IDES

I**mproving water quality in the **D**anube river and its tributaries by integrative floodplain management based on **Ecosystem Services

DTP3-389-2.1 – IDES
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O T2.3 Implementation of the IDES tool in five pilot areas

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Compiled by RCSES - UB, responsible for work package T2

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with support of the entire IDES partnership

Content

Introduction

The Ecosystem Services concept has multiple aims: i) as a tool facilitating the communication on complex management issues with various stakeholders and the public, ii) Supporting a complex social learning process to harmonize multiple competing local interests as a prerequisite of subsequent co-creation processes, iii) as a decision support tool that enables easy assessment of complex management scenarios.

This concept forms the heart of the IDES project aiming *"to improve water quality management along the Danube and its tributaries* ***by applying an Ecosystem Service based integrative floodplain management (IDES tool)****."*

The IDES project has a hierarchical approach from the Danube floodplain scale to the implementation of the IDES tool in selected pilot areas along the Danube where inputs from local stakeholders are integrated.

The general aim of the project was the development of the IDES tool that enables the stakeholders to identify more effective and integrative option for the implementation of related nature-based solutions. In detail, the project has 3 objectives:

- Development of scenarios to improve the retention of nutrients in floodplains,
- Comprehensive assessment of the other ecosystem services (ES) of floodplains and their changes in these scenarios due to synergies with nutrient retention,
- Development of an integrated concept for the management of floodplains in cooperation with stakeholders and decision-makers.

This output focuses on the last objective describing the interaction of stakeholders and decision makers, and also carrying on a comprehensive assessment of the multiple ecosystem services of floodplain and their relative changes in the pilot areas. The assessment was based on multiple methods but it is focusing on co-creation with stakeholders.

Through a careful selection of pilot areas (based on a list of criteria) we applied the IDES tool (see O.T1.1.1, Ides project) ("which is a methodological approach to harmonize the evaluation and visualization of ES") aiming to assess the ecosystem services provided by these areas in a harmonized way across countries and sites. The IDES approach allowed us to identify, at different scales, starting with the entire Danube floodplain and then focusing to the pilot area (or complex of ecosystems – landscapes), many of the ES provided by these ecosystems.

For the ES assessment we have used in fact a tiered approach (Adrienne Grêt-Regamey et al., 2015) taking into account the entire complexity of the landscape but also other criteria like data availability and the involvement of the stakeholders in a transdisciplinary way.

For the pilot areas three approaches were used to map, assess and evaluate the ES: i) the (see O.T1.1.1, Ides project)., ii) the matrix approach (Stoll et al. 2015) and finally iii) the methods for social analysis (questionnaires) and FCM (fuzzy cognitive mapping).

It has to be noted that the IDES tool was actually developed based on the RESI approach „River Ecosystem Service Index" (Podschun et al., 2018) that is taking into account both the structures (e.g. topography, soil types, land cover/land use - LC/LU) and processes (e.g. floods, sediment deposition and remobilization) to calculate and map the respective ES.

The matrix approach is based on scores provided to each of the ES and land cover classes; the scores are provided based on local stakeholders' understanding; This approach represents an adaptation of the landscape matrix approach by Burkhard B, 2009.

Finally, the FCM and the questionnaire were selected as participatory approaches used to analyse socio-ecological systems in the selected pilot areas, largely due to the vast implication of the methodology that is acting as a i) social learning; a ii) communication; a iii) co-creation and an iv) co-development tool.

This output provides a short description of the conceptual understanding, the identification process of the pilot areas, the implementation of the IDES tool and also of the FCM to highlight the status quo of the areas in terms of supply of ecosystem services. **Additionally, a synthesis of all ES, synergies and trade-offs between ES is visualized graphically** (FCM) which will allow the objective analyses on management efficiency and trade-offs at several levels of ES data aggregation. We used this approach to identify the **sustainable management concept with the highest ES values addressing at the same time the negative and positive effects** of the various management options. This will result in the **identification of the most sustainable and integrative water quality management actions in floodplains and thus**, of the practical implementation of the Ecosystem Service based integrative floodplain management approach in five pilot areas. Once identified, the most sustainable action might be implemented faster and easier.

1. Conceptual understanding

Identifying, assessing, evaluating and providing decision support tools based on ES usually requires understanding of the complex interactions in socio-ecological systems that need not only modelling tools based on a merely bio-physical understanding of the systems interactions, but also, and this is very important, on a deep understanding of the social system and the values and perceptions of the society. In the same time the ecosystems and their ecological status form the basis for socio-economic development. Ecosystems provide a diversity of ES to human society, and in doing so they represent life supporting units for humans (van Rees CB et al., 2000).

Based on this understanding our intention was not to create another way (tool) in which scientists are developing tools and stakeholders will work with those or with their outputs, but rather the approach was to co-create (from the very beginning) together with the stakeholders the tools and assess the results together. For this we needed to understand how ES are perceived by the local stakeholders of the different pilot areas and propose actions and ways to act together (integrating with them within a policy framework).

This output is centred on the stakeholders and their social dimension meaning that the evaluation of ecosystem services was built on a participatory, inclusive and deliberative approach allowing community members (including scientists, decision makers etc.) to discover, explore, share opinions and build consensus on benefits (ecosystem services) provided by a specific ecosystem. (Figure 1)

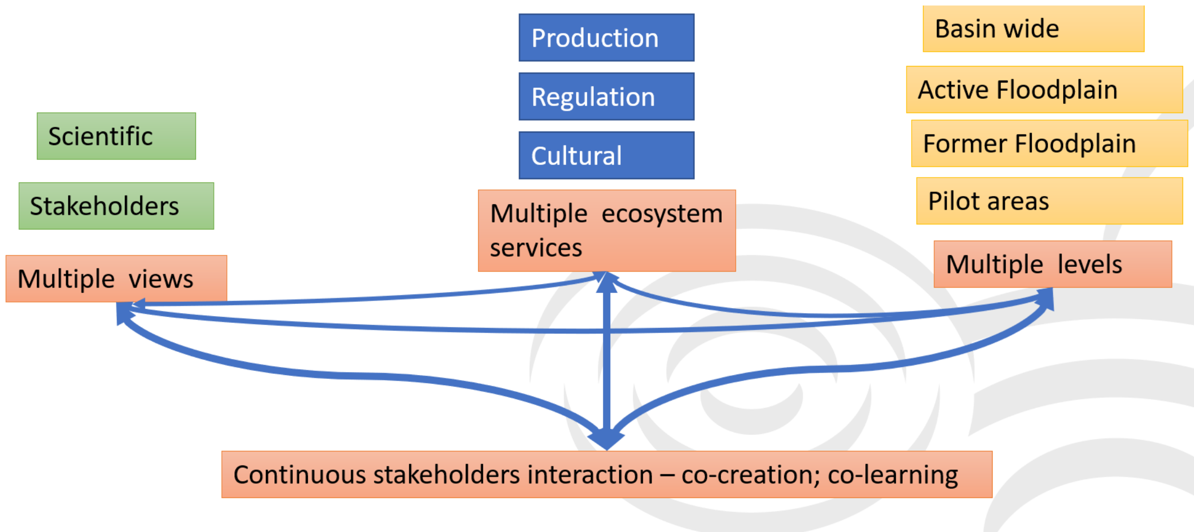
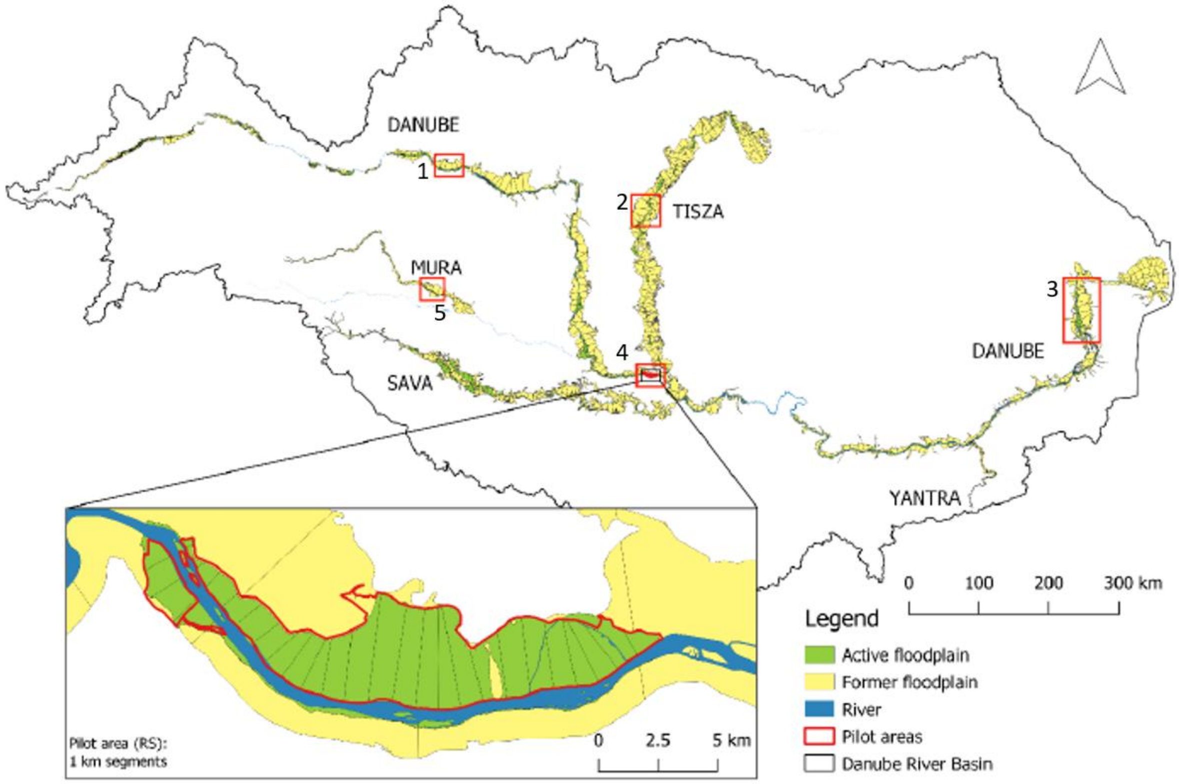


Figure 1. A complex approach for mapping, assessing and evaluating ES in pilot areas

2. Identification of pilot areas

Five pilot areas were selected (Figure 2) to represent different territorial and practical challenges, as conflicts with e.g. agriculture, forestry, flood prevention, navigation, and fishery, and to capitalize on other DTP projects (e.g. Danube Floodplain). All pilot areas were analyzed for their suitability to water quality management actions.



1. AT – Donauauen Nationalpark
2. HU – Tisza near Szolnok
3. RO – Braila Islands
4. RS – Special Nature Reserve 'Koviljsko-Petrovaradinski Rit'
5. SL – Mura River Kučnica Mura Petajnci – Gibina

Figure 2 Location of the 5 pilot area

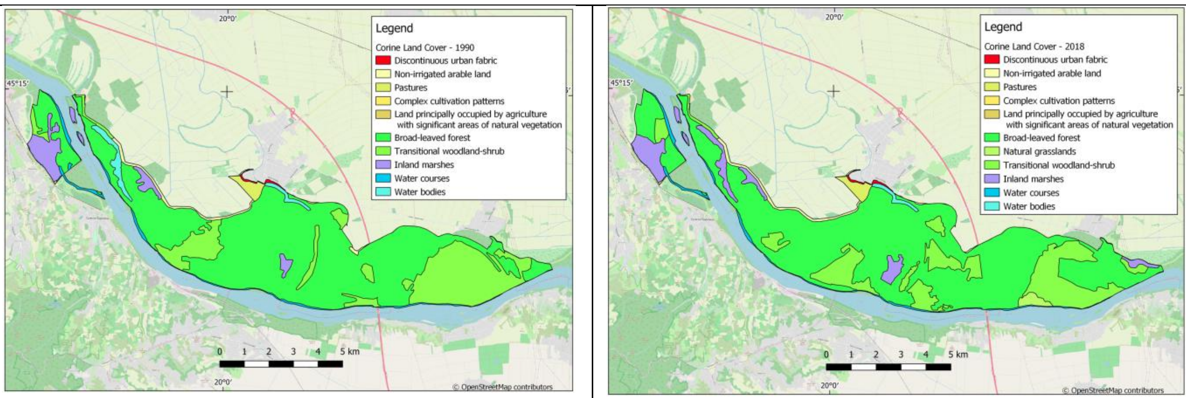
1. Donauauen Nationalpark (Austria)

Figure 3 Donau-Auen National Park

Donau-Auen National Park is a 'green ribbon' in Austria, connecting the conurbations of Vienna and Bratislava. It is one of the last great floodplain landscapes in Central Europe. It is characterized by the nearly free-flowing upper Danube, which retains the characteristics of an alpine stream. The section of the Danube River crossing the national park has a length of 36 km with a river width of about 350 m, with water level fluctuations of up to 7m. The pilot area exhibits a wide variety of habitats, plants and animal species and it is home to many endangered species, which include 800 types of vascular plants, 30 mammalian species, 100 breeding bird species, 8 reptilian and 13 amphibian species and about 60 different types of fish (Natho et al. 2020; https://www.donauauen.at/) . There are relatively low levels of water pollution and thus the importance of that floodplain for water purification is moderate. Donau-Auen was declared a national park in 1996 and is protected on both at national and international (RAMSAR, SPA, SCI, Biosphere reserves – conservation status) level. Of the 9600 ha, 65% are covered by riparian forests, 15% by meadows and approximately 20% by water. The Donau-Auen National Park is not only home to a wide variety of plants and animals, but is also important for the residents of the area. It forms a natural retention area for flood waters, (Schober et al 2015) it represents a high-quality drinking water resource, a recreational area for the population and 'green lung' and important climatic regulator for the region.

2. Special Nature Reserve “Koviljsko-Petrovaradinski Rit” (Serbia)

The Special Nature Reserve 'Koviljsko-Petrovaradinski Rit' (KPR) in Serbia is located in the autonomous province of Vojvodina, northern Serbia, near the city of Novi Sad. The KPR is located on the left and right banks of the Danube River, between river km 1250 and 1225. The smaller part of the KPR wetlands (on the right side of the Danube river) is known as the Petrovaradin marsh while the significantly larger side of the KPR (located on the left side of the Danube river) is known as the Kovilj marsh.



a) b)

Figure 4 The changes in the Corine land cover in the Special Nature Reserve (KPR) from 1990 (a) to 2018 (b).

Forests cover the majority of the area of KPR (69% of the total area), while wet meadows and pastures occupy 15% of KPR. Wetlands and aquatic habitats (e.g. marshes, oxbows, channels, riverine habitats) cover around 12%. KPR is a protected area of national importance. Due to its exceptional natural values (rare and protected flora and fauna, as well as preserved habitats) and specific characteristics of wetlands, it has been declared as a Special Nature Reserve (First Category protected area), according to the Serbian Law on Nature Protection. The importance of KPR for biodiversity preservation has been recognized internationally, therefore it has been included into several international protection schemes:

- Important Bird area (IBA)
- Important plant areas(IPA)
- Special nature reserve (ICPDR 2004), as a protected area dependent on water and significant for the Danube basin
- Danube Network Protected Areas (2007), as one out of five protected areas from Serbia, which has spatial area larger than 1000 ha
- RAMSAR Site (2012) under the Ramsar Convention
- Emerald network of habitats and types.

The KPR is part of the international ecological corridor of the Danube River. It represents an important area for the resting and feeding ground for migratory birds during their seasonal migrations and a reproduction ground for many amphibian species

3. Tisza near Szolnok (Hungary)

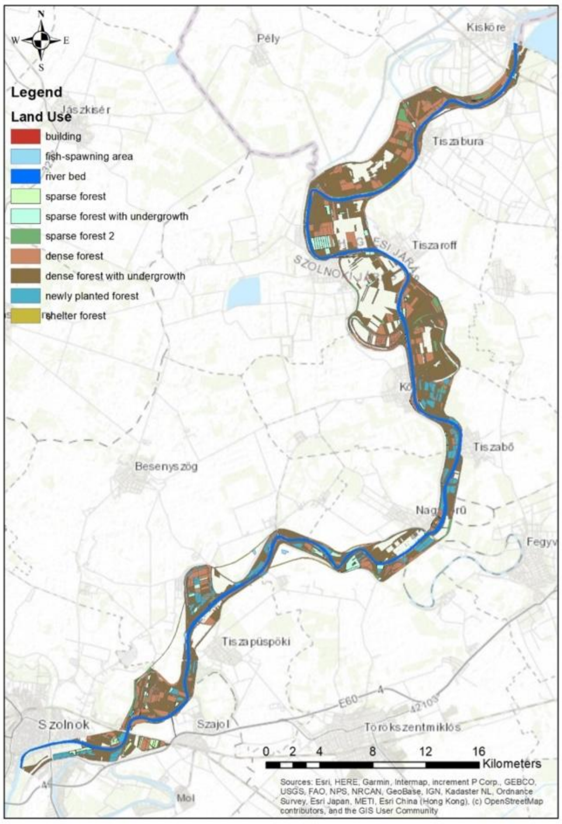


Figure 5 The current land use and the status of the forest plain between Kisköre and Szolnok

The Hungarian pilot site is located in middle of the Great Hungarian Plain. This floodplain landscape is known as a natural formation, although this landscape was created by water engineers and foresters. The area of the floodplain between Kisköre and Szolnok is 9,197 ha, of which 7,440 ha is agriculturally usable area. Along this river section of the Tisza River dikes were built more than 100 years ago. The area represents a well-preserved complex of wetlands and forest ecosystems. The floodplains and wetlands of this river section are uniquely valuable ecosystems. Protected floodplain areas provide habitats for endangered species, help to even out flood peaks and reduce flood damage by storing surplus water.

The Tisza is the second most significant river in Hungary. The Tisza's full gradient is 30 m (5 cm/km) in Hungary. Based on the MTDWD's hydrometric data, the minimum discharge of the river is 46.9 m^3/s, and the maximum discharge is 2 610 m^3/s at Szolnok. The long-term average discharge is 532 m^3/s at this river section.

During the establishment of the forests, it was expected that afforestation would not cause significantly higher sediment deposition, thus not reducing the water absorption capacity of the floodplain. Based on these, plantation-like forests were planted, consisting of fast-growing Populus euramericana species. These plantation-like stands produce much higher timber yields and industrial timber yields than our Populus alba stands. The explosive spread of the Populus x euramericana can be explained by these reasons.

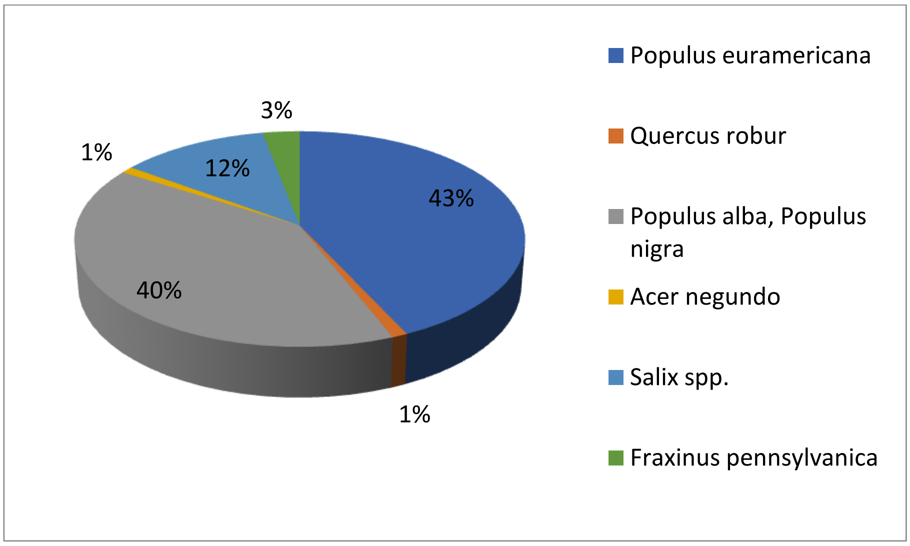


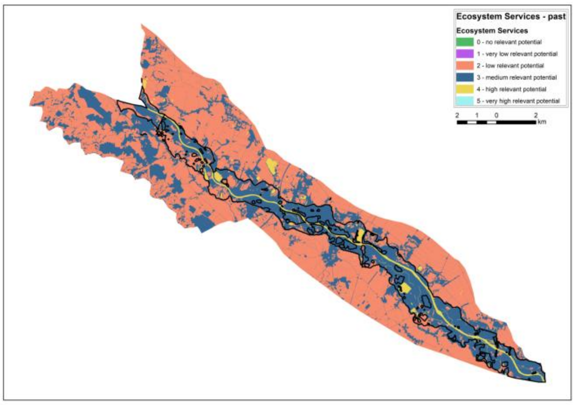
Figure 6 Distribution of floodplain forests along the pilot area

This floodplain landscape lives in the minds of many as a natural formation, although this landscape was created by water engineers and foresters. This artificially created floodplain has grown over time into an excellent, diverse protected living space. The proportion of areas of nature conservation value has increased in the floodplains over the years. Especially along oxbow lakes, cubic pits and shores. Due to the mentioned values and the great diversity of the species, the floodplain is invaluable. Nature conservation organizations have declared these areas protected.

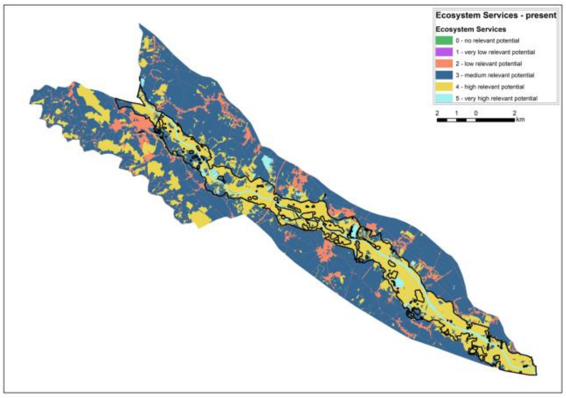
According to the Habitat Directive, there are 53 different protected species in the pilot site, such as amphibians (2), birds (24), fish (11), invertebrates (6), mammals (8), plants (1), reptiles (1). On an international level, the Middle Tisza is part of the NATURA 2000 SCI (HUHN20015) and SPA (HUHN10004) site.

4. Mura River Kučnica Mura Petajnci – Gibina (Slovenia)

Mura River is located in the north-eastern part of Slovenia. It flows through Austria, Slovenia, Croatia and Hungary. It is a tributary of the Drava and subsequently the Danube River. The total length of the Mura River is 465 km and on Slovenian territory, the length is 95 km (Natura Mura, 2020). The pilot area is located in the middle part of the river that flows through Slovenia and where it is not bordering other countries. The area is located between Radenci village (upstream) and the confluence with Ščavnica River (downstream). The pilot area covers the catchment area of Kučnica Mura Petajnci – Gibina and has a total size of 122 km^2.



a)



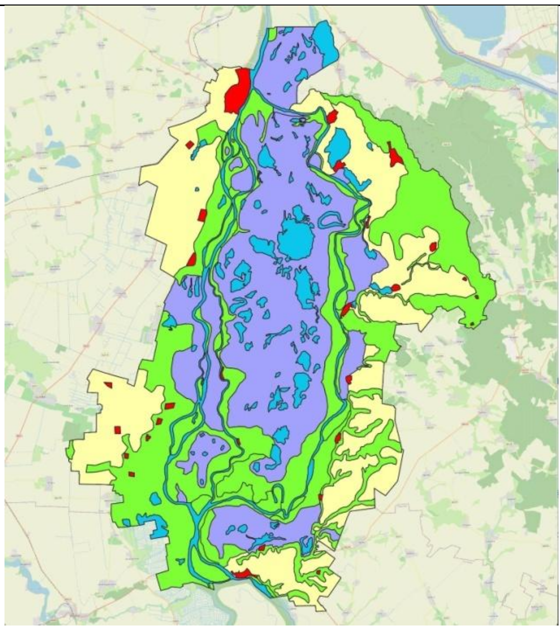
b)

Figure 7 Two maps showing the past (18th century) (a) and present (b) ecosystem services potential and when comparing the change over time

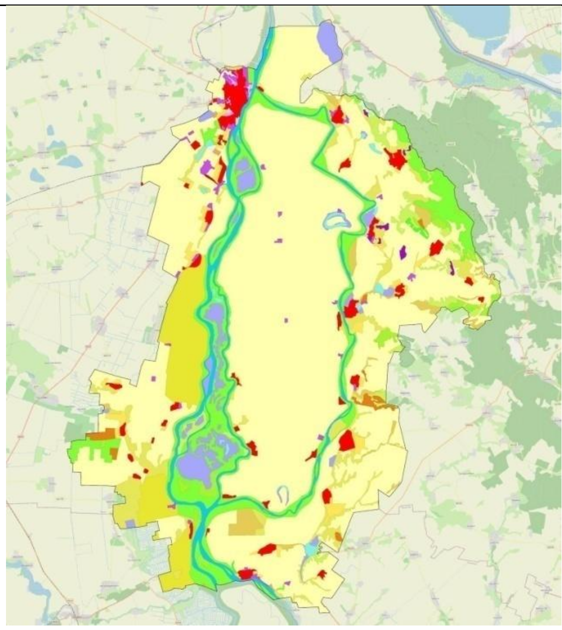
37% of the pilot area are classified as an ecologically important area. Natural values are also defined by the Nature Conservation Act. Inside the pilot area, there is one area with a natural value of national importance and five points with natural values of national importance, as well as two points with natural values of local importance. Based on the Forest Act (1993), most forests directly along the Mura River are defined as protective forests. The Decree on Special Protection Areas (Natura 2000 sites) was adopted in 2004. Additionally, the supplements of the Article 33 on the Nature Conservation Act were also adopted at the same time.

5. Braila Islands (Romania)

Braila Islands is a socio-ecological system located in the South East of Romania, on the Danube, stretching over 78 km between Harsova and Braila, with a total surface of about 2600 km^2. It is shared between four counties and comprises 20 administrative territorial units. It also contains nine EUNIS level 1 habitats, including aquatic, terrestrial and socio-economical ecosystems (Cazacu et al., 2015).



a)



b)

Figure 8 Land cover changes in Braila Islands in the past (1900) (a), and in present times (2018) (b)

Braila Islands are in fact a group of islands on the Danube River dominated by Big Island of Braila and Small Island of Braila respectively. 205 km^2 of the total area of the Braila Islands are recognised as protected, both on a national level (Natural Park - 06/03/2000) and on an international level (Ramsar - 15/06/2001).

Once a former wetland, the Big Island of Braila consists of heavily modified ecosystems and 96.4% of the area of the island were converted into agricultural land. Prior to the conversion to agricultural land, the Big Island of Braila contained large numbers of lakes, ponds and marshes that were linked to each other and connected to the river (Vadineanu et al., 2003).

On the other hand, the Small Island of Braila maintains ecosystems under a natural functional regime and has preserved its natural hydrological conditions. It is the main remnant of floodplains in the area, making it crucial to preserve.

3. Methods

3.1. Mapping and assessing the ES using IDES approach in pilot areas

The IDES approach was used to assess the availability of ecosystem services (ES) based on GIS indicator data that are processed using relatively simple algorithms (Podschun, Albert, et al., 2018). A variety of ES, based on the international CICES classification (Haines-Young & Potschin, 2018), can be assessed in a non-monetary way depending on the focus of the study (Stammel et al., 2021). All assessments are calculated for standardised segments in the morphological and active floodplain compartments on both sides of the river. These segments are oriented perpendicular to the river channel and are hence separated into river, active floodplain (flooded area during a 100-year flood) and inactive floodplain (areas of morphological floodplain that is separated from the river dynamics by regulation structures) compartments.

3.2. Mapping and assessing the ES using matrix approach in pilot areas

To map the availability of ecosystem services, we followed the matrix methodology described by Stoll et al. (2015). In order to map the riparian ecosystem distribution, we used the most recent high resolution Land Use Land Cover (LULC) type classification of the European riparian zones and a matrix relating each of the 55 LULC classes with individual Ecological Integrity (EI) and Ecosystem Services (ES) components. In total 39 individual EI and ES components were assessed. This matrix includes the ranked contribution of each LULC class to individual EI and ES components and is mainly based upon expert assessments (range from 0: 'no capacity to provide demanded particular service' to 5: 'very high capacity to provide demanded particular service'; for a detailed description how this matrix was conceived, see Burkhard et al., 2009, Burkhard et al., 2012, Burkhard et al., 2014, Stoll et al., 2015).

In order to keep a comparable approach on the representation of the various ecosystem services across the case studies, we used 1 km wide segments perpendicular to the river floodplain for which an area weighted mean approach was applied. Thus, a corresponding area of a LULC contained by a segment was used to weight the rank of a EI or ES for each floodplain segment.

3.3. Understanding the conceptual model of the stakeholders using FCM

A **model (Fuzzy Cognitive Model)** was developed in cooperation with the stakeholders to integrate the ES and the DPSIR frameworks (EEA, 1995). This step was done in order to understand the linkages between the DPSIR framework and the ES for each of the pilot areas as our understanding was that it may be possible that several drivers and pressures as well as the status and the responses are both characteristic to the entire Danube basin but also pilot area specific.

A **step-wise approach** was implemented as follows:

1. ES are identified by the stakeholders in each pilot area (using a harmonized list of ES)
2. The stakeholders proceed to identify for their pilot zone the specific pressures (by selecting from a common list of pressures)
3. Then the collective socio-ecological-system analysis was carried out using a FCM
4. Finally, the stakeholders carried out the identification of possible responses (e.g. management options, restoration measures)

The aspect of water quality was integrated within the framework as ES "**water purification / water quality improvement**".

We also used questionnaires to understand the differences between the collective (learning experience) and the individual thinking process by comparing the ranking of ES obtained using FCM and respectively the questionnaires. For this we have used the ranking based on expressed options and from the FCM we considered the centrality and then compared the results.

4. Results

4.1. Mapping and assessing the ES using IDES tool and Stoll approach in pilot areas

4.1.1. Austria

4.1.1.1. Cultural Ecosystem services (Austria)

Cultural ecosystem services are defined as non-material benefits that people obtain from ecosystems through a variety of activities from recreation, tourism, intellectual development, spiritual enrichment, reflection and creative and finally to the aesthetic experiences (Haines-Young R., Potschin M., 2018). The assessment of cultural ecosystem services is of great importance for understanding the possible trade-off and synergies that different local stakeholders have in relationship with other types of ES. The indicator-based IDES approach (Figure 8) provides more precise assessment options than the matrix approach (after Stoll).

Applying the IDES approach, the matrix approach the questionnaires as well as the discussions during the development of the FCM models provided us a multi-dimensional, comprehensive understanding of ESS availability and appreciation in each of the pilot areas.

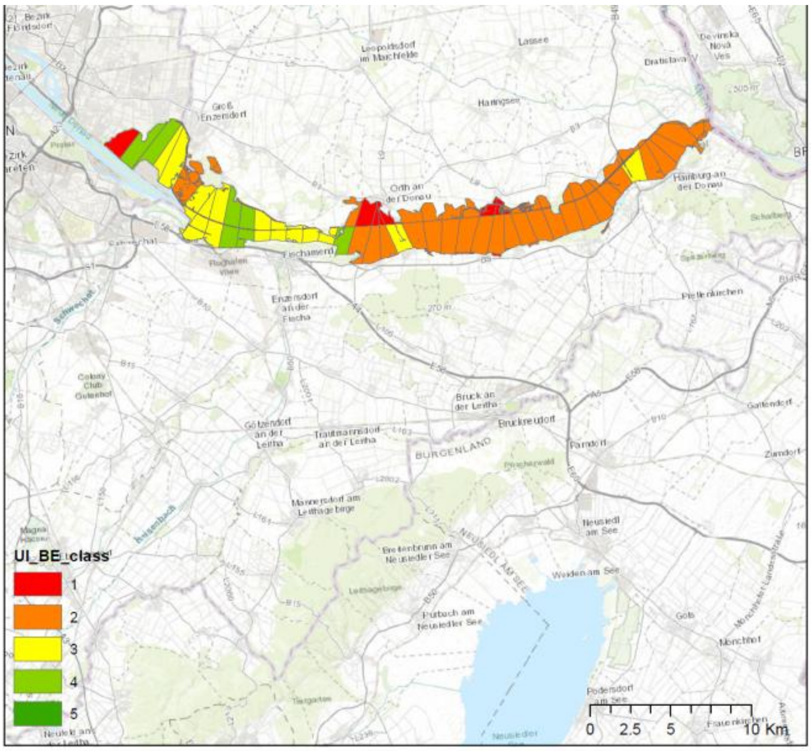


Figure 8 Austrian cultural ecosystem services assessment using the matrix approach

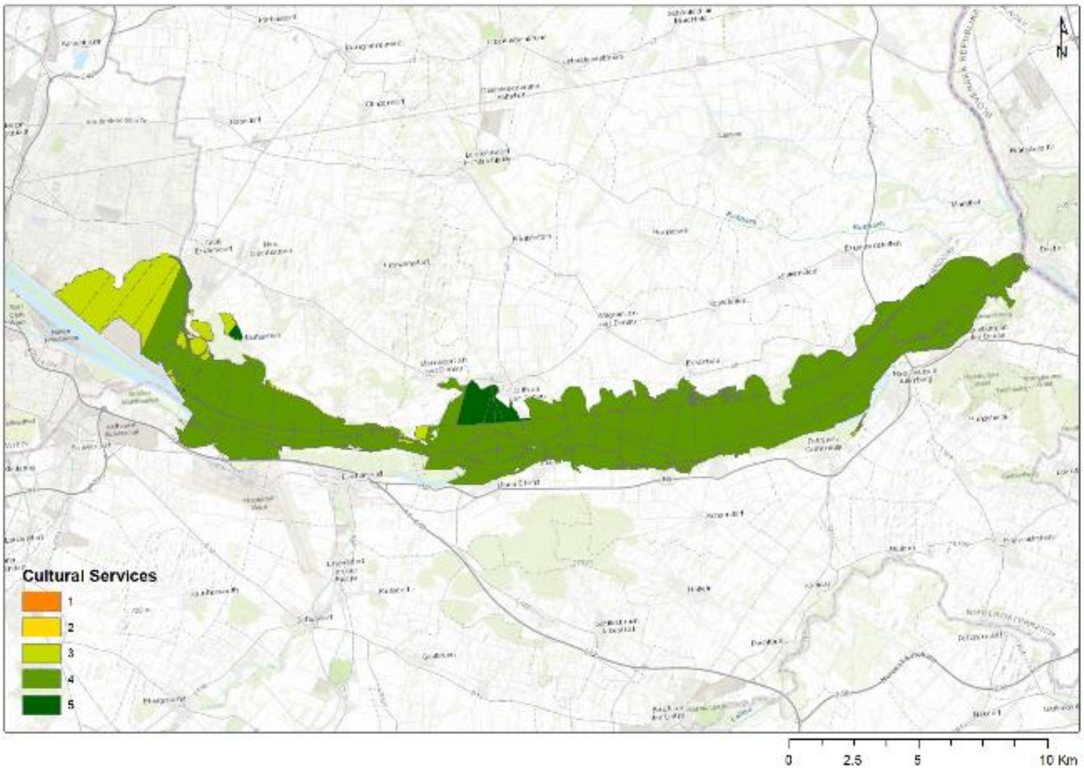
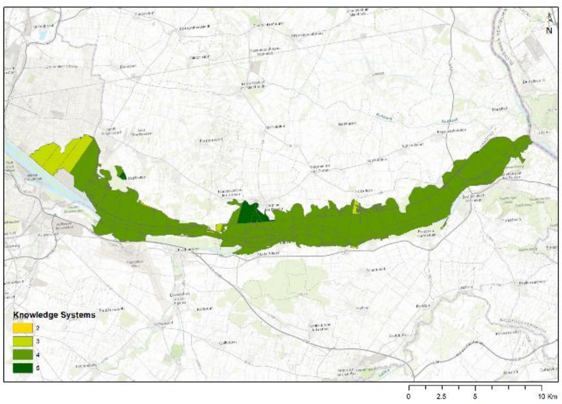
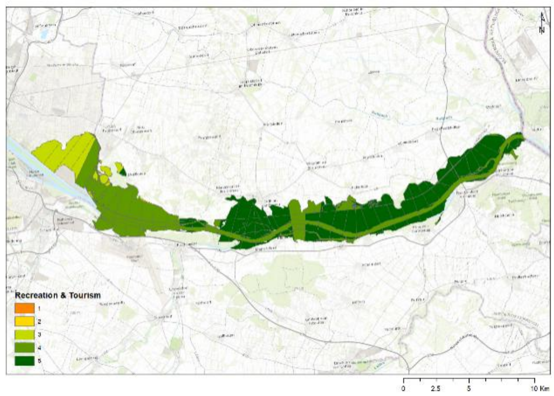


Figure 9 Austrian cultural ecosystem services assessment using the IDES approach

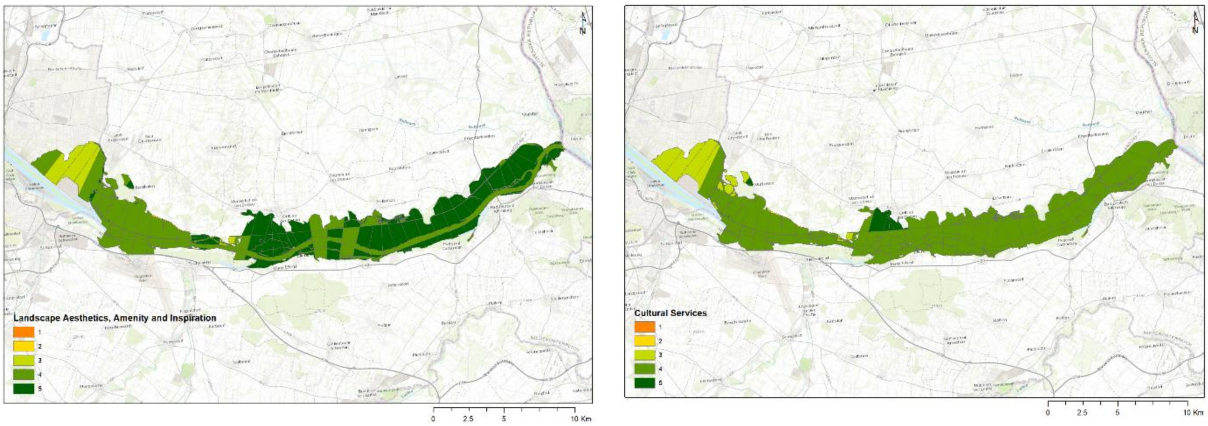
Based on the Corine land cover and the inputs from different local stakeholders, we have mapped different categories of cultural ecosystem services for the Austrian pilot area (Figure 10).





Knowledge system (using matrix approach)

Recreation &Tourism (using matrix approach)



Landscape aestethics amenity &inspiration (using matrix approach)

Total cultural services (using matrix approach)

Figure 10 Cultural ecosystem services assessment using the matrix approach for the Austrian pilot area

The use of different methods to map ecosystem services shows the respective strengths and weaknesses of the various approaches. The IDES approach being standardised at the Danube scale has more relevance for comparison across pilot areas allowing a better comparative analysis of the importance of different pilot areas.

4.1.1.2. Regulation ecosystem services (Austrian)

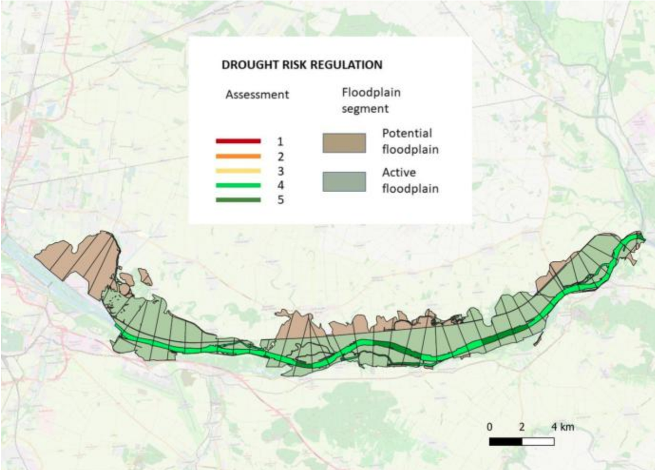
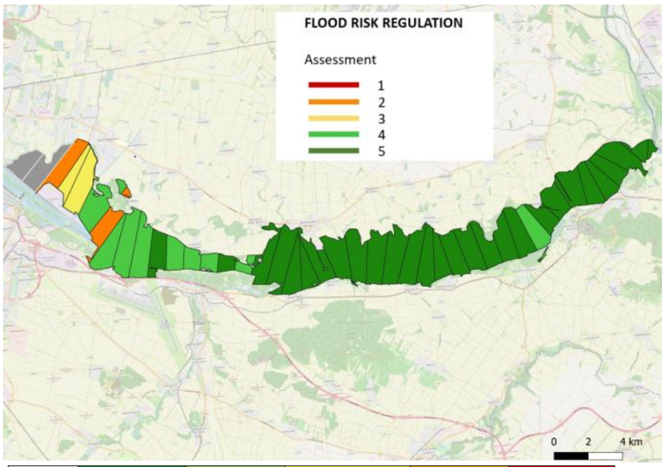


Figure 11: Assessment of drought risk regulation ecosystem service in the Austrian pilot site using the **IDES approach**



Evaluation Class	5	4	3	2	1
Qualitative Evaluation	**No or very little loss** of active floodplain volume, **very high** wave reduction	**Little loss** of active floodplain volume, **high wave** reduction	**Moderate loss** of active floodplain volume, **moderate** wave reduction	**High loss** of active floodplain volume, **little** wave reduction	**Very high loss** of active floodplain volume, **no or little** wave reduction

Figure 12: Austrian Assessment of flood risk regulation ecosystem service in the Austrian pilot site using the **IDES approach**

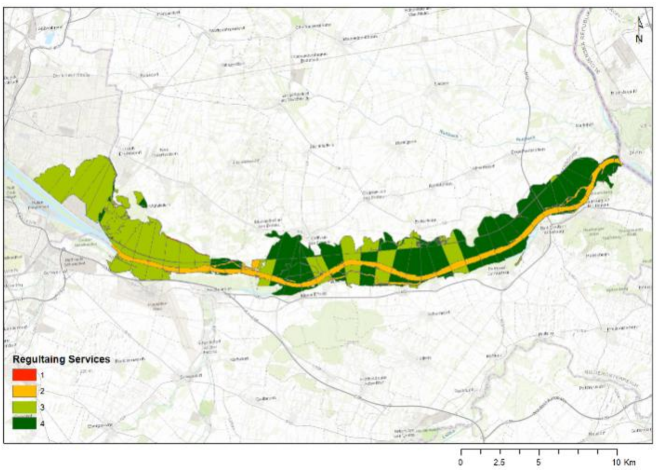


Figure 13: Availability of regulating ecosystem services assessment in the Austrian pilot site as assessed by the **matrix approach**

4.1.1.3. Provisioning ecosystem services (Austria)

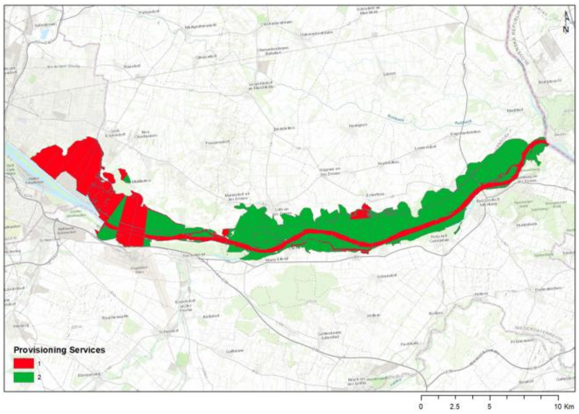


Figure 14: Availability of provisioning ecosystem services assessment in the Austrian pilot area using the **matrix approach**

4.1.1.4. Integrity ecosystem services (Austria)

Finally, the integrity was assessed for the Austrian pilot case using the matrix approach

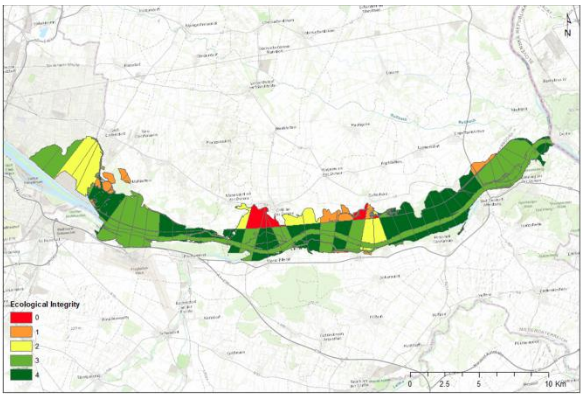


Figure 15: Availability of integrity ecosystem services assessment in the Austrian pilot area using the matrix **approach**

4.1.2. Hungary (Tisza near Szolnok)

4.1.2.1. Cultural Ecosystem services (Hungary)

Several cultural ecosystem services have been assessed here with multiple methods. Results show that the area has great cultural potential especially concerning landscape aesthetics & inspirations and knowledge.

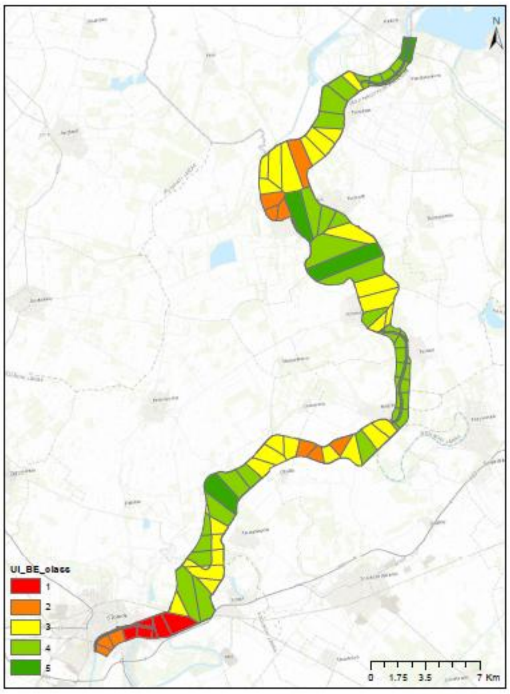


Figure 16: Availability of cultural ecosystem services in the Hungarian pilot area using the IDES approach

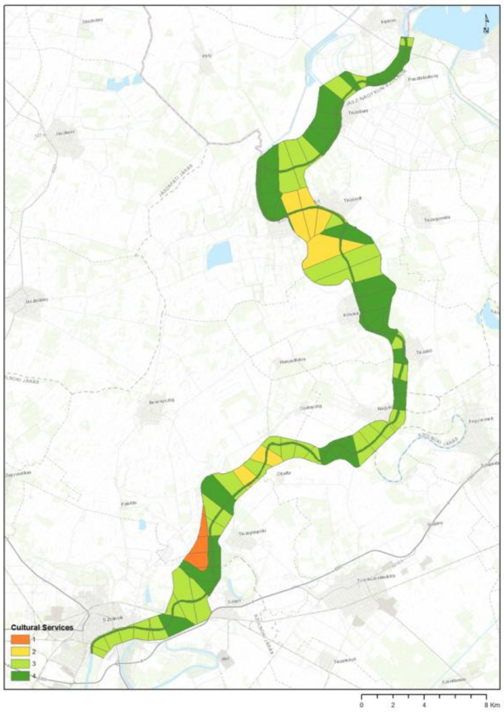


Figure 17: Availability of cultural ecosystem services in the Hungarian pilot area using the matrix approach

4.1.2.2. Regulation ecosystem services (Hungary)

The capacity of different areas to provide such ES is directly linked with the “complexity” of the ecosystems and the naturalness of the area. Systems that are closer to the initial natural status have usually a greater capacity to provide regulating ecosystem services. There is usually a trade-off between the productive capacity of the ecosystem and the regulation and cultural ES as well as the integrity of ecosystems. In figure 18 -21 we assessed the capacity of the ecosystems in the Hungarian pilot area to provide regulating ecosystem services using both approaches (matrix and IDES).

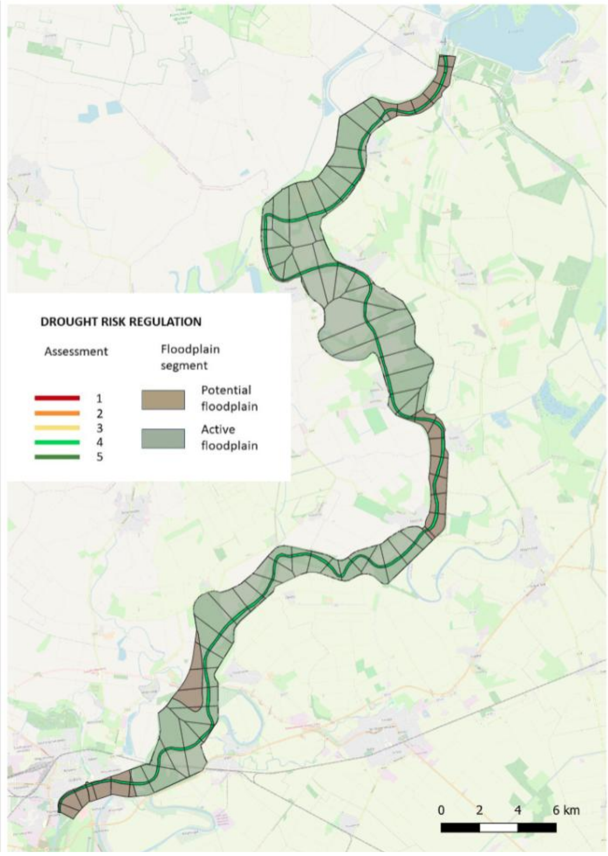


Figure 18: Availability of drought risk regulation in the Hungarian pilot area using the IDES approach

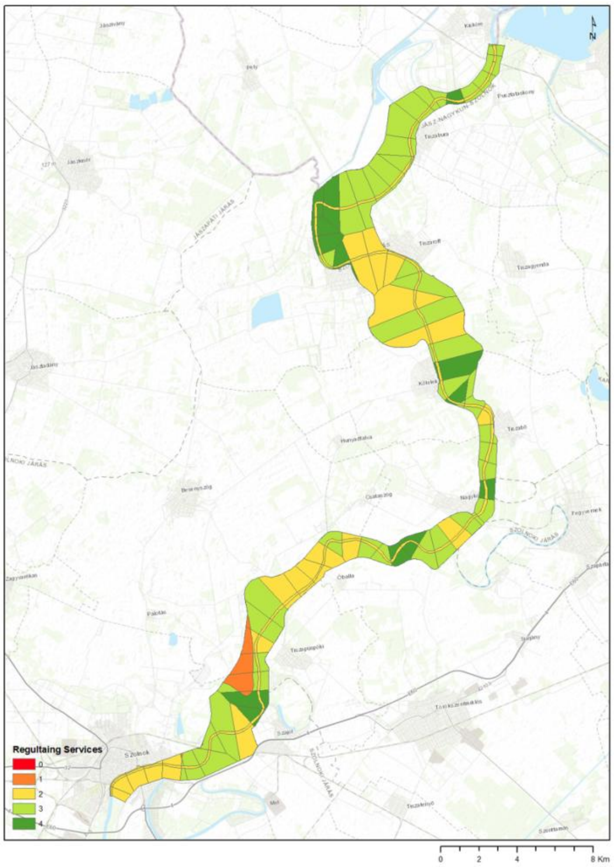


Figure 19: Availability of regulating ecosystem services assessment using the matrix approach in the Hungarian pilot area

4.1.2.3. Provisioning ecosystem services (Hungary)

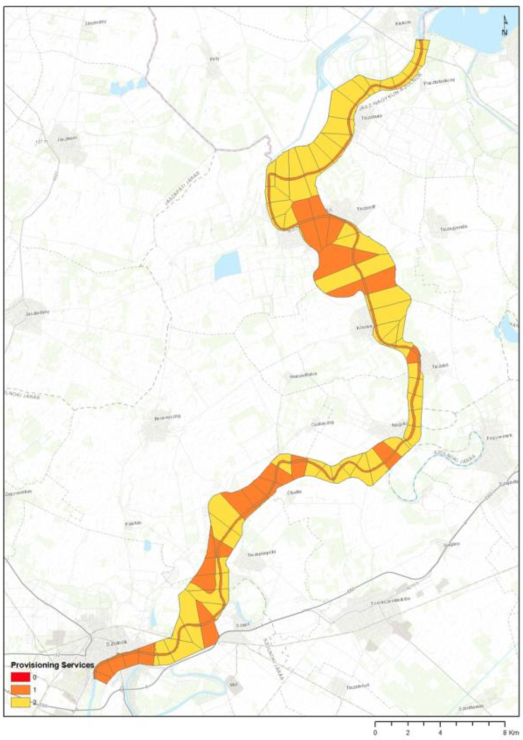


Figure 20: Availability of provisioning ecosystem services using the matrix approach in the Hungarian pilot area

4.1.2.4. Integrity ecosystem services (Hungary)

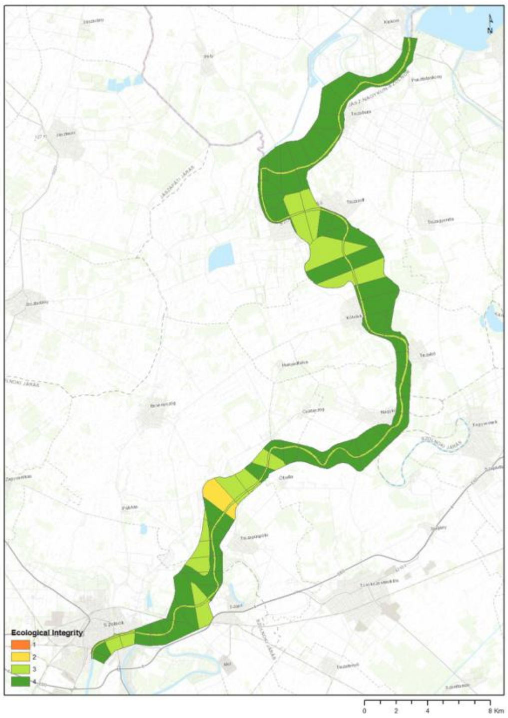


Figure 21: Availability of the integrity ecosystem services using the matrix approach in the Hungarian pilot area

4.1.3. Romania (Braila Island)

4.1.3.1. Cultural Ecosystem services (Romania)

The stakeholders are valuing in a different way the agricultural areas as compared with the IDES approach. While the calculation of cultural ecosystem services using the IDES approach is based on a formula containing among others the number of protected areas that are being intersected in a 1km segment, the matrix approach is based on the stakeholder's opinion regarding the cultural values of different ecosystems types. The results are clearly different as they may be seen in figure 23 and 24.

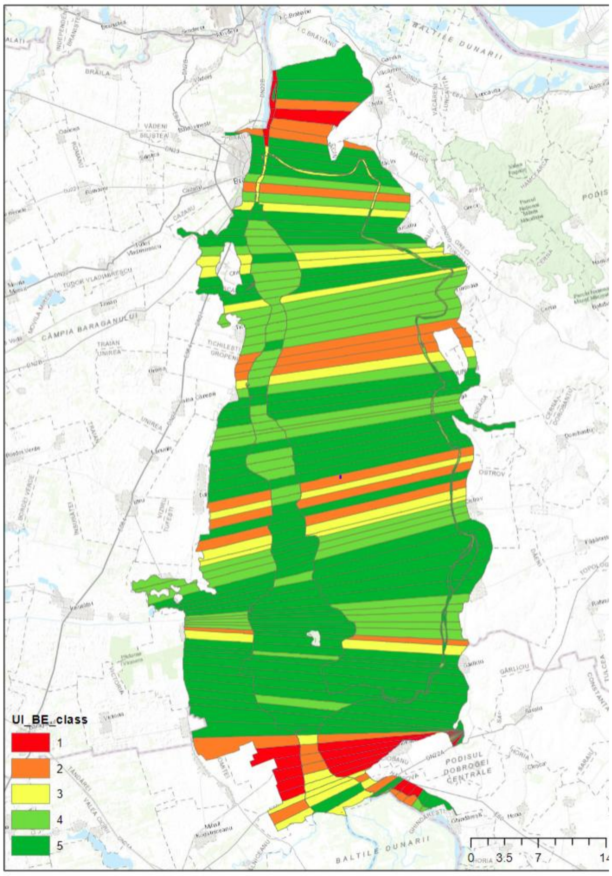


Figure 22: Availability of the cultural ecosystem services using the IDES approach in the Romanian pilot area

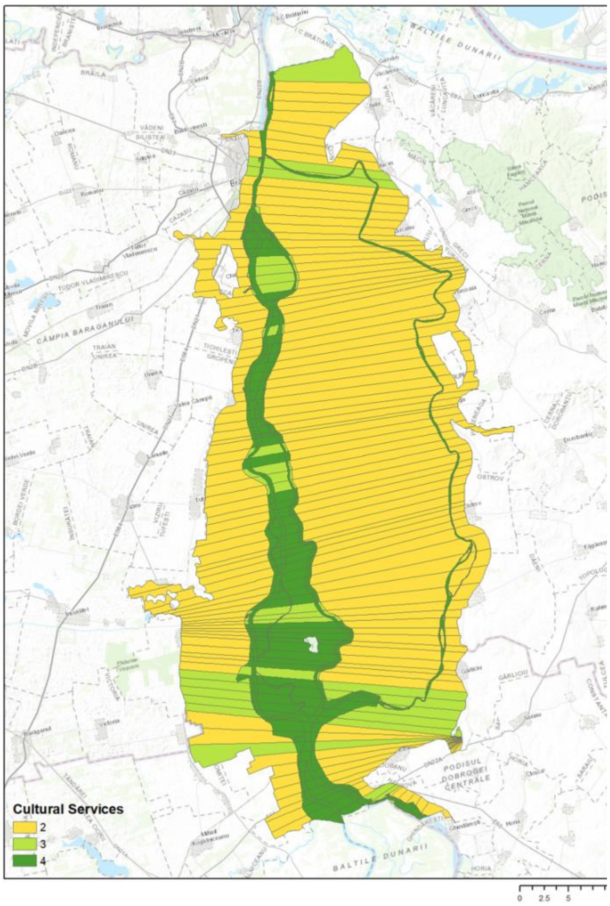


Figure 23: Availability of the cultural ecosystem services using the matrix approach in the Romanian pilot area

4.1.3.2. Regulation ecosystem services (Romanian)

The Braila Island is characterized by two main ecosystem categories: a more natural category that has a higher regulation capacity, and a transformed one that has a lower capacity of providing regulating services.

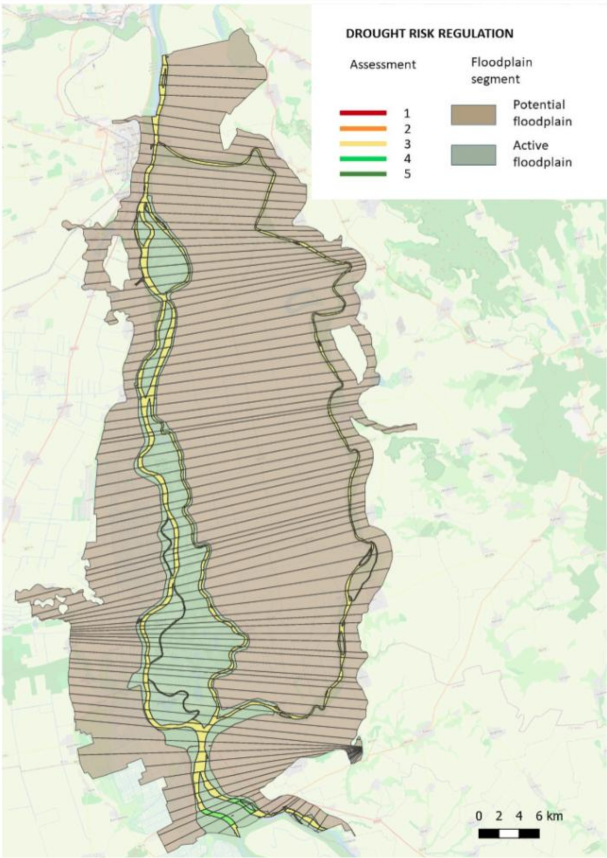


Figure 24 Availability of the drought risk regulation ecosystem services using the IDES approach in the Romanian pilot area
The difference between the two zones, as the diked area (grey) of the potential floodplain and the natural floodplain (green) is clearly visible.

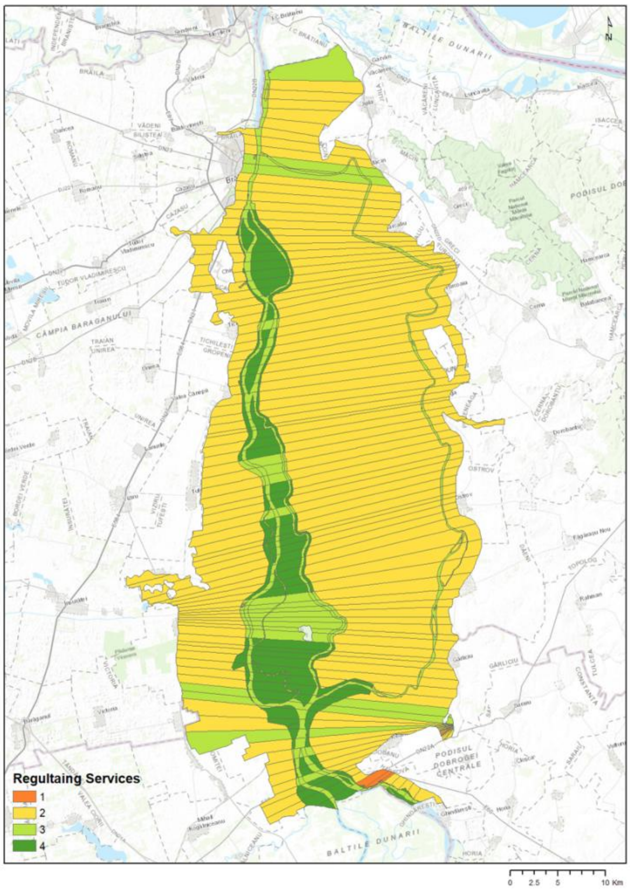


Figure 25: Availability of the regulating ecosystem services assessment using the matrix approach in the Romanian pilot area

4.1.3.3. Provisioning ecosystem services (Romania)

In terms of provisioning ESSs, the agricultural area has a capacity to provide a much higher quantity.

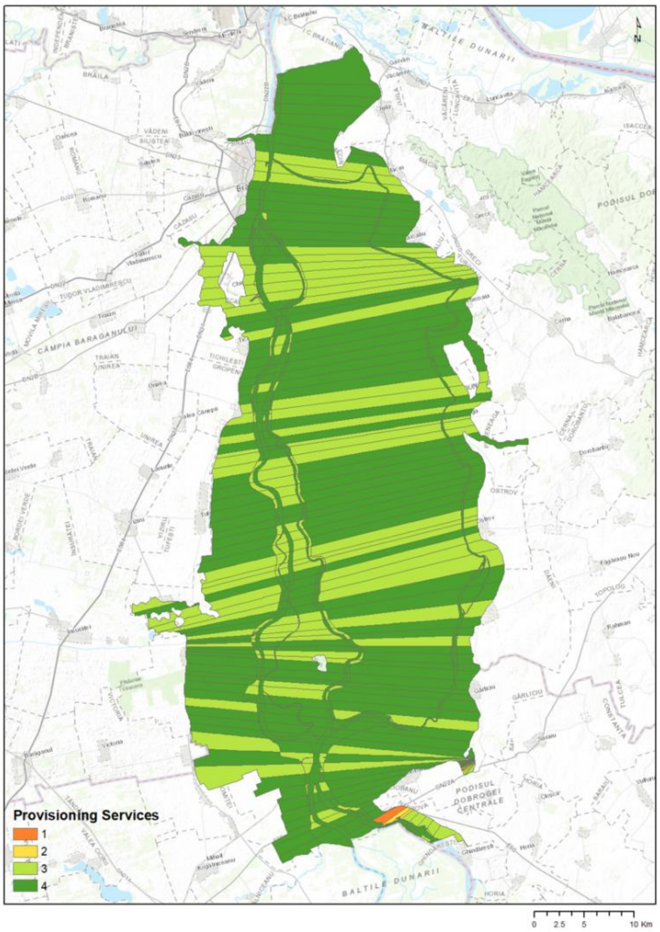


Figure 26: Availability of the provision ecosystem services assessment using the matrix approach in the Romanian pilot area

4.1.3.4. Integrity ecosystem services (Romania)

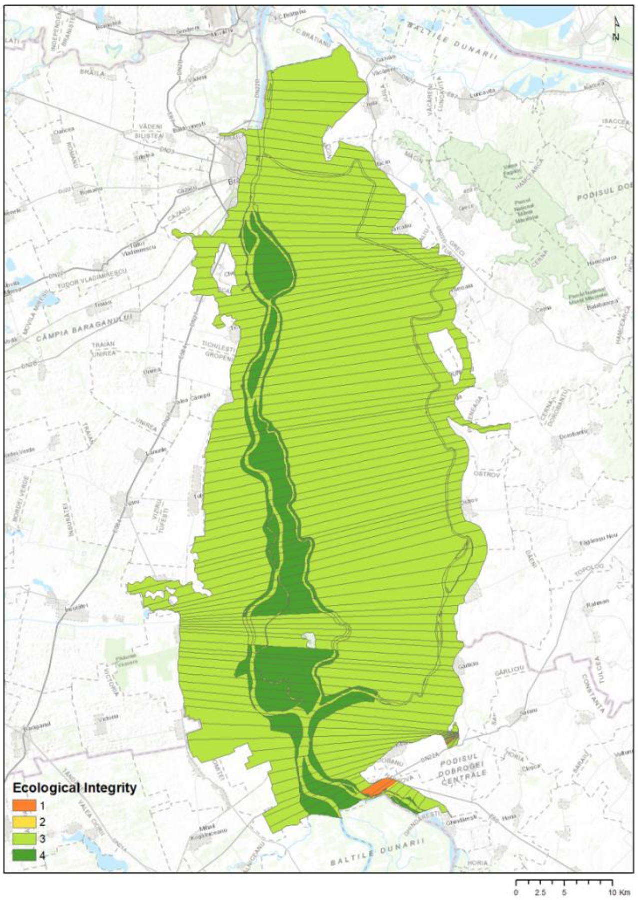


Figure 27: Availability of the integrity ecosystem services assessment using the matrix approach in the Romanian pilot area

4.1.4. Special Nature Reserve "Koviljsko-Petrovaradinski Rit" (Serbia)

4.1.4.1. Cultural Ecosystem services (Serbia)

Like in the case of Romania the matrix approach provides higher values as compared with the IDES approach, due to the differences in the values as provided by the local stakeholders.

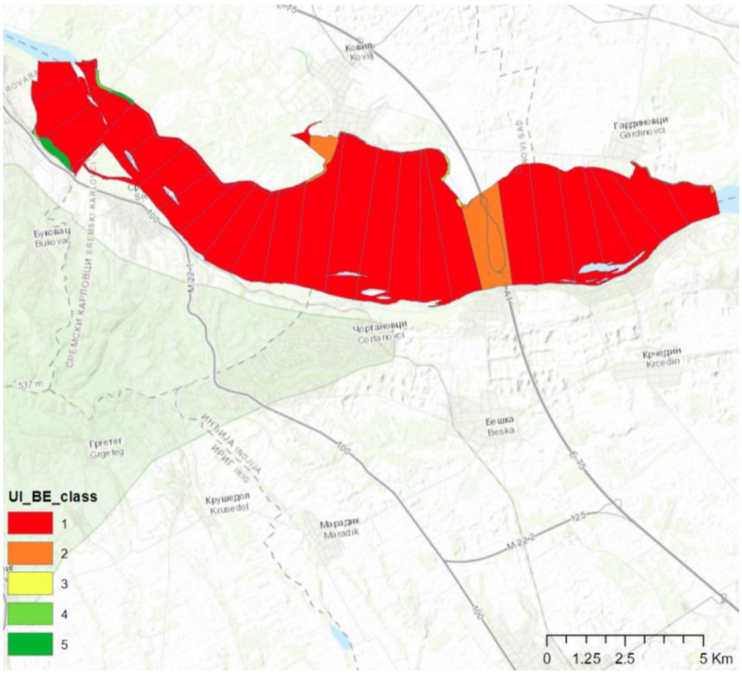


Figure 28: Availability of the cultural ecosystem services assessment using the IDES approach in the Serbian pilot area

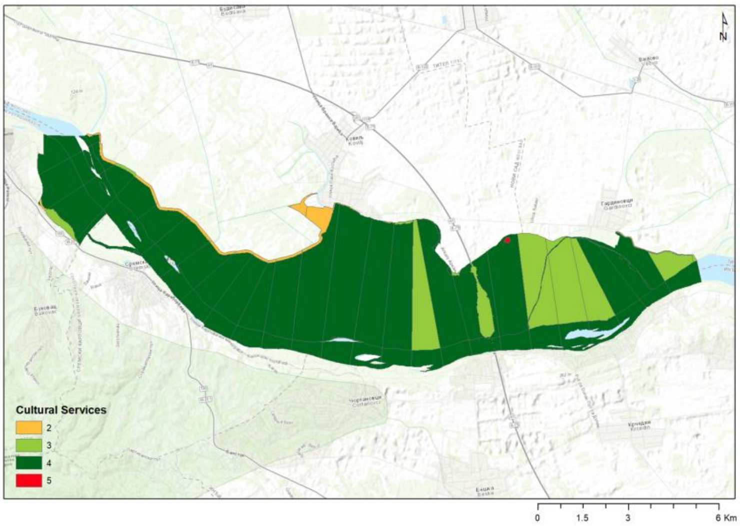


Figure 29: Availability of the cultural ecosystem services assessment using the matrix approach in the Serbian pilot area

4.1.4.2. Regulation ecosystem services (Serbia)

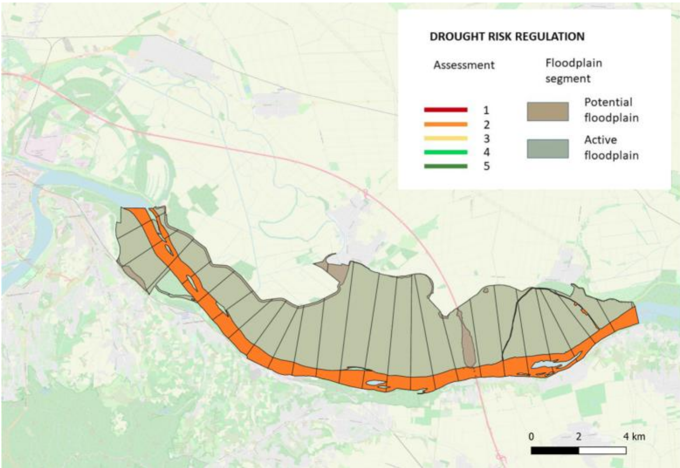


Figure 30: Availability of the drought risk regulation ecosystem services assessment using the IDES approach in the Serbian pilot area.

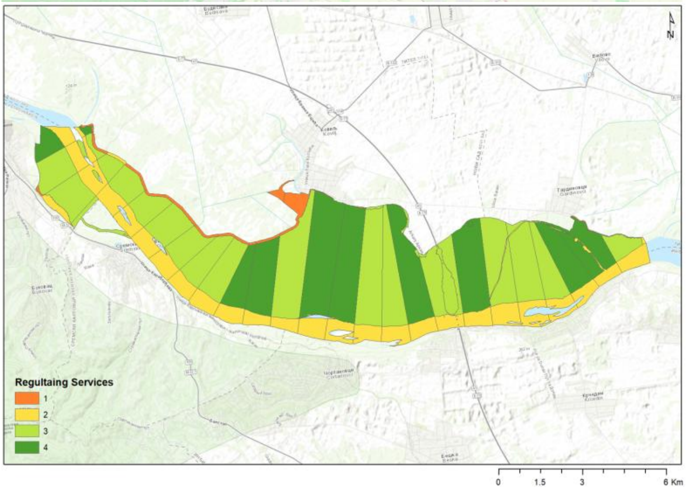


Figure 31: Availability of the regulating ecosystem services assessment using the matrix approach in the Serbian pilot area.

4.1.4.3. Provisioning ecosystem services (Serbia)

Only 2 classes could be differentiated (one with higher values characteristic for the higher grounds and the second one for the river itself).

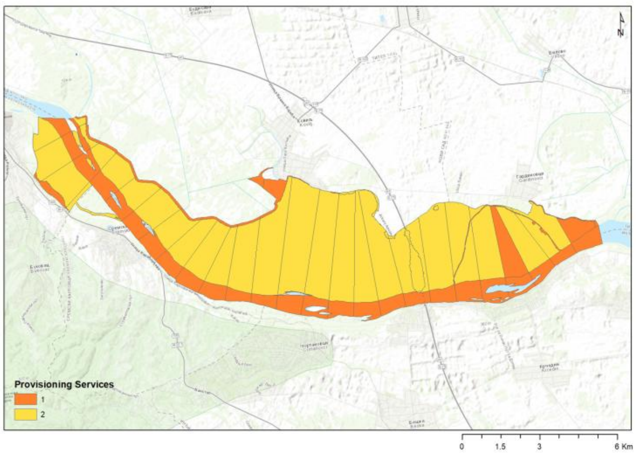


Figure 32: Availability of the provision ecosystem services assessment using the matrix approach in the Serbian pilot area.

4.1.4.4. Integrity ecosystem services (Serbia)

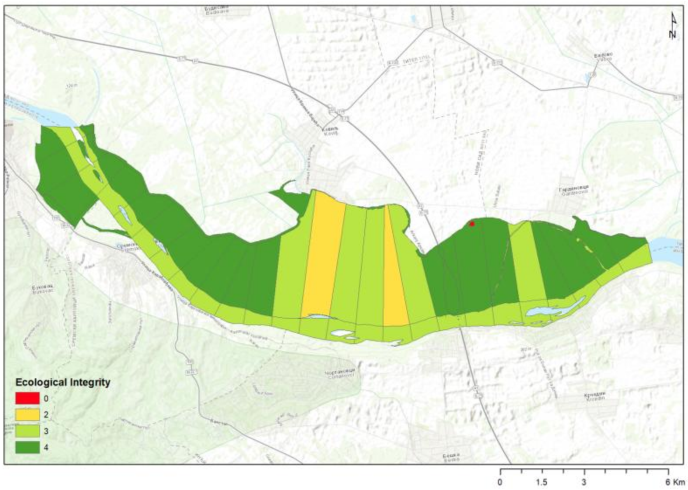


Figure 33: Availability of the integrity ecosystem services assessment using the matrix approach in the Serbian pilot area.

4.1.5. Mura River Kučnica Mura Petajnci – Gibina (Slovenia)

4.1.5.1. Cultural Ecosystem services (Slovenia)

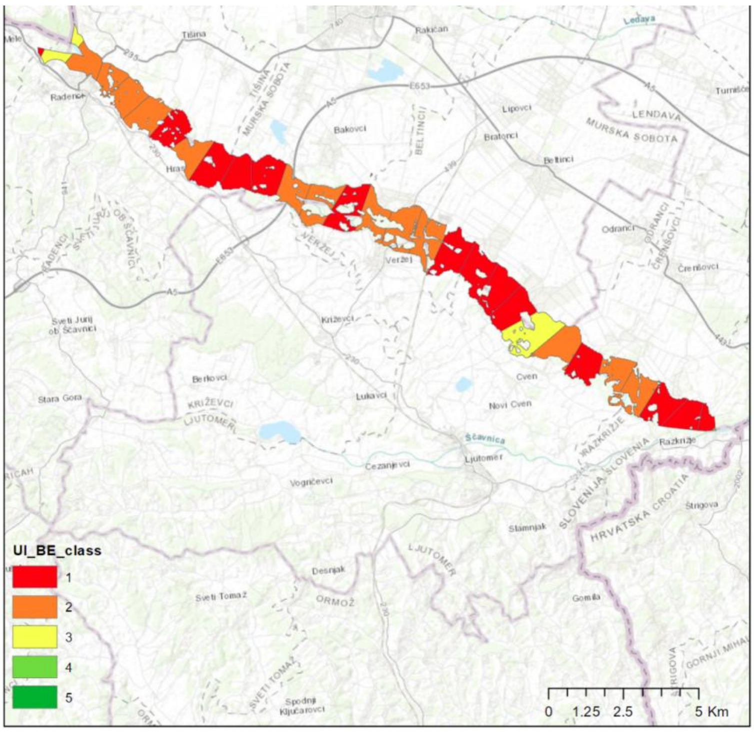


Figure 34: Availability of the cultural ecosystem services assessment using the IDES approach in the Sl ovenian pilot area.

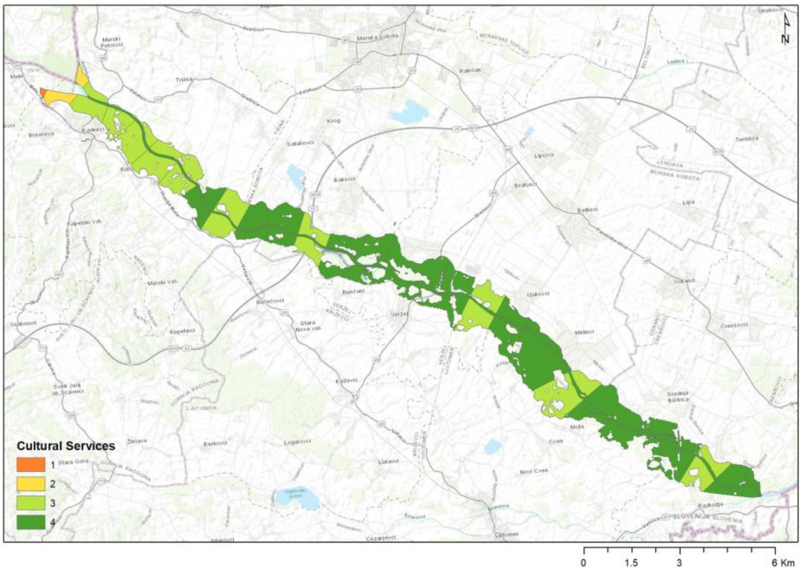


Figure 35: Availability of the cultural ecosystem services assessment using the matrix approach in the Slovenian pilot area

4.1.5.2. Regulation ecosystem services (Slovenia)

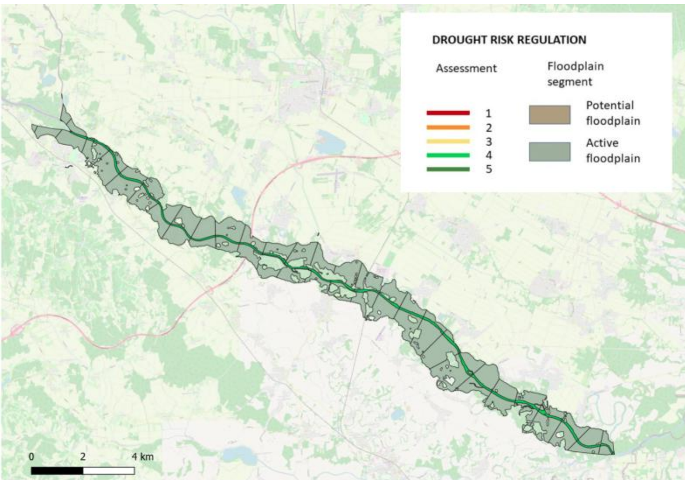


Figure 36: Availability of the drought risk regulation ecosystem services assessment using the IDES approach in the Slovenian pilot area.

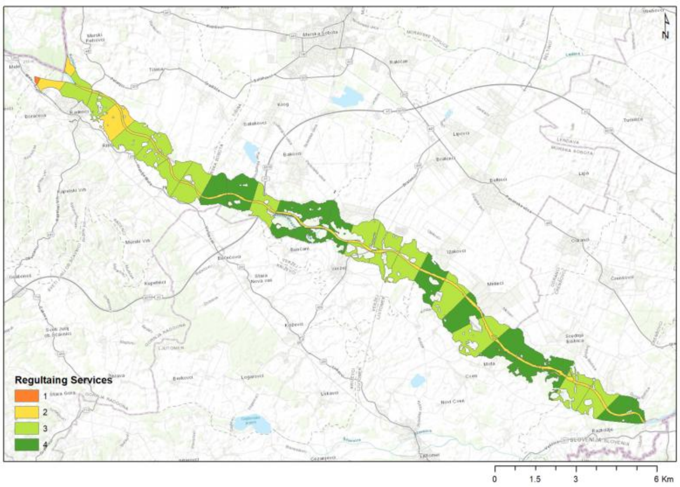


Figure 37: Availability of the regulating ecosystem services assessment using the matrix approach in the Slovenian pilot area.

4.1.5.3. Provisioning ecosystem services (Slovenia)

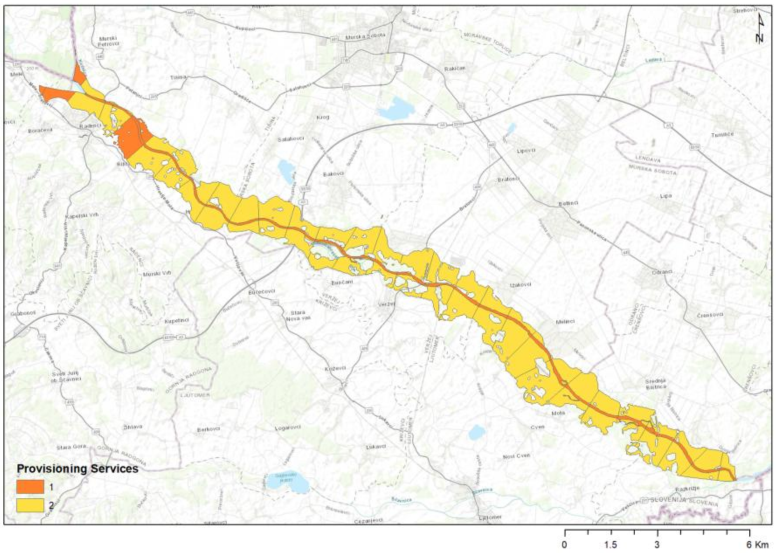


Figure 38: Availability of the provision ecosystem services assessment using the matrix approach in the Slovenian pilot area.

4.1.5.4. Integrity ecosystem services (Slovenia)

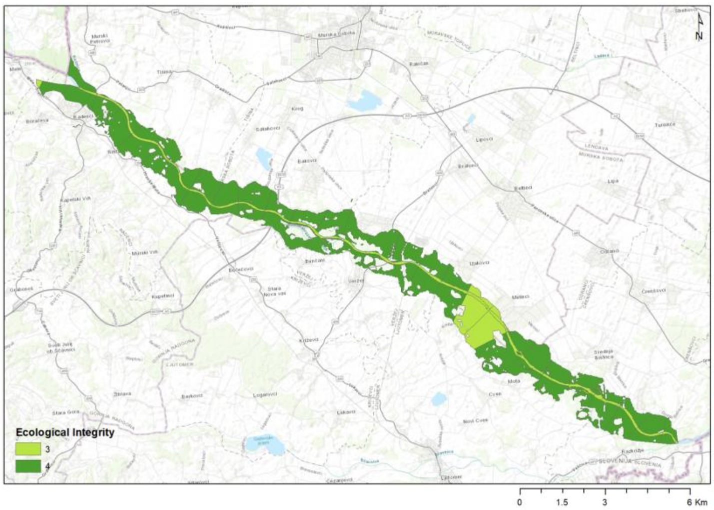


Figure 39: Availability of the integrity ecosystem services assessment using the matrix approach in the Slovenian pilot area.

4.2. Fuzzy cognitive maps and questionnaires

We have applied the FCM in all five pilot cases during the first IDES stakeholder workshop. This allowed us to identify how different stakeholders are related with the ES, what are the most common ESSs across pilot areas, but also what are the pressures and the measures different stakeholders envisage to improve the water quality in their areas.

In table 1 we are presenting 10 ecosystem services in the order of importance in different pilot areas (having the Austrian pilot data as a base line – we used the number of people attending the meetings to create a standard value) so that the results are allowing cross comparison.

Table 1. Cross site comparison (with AU as a base line) for the ES importance (using the centrality of the FCM models for each of the pilot areas.

Ecosystem service (ES)	AT	HU	RO	RS	SI
ESC_landscape aesthetic	11	9	8	10	7
ESC_nat. monuments	10	0	0	8	5
ESR_water purif.	9	0	0	0	8
ESR_habitat prov.	8	0	5	9	10
ESR_soil quality/ formation	7	0	0	0	0
ESC_res.&edu.	6	6	7	7	0
ESR_drought risk reg.	5	7	0	3	6
ESR_air pollution red.	4	0	5	6	7
ESC_non water-related act.	3	0	5	0	8
ESR_flood risk reg.	2	10	0	8	10
ESR_sediment reg.	1	3	0	0	0

The values have been standardised based on the number of people attending the meetings. For this table we only took into consideration the ES that common for each of the pilot areas. Besides this ES (common ones) in each of the pilot areas people are valuating also additional ecosystem services. For e.g. in Serbia beside the ES already presented (table 1) the stakeholders valued as well other ES (table 2) (biomass provisioning and symbolic significance).

Table 2. Identification of ES importance based on questionnaire and FCM Serbian pilot case

No	ES_short	place_Score Q	Place_FCM
2	ESR_habitat prov.	1	1
1	ESC_landscape aesthetic	2	2
8	ESP_biomass	3	3
3	ESC_nat. monuments	4	4
4	ESR_flood risk reg.	5	5
5	ESC_res.&edu.	6	6
6	ESC_water-related act.	7	7
10	ESR_drought risk reg.	8	8
7	ESR_air pollution red.	9	9
9	ESC_symbolic significance	10	10

We have used the questionnaires (Q) and the FCM as tools that have a different outcome in the sense that the questionnaires are based on individual thinking process, while the FCM is in fact the result of the collective co-learning process, as people were debating and agreeing on a hierarchy of ES, pressures and possible measures for increasing water quality.

Analysis of results shows some differences between the results from the Q vs FCM (like Austria and Hungary).

For Austria FCM values are higher than the Q values. Because the FCM was developed after the questionnaire we could say that a learning process occurred and that people listened to each other and took note of the different arguments. Another possible explanation is that the stakeholders that took part in the meeting and responded to the questionnaire have a very complex representation (they understand the multiple variables that are influencing the ES) that of their system (their pilot area).

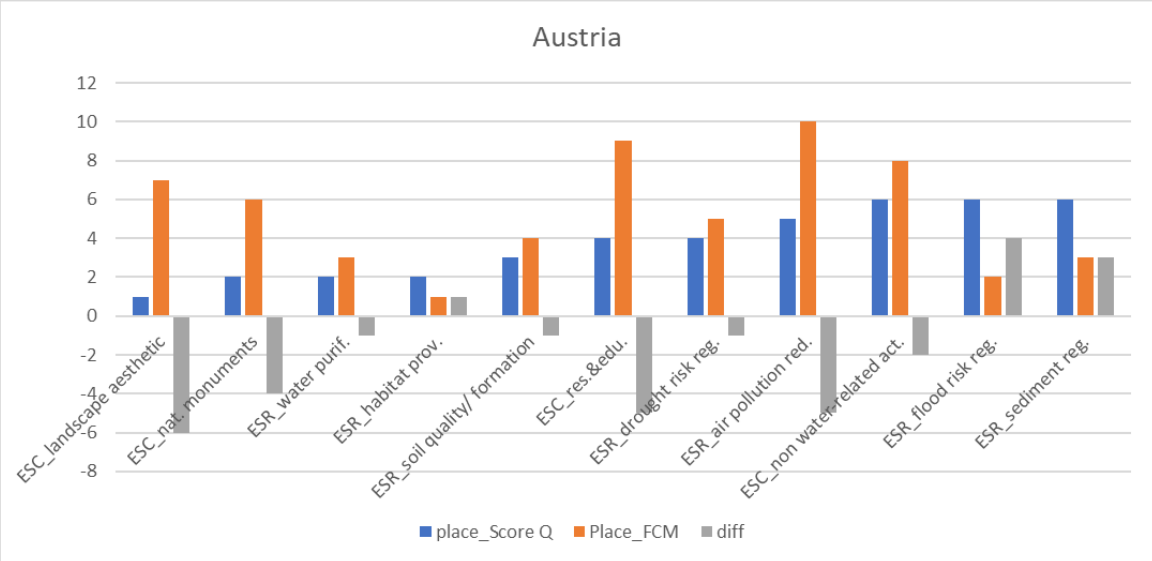


Figure 40: Values of the Q (standardised) and FCM (centrality) for Austria

In the case of Hungary, where the FCM values are lower than the Q values, it appears that the participants have strong beliefs (and as a result the learning process didn't change the results) on the ES and they do not necessary reach an agreement but kept their believes despite the opportunity given by the learning possibility offered by the FCM process.

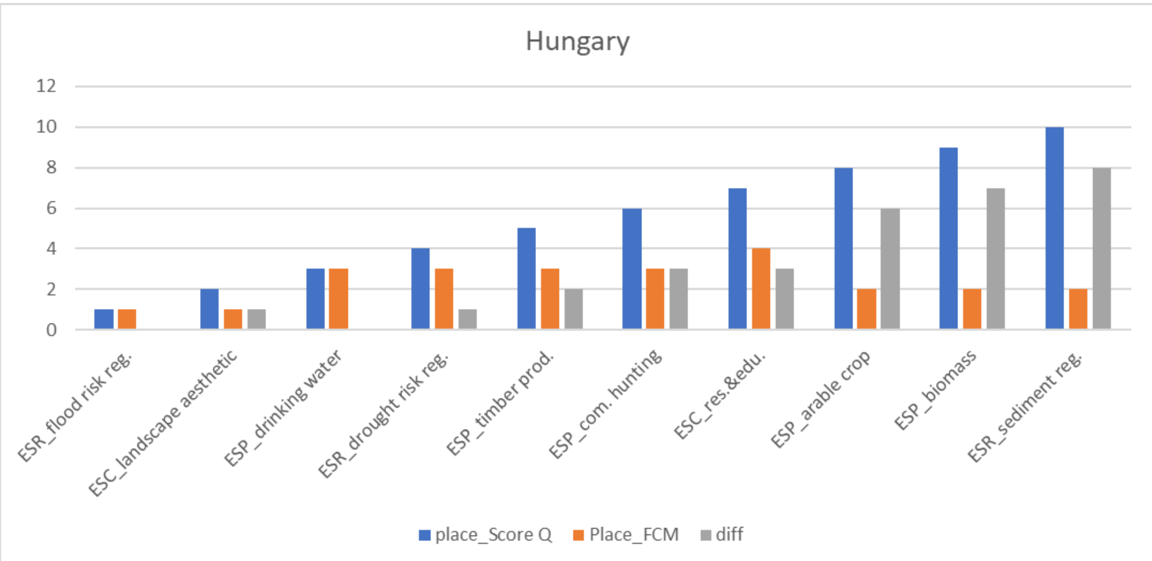


Figure 41: Values of the Q (standardised) and FCM (centrality) for Hungary

In other countries (Romania, Serbia, Slovenia) we did not observe any difference between the values of the Q and FCM (fig 42, 43, 44). Multiple explanations could be found for this from the lower know how about the ES up to a better understanding of how the ES are valued by the community or even lower debating stances of the stakeholders involved.

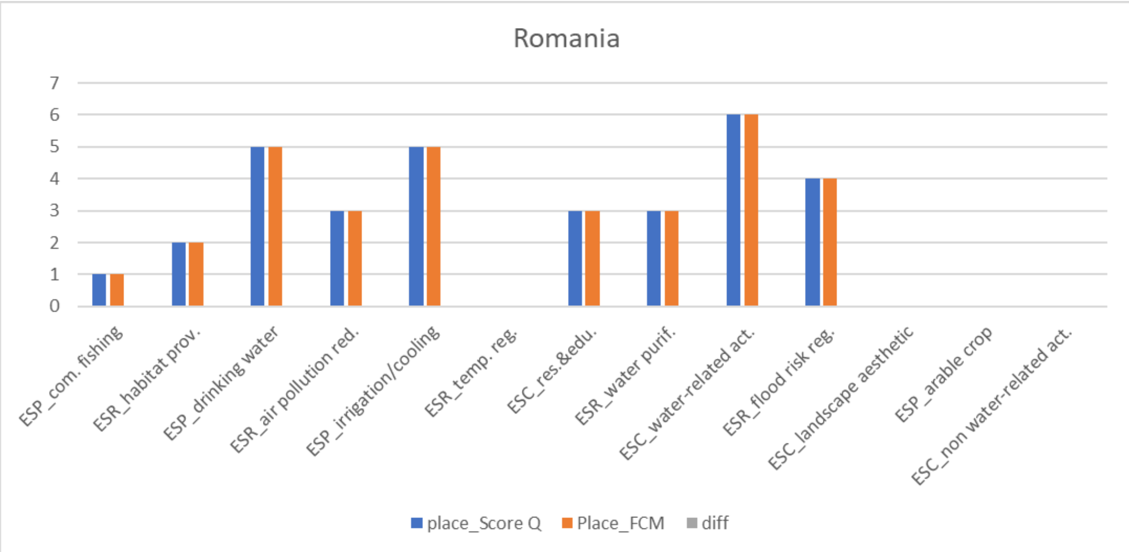


Figure 42: Values of the Q (standardised) and FCM (centrality) for Romania

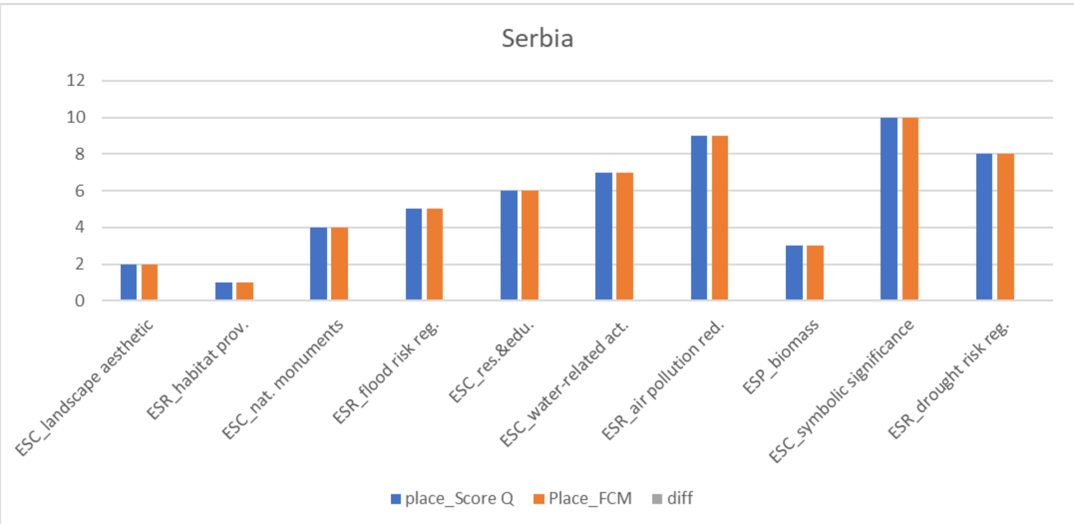


Figure 43: Values of the Q (standardised) and FCM (centrality) for Serbia

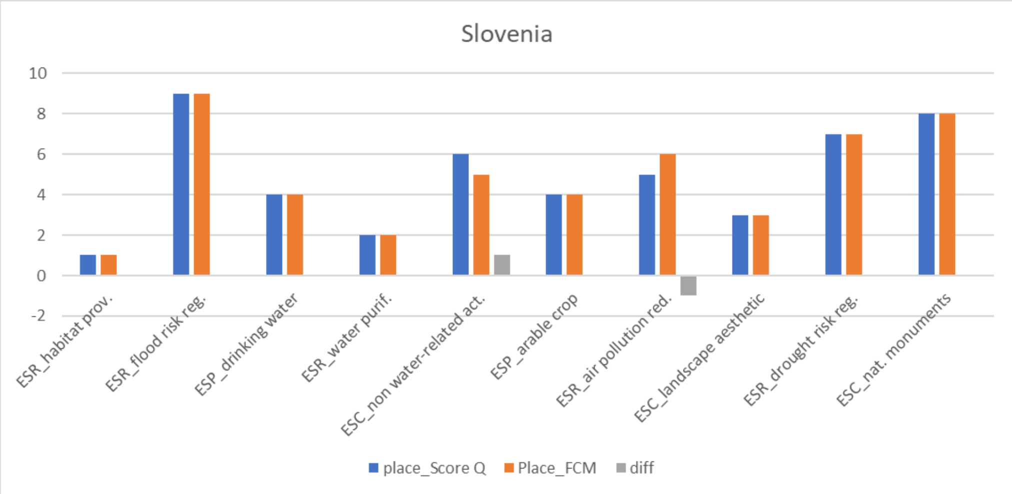


Figure 44: Values of the Q (standardised) and FCM (centrality) for Slovenia

A series of ES are characteristic to all of the pilot areas, for e.g. **Flood risk regulation** has been identified (a regulation ecosystem) in all of the pilot areas (Table 3). Other 5 ES (Landscape aesthetic, habitat prov., air pollution reduction, research and education and drought risk) have been identified in 4 of the five pilot areas. This are the "commonalities" the ES that stretch over the borders and case studies. Other seven (7) ES have been identified in separate country pointing towards the specificity of each of the pilot areas and the need to address them in specific management actions at the local or regional level after debates with local stakeholders (in co-created scenarios).

Table 3. Frequency of ES in pilot areas

Ecosystem service	Frequency	Countries
ESR_flood risk reg.	5	all
ESC_landscape aesthetic	4	except RO
ESR_habitat prov.	4	except HU
ESR_air pollution red.	4	except HU
ESC_res.&edu.	4	except SI
ESR_drought risk reg.	4	except RO
ESR_water purif.	3	SI, AT, RO
ESC_nat. monuments	3	AT, RS, SI
ESP_drinking water	3	HU, SI, RO
ESP_arable crop	2	SI&HU
ESR_sediment reg.	2	AT&HU
ESC_water-related act.	2	RO&RS
ESP_biomass	2	RS&HU

ESP_com. fishing	1	RO
ESR_soil quality/ formation	1	AT
ESP_timber prod.	1	HU
ESP_irrigation/cooling	1	RO
ESP_com. hunting	1	HU
ESC_non water-related act.	1	SI
ESC_symbolic significance	1	RS

4.3. Scenario development

Both qualitative and quantitative mathematical models have been used to predict to future trends (trend analysis) or pure and simple narratives, like the storylines that describe as best as possible the future.

In order to tackle uncertainties linked with future usually several alternatives are taken into consideration, in form of future scenarios. Usually, ecological scenarios are based on describing the initial situation, the key driving forces and the envisaged changes to describe a future situation. The scenarios were already used in some of the case studies selected by IDES as testing grounds for looking at the use of ESSs and their interplay with water quality. The Openness project (FP7 project) looked also at the use of ES and the trade-offs under different socio-ecological scenarios. Based on the results of the first stakeholder workshop we have used the FCM results to identify the pressures, the trade-offs among the ES and the measures proposed in each of the case-studies. We have then identified the trade-offs among the ES across the 5 case studies distributed across the Danube basin to construct 4 scenarios that are combining several measures in a logical way. A workflow was proposed that merged the Fuzzy Cognitive Models from each of the pilot areas into one single model for the entire Danube (figure 3). The most important measures were identified and then used to define the most frequent measures that were then integrated into 4 scenarios:

A) Nature based solutions

B) Grey solution

C) Hybrid solutions (NBS-Grey)

D) Business as usual

A) Nature Based Solutions: NBS are solutions that are inspired and supported by nature, are cost-effective, providing multiple environmental, social and economic benefits and at the same time improved resilience. As a result of the implementation of NBS biodiversity a range of ecosystem services will be improved. The NBS scenario is including a range of measures selected from the measures used by the stakeholders: a) Floodplain restoration; b) Restoration of longitudinal connectivity c) Habitat improvement; d) Use of autochthonous plants and trees (in case of forests); e) Establishment of buffer zones; f) Restoration of the natural flow regime

B) Grey solution scenario includes a series of 5 measures, as suggested by the stakeholders during the FCM session such as: a) Dyke relocation, slotting or dismantling; b) Construction or upgrades of wastewater treatment plants; c) Prevention or control of the adverse impacts of invasive species; d) Stocking; f) Flood risk reduction on agricultural land

C) Hybrid solutions (NBS-Grey) Is a combination of the NBS and Grey scenarios that actually is much closer to a reality than both the A and B scenarios.

D) Business as usual meaning that the activities in the floodplain will remain the same.

Conclusions

This output provides a description of the identification and prioritisation process of the ESSs in IDES pilot areas based on the stakeholder's inputs, implementation of the IDES tool and also of the FCM, aiming to highlight the status quo of the areas in terms of supply of ecosystem services for the benefits of the people.

Several methods have been used to prioritise the ES across different regions in the Danube Basin using pilot areas. The IDES approach has been applied in a *standardised* way across the Danube floodplain which represents a systematic difference to the application of the matrix approach (after Stoll). Using pilot areas, we worked with concreate spatial units, with real socio-ecological systems in a coordinated and standardized way across Danube floodplain in different countries.

The IDE approach is dependent on the available data, as it is much more data intensive as compared with the matrix approach. The added values of the IDES approach are the possibility to compare across the sites along the Danube floodplain based on data and not on the stakeholder’s views, the capacity to use the data to map and provide inputs to the decision makers in terms of support for restoration activities, and the possibility to identify the most important areas for restoration. The matrix approach (after Stoll), however, might have a higher value as a communication tool for local stakeholders.

The various concurring societal interests supporting navigation, hydropower, agriculture and nature conservation, tourism, flooding and nutrient and pollutants retention and the way in which society is dealing with these different interests are among the most important factors that hinder the implementation of existing strategies and visions aiming to improve water quality and quantity in the river basins and in particular in Danube River.

By using pilot areas for IDES tool implementation, we were able to co-create a conceptual framework (management options, ideas, values, visions) together with the local stakeholders the that facilitates a better harmonisation of the already mentioned concurring societal interest.

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