ISSN 2070-1292

danube news

International Association for Danube Research (IAD)

Photo: 'Novi Sad – Ramsar Wetland City, Nature Park 'Begečka Jama' – Two Common Kingfishers on a branch (Alcedo atthis). Credit: Nenad Mihajlović'

Content

Danube News No. 53

Remote sensing-based classification of river and floodplain vegetation types and FFH habitat types along three Danube tributaries

Isabell Becker[1], Gregory Egger[1, 2]

[1] *Karlsruhe Institute of Technology, Institute of Geography and Geoecology, Department of River and Wetland Ecology, Rastatt, Germany, isabell.becker@kit.edu, gregory.egger@kit.edu*

[2] *Naturraumplanung Egger, Klagenfurt, Austria, gregory.egger@naturraumplanung.at*

DOI: 10.5281/zenodo.19827226

Abstract

Riverine and floodplain habitat types listed under the European Habitats Directive are among the most threatened ecosystems in Germany. Their poor conservation status and regulatory requirements create an urgent need for restoration and efficient monitoring. Conventional field surveys are often limited by cost, time, and accessibility. This study presents 'Google4Habitat', a remote sensing tool implemented in Google Earth Engine for large-scale supervised vegetation classification using satellite and aerial data. Applied to multiple Danube catchment sites, results demonstrate its strong potential for habitat mapping, change detection, and restoration planning, despite limitations in species-specific differentiation.

Habitat classification in floodplains by remote-sensing techniques

Rivers and their floodplains belong to the most dynamic and biodiverse ecosystems in Central Europe, providing important ecosystem services such as flood retention, nutrient cycling, and habitat connectivity. At the same time, these systems are among the most threatened landscapes in Europe. Over the past centuries, river channelization, bank stabilization, hydropower production, and flood protection infrastructure have substantially altered natural hydromorphological processes and reduced the spatial extent and ecological integrity of floodplains (Ward et al. 1999; Tockner & Stanford, 2002; Nilsson et al. 2005).

To conserve remaining near-natural habitats, many riverine landscapes have been designated as protected areas within the European conservation network Natura 2000 under the EU Habitats Directive. Along the Danube corridor, 60% of the total area of 9985 km^2 are protected by law (Frank et al. 2025). Effective management of these areas requires up-to-date and spatially explicit information on the distribution and conservation status of habitats, particularly habitat types listed in Annex I of the directive. Such mapping must follow standardized criteria and be spatially precise to support monitoring and conservation planning.

Traditionally, habitat mapping relies on detailed field surveys conducted by experts. Although these surveys provide detailed and valuable ecological information, they are strongly dependent on seasonal vegetation development and often require access to remote or difficult terrain. Consequently, field mapping can be time-consuming and costly, especially in large and dynamic riverine landscapes.

Remote sensing approaches offer promising opportunities to complement field surveys by enabling large-scale, consistent observations of vegetation patterns and landscape structures (Pettorelli et al. 2014; Corbane et al. 2015). One recent development is the supervised classification tool Google4Habitat, which was developed and successfully applied in alpine environments to delineate habitat types using satellite imagery (Sentinel-2), orthophoto and environmental variables (Egger et al. 2024).

Within a project funded by the German Federal Environmental Foundation (DBU), this approach is currently being adapted to river floodplains (https://www.dbu.de/en/projektdatenbank/39546-01/). Methodological improvements include the integration of additional spectral indices such as the normalized difference water index (NDWI), a more detailed consideration of surface textures, and the possibility to restrict the temporal range of satellite imagery used for classification. These adjustments aim to better capture the dynamic vegetation patterns typical of floodplain ecosystems.

The improved methodology is currently being tested in several river landscapes across Germany. This article presents three study areas located within the Danube River catchment: the Litzauer Schleife on the Lech River, the Upper Isar between the Krün weir and the Sylvenstein reservoir, and the confluence of the Brigach and Breg rivers creating the Danube River in Donaueschingen *(fig. 1).*

Study sites

Here, we will present the vegetation maps for three study sites in the Danube River catchment (*fig. 1*).

Danube headwaters (confluence of the rivers Brigach and Breg)

The Danube River originates in Donaueschingen at the confluence of the Brigach and Breg rivers. Historically, both rivers were heavily modified there through channel straightening and morphological degradation, resulting in the loss of typical riverine habitats. In 2022, a large-scale restoration project was implemented to improve the ecological conditions of the confluence area (State of Baden-Württemberg, 2022; *fig. 2*). The study site includes the last 1.1 km of the Brigach River and about 2.3 km of the Breg River. After the confluence, the modeled Danube reach extends approximately 4 km. The mean discharge at the confluence is about 8.93 m^3 s^{-1} (Schneider et al. 2023).

Litzau Loop at the Lech River

The Litzau Loop represents the last free-flowing river section of the Bavarian Lech between the Forggensee reservoir

Figure 1. Location of the three study sites in the Danube River catchment analyzed in detail here, and all study sites of the DBU-funded project for which vegetation maps are being created using the Google4Habitat tool.

and its confluence with the Danube. The study area covers a river stretch of approximately 7.5 km south of Schongau, extending from the Dessau hydropower plant at river kilometer 140.0 to the backwater of the Dornau hydropower plant. It includes the characteristic 180° river meander known as the 'Litzauer Schleife' (*fig. 3*). The mean discharge of the Lech in this reach is 71.1 $m^3 s^{-1}$. However, since the construction of the Dessau hydropower plant in 1967, hydropeaking operations have caused pronounced daily discharge fluctuations between 10 $m^3 s^{-1}$ (minimum residual flow) and 160 $m^3 s^{-1}$ (maximum peak discharge) (Schneider et al. 2016). Because this section represents the last free-flowing reach within a chain of impoundments and still contains many habitats characteristic of the original Lech River landscape, it is considered of high conservation value. Additionally, in recent years several morphological restoration measures have been implemented along the riverbanks to mitigate the impacts of hydropeaking on juvenile fish habitats.

Upper Isar

The Upper Isar represents a typical Alpine river system and belongs to the river type 'Alpine and Alpine foreland rivers.' Upstream of the Sylvenstein Reservoir, the Upper Isar is con-

Figure 2. The confluence of the Brigach and Breg rivers in Donaueschingen was restored a few years ago. The area is dominated by reeds and willow thickets along the water's edge, with narrow strips of riparian forest adjacent to them (left). After the confluence, the newly formed Danube flows through a landscape dominated by grassland, bordered by willow shrubs and softwood riparian forest (right).

sidered the last larger near-natural braided river landscape in Germany. Despite several hydrological modifications including water diversion, its floodplains still belong to the most valuable conservation areas in the northern Alpine region (Binder et al. 2011; Juszczyk et al. 2020).

The study area is located in the upper course of the Isar between the Krün weir and the Sylvenstein Reservoir, which was completed in 1959. It comprises approximately 17 km of river channel and the adjacent floodplain (*fig. 4*). The hydrological regime of the Upper Isar is characteristic of Alpine rivers, with low discharge in winter and peak flows during summer due to snowmelt and precipitation (Speer, 1977). Downstream of the Krün weir, discharge is influenced by impoundment and water diversion. In the bypass reach, the Rißbachdüker gauge records a mean discharge (MQ) of 4.69 $m^3 s^{-1}$ (GKD Bayern, 2025).

Methods

For each study site a set of frequent and river-type-specific vegetation types was defined. These types were characterized based on habitat structure attributes, particularly the cover and height of the herb, shrub, and tree layers. Where possible, the defined vegetation types were assigned to corresponding biotope types and habitat types listed under the EU Habitats Directive (Annex I).

For the collection of reference data and their field verification, approximately 50 reference points per vegetation type were placed using high-resolution aerial imagery (e.g., Google Satellite) within the respective study area.

For each vegetation type, approximately 50 reference points were placed using high-resolution aerial imagery (e.g., Google Satellite) within the respective study site. For vegetation types occurring only in very small patches, 25 reference points were used. Each reference point was placed within a homogeneous vegetation covering a radius of approximately 10 m. This ensured that vegetation types could be clearly defined and distinguished even within the coarser spatial resolution of satellite imagery.

The predefined vegetation types and reference points were verified in the field. During field surveys, vegetation types were checked and adjusted if necessary to ensure that the classification scheme accurately reflected the vegetation conditions in the study areas.

In addition to field verification, the entire study area or selected representative sections were surveyed using a DJI Mavic 3 Multispectral UAV equipped with a multispectral camera

Figure 3. The Litzau Loop of the Bavarian Lech is a free-flowing river section located between two hydropower plants. The river development and vegetation succession at the valley bottom are near-natural and framed by the steep valley slopes with mixed forests.

Figure 4. The Upper Isar in the project area between the Krün Weir and the Sylvenstein Reservoir is a diversion channel but hosts one of the most natural vegetation types including endangered species like Myricaria germanica in the German alpine region.

and an RTK positioning module. The UAV flights produced both true-colour imagery and multispectral datasets. The aerial images were processed using the Structure-from-Motion (SfM) approach implemented in Agisoft Metashape. This workflow generated a georeferenced high-resolution orthophoto, a digital terrain model (DTM), and a digital surface model (DSM).

Vegetation types were classified using the Google4Habitat tool implemented in Google Earth Engine. The reference points for each vegetation type were characterized using the available input datasets, including drone imagery, orthophotos, and satellite data. The classification primarily relied on the spectral profiles of vegetation over the course of the year, derived from Sentinel-2 satellite imagery, as well as surface texture information. The following datasets were used as input variables: UAV imagery (1–3 cm spatial resolution, resampled to 1 m for segmentation), orthophotos (DOP20, 20 cm spatial resolution) and Sentinel-2 satellite imagery (10 m spatial resolution).

Additional environmental variables derived from the terrain models were also included, such as vegetation height classes, surface roughness, slope exposure, and elevation. The output of this classification step was a vegetation type map at the spatial resolution of the Sentinel-2 pixels.

To improve the spatial delineation of vegetation types, the orthophoto (resampled to 1 m resolution) was segmented into homogeneous surface structures based on texture using the i.segment tool in QGIS (version 3.40.10). The resulting segmented polygons were then intersected with the classified vegetation structure type map. Each polygon was assigned the vegetation type with the largest proportional coverage within the polygon. Adjacent polygons belonging to the same vegetation type were subsequently merged. This workflow resulted in a spatially refined and high-resolution vegetation type map for each study area.

Vegetation type map for the Danube headwaters

Today, only remnants of near-natural floodplain vegetation remain in the confluence area close to Donaueschingen, while managed forests, conifer plantations, and grassland dominate the surrounding landscape. Within the study area, eleven vegetation types were distinguished and categorized in the succession phases: (i) aquatic phase: water (FFH habitat type 3260), (ii) geomorphic phase: sand banks (3220), (iv) biogeomorphic phase: willow shrubs (3240), forbs and reed (6430), (v) ecologic phase: willow forest (with poplars; 91E0*) especially as gallery forest stripes along the running waters, black alder forest (91E0*), deciduous forests, and (vi) no succession phase (due to human influence no part of the natural succession): grassland, spruce mixed forest, agriculture and infrastructure.

The resulting vegetation map had a validation accuracy of 0.72 with a Cohen's kappa of 0.68 (*fig. 5*). There was only one *Alnus glutinosa* (Black alder) stand in the study site which was not very well classified whereas the water bodies and the grassland had very high classification accuracies.

Vegetation type map for the Litzau Loop at the Lech River

In the Lech study area, twelve vegetation types were distinguished and categorized in the succession phases: (i) aquatic phase: water (FFH habitat type 3220), (ii) geomorphic phase: gravel banks (3220), (iii) pioneer phase: pioneer vegetation (3220), (iv) biogeomorphic phase: Canarygrass (*Phalaris arundinaceae*) reed (6430), forbs and reed (6430), willow shrubs (3240), willow forest (3240), young spruce forest, (v) ecologic phase: grey alder forest (91E0*), and (vi) no succession phase: spruce forest, mixed hillside forest and extensive grassland.

The resulting vegetation map had a validation accuracy of 0.63 with a Cohen's kappa of 0.59 (*fig. 6*). Water and the two grassland types had very high classification accuracies (see *Table 2*) whereas there were misclassifications between the different forest types and between pioneer vegetation and the gravel banks.

Vegetation type map for the Upper Isar River

Within the Isar study area, 14 vegetation types were distinguished and categorized in the succession phases: (i) aquatic phase: water (FFH habitat type 3220), (ii) geomorphic phase: open dynamic bars (3220), (iii) pioneer phase: dynamic pioneer vegetation (3220), stable pioneer vegetation (3220), willow pioneer shrubs (3240), (iv) biogeomorphic phase: calcareous

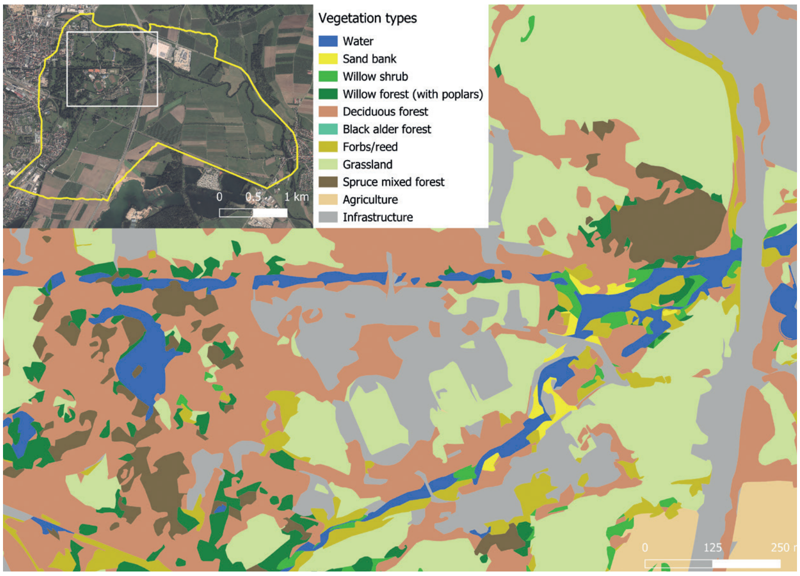

Figure 5. Vegetation type map created with the Google4Habitat tool in the Danube headwaters study site.

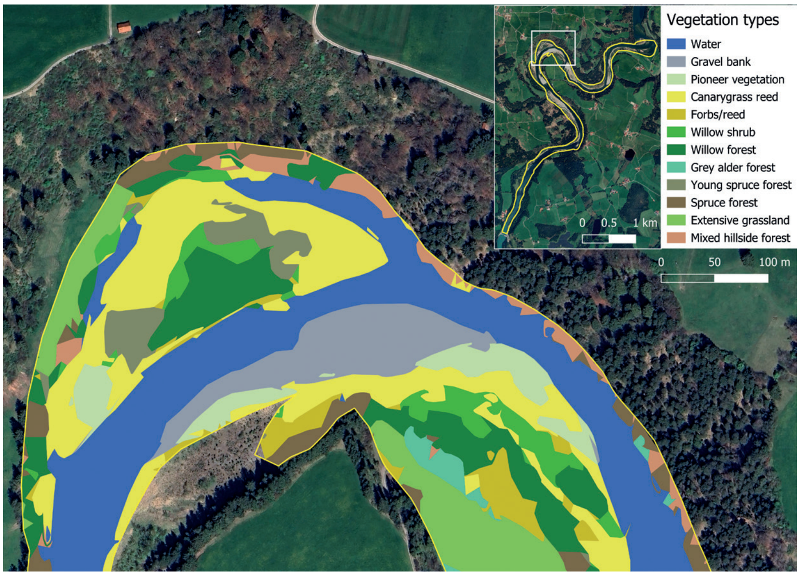

Figure 6. Vegetation type map created with the Google4Habitat tool in the Lech study site.

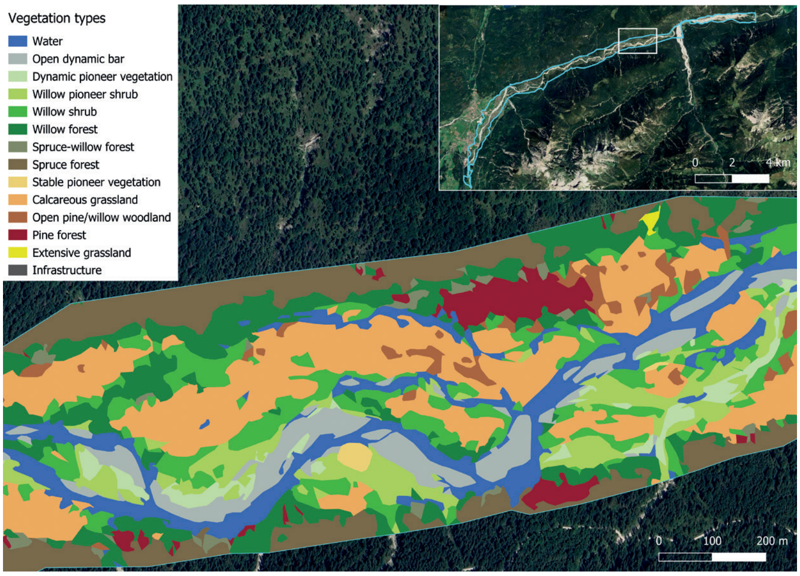

Figure 7. Vegetation map created with the Google4Habitat tool in the Isar study site.

grassland (6210), willow shrubs (3240), open pine/willow woodland, (v) ecologic phase: willow forest (3240 or 91E0*), spruce-willow forest (3240 or 91E0*), spruce forest, pine forest), and (vi) no succession phase: extensive grassland and infrastructure.

The resulting vegetation map had a validation accuracy of 0.69 with a Cohen's kappa of 0.62 (*fig. 7*). The vegetation types of water, open dynamic bar and the two grassland types were classified with very high accuracies of more than 82%. There were misclassifications between types with similar dominant tree species, such as willow shrubs with spruce-willow forests, and between calcareous grasslands, where pine trees grow sparsely, and pine forests.

Succession phases

To compare the three study areas from an ecologic perspective, the vegetation types in each area were categorised into succession phases according to Corenblit et al. (2007), and the proportions were compared (*Table 1*).

The area shares of the aquatic phase range from below 3% in the Danube study site to almost 50% on the Lech River. This is caused by the site conditions of the wide Danube valley and the narrow Lech valley with small natural floodplain expansion. The vegetation-free geomorphological phase and the pioneer phase were relatively small in all areas, but hardly present at all along the Danube, whereas they accounted for nearly 20% of the area along the Isar. The biogeomorphic phase covered about one quarter of the floodplain along the Isar and Lech River whereas on the Danube it was only 4%. The ecologic phase with stable habitat and vegetation conditions varied greatly between the study sites. Reasons are e.g. agricultural use of the area around the Danube which were no longer part of the natural succession and were categorized as belonging to no succession phase. On the Lech River, the steep valley slopes left no space for extensive floodplain forests. Along the Isar there are extensive riparian forests that are part of the ecological phase.

Discussion

The application of the Google4Habitat tool in different river floodplains demonstrated its considerable potential for semi-automated habitat mapping, while also highlighting several methodological limitations typical for remote sensing-based vegetation classification.

Succession phase	Area (ha)			Area (%)		
	Isar River	**Lech River**	**Danube confluence**	**Isar River**	**Lech River**	**Danube confluence**
aquatic	97.4	54.5	20.1	10.4	48.8	2.8
geomorphologic	91.5	4.4	0.8	9.8	3.9	0.1
pioneer	77.0	4.2	0.0	8.2	3.7	0.0
biogeomorphic	230.0	30.8	31.6	24.6	27.6	4.3
ecologic	366.8	1.2	115.0	39.2	1.1	15.8
no	17.4	16.7	560.7	1.9	14.9	77.0
sum	**935.0**	**111.7**	**728.2**	**100.0**	**100.0**	**100.0**

Table1. Succession phase areas and area shares in the three study sites.

However, the classification performance was not uniform across all vegetation types and study areas. One of the main challenges encountered during the classification process was the differentiation between structurally or spectrally similar vegetation types. For example, the separation of willow forest and grey alder forest proved difficult in some cases, e.g. at the Lech River (*Table 2*, vegetation types 2 and 11), because both vegetation types exhibit comparable canopy structures and similar spectral signatures in multispectral satellite imagery. Likewise, distinctions between willow forest and dense willow shrubland (*Table 2* vegetation types 10 and 11) were sometimes ambiguous due to their similar vegetation composition and structure. These difficulties reduce the overall accuracy of the supervised classification, even if the succession phases or species composition are comparable. Such classification difficulties are common in remote sensing-based vegetation

		Validation points (%)												
		0	1	2	3	4	5	6	7	8	9	10	11	CA
Training points	0: Young spruce forest	**43**	0	0	0	0	0	0	0	0	0	0	0	1
	1: Spruce forest	0	**74**	22	22	0	7	0	0	0	0	8	8	0.67
	2: Grey alder forest	0	0	**22**	11	0	7	0	0	0	0	0	0	0.5
	3: Mixed hillside forest	0	11	0	**44**	0	0	0	0	0	0	0	0	0.67
	4: Forbs/reed	29	0	0	0	**63**	0	0	10	0	0	8	8	0.63
	5: Extensive grassland	0	5	11	0	0	**86**	0	0	0	0	0	0	0.86
	6: Pioneer vegetation	0	0	0	0	0	0	**27**	5	33	0	0	0	0.43
	7: Phalaris arundinaceae reed	14	0	0	0	25	0	0	**86**	0	0	23	8	0.67
	8: Gravel bank	0	0	0	0	0	0	64	0	**67**	0	0	0	0.46
	9: Wasser	0	0	11	0	0	0	9	0	0	**100**	0	0	0.87
	10: Willow shrub	14	0	0	0	0	0	0	0	0	0	**23**	8	0.6
	11: Willow forest	0	11	33	22	13	0	0	0	0	0	38	**69**	0.39
	Sum (%)	100	100	100	100	100	100	100	100	100	100	100	100	
	PA	0.43	0.74	0.22	0.44	0.63	0.86	0.27	0.86	0.67	1	0.23	0.69	0.63

Table 2. Error matrix for the Lech River study site as percentage of the correctly identified validation points per vegetation type. CA: Consumer's accuracy, PA: Producer's accuracy.

mapping, particularly when species composition differs but structural properties and spectral reflectance remain similar (Pettorelli et al. 2014; Corbane et al. 2015).

Another factor influencing classification accuracy was the number of available training points. Vegetation types that occurred only in small patches often had fewer reference points available for training the supervised classification model. As a result, these classes tended to show lower classification accuracy compared to more widespread vegetation types with a larger number of training samples. This observation is consistent with findings from other supervised classification studies, which show that classification performance strongly depends on the representativeness and size of training datasets (Belgiu & Drăguț, 2016).

In addition, the current implementation of the tool performs best when the number of vegetation classes is limited. In practice, approximately fifteen classes could be differentiated reliably, whereas attempts to classify a larger number of vegetation types resulted in reduced accuracy. Furthermore, individual plant species cannot be directly detected using the applied multispectral satellite data. Species can only be inferred indirectly when they dominate a vegetation type and therefore determine its structural and spectral characteristics. An example is lavender willow (*Salix eleagnos*) shrub communities typical for dynamic gravel bars in northern Alpine rivers.

Despite these limitations, the results demonstrate that the Google4Habitat tool is highly suitable for the preliminary delineation of habitat types, particularly across large areas. Such pre-classification can substantially reduce the effort required for field surveys and improve the efficiency of habitat mapping campaigns. This is especially valuable in remote or difficult-to-access floodplain environments where traditional field mapping is time-consuming and logistically challenging. Similar benefits of remote sensing approaches for conservation monitoring have been reported in numerous studies (Turner et al. 2003; Pettorelli et al. 2014).

Ongoing methodological refinements indicate that the performance of the model can be further improved, particularly with regard to the differentiation of structurally similar vegetation types. Recent test applications in additional study areas, such as the Elbe floodplain, have demonstrated increased classification accuracy exceeding 80%. In these cases, the model was also able to reliably distinguish between ecologically relevant classes such as flowing and standing water bodies. These results suggest that, with continued optimization of input variables, training data, and classification parameters, the approach has strong potential to enable more detailed and robust habitat differentiation across diverse riverine landscapes.

Beyond habitat mapping, the derived vegetation maps can also support other environmental modelling applications. For example, in all three shown study sites the detailed vegetation maps are used to derive spatially differentiated surface roughness values. These values are subsequently integrated into existing hydrodynamic-numerical models (HN models), which previously relied on comparatively coarse vegetation information derived from land-use maps. The improved representation of vegetation-related roughness allows for more precise estimation of hydraulic resistance and water surface levels during flood events. Such improved model accuracy is particularly relevant for flood risk assessment and the design of flood protection measures. Previous studies have similarly highlighted the importance of detailed vegetation information for hydraulic modelling in river floodplains (Straatsma & Baptist, 2008; Vargas-Luna et al. 2015).

Overall, the results indicate that remote sensing-based tools such as Google4Habitat can provide an efficient and scalable approach for habitat mapping in riverine landscapes. When combined with targeted field verification and high-resolution UAV data, the method offers a promising pathway toward more cost-effective and spatially consistent monitoring of floodplain habitats.

References

Belgiu M, Drăguț L (2016): Random forest in remote sensing: A review of applications and future directions. ISPRS J Photogramm Remote Sens 114, 24-31

Binder W, Wagner A, Wagner I (2011): Flusslandschaft Isar im Wandel der Zeit. Bayerisches Landesamt für Umwelt, Augsburg

Corbane C, Alleaume S, Deshayes M, Tatoni T (2015): Remote sensing for mapping natural habitats and their conservation status. Ecol Indic 37, 255-268

Egger G, Preinstorfer S, Kollmann M, Becker I, Izquierdo-Verdiguier E, Paul M (2024): Google4Habitat – a novel method for remote sensing-based habitat classification using Google Earth Engine. Carinthia II 1(1), 8-28

European Commission (1992): Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive)

Frank G, Funk A, Becker I, Schneider E, Egger G (2025): The key role of floodplains in nature conservation: How to improve the current status of biodiversity? In: Bloesch J, Cyffka B, Hein T, Sandu C, Sommerwerk N (eds), The Danube River and the Western Black Sea Coast. Elsevier, 335-364.

GKD Bayern (2025): Hauptwerte Abfluss Pegel Rißbachdüker / Isar. https://www.gkd.bayern.de/de/fluesse/abfluss/isar/rissbachdueker-16001303/statistik

Juszczyk I, Egger G, Müller N, Reich M (2020): Auswirkungen der Ausleitung der oberen Isar auf die Auenvegetation. Auenmagazin 17, 28-37

Nilsson C, Reidy CA, Dynesius M, Revenga C (2005): Fragmentation and flow regulation of the world's large river systems. Science 308, 405-408

Pettorelli N, Laurance WF, O'Brien TG, Wegmann M, Nagendra H, Turner W (2014): Satellite remote sensing for applied ecologists: opportunities and challenges. J Appl Ecol 51, 839-848

Schneider M, Hägele T, Ortlepp J, Sattler S, Egger G (2023): Habitatmodellierungen für die ökologisch wirksame Umgestaltung der Donau am Zusammenfluss von Brigach und Breg. Projektbericht, Regierungspräsidium Freiburg, Stuttgart

Schneider M, Kopecki I, Kikillus A, Egger G (2016): Modelluntersuchungen zur Wiederherstellung einer morphologischen Basisdynamik in der Litzauer Schleife, Lech. Gutachten, Lebensraum Lechtal e V, Augsburg, Stuttgart

Straatsma MW, Baptist MJ (2008): Floodplain roughness parameterization using airborne laser scanning and spectral remote sensing. Remote Sens Environ 112, 1062-1080

Tockner K, Stanford JA (2002): Riverine flood plains: Present state and future trends. Environ Conserv 29, 308-330

Turner W, Spector S, Gardiner N, Fladeland M, Sterling E, Steininger M (2003): Remote sensing for biodiversity science and conservation. Trends Ecol Evol 18, 306-314

Vargas-Luna A, Crosato A, Uijttewaal WSJ (2015): Effects of vegetation on flow and sediment transport: Comparative analyses and modelling. Earth Surf Process Landf 40, 157-176

Ward JV, Tockner K, Arscott DB, Claret C (1999): Riverine landscape diversity. Freshw Biol 41, 1-18

Living Floodplains: an educational toolbox for understanding and restoring Danube Wetlands

Gabriela Costea[1], Tim Grandjean[2], Mihai-Cristian Adamescu[3]

[1] *Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB) Berlin, Germany, gabriela.costea@igb-berlin.de*

[2] *Archipelagos Institute of Marine Conservation (AIMC), Samos, Greece, e-mail: t.grandjean@archipelago.gr*

[3] *Research Center in Systems Ecology and Sustainability (RCSES), University of Bucharest, Romania, e-mail: mihaicristian.adamescu@g.unibuc.ro*

DOI: 10.5281/zenodo.19827434

Abstract

River floodplains and wetlands are among the most threatened ecosystems worldwide, despite being hotspots for biodiversity and providing essential ecosystem services. Their conservation and restoration depend not only on scientific expertise but also on public understanding of their key functions. However, in current environmental education, information about the structure and functioning of wetlands is poorly represented. The Living Floodplains Toolbox aims to address this gap with an innovative hybrid educational framework that translates wetland science into intuitive, emotionally engaging, and durable learning experiences for teenagers and beyond. By combining inquiry-based pedagogy with visual and participatory tools, the toolbox supports awareness, engages diverse audiences and contributes to strengthening stewardship for wetland restoration.

1 Introduction

River floodplains and wetlands are among the most dynamic and valuable ecosystems in the Danube Basin, yet they are also among the most threatened worldwide (Schindler et al. 2014). Through their natural interaction with rivers, they regulate water flows, store sediments and nutrients, support high water-dependent biodiversity, and provide essential ecosystem services such as water purification, flood mitigation, and climate regulation. They also play a key role in climate mitigation and adaptation, acting as carbon sinks, reducing flood risks, and increasing resilience to drought.

Despite their importance, many floodplains have been degraded or disconnected from rivers due to regulation, drainage, and land-use changes. While restoration efforts across the Danube Basin are increasing through Nature-based Solutions, their long-term success depends not only on technical measures but also on public understanding and engagement. However, knowledge of wetland functioning remains underrepresented in environmental education and is rarely communicated in accessible and engaging ways.

To address this gap, the Horizon Europe project Restore4Life has developed the Living Floodplains Toolbox, an innovative educational framework that translates wetland science into intuitive, interactive, and emotionally engaging learning experiences. As part of a broader restoration platform, the toolbox aims to support students, educators, and communities in understanding and contributing to the protection and restoration of resilient river landscapes.

2 Methodological approach – From scientific knowledge to educational design

The development of the Living Floodplains Toolbox followed a structured process combining scientific expertise, pedagogical design, and collaborative development. The objective was to translate complex knowledge on floodplain and wetland ecosystems into scientifically, engaging, and applicable educational resources across the Danube Basin.

The process began with a systematic review of existing educational resources related to rivers, wetlands, and aquatic ecosystems, conducted by project partners in their respective countries. This analysis covered more than 160 educational projects and initiatives across Europe and revealed important gaps. In particular, educational activities were found to be unevenly distributed across countries and languages, with limited emphasis on functional aspects of ecosystems, such as flood regulation, nutrient retention, ecosystem services, and climate relevance. Based on these findings, key thematic priorities and learning objectives for the toolbox were defined.

Building on this foundation, the toolbox was developed through a co-creation process involving scientists, educators, and communication specialists within the Restore4Life consortium. The pedagogical framework is based on the 5E Instructional Model (Engage–Explore–Explain–Elaborate–Evaluate), an inquiry-based approach grounded in constructivist learning theory (Bybee et al. 2006). This model structures learning as a progressive cycle, encouraging learners to actively explore phenomena, build explanations from observations, and apply knowledge to real-world environmental challenges.

The use of the 5E framework ensures a coherent alignment between scientific content and learning processes, supporting the development of inquiry skills, critical thinking, and long-term understanding. Research has shown that such approaches significantly enhance conceptual learning and student motivation compared with traditional teaching methods (Bybee 2014; Wilson et al. 2010; Seker & Köksal 2019).

In addition to the pedagogical structure, the methodological approach placed strong emphasis on accessibility, usability, and engagement. Scientific concepts were carefully translated into formats that support intuitive understanding, including visual, interactive, and participatory elements. The design process followed an iterative, user-oriented approach, integrating feedback from educators, students, and project partners to ensure relevance and adaptability in different educational and cultural contexts.

Furthermore, the methodology integrates experiential and participatory learning principles, enabling learners not only to acquire knowledge but also to reflect on environmental challenges, explore solutions, and engage with real-world restoration contexts.

Overall, the Living Floodplains Toolbox was conceived as a flexible and scalable educational framework, capable of supporting learning, awareness, and engagement in floodplain and wetland restoration across the Danube Basin and beyond.

3 Living Floodplains Toolbox components

The Living Floodplains Toolbox brings together a set of complementary educational components designed to support different learning styles and contexts. Together, they form an integrated framework that combines visual learning, inquiry-based teaching, access to existing knowledge, and participatory engagement.

3.1. Gamified interactive illustrations

A central entry point to each topic is provided by gamified interactive illustrations (*fig. 1*), that visually introduce key ecological processes and terminology in floodplains and wetlands. These illustrations translate complex concepts – such as flood dynamics, nutrient cycling, or habitat diversity – into intuitive visual narratives.

By allowing users to explore interconnected elements within a floodplain system, the illustrations foster curiosity and support a systems-level understanding of how natural processes and human activities interact. They are particularly effective for engaging younger audiences and non-specialists, while also serving as a starting point for deeper learning activities.

Topic	Learning focus	Authors	Access
Floodplain Living Environment	Introduction to floodplains as dynamic systems shaped by floods and low-water periods.	Gheorghiu, C.; Costea, G. (2025)	https://doi.org/10.5281/zenodo.17494367
Map Your Wetland	Citizen-science mapping of wetlands including vegetation, species, water quality, and land use.	Drešković, N.; Radulovic, S.; Djug, S. (2025)	https://doi.org/10.5281/zenodo.17476800
Exploring the Habitat of a Stream	Field-based assessment of river habitats and ecological quality.	Costea, G.; Pusch, M. (2025)	https://doi.org/10.5281/zenodo.17484378
Floodplains Like a Sponge	Understanding flood retention and the role of floodplains in reducing flood risks.	Mikuska, A.; Čerba, D. (2025)	https://doi.org/10.5281/zenodo.17472524
Climate Protection and Carbon Sink	Carbon storage in floodplain forests and soils and their role in climate mitigation.	Weigelhofer, G.; Feldbacher, E.; Rosenberger, C. (2025)	https://doi.org/10.5281/zenodo.17463283 (in floodplain forests) https://doi.org/10.5281/zenodo.17453839 (in soils)
Self-Purification Function	Natural filtration of water through sedimentation and nutrient uptake in wetlands.	Grabić, J.; Srđević, Z.; Costea, G. (2025)	https://doi.org/10.5281/zenodo.17474269
Treatment Wetlands	Constructed wetlands and nature-based wastewater treatment systems.	Ilić Paunić, M.; Srđević, Z.; Grabić, J.; Langergraber, G.; Schobert, J. (2025)	https://doi.org/10.5281/zenodo.17478432
Floodplain Aesthetics vs. Functions	Exploring perceptions of floodplains and their ecological functions.	Feldbacher, E.; Rosenberger, C.; Weigelhofer, G. (2025)	https://doi.org/10.5281/zenodo.17453699
Floodplains as Sources of Inspiration	Cultural and creative connections with floodplain ecosystems.	Miklósová, V. (2025)	https://doi.org/10.5281/zenodo.17478184
People and Aquatic Ecosystems	Human pressures on rivers and the role of Nature-based Solutions in restoration.	Costea, G.; Dinu, V.; Adamescu, M.C.; Pusch, M. (2025)	https://doi.org/10.5281/zenodo.17477839

Table 1. Overview of the ten Living FloodplainsToolbox topics, their developers, and corresponding Zenodo access links

Figure 1. Overview of the Living Floodplains Toolbox components: Gamified interactive illustrations, '5E' Teaching Materials and Repository of existing educational resources

3.2. '5E' Teaching Materials (Engage–Explore–Explain–Elaborate–Evaluate)

The core of the toolbox consists of teaching protocols and student worksheets (*fig.1*) structured according to the 5E model, supporting educators in implementing inquiry-based learning. Each thematic unit follows the five learning phases and provides clear guidance for facilitating exploration, discussion, and reflection.

The materials address key aspects of floodplain processes such as flood protection, nutrient retention, carbon sequestration, biodiversity support, ecosystem services, and restoration measures. Activities are designed to be flexible and can be used in classroom lessons, field visits, workshops, or environmental education programmes.

All materials are openly accessible via Zenodo, ensuring long-term availability and enabling users to download, use, readapt, and cite the resources. An overview of the ten *Living Floodplains* learning units and their contributors is provided in *Table 1*, together with references to the corresponding Zenodo entries.

3.3. Repository of existing educational resources

To complement the newly developed materials, the toolbox includes a repository (*fig.1*) of curated educational resources related to rivers, wetlands, and floodplains. The repository builds on the initial review of over 160 educational initiatives and provides users with access to a broad range of existing materials and approaches.

Accessible through the Wet-Edu platform, it functions as a reference base where educators and practitioners can explore additional teaching resources and gain inspiration for their own activities. In the longer term, the repository is intended to evolve into a dynamic knowledge hub, enriched through user contributions and feedback.

3.4. Complementary tools

To further enrich learning experiences and extend engagement beyond the core materials, the toolbox integrates a set of complementary digital and participatory tools that support interactive learning, stakeholder dialogue, and citizen involvement in wetland restoration.

The Blue-Green Space4All online game offers a scenario-based learning experience, in which users explore environmental challenges along the Danube and test solutions through decision-making processes. By linking actions to ecological outcomes, it helps users understand trade-offs and cause-and-effect relationships in ecosystem management. Its intuitive design makes it suitable for schools, workshops, and independent learning.

The Wetland Fresk provides a collaborative workshop format, in which participants use illustrated cards to reconstruct relationships among ecosystem services, human pressures, and restoration actions. This approach encourages systems thinking and facilitates dialogue among diverse stakeholder groups, and can be applied in educational, community, and professional contexts.

The Wetland4Life citizen science app connects learning with real-world engagement by enabling users to assess wetland conditions, map restoration opportunities, and collect standardised data valuable for researchers and practitioners. In this way, it supports both environmental education and practical contributions to restoration efforts.

Together, these components create a coherent and multilayered learning environment, enabling users not only to understand floodplain ecosystems but also to engage with their protection and restoration in meaningful ways.

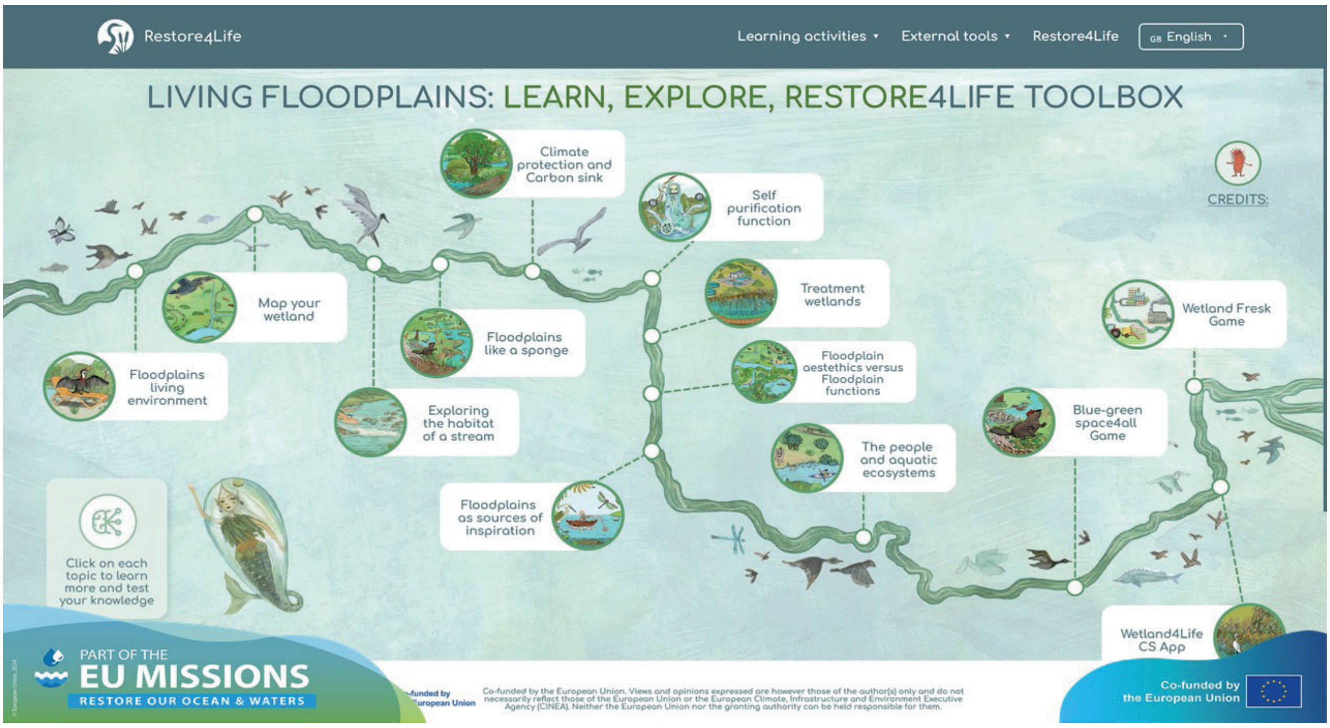

Figure 2. Overview of the 'Living Floodplains: Learn, Explore, Restore4Life Toolbox' dashboard showing all ten interactive topics distributed along the Danube River course (https://education.restore4life.eu/).

4. Implementation, accessibility and future outlook

The Living Floodplains Toolbox is designed for a broad and diverse audience, including students, teachers, environmental educators, NGOs, nature guides, and local communities. Its flexible structure allows application in both formal education settings (schools, universities) and non-formal contexts, such as workshops, training sessions, and community engagement activities. By combining visual, inquiry-based, and participatory approaches, the toolbox is accessible to both young learners and non-specialist audiences.

A key priority in its development is accessibility across the Danube Basin and beyond. The materials are hence being translated into multiple languages, with the interactive illustrations already available in eight languages in addition to English. Further translations of teaching materials and complementary tools are ongoing. This multilingual approach supports cross-border use and adaptation to diverse cultural and educational contexts:

The toolbox is implemented through a dedicated digital platform (https://education.restore4life.eu/) (*fig. 2*), providing a single access point to all components, including teaching materials, interactive illustrations, the resource repository, and complementary tools. It is actively promoted through teacher trainings, workshops, stakeholder events, and collaboration with networks such as the Danube Nature Guides and other educational initiatives.

Looking ahead, the toolbox is conceived as a living and evolving resource. Its modular structure allows the integration of new topics and learning units, while ongoing user feedback will support the further development of the platform into a dynamic knowledge hub. Strong emphasis is placed on creating synergies with other projects and initiatives, to foster knowledge exchange, joint activities, and wider dissemination.

Beyond the Danube Basin, the toolbox is designed to be scalable and transferable. It can be adapted to other river basins and educational contexts by integrating local data and examples while maintaining its core pedagogical framework. In this way, the Living Floodplains Toolbox contributes to strengthening environmental literacy and supporting long-term wetland restoration efforts across Europe and beyond.

Acknowledgment

The Living Floodplains Toolbox is part of a broader web platform for floodplain and wetland restoration developed within the Horizon Europe Danube Lighthouse project Restore4Life (grant agreement no. 101112736). We gratefully acknowledge the contributions of all project partners and collaborators involved in the development, translation, and dissemination of the toolbox.

References

Bybee, R. W. (2014). The BSCS 5E Instructional Model: Personal Reflections and Contemporary Implications. Science and Children, 51(8), 10–13.

Schindler S, Sebesvari Z, Damm C, Euller K, Mauerhofer V, Hermann A, Biró M, Essl F, Kanka R, Lauwars SG, Schulz-Zunkel C, van der Sluis T, Kropik M, Gasso V, Krug A, Pusch M, Zulka KP, Lazowski W, Hainz-Renetzeder C, Henle K, Wrbka T (2014): Multifunctionality of floodplain landscapes: relating management options to ecosystem services. Landscape Ecology 29: 229-244.

Seker, H., & Köksal, M. S. (2019). Effects of the 5E Learning Cycle Model on Science Achievement in Different Educational Levels: A Meta-Analysis. Education and Science, 44(197), 167–195. https://doi.org/10.15390/EB.2019.8085

Wilson, C. D., Taylor, J. A., Kowalski, S. M., & Carlson, J. (2010). The Relative Effects and Equity of Inquiry-Based and Commonplace Science Teaching on Students' Knowledge, Reasoning, and Argumentation. Journal of Research in Science Teaching, 47(3), 276–301.

Novi Sad – Ramsar Wetland City

Mirjana Budinčević[1], Jelena Moravski[1], Vanja Petković[1]

[1] City Administration for Environmental Protection, City of Novi Sad, Serbia
E-mail: mirjana.budincevic@uprava.novisad.rs

DOI: 10.5281/zenodo.19827434

Abstract

Novi Sad has been awarded the prestigious Ramsar 'Wetland City' accreditation, becoming the first city in Southeast Europe to receive this recognition (Ramsar Convention Secretariat, 2025). The title highlights the city's commitment to balancing urban development with wetland conservation, particularly in areas such as Kovilj–Petrovaradin Marsh and Begečka Jama. These ecosystems play a vital role in biodiversity protection, climate regulation, and flood resilience. The designation also opens new opportunities for education, sustainable tourism, and community engagement, positioning Novi Sad as a regional leader in nature-based urban development.

Novi Sad – Ramsar Wetland City

In January 2025, Novi Sad was awarded the prestigious international accreditation 'Ramsar Wetland City', becoming the first city in the Balkans and the wider Southeast European region to receive this significant recognition (Ramsar Convention Secretariat 2025). This title confirms that the city is developing in accordance with modern principles of sustainability, recognizing the exceptional value of its natural resources , particularly wetlands.

By obtaining the 'Wetland City' status, Novi Sad has been placed among cities that successfully balance urban development with nature conservation. This recognition indicates that the city not only protects its wetlands but also actively integrates them into development strategies, climate adaptation measures, and efforts to improve the quality of life of its citizens. Wetlands play a crucial role in climate regulation, flood protection, biodiversity conservation, and providing space for recreation and education – roles that Novi Sad both acknowledges and effectively implements in practice.

The 'Wetland City' accreditation was introduced in 2015 under the Ramsar Convention, an international agreement dedicated to the protection of wetlands of global importance. The main goal of this initiative is to encourage cities worldwide to develop urban systems that do not harm natural ecosystems, but instead preserve and enhance them (Ramsar Convention Secretariat 2015). To date, 74 cities around the

Figure 1. The Special Nature Reserve 'Kovilj-Petrovaradin Marsh' – Panoramic view. Credit: Nenad Mihajlović

Figure 2. The Special Nature Reserve 'Kovilj-Petrovaradin Marsh'. Credit: Nenad Mihajlović

Figure 3. The Special Nature Reserve 'Kovilj-Petrovaradin Marsh' – Black stork (Ciconia nigra). Credit: Nenad Mihajlović

Figure 4. Morning at The Special Nature Reserve 'Kovilj-Petrovaradin Marsh'. Credit: Nenad Mihajlović

world have been accredited, and Novi Sad is one of them. In Europe, it is among 15 cities holding this title, with nine located in France, and one each in Poland, Belgium, Spain, Switzerland, Hungary, and Serbia.

The accreditation covers significant natural areas within the territory of Novi Sad, most notably the Special Nature Reserve 'Kovilj-Petrovaradin Marsh' (*fig. 1–4*) and the Nature Park 'Begečka Jama' (*fig. 5–8*), along with other smaller wetland habitats that contribute to the overall ecological value of the area.

The Special Nature Reserve 'Kovilj-Petrovaradin Marsh' represents one of the most important wetland areas in Serbia. This complex of marsh, wetland, and forest ecosystems covers approximately 5,895 hectares in the floodplain of the middle Danube. It has been protected by the state since 1998 and is classified in the highest category of natural assets of exceptional importance (Lujić et al. 2017; Provincial Institute for Nature Protection 2015). The uniqueness of this reserve lies in the preservation of its natural features. The marsh includes diverse hydrological forms such as river islands, channels, meanders, and oxbow lakes, which together form a distinctive natural system. Plant communities are also highly diverse, ranging from floodplain forests to marshes, meadows, and reed beds, supporting the survival of a wide range of animal species. The fauna of this area is exceptionally rich, with birdlife being particularly prominent. A total of 172 bird species have been recorded in the reserve, of which 103 have the status of natural rarities. In addition, the marsh serves as a natural spawning ground for numerous fish species, including pike, sterlet, and carp, with a total of 46 fish species identified. These figures confirm that the reserve is one of the most important biodiversity centers in the region.

The Nature Park 'Begečka Jama' is located on the left bank of the Danube, near the settlement of Begeč, and extends across a floodplain area between Bačka Palanka and Novi Sad over a length of approximately 7.8 kilometers (Provincial Institute for Nature Protection 2022). This area is characterized by a remarkable diversity of geomorphological features shaped by river activity, resulting in a mosaic of different wetland habitats. These habitats exist at various stages of vegetation development, further enhancing their ecological value. The central feature of this park is Begečka Jama, a fluvial lake connected to the Danube via the Begej canal. Thanks to this connection, water is present throughout the year, enabling the survival of numerous plant and animal species. This area represents an important spawning ground for many Danube fish species, as well as a key breeding site for amphibians, thus playing a crucial role in preserving the biodiversity of the wider region. The biodiversity of Nature Park 'Begečka Jama' is reflected in the large number of species inhabiting it. A total of 125 taxa of higher plants have been recorded, along with around 150 bird species, 14 fish species, 11 amphibian species, 6 reptile species, and 18 insect species of national and international importance (Provincial Institute for Nature Protection 2022). This diversity indicates

Figure 5. Nature Park 'Begečka Jama' – Two Common kingfishers on a branch (Alcedo atthis). Credit: Nenad Mihajlović

Figure 6. Nature Park 'Begečka Jama' - Great white heron (Ardea alba). Credit: Nenad Mihajlović

Figure 7. Nature Park 'Begečka Jama' - Blue tit (Parus caeruleus). Credit: Nenad Mihajlović

Figure 8. Sunset at the Nature Park 'Begečka Jama'. Credit: Nenad Mihajlović

the well-preserved state of the ecosystem and its significance within Serbia's natural heritage. The area of 'Begečka Jama' was first placed under protection in 1999. Following a revision of its status, a new decision was adopted in 2022, expanding the protected area from 379.4 to 489.5 hectares, representing an important step toward its further protection and enhancement (Provincial Institute for Nature Protection 2022) .

The Importance of the Accreditation for Novi Sad

Obtaining the 'Ramsar Wetland City' accreditation opens new opportunities for the further development of Novi Sad. This status enables the city to strengthen its relationship with nature and improve cooperation among institutions, experts, and citizens in the field of environmental protection (Ramsar Convention Secretariat 2025). Raising public awareness about the value of wetlands, as well as actively involving citizens in planning and decision-making processes, is of particular importance.

Planned activities in the coming period include the establishment of educational and interpretation centers within wetland areas, the organization of guided tours for citizens and tourists, and educational programs for preschool and school children. Additionally, the city plans to mark important dates such as World Wetlands Day through various media and public events.

Wetlands represent one of Novi Sad's most valuable natural resources, and their protection requires continuous investment, a systematic approach, and cooperation among all relevant stakeholders. Their role in a modern urban environment is multifaceted – ranging from ecological and protective to social and economic. Through the concept of nature-based solutions, these areas gain a new dimension and importance in planning the future of cities.

Finally, this accreditation is not only a recognition for Novi Sad but also for Serbia as a whole. It demonstrates that it is possible to align economic development with nature conservation, and that a responsible approach to the environment can serve as a foundation for long-term progress and an improved quality of life for all citizens.

References

Lujić, J., et al. (2017). Ichthyofauna composition and population parameters of fish species in the Kovilj-Petrovaradin Marsh. Turkish Journal of Fisheries and Aquatic Sciences, 17(3), 489–497.

Ramsar Convention Secretariat. (2015). Wetland City Accreditation of the Ramsar Convention.

Ramsar Convention Secretariat. (2025). Wetland City Accreditation – Novi Sad.

Provincial Institute for Nature Protection. (2010). Study of protection: Kovilj-Petrovaradin Marsh. Novi Sad.

Provincial Institute for Nature Protection. (2015). Biodiversity of Kovilj-Petrovaradin Marsh. Novi Sad.

Provincial Institute for Nature Protection. (2022). Protection and management of Nature Park Begečka Jama. Novi Sad.

From 10 to 13 August 2026, the 46th IAD Conference will take place in Baja, Hungary, hosted by the Faculty of Water Sciences of the Ludovika University of Public Service. The central theme is: 'The socio-ecological future of the Danube: integrating riverine and terrestrial systems for a sustainable Danube.'

The Danube River Basin connects 19 countries and encompasses highly diverse aquatic, floodplain and terrestrial systems. Over decades, hydromorphological alterations, river regulation, hydropower development, land-use change and pollution have significantly reshaped ecological processes. Climate change further intensifies these pressures through rising temperatures, altered precipitation regimes and more frequent extreme events. The conference aims to promote integrated, science-based approaches to understanding and managing these interconnected systems.

The scientific programme focuses on five main topics:

1. Anthropogenically induced changes
2. Monitoring of aquatic species and habitats
3. Protected areas and biodiversity conservation
4. Climate change impacts
5. Integrated water management embracing riverine and terrestrial systems

Plenary lectures, thematic sessions and poster presentations will provide a platform for knowledge exchange and interdisciplinary dialogue. A full-day field excursion to the Gemenc floodplain will offer direct insight into river–floodplain interactions and ongoing restoration efforts along the Danube.

Researchers, PhD candidates and practitioners are warmly invited to submit abstracts related to the conference topics. Abstracts (1000–1500 characters, in English) should be submitted by 30 April 2026. The conference offers an excellent opportunity to present new scientific results, share monitoring experiences and contribute to shaping integrated, science-based solutions for the future of the Danube River Basin.

Official conference website:

http://iad2026.uni-nke.hu

Abstract submission and registration deadline: 30 April 2026.

ISSN 2070-1292

danube news

International Association for Danube Research (IAD)

International Association for Danube Research (IAD)

Presidium	**President** Prof. Dr. Bernd CYFFKA	**Vice President** Dr. Cristina SANDU	**General Secretary** PD Dr. Katrin TEUBNER

Member Country Representatives

DE Prof. Dr. Bernd CYFFKA	**CH** Dr. Edith DURISCH-KAISER	**AT** Dr. Gertrud HAIDVOGL	**CZ** Dr. Petr PARIL	**SK** Mag. Maroš KUBALA Prof. V. KOVÁČ (VNR)	**HU** Prof. Dr. Vera ISTVÁNOVICS	**HR** Prof. Dr. Melita MIHALJEVIC
SI Prof. Dr. Mateja GERM	**BA** N.N.	**RS** Dr. Snezana RADULOVIC	**RO** Dr. Albert SCRIECIU	**BG** Prof. Dr. Teodora TRICHKOVA	**MD** Prof. Dr. Ion TODERAS	**UA** Prof. Volodymyr YURYSHYNETS

Expert Groups

Habitat Monitoring & Conservation Dr. Dušanka CVIJANOVIĆ	**Water Quality** Prof. Dr. Carmen POSTOLACHE	**Hygienics / Microbiology** Prof. Dr. Alexander KIRSCHNER	**Phytoplankton / Phytobenthos** PD Dr. Katrin TEUBNER	**Macro-phytes** Prof. Dr. Georg JANAUER	**Fish Biology / Fishery** Dr. Mirjana LENHARDT	**Biotic processes** Prof. Dr. Thomas HEIN
Sediment Dynamics & Hydro-morphology Dr. Ronald PÖPPL	**Invasive Alien Species** Prof. Dr. Teodora TRICHKOVA	**Danube Delta** Dr. Julian NICHERSU Mag. Dragos BALAICAN	**Coastal Ecology** Dr. Markus G. WEINBAUER	**Danube River Education** Dr. Gabriela COSTEA	**Sustainable Development & Public Participation** Dr. Harald KUTZENBERGER Prof. Dr. Doru BĂNĂDUC	**LTSER & Environ-mental History** Dr. Gertrud HAIDVOGL Prof. Dr. Martin SCHMID

© EuroGeographics for the administrative boundaries, ICPDR for river network, Cartography: C. Pietsch, 2019, 2023

Catchment of the River Danube

General Secretary:

Int. Assoc. f. Danube Research
PD Dr. Katrin Teubner
University of Vienna
katrin.teubner@univie.ac.at

Editors:

Prof. Dr. Bernd Cyffka
CU Eichstätt-Ingolstadt
PD Dr. Gertrud Haidvogl
BOKU Vienna
Dr. Gabriela Costea
IGB Berlin
Prof. Dr. Dušanka Cvijanović
Faculty of Sciences, University of Novi Sad
contact e-mail:
gertrud.haidvogl@boku.ac.at

Layout:

Diener-Grafics
info@diener-grafics.ch

Printing:

Druckwerk24, Wolfgang Rückel
Nördliche Grünauer Str. 5 1/3
D-86633 Neuburg a.d. Donau