RIVER, LAKESIDE, FLOODPLAIN AND WETLAND MANAGEMENT

WETLAND CONSERVATION AND RESTORATION

RW9

NATURE-DEMO

WWW. NATURE-DEMO.EU/

ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Rural wetland.
Image Credit: [Freepik], [n.d.], Free to use;

Wetland in an urban setting.
Image Credit: [Freepik], [n.d.], Free to use;

What is it?

Wetlands are ecosystems characterised by water-saturated or submerged soils that support plants adapted to wet conditions. They bridge aquatic and terrestrial environments, and include marshes, swamps, and bogs. Wetlands play a vital role in flood regulation, water filtration, and carbon sequestration. Wetland conservation focuses on protecting and maintaining existing wetlands, while wetland restoration aims to rehabilitate degraded or drained areas, restoring their natural functions. By reintroducing these vital functions, wetland restoration helps recover ecosystem services lost due to human activity.

Challenges this NbS addresses

- **Flood –** prevention/reduction
- **Drought –** reduction/recovery
- **Heatwaves –** reduction
- **Soil erosion –** prevention
- **Storm surges –** prevention/reduction

Primary functions and key services

(Temmerman et al., 2013; Ferreira et al., 2023)

- **Flood Risk Reduction:** wetlands absorb excess water and slowing runoff. This reduces strain on **stormwater drainage systems, roads, and bridges** can be protected from heavy rainfall, river overflow, and coastal storm surges impacts.
- **Erosion and Sediment Control:** wetlands help wash-off from heavy rainfall and vegetation stabilises soil. This protects **riverbanks, roads, and bridges** from undercutting and collapse.
- **Sedimentation control:** help trap sediment, reducing sedimentation in **hydropower reservoirs, drainage canals, and drinking water supply** systems.
- **Temperature Regulation:** act as a buffer, increasing local humidity, reducing heat stress on **roads, railways, and urban areas**.
- **Water Storage and Drought Resilience:** wetlands store and gradually release water, ensuring water availability during dry periods and help soil desiccation.
- **Wildfire Risk Reduction:** due to their high moisture content, wetlands act as natural firebreaks,protecting **power transmission lines**, **transportation networks**, and **settlements** in vulnerable regions.
- **Water Quality Improvement:** wetlands filter pollutants and excess nutrient.

Site suitability, scale and coverage

- Wetland restoration and conservation are highly effective in **low-lying landscapes, floodplains, river valleys, and coastal zones.** In urban areas, wetlands can be integrated into green spaces for stormwater management and flood mitigation.
- **Scale:** wetland-based solutions can be implemented at various scales. Larger wetlands provide regional-scale flood protection, while smaller systems are effective in localised stormwater management and water filtration.
- Applicable in **coastal, temperate, and humid climates, as well as semi-arid regions.**
- Restoration efforts are particularly relevant in agricultural zones, urban peripheries, and areas impacted by wetland degradation due to land-use change, infrastructure expansion, or drainage modification.

Environmental impacts
(EU taxonomy)

- [x] Climate change mitigation
- [x] Climate change adaptation
- [x] Sustainable use and protection of water and marine resources
- [ ] Transition to a circular economy
- [x] Pollution prevention and control
- [x] Protection and restoration of biodiversity and ecosystems.

RIVER, LAKESIDE, FLOODPLAIN AND WETLAND MANAGEMENT

WETLAND CONSERVATION AND RESTORATION

RW9

NATURE-DEMO

WWW. NATURE-DEMO.EU/

Ecosystem services

(Xiong et al., 2003; Mitsch et al., 2013; Ferreira et al., 2023)

- **Water Filtration:** removes pollutants, excess nutrients, and sediments, improving downstream water quality.
- **Carbon Sequestration:** stores CO_2 in vegetation and soils, acting as a long-term carbon sink.
- **Groundwater Recharge:** enhances aquifer replenishment and maintains water availability during droughts.
- **Biodiversity Support:** provides critical habitat for diverse plant and animal species.
- **Temperature Regulation:** moderates local climate through evapotranspiration, reducing heat extremes.
- **Erosion Control:** stabilises soils, prevents shoreline and streambank erosion, and reduces sediment loads.
- **Flood & Drought Buffering:** absorbs excess rainfall to mitigate flooding and retains water for dry periods.
- **Recreation & Culture:** supports tourism, education, and cultural heritage.
- **Nutrient Cycling:** promotes decomposition and nutrient retention, preventing eutrophication.

Cost-benefit profile

In the Brdy region, a population of Eurasian beavers naturally constructed a series of dams, creating wetlands that provided effective flood mitigation, water retention and enhanced biodiversity. This natural intervention saved the Czech government approximately $1.2 million in planned infrastructure costs for artificial dams (Galvin, 2025).

CAPEX: Restoration Activities: include site preparation, planting native vegetation, hydrological engineering, and soil restoration. Costs can range from $2,000 to $20,000 per hectare, depending on the complexity and size of the project (Keating et al 2010).

Conservation Costs: involves land acquisition, protection measures, and maintenance. Costs vary widely, with typical expenses around $100–$5,000 per hectare annually.

OPEX: Long-term management to ensure ecosystem health and functionality can cost $100–$500 per hectare annually (Keating et al., 2010). Nature-based solutions (NbS) also offer decentralized treatment options with added socio-environmental benefits—particularly valuable for improving conditions in underserved urban areas. Research on Horizontal Sub-Surface Flow Constructed Wetlands (HSSF-CW) shows their cost-efficiency as complementary, low-cost sewage treatment. A cost-benefit analysis (CBA), using shadow prices of phosphorus, nitrogen, and BOD as proxies for environmental value, quantified the benefits of CWs in monetary terms. This approach demonstrates the cost-effectiveness of NbS in similar contexts (Castaner et al., 2020).

Main components

- **Vegetation:** native wetland species such as reeds, sedges, and rushes to stabilise soil, which improve filtration, and enhance biodiversity.
- **Bank and Shoreline:** designs could include bioengineering techniques (see SE and RW factsheets), such as coir logs, willow staking, or natural barriers that protect wetland edges from degradation processes (erosion).

Additional design considerations:

- **Conceptual design should consider aspects of restoration of hydrological connectivity and sediment dynamics, to enhance regulation of** water levels, soil moisture, sediment influx, soil re-wetting and microbial habitat. In certain circumstances, the removal of artificial hydraulic control elements could be considered, which may benefit floodplain hydrological connectivity.

Wetland conservation and restoration.
Image Credit: [Freepik], [n.d.], Free to use

Example of installation

- **Emiquon Wetland Restoration Project (SER, 2007)**
- **Implemented by:** The Nature Conservancy
- **Location:** Illinois, USA
- **Description and results:** the Emiquon Wetland Restoration Project, launched in 2007 by The Nature Conservancy, restored 2,873 hectares of former farmland along the Illinois River into a functional floodplain wetland Efforts included planting 180,000 trees, sowing 3,628.74 kilograms of native seeds, and reintroducing native fish while removing non-native species. The project has significantly revitalised biodiversity, improved ecosystem services, and re-established natural hydrological processes, making Emiquon a model for large-scale wetland restoration (SER, 2007).

References

Castañer, C.M., Bellver-Domingo, Á. & Hernández-Sancho, F. (2020) Environmental and Economic Approach to Assess a Horizontal Sub-Surface Flow Wetland in Developing Area. Water Resour Manage 34, 3761–3778. https://doi.org/10.1007/s11269-020-02629-x

Ferreira, C. S., Kašanin-Grubin, M., Solomun, M. K., Sushkova, S., Minkina, T., Zhao, W., & Kalantari, Z. (2023). Wetlands as nature-based solutions for water management in different environments. Current Opinion in Environmental Science & Health, 33, 100476.

Freepik (n.d.). Small lake surrounded by greenery. Retrieved from: https://www.freepik.com/free-photo/beautiful-shot-small-lake-surrounded-by-greenery-cloudy-sky_12305328.htm (accessed 11.03.2025)

Freepik (n.d.). Wetland in urban setting. Retrieved from: https://ebe.uct.ac.za/cpd/events/urban-hydrology-modelling-urban-drainage (accessed 11.03.2025)

Freepik (n.d.). Wetland restoration. Retrieved from: https://www.freepik.com/free-photo/bharatha-river-with-little-water_1277898.htm#fromView=keyword&page=1&position=16&uuid=0efd5a6b-8cc1-44b6-a410-06320bf-8d986&query=Wetland+Restoration (accessed 11.03.2025)

Galvin, S. (2025). Beavers save european country 1 million on infrastructure project. Retrieved from: https://nypost.com/2025/02/15/world-news/czech-republic-beavers-save-european-country-1-million-on-infrastructure-project/?utm_source=chatgpt.com (accessed 10.03.2025)

Keating, K., Pettit, A., & Rose, S. (2010). Cost estimation for habitat creation: Summary of evidence. Department for Environment, Food & Rural Affairs (DEFRA). Retrieved from: https://assets.publishing.service.gov.uk/media/6034ef5ee90e0766033f2ea7/Cost_estimation_for_habitat_creation.pdf (accessed 26.12.2024)

Mitsch, W. J., Bernal, B., Nahlik, A. M., Mander, Ü., Zhang, L., Anderson, C. J., ... & Brix, H. (2013). Wetlands, carbon, and climate change. Landscape ecology, 28, 583-597.

SER (2007). Emiquon Wetland Restoration Project. Retrieved from: https://nicholasinstitute.duke.edu/sites/default/files/projects/NbS-roadmap/case-studies/SER77369.pdf (accessed 10.03.2025)

Temmerman, S., Meire, P., Bouma, T. J., Herman, P. M., Ysebaert, T., & De Vriend, H. J. (2013). Ecosystem-based coastal defence in the face of global change. Nature, 504(7478), 79-83.

Xiong, S., Johansson, M. E., Hughes, F. M., Hayes, A., Richards, K. S., & Nilsson, C. (2003). Interactive effects of soil moisture, vegetation canopy, plant litter and seed addition on plant diversity in a wetland community. Journal of Ecology, 91(6), 976-986.