the planning process.

At the **national or basin-wide level** the assessment of ES and the multi-functionality of floodplains will serve more the conceptual and strategic planning, by identifying potentials and deficits and comparing scenarios. The IDES Tool may be effectively implemented to adapt river-floodplain systems that formerly had been modified to maximise one or a few societal benefits to the more sustainable and more diverse societal requests and legal requirements of the 21st century. For that purpose, we recommend here to implement the IDES Tool also at Danube-wide and national levels in addition to the positive experiences at local level.

Basin-wide level

- **Spatial analysis of the whole course of the major rivers and their floodplains** with the IDES Tool for single and multiple ES: Identification of deficits and potentials to improve the availability of specific ES in certain areas in order to meet societal needs or legal goals.
- **Identification of hot spots of ES availability**: the IDES Tool may distinguish areas with high scores for one or multiple ES and of specific ES only provided in certain areas, which then should be protected due to their extraordinary functional benefits to society.
- **Integration of deficits and potential of ES and their management needs into the DRBMP and its regular updates**: The IDES Tool enables to integrate results on ES availability and ES development needs into the DRBMP, and thus to fulfil EU goals on ES assessments and the implementation of NBS, as stipulated by the EU Biodiversity Strategy for 2030. Especially, the ES assessment may be used to demonstrate and visualise the multiple benefits of restoration projects conducted in the DRB, as well as the benefits of NBS implementation that also increase resilience against climate change.
- **Comparison of management scenarios based on ES**: We recommend to use the IDES Tool as basin-wide framework for a standardised indicator-based approach to compare the effects of large-scale management measures in floodplains on ES availability in the DRB.

National level

- **Development of national floodplain atlases** with indications of the available ES (based on the IDES analyses), as well as national road maps to improve the availability of key ES.

- **Integration of ES evaluation into regional planning protocols**, thus **promoting NBS** to be better adapted against the upcoming challenges in water management (incl. water quality, climate change, increased frequency of floods and droughts).

- **Fostering the elaboration of joint water management planning documents** based on ES assessment including all relevant sectors, such as drinking water supply, flood management, water quality management, nature protection, local economy, tourism.

- **Establishing the ES approach as tool for assessment of cost-benefit analyses** of measures and adjustment payments/compensation of land owners in floodplains.

- **National educational programmes on ES provided by floodplains** and their integrative management incl. capacity building and education of interested stakeholders on the IDES Tool.

- **Co-creation and transparent decision-making on water management concepts at the regional/local scale**: Integration of interested citizens and stakeholders into planning processes from the beginning in order to increase the quality, acceptance and sustainability of projects that have implications on surface waters and floodplains. The IDES Tool may thereby facilitate the visualisation and comparison of different scenarios and thus support a joint agreement on the most effective scenarios for society with greatest synergies, and the lowest trade-offs.

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Interreg
Danube Transnational Programme
IDES

Project co-funded by the European Union (ERDF, IPA)