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Conclusion

Restoring coasts and floodplains - Conclusions and recommendations for enabling action across science, policy, and practice

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Wetlands are vital ecosystems for people and nature. The future integrity and health of European riverine and coastal wetlands are intimately linked to our social, economic, and ecological well-being (Kaden et al. 2023). As hotspots of biodiversity with important ecosystem functions, they provide crucial nature-based solutions to climate change mitigation and adaptation (EEA 2024). With this paper, we provide recommendations for practice, policy, and science to enable restoration of coasts and floodplains through policy changes, scaling up restoration action in practice, and expanding the evidence base (see also ENCA 2023).

In this Special Issue, we have addressed critical questions on the state and future of wetlands: How vulnerable are riverine and coastal wetlands to climate change, and how will these changes affect their ecological integrity? What ecosystem services do they provide, and how can nature-based solutions unlock their potential for climate mitigation and adaptation? What can we learn from practical restoration efforts across Europe to overcome barriers and scale up action? And finally, how can policy and governance frameworks be adapted and strengthened to enable effective, long-term wetland restoration and protection?

The interdisciplinary research, practical case studies, and policy analyses presented in this volume offer a comprehensive picture of wetlands as dynamic, multifunctional landscapes. Healthy and naturally functioning wetlands contribute to human health and well-being, e.g. through food and water provision, nutrient retention, recreation, and nature tourism, among many other co-benefits (see Stammel et al. 2026; Wantzen and Cao 2026; Zak et al. 2026).

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By capturing and storing carbon, wetlands such as floodplain forests or coastal salt marshes help to mitigate climate change itself (see Ludewig et al. 2026). Wetlands also provide irreplaceable habitats, offering spawning grounds for fish, breeding and resting places for birds, and home to a wide variety of highly specialized plant and animal species (Kaden et al. 2023; see also Fink et al. 2026, Ibáñez et al. 2026). As natural sponges, they play a pivotal role in climate change adaptation as they regulate the landscape water balance and buffer floods and droughts, thus boosting our water resilience (EEA 2024, see also Macháč et al. 2026). During extreme events, river floodplains provide natural water retention areas, while coastal wetlands form an important component of hybrid flood defence approaches, thus reducing risks to people and property (see de la Vega-Leinert et al. 2026; Stoffers et al. 2026). These key wetland ecosystem services provide the foundation for environmental and socio-economic systems at many spatial scales (see Stammel et al. 2026; Macháč et al. 2026), making wetlands essential for delivering the European Green Deal and global biodiversity, climate, and sustainable development targets (see ENCA 2023, Klusmann et al. 2026; Rouillard et al. 2026).

Yet, wetlands are also among the most vulnerable ecosystems, both in Europe and globally (Convention on Wetlands 2025; Verhoeven 2014). They face intense anthropogenic pressures, which are further exacerbated by climate change (see Kaden et al. 2026). Among the human-induced impacts, hydrological and hydromorphological changes such as drainage, dams and hydropower infrastructure, water abstraction, and flow regulation result in critical alterations, while unsustainable land use, eutrophication, and other pollution drive further wetland degradation (ENCA 2023, see also Stoffers et al. 2026). These pressures reduce the resilience of wetland ecosystems and diminish their chances of surviving in a changing climate. Climate change and associated alterations in the hydrological cycle are already causing severe losses of wetland habitats and species (Čížková et al. 2011, Kaden et al. 2026). The scale and severity of the challenge we face must not be underestimated (ENCA 2023). We are already losing these vital ecosystems at an alarming rate: about 80% of the European wetlands that existed 100 years ago have been lost, and 89% of the remaining wetland habitats protected under EU law show an unfavorable conservation status (EEA 2020).

With this Special Issue, we highlight the increasing stress that climate change places on these ecosystems, but also their unique potential to provide nature-based solutions to some of our most pressing environmental problems. We therefore face an urgent need to ensure the protection of remaining intact wetlands (see Kmetova-Biro et al. 2026) and to significantly scale up the restoration of degraded wetlands across Europe (see Birk et al. 2026). This requires reducing human pressures, restoring natural dynamics, increasing water retention in the landscape, reconnecting floodplains, and providing space for coastal wetlands to recover (ENCA 2023). Such action should be underpinned by integrated, long-term monitoring to assess biodiversity responses and the effectiveness of nature-based solutions (see Cvijanović et al. 2026).

It is estimated that each Euro invested in ecosystem restoration in the EU generates 8 to 38 Euros of economic benefits in the form of natural capital or

ecosystem services (EC 2022). Wetland nature-based solutions can be especially cost-effective in the long term, as many measures, (e.g. rewetting or dam removal), require comparatively low or no maintenance costs after an initial investment, yet keep delivering benefits for decades (see Macháč et al. 2026). The costs of inaction, on the other hand, steadily increase (Convention on Wetlands 2025; ENCA 2023).

This Special Issue brought together expertise from science, practice, and policy, highlighting the transdisciplinary nature of both the challenges we face and the solutions that wetland restoration offers. Building on the diverse experiences and perspectives shared in this special issue, we conclude with a set of recommendations addressing policy-makers, practitioners, and researchers (Box 1, 2, 3, respectively). These recommendations were developed in interactive workshop sessions of the 5th European Conference on Biodiversity and Climate Change on 26-28 September 2023 in Bonn, which focused on riverine and coastal wetlands, organised by the German Federal Agency of Conservation (BfN) and the European Network of Heads of Nature Conservation Agencies (ENCA). They were originally published as ENCA Recommendations under the title "Restoring Riverine and Coastal Wetlands in Europe - Scaling up Action for Biodiversity and Climate" (ENCA 2023) and now need to be put into action.

Fostering constructive exchange and transdisciplinary cooperation among scientists, practitioners, and policy-makers is key to overcoming prevailing barriers to wetland restoration (ENCA 2023).

Policy provides the targets and implementation framework for restoration action. Policy-makers need to ensure that their decisions are well-aligned with scientific knowledge, taking future climate change scenarios into account. They also need to address practical implementation challenges effectively, such as land availability and sufficient availability and accessibility of funding. Moreover, cross-sectoral policy coherence must be improved. Special attention is needed to avoid and reform counteracting policies, making sure that public funding is not spent on environmentally harmful practices that overshadow nature restoration action. For effective wetland conservation and restoration, a whole-of-government approach is key.

Practice refers to on-the-ground implementation of restoration action, including adaptive management. Practice should be informed by the latest research findings and include a monitoring component. Practical implementation must be scaled up significantly to meet wetland-related policy targets.

Science provides the knowledge base for well-informed decisions on all levels. Research should therefore be well-aligned with the prioritised information needs of policy-makers and practitioners. Relevant findings must be easily accessible and should be communicated more effectively.

All three dimensions—policy, practice, and science—must work together to reverse degradation and halt wetland loss in Europe: to demonstrate the value of riverine and coastal wetlands for people, biodiversity and climate; to reduce human pressures across all land use sectors; to create a business case for wetland restoration; to mobilize significant funding and investments; to operationalize integrated approaches that address trade-offs and maximize co-benefits; and to build capacities needed to implement restoration action at scale (ENCA 2023).

Box 1. Policy - Enabling action through policy changes (ENCA 2023).

Policy-makers at all levels have a key role to play in order to accelerate action for protecting and restoring riverine and coastal wetlands in Europe.

- **Make wetlands a political priority.** Raise awareness of their significant natural and socioeconomic value, both in the policy arena and among the wider public.
- **Strengthen synergies across policy sectors.** Recognize and promote the contribution of wetland restoration to a wide range of policy objectives, including international, regional (EU), and national targets on biodiversity, climate change, water quality and freshwater supply, disaster risk reduction, food security, health, and land degradation neutrality. This includes the Sustainable Development Goals, the Global Biodiversity Framework, the Paris Agreement, the Ramsar Convention, the EU Green Deal, the Water Framework and Nature Directives, and the EU Nature Restoration Regulation. Implement and enforce existing policies ambitiously and effectively.
- **Recognize trade-offs and improve cross-sectoral policy coherence.** Renegotiate policies that currently contribute to wetland degradation, with special attention to agriculture (including the EU Common Agricultural Policy), forestry, fishery, renewable energies (including hydropower), coastal protection, tourism, and infrastructure development. Phase out harmful subsidies and redirect them into nature-positive investments.
- **Provide incentives for shifts towards more sustainable land use in wetlands and their catchments.** For example, develop ecologically effective agri-environmental schemes and/or establish payments for wetland ecosystem services. Engage land users and other stakeholders directly, and develop joint, adaptive solutions for a just transition. In the long term, develop policy instruments that genuinely integrate land-use planning across all sectors.
- **Promote nature-based solutions (NbS) for biodiversity and climate.** Integrate wetland NbS, for example, into National Biodiversity Strategies and Action Plans, Nationally Determined Contributions, and National Adaptation Plans. Set strong ecological and social safeguards for all NbS, including strict criteria for carbon removal certification.
- **Promote coastal NbS.** Develop long-term strategic regional "masterplans" for coastal management, taking future climate-change scenarios into account. Recognize that it is not feasible to protect every coastline with hard defences. Support coastal wetland restoration at increasing scales and promote managed realignment as a long-term solution.
- **Develop legally binding instruments to scale up ecosystem restoration.** Set ambitious and measurable targets for wetland restoration, clear timelines, robust monitoring and evaluation criteria, and sufficient funding. EU Member States should ensure fast and effective implementation of the EU Nature Restoration Regulation through ambitious National Restoration Plans, underpinned by a significant increase in capacity and resources. Non-EU Member States should follow an equally ambitious approach in implementing global nature restoration targets.
- **Require businesses to assess and mitigate their impacts on nature.** Create legal obligations for mitigation and, only as a last resort, compensation of unavoidable impacts through ecosystem restoration, while enforcing meaningful biodiversity standards (e.g., permanency).
- **Mobilize private funding at scale for wetland restoration.** Develop a portfolio of projects and programmes and demonstrate suitable business models for private-sector investments. Set meaningful biodiversity criteria to prevent green-washing, ensuring additionality and permanency. In particular, ensure that all wetland carbon schemes are ecologically sound.
- **Significantly increase public funding for wetland restoration.** Ensure long-term funding for restoration projects, including monitoring and evaluation. Improve access to funding for local actors and increase flexibility to facilitate adaptive management.

The solutions to the biodiversity, climate, and water crises are clear. With the EU Nature Restoration Regulation, a highly promising policy response has already been adopted, mandating action across multiple sectors and ecosystem types (see Klusmann et al. 2026). Yet political priorities appear to have shifted in the current EU legislative period, and maintaining the ambition of existing environmental policies is becoming increasingly challenging in light of endeavours to 'simplify', delay, or weaken their implementation (see Klusmann et al. 2026). In this context, it is more crucial than ever to uphold science-based recommendations and insist on the European Green Deal's and the EU Biodiversity Strategy's promise that the EU would lead by example to address the global biodiversity crisis.

Box 2. Practice - Scaling up wetland restoration in practice (ENCA 2023).

Wetland restoration pilot projects across Europe are already demonstrating success. To scale up implementation in practice, we need to:

- **Think long-term.** Take future climate change impacts and uncertainties into account when planning wetland management and restoration. Recognize that we will face severe climatic, hydrological, and ecological changes. Be adaptive and embrace new dynamics.
- **Think source-to-sea.** Use a systemic, integrative approach at appropriate scales (e.g., whole catchment level or landscape scale). Develop mechanisms for cross-border and cross-sector cooperation, and establish joint conservation initiatives and agreements.
- **Advance step by step.** Be ambitious in your strategic long-term vision and help develop portfolios of projects, but start with low-hanging fruits to showcase success and generate momentum.
- **Demonstrate benefits.** Assess and widely communicate the multiple socio-economic benefits of wetland restoration (including guided visits to demonstration sites). Show long-term costs and benefits of wetland NbS compared to true costs of "grey" alternatives (e.g., floodplain restoration vs. dike maintenance).
- **Enhance capacities for wetland restoration.** Invest in training programs to develop skilled personnel for planning and implementation across government agencies, NGOs, and local communities.
- **Make people part of the process.** Engage local communities as early as possible during project planning; this is key to success. Integrate local knowledge, build ownership, address trade-offs, and develop joint solutions to maximize co-benefits. Allocate sufficient resources (time, personnel, and money) for co-design processes.
- **Bring all relevant stakeholders together**. Include land users as well as actors working on nature conservation, climate change, water, flood protection, tourism, and local governments. Use well-tailored channels and formats to foster dialogues and, where appropriate, build on existing structures and mechanisms (e.g., integrated river basin management). Break silos and seize opportunities to win new allies (e.g., banks, insurers, water utilities, schools).
- **Build a business case for private landowners.** Demonstrate opportunities to generate income through sustainable wetland-use options (including effective agri-environment measures), carbon removal certificates, nature tourism, etc., while ensuring biodiversity benefits.
- **Build long-term local partnerships.** Recognize contributions and build trust, among other things, to ensure acceptance and long-term maintenance of measures.
- **Protect healthy and naturally functional wetlands.** Prioritize conserving wetlands that can withstand climate change, recognizing that it is always easier to conserve what remains than to restore what has been lost.
- **Restore free-flowing rivers.** Define, identify, and remove obsolete barriers, prioritizing biodiversity gains (e.g., restoring lateral and longitudinal connectivity along large river stretches connected to the sea). Modify barriers that cannot be removed to enable fish passage.
- **Reconnect river floodplains.** Promote large-scale projects as "blue-green infrastructure development" and prioritize them in regional land-use planning.
- **Restore coastal dynamics.** Realign defence structures that are too costly to maintain and recreate accommodation space for coastal wetlands. Restore sediment fluxes to increase the capacity of coastal habitats to cope with sea-level rise. Combine engineered and nature-based solutions where suitable (a hybrid approach; "greening the grey").
- **Restore urban wetlands.** Recognize that even small projects can yield large benefits. Plan strategically to support wider wetland functionality beyond the settlement.
- **Promote passive restoration where suitable.** Reduce human pressures in the catchment and restore connectivity and natural dynamics. Then, where appropriate, allow nature to take its course.
- **Learn and adapt.** Continuously expand our understanding of systems and contexts, restoration potentials and constraints. **Monitor and evaluate restoration outcomes**, learn from experience, and improve adaptively.

We must not underestimate, ignore, or downplay the seriousness of the environmental crisis we face. Climate change and biodiversity loss are existential threats, but their gravest impacts can still be minimized—if we act with urgency, integrity, and ambition. Protecting and restoring wetlands offers no-regret solutions, with long-term benefits that far outweigh the costs (Convention on Wetlands 2025).

Box 3. Science - Expanding the evidence base & informing decisions (ENCA 2023).

We can act on what is known. The evidence base is sound: Wetland nature-based solutions provide no-regret options for long-term sustainable management of river basins and coasts, even in a changing climate. To halt the rapid wetland loss in Europe and preserve their valuable services, we must not let residual uncertainties stall action - the costs of inaction are higher.

The following recommendations and research priorities aim to further improve the availability, uptake, and impact of wetland science for adaptive management:

- **Integration is key.** Combine social and natural science, local knowledge, riverine and coastal research, climate and biodiversity science, policy needs, and lessons learned from practice to develop well-integrated recommendations.
- **Refine models of future climate change impacts.** How will the landscape water balance be affected? Which hydrological, morphological, and ecological changes are expected? Improve context-specific understanding of threats to wetland systems. Build scenarios and models at all relevant scales.
- **Reassess nature-conservation priorities.** How will species ranges shift? Which losses of wetland habitats and species may be inevitable? How should wetland management respond?
- **Close knowledge gaps on ecological outcomes.** Improve understanding of the biodiversity benefits of specific wetland restoration methods, and better quantify climate benefits (greenhouse-gas fluxes, long-term carbon storage, water storage as a drought buffer, flood protection, etc.).
- **Strengthen evidence on socio-economic benefits.** Better quantify adaptation benefits (flood-risk reduction, coastal protection, etc.) as well as other regulating, provisioning, and cultural ecosystem services. Critically assess the long-term viability of "grey" business models under climate change, and promote green alternatives.
- **Improve understanding of socio-economic barriers.** Include trade-offs among services and stakeholder constraints.
- **Identify priority areas for wetland restoration.** Base this on integrated assessments of restoration needs and potentials, feasibility, and co-benefits, etc.
- **Improve monitoring of restoration outcomes.** Provide a comprehensive set of standardized indicators suitable for multiple scales and contexts. Complement professional monitoring with citizen science where relevant. Develop functional data infrastructure and improve data comparability across Europe.
- **Enhance data accessibility.** Develop digital platforms to present information on restoration outcomes transparently (e.g., on easily accessible maps and dashboards) so civil society can track their governments´ progress towards international restoration targets.
- **Communicate results effectively.** Avoid jargon and tailor science-based recommendations to the intended audiences.

We must accelerate action now. There is an undeniable urgency to massively scale up the protection and restoration of riverine and coastal wetlands to safeguard this key component of our natural life support system.

It is time for a transformative change for riverine and coastal wetlands in Europe.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

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Use of AI

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Data availability

All of the data that support the findings of this study are available in the main text.

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