IGB
Leibniz Institute of Freshwater Ecology and Inland Fisheries

EU CALL FOR EVIDENCE

European Water Resilience Strategy – Identifying research needs

IGB Feedback

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Research for the future of our freshwaters

European Water Resilience Strategy – Identifying research needs

The Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB) is Germany's largest research centre for freshwaters. Our research findings help to tackle environmental changes and to develop strategies for sustainable water management – true to our guiding principle "Research for the future of our freshwaters". Based on our research and expertise, we comment on the EU Call for Evidence on the European Water Resilience Strategy (EWRS).

1 Background and focus

Europe's freshwaters are both important strategic resources for humans and valuable habitats for nature. They provide a wide variety of ecosystem services and play a major role in climate change adaptation and mitigation. However, at the same time, these freshwater ecosystems are threatened by ongoing man-made climate change and other constantly increasing human pressures. The European Water Resilience Strategy (EWRS) aims to ensure that water sources are properly managed, scarcity is addressed, and that we enhance the competitive innovative edge of our water industry and take a circular economy approach.

IGB provides input for the identification of concrete research activities needed to address one of the main challenges addressed in the strategy: "**Insufficient knowledge and capacity to develop solutions to restore and protect the water cycle.**" To this end, and based on a prior feedback to tackle the implementation and enforcement deficit of the EWRS, IGB outlines research needs **to restore and protect the water cycle**.

2 Pollution prevention and revitalization

The implementation and enforcement of the Water Framework Directive (WFD) should be strengthened by developing effective regulatory, planning, and management approaches to reduce pollutants while supporting the objectives of the WFD and the Nature Restoration Regulation (NRR). Key to avoiding new and mitigating existent pollution is significantly minimizing the emission of contaminants at the source.

Concrete research activities in this field should address:

- **input pathways** of diverse contaminant mixtures including nutrients, metals, and trace organic contaminants into increasingly impacted (urban) water bodies to better understand and protect freshwater resources from pollution,
- ecological impacts and governance of **emerging and combined pollution pressures**, particularly anthropogenic noise, artificial light at night (ALAN), and complex mixtures

of inorganic and organic contaminants, which increasingly impair biodiversity, ecological processes, and ecosystem resilience,
- **emission sources as well as transport and (trans)formation pathways** of certain chemicals that can hardly be removed from water, such as the ultrashort-chain PFAS trifluoroacetate (TFA) and its precursor compounds, aiming to eliminate emissions of these chemicals,
- characterization and prevention of **groundwater pollution inputs from green spaces** such as private gardens, cemeteries, and parks and from leaky public and private sewer systems (in addition to the legacy of contaminated sites and landfill leachates),
- the quantification of the **interaction effects of pollutants** and identification of **ecological thresholds**,
- **natural bioreactor functions** of groundwater-surface water interfaces (hyporheic zones) for purifying overlying stream water (so-called self-purification of streams) and as a barrier to protect groundwater from contamination,
- integrative research on the combined importance of **structural restoration**, including the restoration of **free-flowing rivers**, and the safeguarding of river water quality for sustainable river revitalisation, as the interacting effects of increasing inorganic pollutant loads and climate change-related drought threaten restoration efforts aimed at e.g. preventing or reducing river salinization,
- **digital mapping and monitoring of river connectivity**, including the identification, prioritisation, and tracking of obsolete barriers and their removal in support of Article 9 of the NRR, thereby providing a robust evidence base for adaptive implementation of both the WFD and the NRR,
- understanding **(asymmetric) recovery processes** under multiple stressors conditions.

3 Water quality and novel water treatment technologies

Directives to improve the chemical status of water bodies in the EU need to be translated into practical sustainable actions by the Member states. Key to mitigating the impact of unavoidable emissions is the understanding of the underlying mechanisms and the establishment of suitable water reuse and treatment approaches.

Concrete research activities in this field should address:

- the **effects of extreme weather events** on the quality of surface waters, groundwater, and drinking water to safeguard ecosystems and water supplies because extreme weather events in the form of drought and intense rainfall are becoming more frequent and threaten drinking water resources,
- the **capacity of blue-green infrastructure** to treat stormwater, reduce the adverse effects of storm events on surface-water quality, and improve the capture and reuse of runoff as a water supply – particularly in cities adopting “sponge city” approaches to sustainable stormwater management,
- large-scale **water reuse practices** to strengthen the resilience of water supplies and sustainable agriculture while **minimizing risks** associated with inorganic and organic

pollutants that may pollute pristine groundwater bodies and accumulate in the water cycle and / or the food chain,

- **novel and sustainable water treatment technologies**
  - to reliably remove persistent and mobile contaminants, such as certain per- and polyfluoroalkyl substances (PFAS) from water and prevent their accumulation in the water cycle,
  - taking circular economy approaches into account,
- transfer of novel water treatment technologies **from research into practice**, supported by funding opportunities to transition from Technology Readiness Level (TRL) 3 to 6 with subsequent support for start-ups and market entry.

4 Water quantity

There are often challenging conflicts between water protection and use, but also competition between user interest, and trade-off between green and blue water fluxes. Climate-resilient restoration and water management is needed and requires hydrological knowledge of the system.

Concrete research activities in this field should address the following aspects:

- water age estimates and residence times in **quantification of ecohydrological feedbacks**,
- definition of the **quantitative needs** of aquatic ecosystems and assessment of the **environmental impact** of water use,
- improved predictions of **river dynamics, flow regimes, sediment transport, and water availability** to support risk-informed spatial planning and provide greater certainty for landowners and land managers through integrated modelling approaches.

5 Overarching research needs

To overcome the challenge of "insufficient knowledge and capacity to develop solutions to restore and protect the water cycle" also coordinated action in data infrastructure, experimental capacity, modelling, transdisciplinary research, and knowledge exchange are required.

Concrete research activities in this field should address the following aspects:

- **interoperable data infrastructure** linking taxonomic information, biodiversity data, sampling sites and abiotic parameters and remote sensing information for freshwater ecosystems incl. contextual information (**metadata**) and spatial references for a direct analysis of spatial and temporal patterns,
- **modelling approaches** to identify dominant processes and links in coupled terrestrial-aquatic ecosystems including also groundwater-surface water exchange, such as:
  - integrated long-term, process-based monitoring and multi-site data combined with adaptive modelling and machine-learning approaches as iterative

learning frameworks to improve predictions and reduce uncertainty beyond traditional (hydrological) models, while recognising that machine-learning models are constrained by past observations and must be applied cautiously to future conditions,
    - adaptive modelling to support water-smart land-use planning and decision-making,

– identification of potential **trade-offs and co-benefits associated with freshwater management options**, such as thermal regulation, water quality improvement, habitat provision, and biodiversity conservation. Such analysis will support evidence-based implementation of the WFD and NRR through scenario development and should be more strongly informed by mesocosm and whole-ecosystem experiments. These experiments could examine climate change impacts on physical, chemical, and biological processes in the water column, as well as the ecological consequences of emerging adaptation and mitigation measures, including shading by floating solar installations and other infrastructure, and nature-based solutions such as the vertical greening of artificial shoreline structures,
– transdisciplinary research and innovation to improve the implementation of the WFD and the NRR through **stakeholder co-creation and knowledge exchange**, based on the identification of effective engagement and communication strategies, fostering participation, social acceptance and successful long-term implementation.

Further reading

IGB Feedback (2026) EU water policy – targeted revision of the Water Framework Directive

IGB Feedback (2025) European Water Resilience Strategy – Tackling the implementation and enforcement deficit

IGB Policy Brief (2025) River revitalisation as crisis prevention and public service (DE)

IGB Feedback (2024) Nitrates – updated rules on the use of certain fertilising materials from livestock manure (Renure)

IGB Feedback (2023) Protecting waters from pollution caused by nitrates from agricultural sources

IGB Feedback (2022) Nutrients – Action plan for better management

IGB Feedback (2022) Microplastics pollution – measures to reduce its impact on the environment

IGB Feedback (2022) Renewable energy projects – permit-granting processes & power purchase agreements

IGB Feedback (2021) Possible revision of the lists of pollutants affecting surface and groundwaters, and the corresponding regulatory standards in the Environmental Quality Standards (EQS), Groundwater Directive (GWD) and Water Framework Directive (WFD)

IGB Feedback (2021) Revision of the Urban Waste Water Treatment Directive (UWWTD)

IGB Feedback (2021) The EU Nature Restoration Plan and the binding EU nature restoration targets

IGB Feedback (2021) Feedback on the revision of the TEN-T regulations

IGB Feedback (2021) Feedback on the roadmap for the NAIADES III action plan (2021-2027)

IGB Feedback (2020) EU Roadmap for the EU Biodiversity Strategy to 2030

IGB Policy Brief (2019) Strengths and weaknesses of the Water Framework Directive

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