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A near-natural section of Ottheinrichbach, as a result of successful floodplain restoration, which was monitored in 2022 within the MONDAU II project. Photo: Tim Borgs, May 2022

Content

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Fostering Danube Sediment Restoration in the Danube River Basin – DANSER project

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The most international river basin worldwide, the Danube River Basin, encompasses a diverse social, historic, economic, and cultural heritage as well as a vibrant biodiversity: a mosaic of aquatic and terrestrial habitats, floodplains and ecotone areas shelter numerous species, many of them rare or endangered at European or global level.

Sediments represent a key environmental component supporting the aquatic biodiversity by playing multiple roles, from defining the shape of ecosystems, taking active part in the biogeochemical cycles of nutrients, influencing water quality or provisioning habitats for billions of organisms (e.g. bacteria, macrophytes, benthic invertebrates and fish) (Sandu et al., 2025). In addition, sediments are essential for multiple human activities such as water management, flood and coastal protection or navigation (Apitz, 2012).

Many European wetlands experience negative changes due to the substantial reduction of natural hydrodynamic conditions (Schindler et al., 2016). Increased sedimentation and long-term low water levels, driven by climate change and anthropogenic impacts, have been observed in many river systems, leading to a dramatic loss of biodiversity, especially among sensitive species dependent on habitat availability during high and low water levels (Poff et al., 1997). In the Danube River Basin, anthropogenic changes, including dam construction, gravel exploitation, channelization, embankments, dikes and land use change have significantly altered the sediment balance, affecting sediment input to the adjacent floodplains and downstream ecosystems and leading to various impacts, such as river incision downstream the dams, problems for navigation, coastal erosion and impaired biodiversity.

To address some of these issues and foster sustainable sediment management in the Danube River Basin, the DANSER project (DANube SEdiment Restoration: towards deployment and upscaling of sustainable sediment management across the Danube River Basin), running between 2025-2028 and funded by Horizon Europe program, aims to apply several innovative and holistic solutions in selected sites comprising inter alia mapping of fluvial processes, sediment transport modelling, sediment budget analysis, investigating river-side arms connectivity and river-groundwater dynamics as well as the complex interrelationships with biodiversity. The project builds upon extensive knowledge acquired from previous sediment related projects and initiatives (SIMONA, Danube Sediment), while creating synergies with ongoing projects (e.g.: SUNDANSE, iNNO SED, DanubeSediment_Q2) and aims to enhance its contribution to the EU Digital Twin and to the EU Mission 'Restore our Ocean and Waters'. It aims to foster understanding of mechanisms governing sediment processes in the investigated sites, to identify suitable measures to be applied at the local level for sustainable sediment management and to increase cooperation with local stakeholders to promote the implementation of selected measures (*fig.1*)

From a global policy perspective, the project will contribute to several UN Sustainable Development Goals, such as SDG6 – Clean Water and Sanitation, SDG11 - Sustainable Cities and Communities, SDG13 - Climate Action, SDG14 - Life Below Water, SDG15 - Life on Land and SDG17 - Partnerships for the Goals. From a European perspective, the project will contribute to the implementation of EU water, flood protection and biodiversity policies, in particular the Water Framework Directive, the Floods Directive, the Green Deal, the Nature Restoration Law and the EU Biodiversity Strategy 2030.

Three Innovative Action DEMOs form the backbone of the DANSER project, where each DEMO will include pilot (actual intervention, real action) and sibling sites (where know-how will be used for complementary activities). These DEMO areas are located in the Upper, Middle and Lower Danube and are briefly presented below.

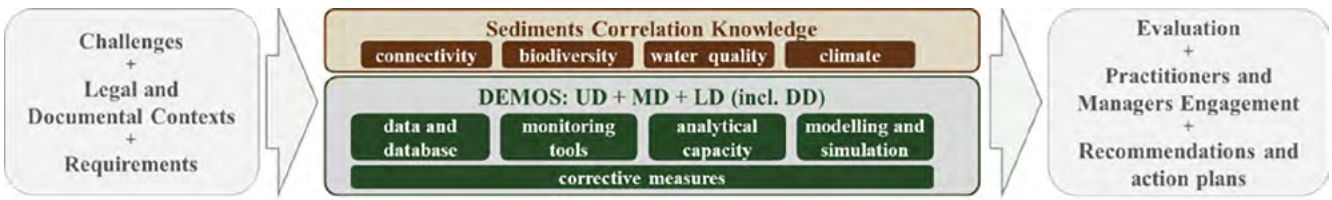

Figure 1. DANSER focus

Figure 2. Free-flowing section of the Danube (Donau-Auen Nationalpark) between Vienna and Bratislava (Photo: Nationalpark Donau-Auen/Kovacs, 2013)

DEMO activities in the Upper Danube

Location: National Park Donau-Auen, Wachau, Morava mouth, Traisen mouth

The Danube section between Vienna and Bratislava (*fig. 2*) is one of the few free-flowing river sections in the Upper Danube, hosting a high biodiversity. However, excessive downcutting of the main channel and aggradation of sediments in the floodplains are currently reducing the lateral connectivity between the main arm and floodplain waterbodies, accelerating the conversion of aquatic to terrestrial ecosystems. To stop this trend, different management strategies have been implemented over the past decades, such as side arm reconnection, optimised bedload management, and riprap removal. To create a holistic picture of the riverscape evolution, a multi-disciplinary approach will be followed by combining sedimentary archives analysis, spatio-temporal mapping, hydromorphological modelling, and hydrological and habitat-related connectivity models, to understand human interventions on river morphology, sediment dynamics and biodiversity on the local to regional scale.

The activities foreseen to be developed at these sites encompass:

- Establishing a best practice template for sustainable sediment management by characterisation and quantification of sediment dynamics and water level fluctuations as a function of hydro-geomorphic system change and human interventions beyond the times of direct observation.
- Regressive iterative (historical) mapping of the area between Vienna and Bratislava to reconstruct channel evolution at several points in time in response to human interventions (river channelization, hydropower plants, maintenance dredging for inland navigation, renaturation and removal of river-bank stabilization).
- Hydromorphological and sediment connectivity modelling
- Biodiversity analysis and correlation of endangered and indicator species, considering changes due to human interventions and connectivity changes, taking into account network approaches and establishing monitoring of indicator groups

DEMO activities in the Middle Danube

Location: Terezino Polje, Drava River; Kopački Rit Nature Park

The Drava River system is of great importance for the local community due to its geographic position and multiple ecosystem services provided. In the last decade, climate change, anthropogenic activities and ecological succession have influenced this area, changing its original conditions and affecting particularly the connectivity of wetlands and floodplains of this system with the main river and water source. To improve their reconnection, the sedimentation regime, water quality and biodiversity, the activities planned at these sites include:

- Monitoring of key habitat parameters (sedimentation/erosion, water/groundwater levels, water quality/quantity) and biodiversity
- Characterization of spatio-temporal changes and dynamics of the water connectivity between the river/canal bed and hydrological restoration works

- Use of nature-based solutions to improve wetland biodiversity, with a particular focus on fish and waterfowl species
- Enhance biodiversity protection and conservation by wetland ecosystem restoration and increased community involvement

The DANSER project will implement its DEMO activities at two pilot sites in the Middle Danube region: the Terezino Polje site along the Drava River in northern Croatia and the Kopački Rit Nature Park along the Danube River. A recent field survey of the Drava River's oxbow channel Gradac near Terezino Polje revealed that the channel has become inactive due to progressive sediment infilling, primarily as a result of long-standing hydrotechnical activities (*fig. 3*). Similarly, previous studies conducted in Kopački Rit have indicated increased sedimentation throughout the park, which could potentially have negative impacts on biodiversity as well as on tourism and local economic activities within the nature park. These findings confirm that such degradation processes are widespread and require systematic monitoring and management.

Effective monitoring and the development of management guidelines for these areas are essential, as past research has shown the cumulative impacts of human activity and climate change such as accelerated sedimentation in channels, reduction or alteration of water surfaces, long-term low water levels, excessive vegetation growth, loss of biodiversity, the spread of invasive species, and significant morphological changes – all contributing to the disruption of the ecosystem's natural balance.

Planned field activities include using a drilling rig for undisturbed sediment sampling, along with geophysical surveys – bathymetry, subbottom profiling, and LiDAR – complemented by biodiversity assessments. These advanced, non-invasive methods will provide a comprehensive understanding of current conditions. The project's innovation lies in combining these techniques with geological, hydromorphological, and ecological data, enhanced by numerical modelling and a real-time dashboard to support targeted restoration efforts. Communication and outreach will involve stakeholder engagement, educational dissemination, and visual documentation to ensure broad public awareness and participation.

DEMO activities in the Lower Danube

Location: Iron Gates, Belene Island, Friendship Bridge, Danube Delta

The activities planned at these sites comprise:

- Comprehensive overview of upstream land management and inventory of sediment resources to identify sustainable solutions for minimizing soil erosion
- Exploring different strategies for sediment replenishment to reduce the negative effects on biodiversity
- Investigating dam management strategies to facilitate the passage of sediments and monitor the restoration of affected habitats

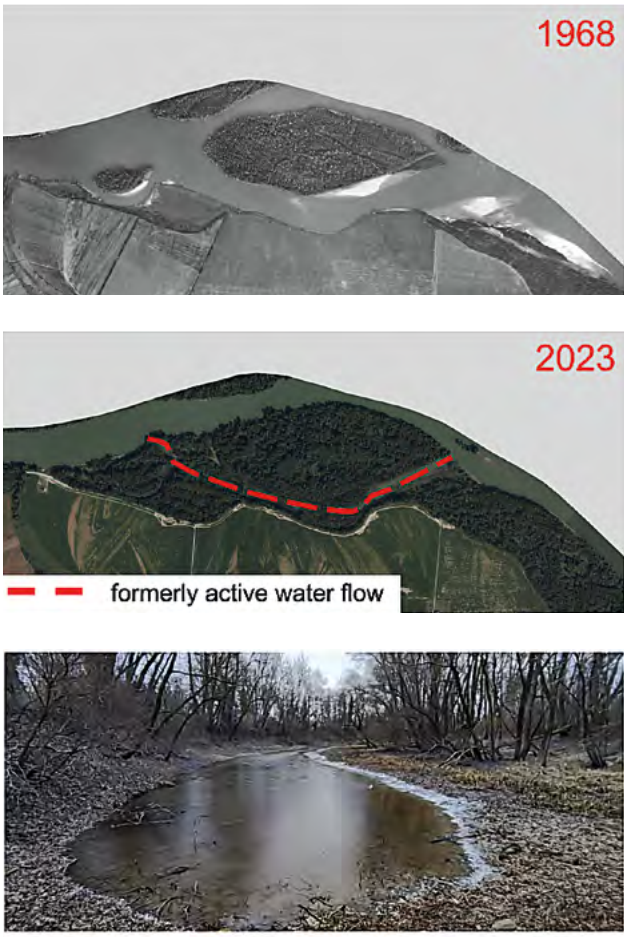

Figure 3. The previous and current state of the Gradac oxbow in Terezino Polje (adapted from Croatian Waters)

- Investigate the connectivity between surface water and groundwater to understand the water circulation pattern and sediment transport dynamics
- Improving the knowledge base regarding sediment management from multi-connectivity restoration works
- Foster community engagement for the implementation of sustainable sediment management measures.

DANSER innovative activities

DANSER's innovation package couples state-of-the-art science with hands-on river-basin governance, aiming that new datasets, model- or pilot actions feed into the decision-making process at the three Danube DEMO sites and their sister locations. Several novelty elements will be in focus, such as:

- Integrated riverscape 'time-machine': dated sediment cores, historical maps and LiDAR surveys will be combined to reconstruct more than a century of channel-floodplain evolution, highlighting connectivity break-points that need to be tackled by restoration activities.
- 3-D Site-evolution Models: drill-hole stratigraphy, geophysical sonar and UAV bathymetry are merged into interactive tools that managers can query in real time to test

different options such as cutoff reconnection or gravel replenishment.

- Basin-linked Hydro-morphodynamic Toolbox: physics-based and AI tools will be combined to facilitate planners in comparing restoration scenarios across all pilot and sibling sites quickly.
- Digital Sediment Portal & Citizen Observatory: web dashboards will emphasize monitoring data and model outputs, while a low-threshold Sediment Café app will provide the residents the possibility to upload water transparency readings that loop straight back into the models for quality-checked assessment.
- Transnational Sediment Task Force & Living Labs: practitioners, authorities and NGOs co-design measures in iterative workshops, fostering the implementation of Danube Sediment Management Guidance from paper to riverbank and aligning with the requirements of EU Nature Restoration Law.
- Nature-based Connectivity Solutions: side-arm reopening, floodplain lowering and bed-load replenishment are piloted in the Lower, Middle and Upper Danube, generating in-situ evidence that restored sediment regimes boost both biodiversity and climate resilience.
- Open-source Training Suite: micro-credential courses, hackathons and summer schools transfer the toolbox to young professionals, ensuring the know-how spreads beyond the consortium to water authorities and engineering consultancies.
- Data-rich link to the EU Digital Twin of the Ocean: harmonized datasets, uncertainty metadata and code containers are delivered through EMODnet nodes, standing ready for integration into Europe's wider ocean-river digital twin ecosystem.

Together, these activities will deliver ready-to-replicate blueprints for two additional European biogeographic regions and provide the knowledge backbone for a Danube Sediment Observatory that will continue informing Mission Ocean and regional RBP targets long after the project ends.

Communication activities

Effective communication is essential for ensuring the success and long-term impact of the DANSER project. A comprehensive and integrated communication strategy has been developed to disseminate project results, engage local communities, and foster collaboration among stakeholders across the Danube River Basin. The project will leverage a variety of channels and tools to ensure that its objectives reach and resonate with a wide range of audiences, such as:

- Branding and Communication Materials: DANSER will adopt an engaging and consistent branding strategy, including the production of printed and digital materials, tailored to local contexts and available in multiple languages. These materials will ensure that stakeholders at each site are well-informed and aligned with the project's goals.
- Project Website and Social Media: A dedicated website will serve as the central hub for all project-related information. It will feature comprehensive resources, including reports, research findings, and key documents, accessible to the public. In addition, DANSER will engage audiences through social media platforms like LinkedIn and Facebook, providing updates, sharing progress, and fostering online discussions with stakeholders, policymakers, and the general public.
- Publications and Scientific Outreach: DANSER will publish its findings in reputable peer-reviewed journals and sectoral magazines. Project results will also be presented at key conferences to ensure that the insights gained from the project are integrated into broader discussions on sediment restoration and environmental management.
- Public Events and Webinars will be central to the communication strategy, providing platforms for direct engagement with stakeholders, the wider public, and the scientific community. These forums will be designed to present results, exchange best practices, and discuss innovative solutions for sediment management across the Danube River Basin.
- Educational Outreach and Summer Schools: DANSER is committed to raising environmental awareness, particularly among young people. Educational materials, such as children's books and colouring books focused on sediment importance for the aquatic communities, will be made available online. These resources will offer an interactive and engaging way for younger audiences to learn about the importance of sediment restoration. Additionally, summer schools will be organized to educate students about sediment dynamics and biodiversity, fostering the next generation of experts in the field.
- Community and Stakeholder Engagement: A key element of DANSER's communication strategy is the establishment of a Community of Practice (CoP), bringing together stakeholders from various sectors – local communities, policy-makers, researchers, and environmental organizations – to share knowledge and experiences. The CoP will also support the development of collaborative solutions to sediment management and contribute to the broader objectives of the EU Mission 'Restore our Ocean and Waters'. Furthermore, citizen science initiatives will empower local communities to participate in water transparency monitoring through an easy-to-use app.
- Synergies with Parallel Projects: Collaboration is central to DANSER's approach. The project will work closely with other ongoing sediment-related initiatives, sharing knowledge, enhancing synergies, and amplifying the impact of its activities. DANSER will also contribute to the EU Digital

Figure 4. DEMO Pilot site in the Danube Delta

Twin of the Ocean initiative, supporting efforts to digitize and model sediment processes on a larger scale.

Key takeaway message

By placing sediment at the centre of river-basin planning, DANSER shows that restoring the Danube's 'moving bed' is not a niche technical exercise but a keystone for biodiversity, climate resilience and local prosperity. The three DEMO sites will illustrate how science-guided, community-owned measures can move whole reaches from diagnosis to action within a single project cycle. Key messages are briefly summarised below:

- What DANSER delivers on the ground: Pilot side-arm reopenings, gravel re-charges and floodplain lowering begin reestablishing natural transport corridors, cutting erosion hotspots and boosting habitat complexity. Early model runs point to a 10–15% drop in sediment deficit at the Iron Gates reach and measurable gains of in-stream diversity once replenishment starts in 2026.
- Broader impacts unlocked: Environmental: healthier flow of sediments that underpins endangered fish nurseries and riparian wetlands. Social: Living Labs and 'Sediment Café' workshops grow a basin-wide constituency of residents who can read turbidity trends and lobby for best practice. Economic: smoother navigation channels reduce dredging costs, while more resilient floodplains lower damage bills and open new eco-tourism niches.
- Scaling beyond the Danube: A suite of open-source tools, micro-credential courses and a repository of Key Exploitable Results will be packaged for at least six Associated Regions and two further EU biogeographic zones, fostering the Mission Ocean lighthouse knowledge transfer.

DANSER thus paves the way for the successful implementation of sustainable sediment practices: data-driven measures restore local sediment balance; visible benefits mobilize community and policy support; and the resulting know-how feeds Europe's Digital Twin of the Ocean, ensuring that the Danube system continues to act as a living laboratory for river restoration long after 2028.

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Monitoring the dynamisation of the Danube floodplains between Neuburg and Ingolstadt in Germany (MONDAU II)

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Abstract

The dynamisation measures in the Danube floodplain forest between Neuburg and Ingolstadt are among the most important floodplain restorations in Germany. Their short-term effects on aquatic and terrestrial habitats were scientifically monitored between 2009 and 2014 (5 species groups, abiotic parameters). In 2022, these studies were repeated for several parameters (hydrological and morphodynamic indicators, vegetation, molluscs, arthropods, fish) with funding from the German Federal Agency for Nature Conservation. The results indicate that even twelve years after the implementation of the measures, the ecosystem is still changing and diversifying due to the ongoing hydraulic dynamics. This change in river hydraulics resulted in a heterogenous river morphology, triggering different effects for individual species groups. The aquatic habitats continue to show greater changes than the terrestrial habitats, as was already the case in the investigations from 2009 to 2014. The repeat study resulted in a joint, spatially and temporally comparative evaluation of the monitoring data, which also generated findings that can be transferred to other nationwide projects on the dynamisation of highly degraded floodplains. The article emphasises the central role of a long-term monitoring in order to better understand floodplain ecosystems in their spatial and temporal changes and thus to be able to better manage them in the context of restoration.

MONDAU and the Danube floodplains – The Dynamisation Project

In one of the largest contiguous alluvial forests in southern Germany, along the straightened and dammed Danube between Neuburg and Ingolstadt, extensive dynamisation measures were completed in 2010 to permanently divert water into the alluvial forest even outside flood events. The aim was to induce more water level fluctuations and morphodynamics in order to preserve and promote the remaining habitat types despite the considerable disruption caused by the two barrages. The dynamisation measures consisted of three individual core measures (*fig. 1*):

1. Creation and design of the Ottheinrichbach, an 8 km long floodplain watercourse along former flood channels with different initial conditions (dry, stagnant, running and temporary watercourses). The Ottheinrichbach is fed dynamically with 1 to 5 m^3/s depending on the discharge in the Danube.
2. Ecological flooding, in which up to an additional 25 m^3/s can be discharged along the Ottheinrichbach into the floodplain in the event of higher Danube discharges (e.g. HQ1).
3. Groundwater lowering during low water in the Danube, so that the permanently high groundwater levels in the eastern area caused by the Ingolstadt barrage can be lowered during drought periods.

The first two measures were implemented by the Free State of Bavaria, represented by the Ingolstadt Water Management Office. Due to the nationwide significance and uniqueness of the project, the German Federal Agency for Nature Conservation also funded both the third measure and a monitoring programme with funds from the Federal Ministry for the Environment in a test and development project under the acronym MONDAU (Monitoring of the Danube Floodplains) (Cyffka et al. 2016). Both the Dynamisation Project and the comprehensive and balanced monitoring have led to the MONDAU project attracting a great deal of national and international attention, and since 2023 it has been considered a lighthouse project of the EU mission to protect our seas and oceans in the EU Horizon project DALIA.

MONDAU I and further investigations in the area

Before the measures were implemented, researchers from the Floodplain Institute Neuburg-Ingolstadt, which was founded at that time by the district of Neuburg-Schrobenhausen, and other universities carried out initial investigations in the area (Cyffka et al. 2016). From 2009, one year before the Ottheinrichbach was started, a research project with eight partners was launched under the acronym MONDAU, in which the short-term effects of the measures on abiotic (hydrological, hydromorphological) and biotic parameters (forest growth, vegetation, molluscs, birds, arthropods, fish) were jointly analysed (Stammel et al. 2012). The project generated in-depth knowledge of floodplain ecological processes, in particular on their management options in a dam-regulated environment, beyond the usual efficiency control. After the initial ecological flooding and groundwater lowering, MONDAU observed an improvement in hydrodynamics and an increase in typical floodplain species (Cyffka et al. 2016). However, there were clear differences between the species groups: mobile species such as fish or birds responded very quickly (within months) to the restoration, but less mobile

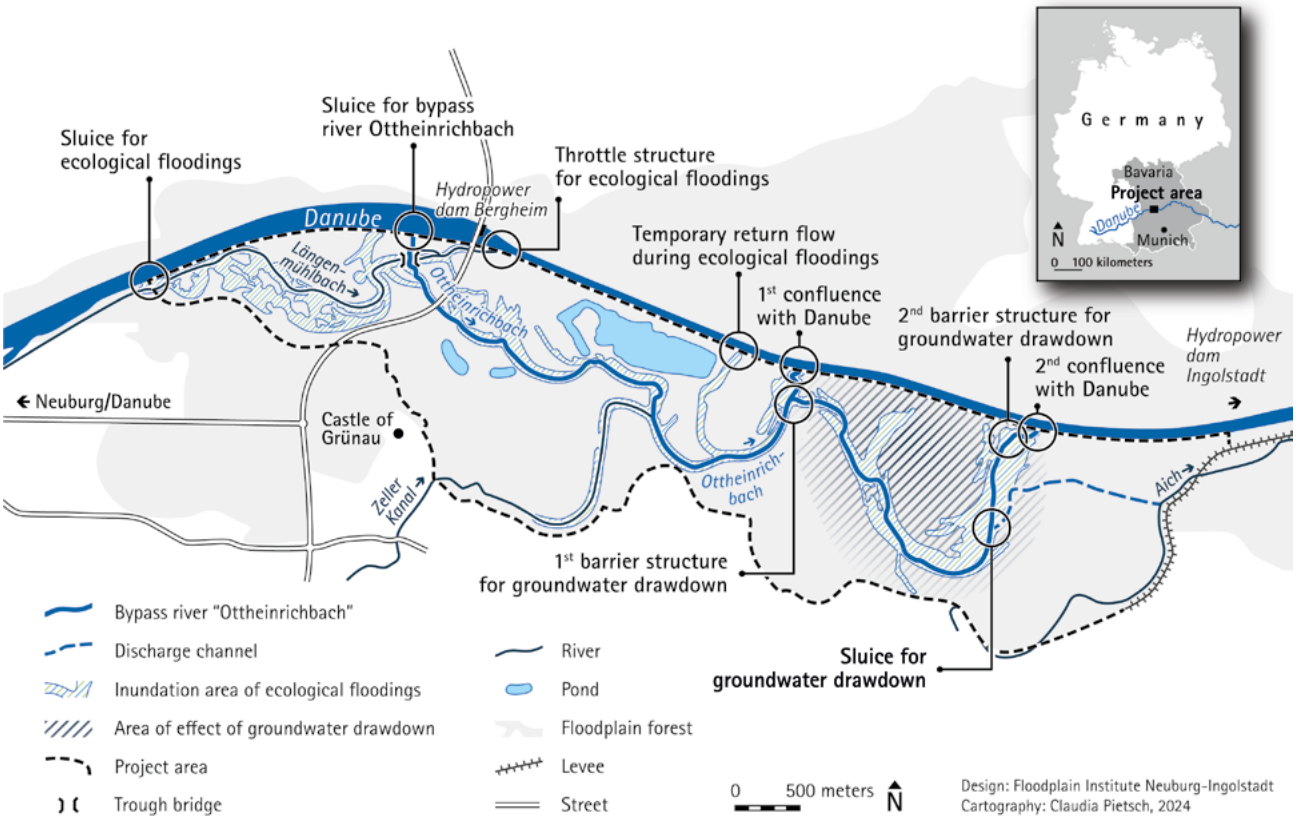

Figure 1. The location of the Dynamisation Project in Germany (small map) and the spatial impact of the measures (source: Aueninstitut Neuburg-Ingolstadt)

species groups such as molluscs also showed positive trends just two years after restoration. Plants reacted heterogeneously: while the vegetation of the water influenced sites responded quickly (within the first few years), the drier forest sites showed hardly any changes. Arthropods, on the other hand, initially reacted negatively to the restoration measures, but individual species groups began to recover in the first few years after the restoration.

MONDAU II – What is new and what has remained the same?

After 2014, the Aueninstitut Neuburg-Ingolstadt and the Technical University of Munich carried out further studies (e.g. Stammel et al. 2021, Pander et al. 2017). During this period, the development of the habitats was not only influenced by the dynamisation measures but above all by the warm and dry years 2014 and 2018 to 2020 and the large-scale ash dieback (*fig. 2*). Twelve years after the implementation of the measures, renewed funding from the Federal Agency for Nature Conservation provided the opportunity for MONDAU II to record the development after the initial phase with a joint study in 2022. In this way, the medium-term, hypothetically less dynamic development could be separated from the short-term effects of restoration. Experience from other projects shows that the initial positive effects of (construction) measures can disappear again after just a few years if there is a lack of hydraulic dynamics (e.g. Januschke et al. 2014). In principle, the study design used in MONDAU I was repeated. However, individual parameters (birds, tree species vitality) for which a very small change was expected were not surveyed again; for other parameters, the original survey effort was reduced (e.g. reduction of forest vegetation surveys due to revision of the stratification). The surveys were mostly carried out by new employees; in the case of arthropods and molluscs, continuity could not even be achieved at the level of research partners. For the studies on aquatic biodiversity, the monitoring of MONDAU I was carried out with the identical sample design and the same core team, resulting in a very high degree of consistency in data collection and analysis (Pander et al. 2024).

Results of the individual sub-projects

A comprehensive presentation of the results of MONDAU II can be found in the final report of the project, which is published in the publication series of the German Federal Agency for Nature Conservation (Stammel et al. 2025). The most important findings for the individual study objects are summarised as follows:

Abiotic site parameters: Since 2011, a total of 30 ecological floods with an average duration of 3.6 days have been carried out, but no flooding took place in the study year 2022 due to the low discharge of the Danube. This is probably one of the reasons why only minor erosion and accumulation processes were observed in MONDAU II compared to MONDAU I. In contrast, no changes in groundwater and discharge dynamics and the extent of flooded areas could

be documented during an ecological flood in 2023. Only the increased deadwood dynamics and the resulting backwater effects caused locally larger flooding in small areas. The investigations of soil moisture showed that the water content in the soil increases almost parallel to the water level during ecological flooding. In contrast, the uppermost soil layer (25 cm) does not appear to be directly affected by the runoff dynamics due to an interruption of the capillary rise.

Floodplain vegetation: Twelve years after restoration, the initial increase in species diversity in the aquatic and riparian vegetation had declined again, as some of the new species in MONDAU I did not establish permanently. The often-steep banks and the low morphodynamic processes provided hardly any dynamic areas for the germination and establishment of riparian plants. The few positive exceptions emphasise the need for more intensive flow dynamics and measures to create suitable site conditions, such as flattening the banks and adding gravel. The forest vegetation also showed a decline in the initial increase in species, but a greater differentiation along the analysed moisture gradient. In particular, the 2013 flood event led to a decline in species not adapted to floodplains and resulted in a change in the vegetation on the subsequently litter- and vegetation-free soils.

Floodplain fauna: The mean species numbers of molluscs had more or less returned to the pre-restoration level by 2022, while the mean numbers of individuals continued to increase significantly. Overall, a mollusc fauna dependent on higher humidity had established itself compared to the pre-restoration period – but still with clear differences to the species inventory of the surrounding more natural floodplains. After the initial decline, species numbers in the arthropod groups studied also returned to levels similar to those before re-dynamisation. The species composition in the various layers analysed (soil, shrub layer and canopy) changed considerably over the years, probably due to the changed conditions in the floodplain, but also to the respective weather conditions. However, with the exception of the dry year 2022, the diversity of beetles typical of floodplain forests was consistently positive, which can certainly be considered a success. The gravel banks further expanded the range of species studied and provide information on the quality of the riparian habitats of the Ottheinrichbach. With proper conservation management, these areas provide habitat for many species relevant to nature conservation, such as ground beetles.

Aquatic biodiversity: As in MONDAU I, the fish communities in the aquatic habitats of rivers, oxbow lakes or floodplain ponds continue to differ significantly from each other, and in general, in MONDAU II more fish were recorded across all age classes. The greatest changes in the fish community composition occurred in the rivers and narrow oxbow lakes of the Ottheinrichbach. Only one new fish species, the invasive blackmouth goby, could be detected in the project area. Individual species such as the rheophilicbarbel have increased in number overall size classes and now comprise a fully established

Figure 2. Impressions of changes over time – 30 ecological floods have passed through the study area since 2010 (cf. upper left photo); in some places the water level is so high that the trees in former alluvial forest areas have died (cf. upper right photo, middle part); a lot of deadwood has been introduced into the Ottheinrichbach (cf. lower left photo, and photo on title page), particularly as a result of the ash dieback, which has a strong impact on the morphodynamic development and the habitats in the watercourse.

population after twelve years. Rare species, such as the *Zingel streber,* were caught with significantly more individuals and age classes, indicating a longer period needed for colonisation by these specialised species (Pander et al. 2024).

Despite the different development of the individual species groups, the joint evaluation of the results of the sub-projects showed the ongoing change of the ecosystem and the dwindling influence of the hydrological initial conditions prior to the restoration (formerly dry, standing, running or temporary floodplain waters). Even though the total number of species and the Red List species of most species' groups (*fig. 3*) decreased significantly, the typical floodplain species increased, and a greater moisture gradient developed. In particular, the increased productivity, expressed by the number of individuals (molluscs, arthropods, fish), was attributed to the changed hydrological conditions. The dynamisation measures together with the natural flooding caused a moderate change in the terrestrial floodplain ecosystem and a significant change in the aquatic ecosystem. The extensive monitoring with its spatial, temporal and species-specific dimensions showed that the initially strong dynamisation effects often diminish over time. The significant importance of hydrological dynamics and longitudinal and lateral connectivity for the floodplain ecosystem confirms the need to bring as much water as possible to the remaining floodplain forests, especially during climatically dry years.

Conclusion for monitoring and floodplain dynamisation

The Ottheinrichbach and its newly created floodplain is a successful example of how an important habitat can be restored, also as a substitute for the heavily modified habitat in the dammed Danube and its floodplains. The management required after the implementation of the measures is based on monitoring results. Such success control offers the opportunity to learn from observations in a timely manner and to derive possible improvement measures for the area itself (e.g. subsequent shaping of banks, adjustment of discharge volumes) in an evidence-based adaptive management process, but also to transfer the knowledge gained to other areas.

The key findings from the two MONDAU projects for efficient and scientifically sound monitoring are:

- Long-term effects: Many measures take years to take effect; in some cases, an extreme event is needed as a catalyst to initiate dynamic processes. Meaningful floodplain monitoring, particularly in the context of expected climatic and hydrological changes, must therefore be designed for the long term (e.g. 10 or 20 years).
- Recording and evaluation standard: The various target species of floodplain restoration projects occur in diverse sub-habitats and at different trophic and functional levels but also require dynamic processes and changes in abiotic parameters. The selected species groups and study parameters should be recorded in a standardised manner, following a common spatial study design wherever possible, in order to allow comparisons between restoration projects. The BACI design (before, after, control, impact) has proven to be the standard for site selection, allowing the effects of both the temporal change and the measure to be analysed.
- Adaptive management: Monitoring is important as part of adaptive management in order to identify potential for improvement in long-term operations. The great importance of hydrological dynamics for the floodplain ecosystem became clear, confirming the need to divert as much water as possible to the remaining floodplain forests.

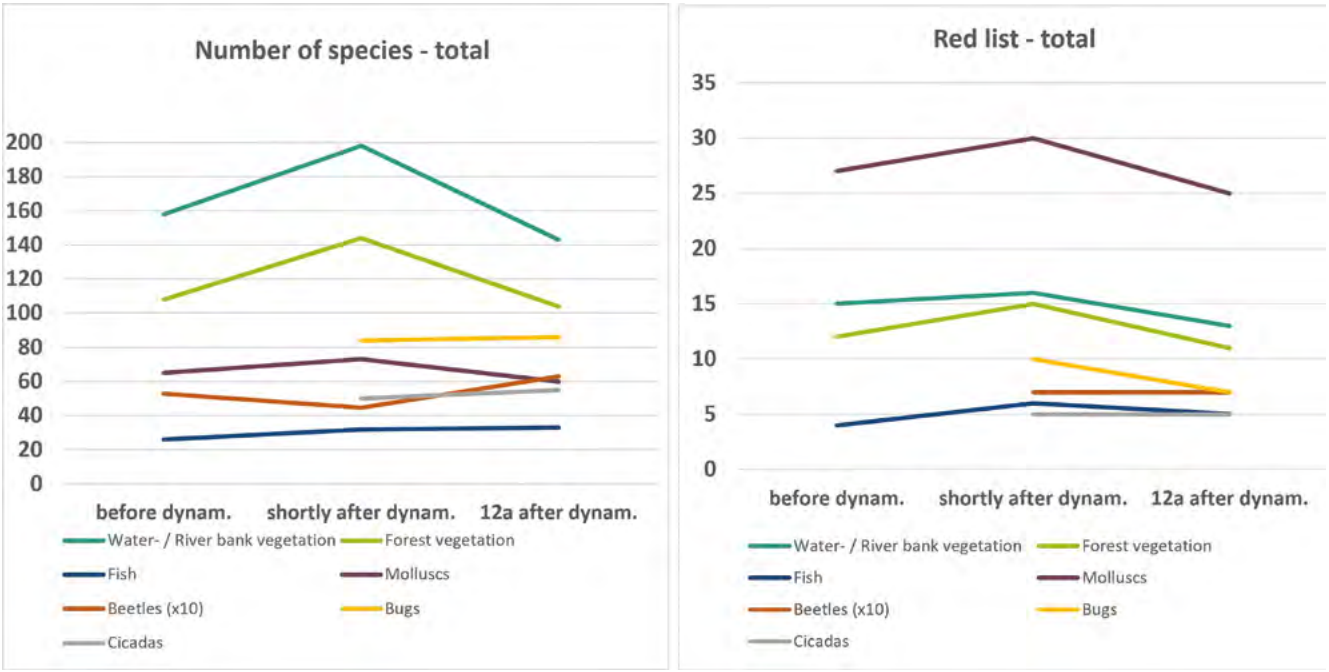

Figure 3. Change in the total number of species recorded on the permanent monitoring plots and the number of Red List species of the individual species groups before the measures were implemented, shortly afterwards and twelve years later (source: Stammel et al. 2025).

Accordingly, discharge volumes and times that are as flexible as possible and orientated towards ecological functionality, should be granted at the approval planning stage. This is the only way to react promptly to monitoring results without further authorisation procedures.

Even in heavily anthropogenically modified floodplain landscapes, as presented herein on the Danube, dynamisation measures were able to induce positive effects in terms of structural diversity (especially deadwood), lateral and longitudinal connectivity and the dynamics of discharge volumes. The monitoring showed that the improvements were only effective for some species groups or in some sections, not in the entire watercourse or across the entire floodplain. The positive experience and knowledge gained from the dynamisation project along the impounded Danube should be applied to other impounded floodplain areas. Of course, the specific local hydrological and ecological conditions and situations must always be taken into account when planning dynamisation measures. However, the large-scale expansion of successful measures of this kind is essential in order to achieve a significant turnaround in the biodiversity crisis in rivers and floodplains.

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45th IAD Conference 'Innovative solutions and cooperation to protect and restore biodiversity and ecosystems in the Danube River Basin'

The conference held from 9 –12 April 2025 in Sofia, Bulgaria, was, after those in 1966, 1976, 1990 and 2014, the 5th IAD Conference hosted by the Bulgarian section of IAD, represented by the institutes of the Bulgarian Academy of Sciences. The conference was organised by the Institute of Biodiversity and Ecosystem Research, BAS (IBER-BAS), Climate, Atmosphere and Water Research Institute, BAS (CAWRI-BAS), the General Secretariat of IAD, Danube Region Invasive Alien Species Network (DIAS) and Union for Conservation of Nature Bulgaria (UCNB). The conference was funded by IAD and co-funded by IBER-BAS and the projects DANUBE4all, DaWetRest and DANSER, in the frame of the EU Mission 'Restore our Oceans and Waters' Danube and Black Sea Lighthouse.

The event was attended by 120 participants from 15 countries. The majority of participants came from the host country, Bulgaria (more than 70 participants), followed by Romania, Serbia, Ukraine, Austria, Hungary, Germany, Czech Republic, North Macedonia, and participants from Croatia, France, Ireland, Slovakia, Slovenia, and Türkiye. About 35 of them were young scientists, PhD- and undergraduate students. A total of 83 communications (nine keynote, 39 oral presentations, 35 posters) were given and allowed insights into the rich and diverse research on the Danube River Basin and the Danube and Black Sea Region.

The conference provided an exchange forum for long-term multidisciplinary research and activities on various topics, highlighting the importance of building innovative solutions and cooperation to protect and restore biodiversity and ecosystems in the Danube River Basin. This year's IAD Conference aimed to showcase the significant achievements made in the Danube and Black Sea Lighthouse by scaling up sustainable solutions related to the main threats to the Danube River Basin as hydromorphological alterations, water pollution, ecosystem degradation, invasive alien species and effects of climate change. The Conference objectives were covered by, but not limited to, 12 scientific

Figure 1. Co-chairs of the Organising and Scientific Committees; from left to right: Cristina Sandu, IAD Vice-President, Teodora Trichkova, IAD Country representative Bulgaria, Katrin Teubner, IAD General Secretary, and Bernd Cyffka, IAD President. Photo: Milcho Todorov.

topics in compliance with major international and regional poicies, commitments, and initiatives (for details http://www.iber.bas.bg/sites/default/files/IAD45/).

The event was opened by Teodora Trichkova, National representative of IAD for Bulgaria and the conference participants were welcomed by Bernd Cyffka, IAD President, Dr. Vladimir Vladimirov, Director of IBER-BAS, Corresponding Member Ekaterina Batchvarova, Director of CAWRI-BAS, Dr. Ina Aneva, Scientific Secretary of Biodiversity, Bioresources and Ecology Division of BAS, and Ms. Iliyana Todorova, Director of Water Management Department of the Ministry of Environment and Water of Bulgaria. In her introductory speech, Ms. Ivelina Vasileva, Member of the Mission Board of EU Mission 'Restore our Ocean and Waters', Danube and Black Sea Lighthouse Leader, talked about the European Ocean policies and Mission 'Restore Our Ocean and Waters' in support of research and innovation for the Danube and Black Sea Region. She presented the aims and objectives of the Mission and highlighted the new initiatives of the EC related to the ocean and waters, as the new European Oceans Pact and preparation of the 'Water Resilience Strategy (WRS): A step towards a water-smart society' and future EU Oceans Research and Innovation Strategy.

In a first keynote presentation, Cristina Sandu, Bernd Cyffka, and Katrin Teubner introduced 'The International Association for Danube Research – Past and future of a scientific network in the Danube River Basin'. Birgit Vogel, Executive Secretary of ICPDR, talked about 'International cooperation in the Danube River Basin: Current key activities including the Joint Danube Survey 5'. Further keynote talks were dedicated to water management and restoration, and specific Danube and Black Sea Lighthouse projects. A central element of the conference was the introduction of four new expert groups, whose leaders contributed keynote presentations on their topics, visions and expertise (for more details, see this DN volume).

Special sessions were dedicated to three Danube and Black Sea Lighthouse projects, with the participation of IAD and its members (DANUBE4all, DaWetRest, DANSER). Students from the IAD Summer School in August 2024 (Danube News volume 50) presented two posters on vegetation cover and the impact of water stress on plants in Letea Forest, Danube Delta, Romania. This research was developed primarily under the supervision of Duška Cvijanović, who also participated in the Summer School as a lecturer.

The Conference concluded with an impressive excursion to the Upper Iskar River (tributary of the Danube River) and the Rila Mountains. Case studies related to river connectivity and restoration activities were presented. The programme included a visit to sites at the Iskar River and Iskar Reservoir; a visit to Dragushinovo Village to learn about a restoration project, using a river bypass, to provide potential habitats of native crayfish populations; a tour of a fish farm in Mala Tsarkva Village to learn about native fish populations and farmed fish; and a breathtaking winter scenery at the Borovets Mountain Resort, including the historic Tsarska Bistritsa Palace and Park. Altogether, the excursion left an unforgettable impression of the work being done by the Bulgarian colleagues and their collaboration, especially with partners from Romania and Ukraine, while also offering a rich and friendly exchange of knowledge in a spirit of genuine camaraderie.

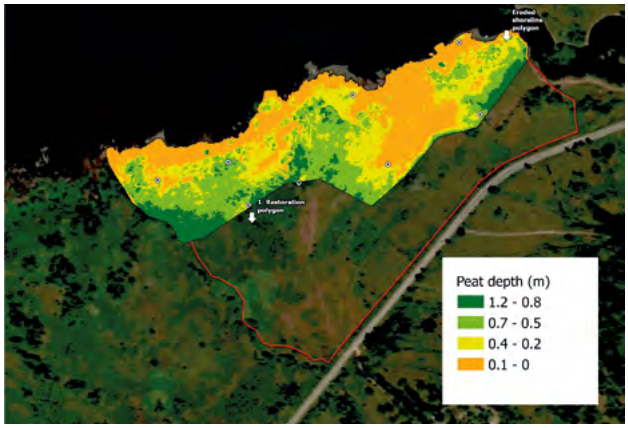
The conference abstracts are available at http://www.iber.bas.bg/sites/default/files/IAD45/. Selected contributions will be published in the peer-reviewed journals Acta Zoologica Bulgarica, Phytologia Balcanica and Transylvanian Review of Systematical and Ecological Research.

The 45th IAD Conference was dedicated to the memory of the eminent and highly respected IAD colleagues and friends, who have made valuable contributions to the study of the Danube River Basin: Dr. Angela Curtean-Bănăduc from Romania (1971–2023), Dr. Artem Liashenko from Ukraine (passed away in 2024), and Ing. Ivan Botev from Bulgaria (1943–2024).

Teodora Trichkova, Katrin Teubner

Figure 2. Participants in the 45th IAD Conference in Sofia. Photo: Ivan Yanchev

New IAD Expert Group: Habitat Monitoring and Conservation



The Expert Group for Habitat Monitoring and Conservation works **to enhance habitat assessment and restoration across the Danube Basin.** By integrating EUNIS standards, remote sensing technologies, and key conservation frameworks such as the EU Habitats Directive and the Bern Convention, we promote **consistent monitoring, data-driven conservation strategies**, and regional collaboration to **preserve biodiversity**.

The specific Objectives and Goals are as follows:

- Develop and coordinate strategies for **long-term habitat monitoring** and monitoring of restoration measures, with a focus on riparian zones, floodplains, and wetlands.
- **Standardisation and Validation** – Conduct national-scale validation of floodplain assessment methods in collaboration with local stakeholders, refining tools for broader application across the Danube region.
- **Address the current gaps in habitat assessments** and promote the development and application of cost-effective remote sensing approaches in habitat monitoring.
- Implement harmonized techniques and classification systems aligned with EU directives in habitat protection and conservation in EU and non-EU countries (e.g., the **Water Framework Directive**, the **Bern Convention of the Council of Europe**, and the **European Union's Habitats Directive**).
- Compile and analyse habitat and species data from ongoing and past surveys to inform conservation strategies and **enhance water management programs.**
- Facilitate the exchange of information, tools, and experiences among projects, scientists, practitioners, and stakeholders in habitat monitoring and conservation assessment.

The Expert Group actively collaborates with universities, research institutes, NGOs, and governmental bodies across the Danube Basin. **We invite scientists and practitioners working in habitat conservation and monitoring to join our efforts, fostering a dynamic network dedicated to the protection and sustainable use of aquatic and terrestrial ecosystems.**

Expert Group leader: Prof. Dr. Dušanka Cvijanović

Prof. Dr. Dušanka Cvijanović is a full professor of Ecology at the University of Novi Sad, Faculty of Sciences, Serbia, a researcher at the Minds Europe-Institute for Research Excellence and Technological Advancement, and a leading expert in aquatic habitat monitoring, classification, and conservation. Her research focuses on integrating remote sensing and artificial intelligence into freshwater ecosystem monitoring, with specific attention to UAV photogrammetry and satellite data in wetland mosaics. She has participated in and coordinated national and EU-funded projects, including those aligned with the EU Natura 2000 network and Horizon Europe missions. Prof. Cvijanović currently leads the task in the Horizon EU 'Restore4Life' project and the EcoDalli task-force initiative. She actively contributes to the standardization of habitat monitoring methods. She fosters regional collaboration across the Danube Basin and the Western Balkans, supporting capacity-building and data harmonisation in line with EU directives.

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New IAD Expert Group: Coastal Ecology

With my background in coastal ecology and microbial ecology, **I propose to see the coastal Black Sea system as an ecotone between the Danube Delta and the marine system**, involving all marine organisms, including free-living microorganisms and microorganisms associated with animals and plants. This ecotone is characterized by dynamic biogeochemical processes, shaped by both autotrophic and heterotrophic microbial metabolism, which respond to seasonal dynamics and episodic events (as highlighted in studies on oligotrophic coastal marine ecosystems).

In this context, the expert group aims to examine microbial carbon fluxes, particularly bacterial carbon demand in relation to primary production, as recent studies suggest the need for a re-evaluation of carbon cycling in seagrass systems such as *Posidonia oceanica.* **The interactions between microbial communities and organic/inorganic particles further influence nutrient cycling and energy flow**, underscoring the role of viruses in regulating microbial populations. Viral ecology, particularly the influence of prokaryotic viruses on microbial commu-

nities, remains an essential factor in **understanding carbon turnover**, bacterial mortality rates, and **ecosystem resilience**. Additionally, changes in **bacterial community composition** due to top-down controls, such as enhanced flagellate grazing, may modulate the balance between bacterial production and viral-induced mortality, affecting overall trophic interactions in this ecotone.

By integrating these perspectives, the expert group seeks **to advance our understanding of microbial-driven processes in the coastal Black Sea and their implications for ecosystem stability and biogeochemical cycles**.

Expert group leader:
Dr. Markus G. Weinbauer

Affiliation: Laboraoire d'Océanographie de Villefranche, Sorbonne University and the French National Research Institute (France)

Main research field:
Viruses & Microbiology

Interests: My background is a master in the ecology and biology of gorgonian corals, i.e. population dynamics and skeletal-based biomarkers. Then I moved for my PhD to the ecology of viruses (still my main topic) and microorganisms.

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New IAD Expert Group: Sediment dynamics & Hydromorphology

The **Danube River Basin (DRB) is one of Europe's most dynamic fluvial systems**, where sediment dynamics and hydromorphological processes shape land- and riverscapes, sustain biodiversity, and impact socio-economic activities. Growing pressures from human interventions and climate change on sediment dynamics and hydromorphology underscore the need for sustainable river basin management. This newly established EG aims to:

- Advance the **understanding of sediment dynamics and hydrogeomorphic changes**
- Assess the **impacts of human activities and climate change** on sediment connectivity and river morphology
- Explore the **ecological implications of altered sediment regimes** on riverine habitats and biodiversity
- **Enhance public awareness** regarding the importance of sediment balance in sustaining river health
- Develop science-based recommendations for **integrated river and catchment management**
- Promote interdisciplinary and transdisciplinary collaborations among hydrologists, geomorphologists, ecologists, engineers, policymakers, and stakeholders
- **Support river restoration efforts** by providing knowledge on sediment transport processes and sustainable management practices

The expert group envisages to organise workshops, seminars, and scientific sessions within IAD conferences, to conduct collaborative research projects and synthesise knowledge on sediment-related issues, to develop guidelines and policy recommendations for sustainable sediment management, to establish a platform for knowledge exchange among scientists, practitioners, and decision-makers, and to engage with local communities and stakeholders to foster participatory river and catchment management.

The establishment of this expert group aligns with IAD's mission to promote **interdisciplinary research** and foster **sustainable management** of the DRB. By **bridging scientific knowledge with practical applications**, this initiative will significantly contribute to addressing current and future challenges in sediment dynamics and hydromorphology. I kindly seek interested IAD members and look forward to further discussions and future collaborations.

Expert Group leader:
Dr. Ronald E. Pöppl

Dr. Ronald Pöppl is a Senior Researcher at the Institute of Hydrobiology and Aquatic Ecosystem Management (IHG), BOKU University, Vienna, Austria, former Senior Lecturer for Physical Geography and Geoecology (Department of Geography and Regional Research), University of Vienna. Main research fields are fluvial dynamics, sediment transport, connectivity, hydromorphology and river (basin) management.

My research focuses on sediment dynamics and hydromorphology, with a particular interest in the role of humans as (dis)connecting agents in fluvial systems. I explore new concepts and applications in fluvial geomorphology and landscape research to better understand how human activities influence fluvial processes and connectivity. Since 2020, I have led the Human Impact and Connectivity (HI-CONN) research

group, investigating the effects of land use, management practices, and climate change on water, sediment, and nutrient/contaminant fluxes. Our work aims to assess and quantify human-induced changes in fluvial systems, further providing insights for sustainable river basin management.

I am author of more than 30 papers in scientific journals, first author of one book, and further contributed to 10 book chapters; Board work and speakership in 9 organisations such as the 'IAG/AIG Internat. Assoc. of Geomorphologists (working group leader 'Connectivity in Geomorphology')', the EGU/European Geoscience Union (scientific officer), and the ÖK-IAD - Austrian Committee Danube Research (management committee).

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New IAD Expert Group: Danube River education

The Danube River and its tributaries are facing significant ecological challenges, affecting the ecological status of the river as well as biodiversity in the river and its floodplains. However, there remains a gap in **effectively communicating such environmental knowledge and awareness to a broader public**. The International Association for Danube Research (IAD), a key player in promoting sustainable management of the Danube River Basin, can expand its impact by enhancing public environmental education efforts.

To bridge this gap, an Environmental **Danube River Education Expert Group** (DEEG) within IAD has been established. This expert group is dedicated to raising public awareness, fostering emotional connections of local residents and tourists with the Danube, and empowering local communities to participate in the protection and restoration of the river and its ecosystems. The European Commission's initiative to reconnect citizens with freshwater ecosystems aligns closely with this objective, positioning IAD to contribute to wider EU goals.

While IAD has traditionally focused on research and policy, the value of these insights is limited without public communication and involvement. An Environmental Education Task Force could **transform complex scientific data into engaging, accessible content for a wider audience.** The aim is to support a broad range of educational initiatives, including programs for schools, community outreach, exhibitions, workshops, and multimedia campaigns. By collaborating with local stakeholders such as schools, NGOs, nature parks, and governments, this effort envisages far-reaching effects across the entire Danube region.

The environmental Danube River Education Expert Group hence serves as a catalyst for coordinated educational efforts, ensuring that local activities are linked and scaled throughout the basin. By initiating and developing timely educational projects, the DEEG enables the creation of an interlinked series of initiatives that foster community-driven conservation efforts. This would include a variety of educational formats, such as school programs, interactive exhibitions, and public events, aimed at diverse audiences across different regions.

In summary, the DEEG will help IAD to significantly increase its visibility and strengthen its role in promoting sustainable practices and synergies among the projects. The **Environmental Danube River Education Expert Group (DEEG) will bridge the gap between scientific research and public engagement**, creating a lasting, community-focused movement for the conservation and protection of the Danube River Basin. This initiative would ensure that the association's efforts reach beyond the scientific community and foster a deeper connection between people and the river based on environmental knowledge and emotional linkages to the Danube's unique nature.

Expert Group leader: Dr. Gabriela Costea

Dr. Gabriela Costea is a research associate at the Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB) in Berlin, specialising in aquatic ecology and the ecosystem services of rivers and floodplains. She has previously worked for 16 years as a curator at the Natural Science Museum Complex in Galati, Romania, where she developed exhibitions and environmental education programs that made scientific knowledge about the Danube's biodiversity accessible to the public. Her work bridges science, education, and community engagement, focusing on ecosystem services of rivers and floodplains, stakeholder involvement, participatory processes, and creative outreach tools such as a children's book, exhibitions and educational programs. She co-leads the Danube Nature Guides project, promoting intergenerational learning and emotional connections to the river, and is currently active in two EU Horizon projects– Restore4Life and Danube4all – also developing innovative educational packages and tools for wetland conservation. Her interdisciplinary background combines scientific expertise with a passion for communication and awareness-raising in support of sustainable river management.

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International Association for Danube Research (IAD)

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Catchment of the River Danube

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