RIVER, LAKESIDE, FLOODPLAIN AND WETLAND MANAGEMENT

FLOODPLAIN RESTORATION

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ADDRESSED HAZARDS

PROTECTED CRITICAL INFRASTRUCTURE

Restored floodplain landscape of the Deer Park Obelisk in the Lednice–Valtice area, showcasing revitalised oxbow lakes. This restoration demonstrates effective landscape-scale flood mitigation by preventing flooding of nearby roads and agricultural fields (Biennal Internacional De Paisatge, 2019). Image Credit: [Design Team, Biennal Internacional De Paisatge Barcelona], [2019]. Used with permission.

What is it?

Floodplain restoration is a nature-based solution that rehabilitates the natural hydrological, ecological, and geomorphological functions of floodplains to reduce flood risks and enhance ecosystem resilience. By reconnecting rivers with their floodplains, restoring vegetation, and allowing dynamic water flows, restored floodplains absorb and temporarily store excess water, slowing floodwaters and reducing peak flows. This natural water retention reduces pressure on engineered flood defences such as levees, dams, and drainage systems, while also protecting infrastructure like roads and bridges from erosion, sedimentation, and flood-related damage. Additionally, restored floodplains enhance groundwater recharge, improve water quality, and provide habitat for biodiversity, contributing to long-term climate resilience Kousky and Walls, 2014; (Serra-Llobet et al., 2022)

Challenges this NbS addresses

- **Floods –** prevention/reduction: mitigates flood peaks by allowing water to spread naturally.
- **Erosion –** prevention/reduction: by stabilising riverbanks and controlling sediment transport, floodplain restoration minimises erosion.
- **Heatwaves –** reduction/recovery: increased vegetation moderates local temperatures and mitigates urban heat island effects.
- **Drought –** prevention/reduction: restored floodplains enhance water retention and groundwater recharge, improving water availability during dry periods.
- **Wildfires –** prevention: moist, resilient floodplain ecosystems are less prone to wildfires, contributing to reduced fire risk.
- **Water Pollution –** prevention/reduction: natural filtration processes remove pollutants and sediments from runoff, improving water quality.
- **Climate Change –** mitigation: floodplain restoration sequesters carbon in soils and vegetation, supporting broader climate change mitigation efforts.

Primary functions and key services

- **Flood Mitigation:** floodplain restoration increases water storage and delays peak flows, reducing the severity of pluvial, fluvial, and coastal floods. This protects **roads, bridges, and flood control systems** such as **dams** and **spillways** from water damage.
- **Erosion and Sediment Control:** by stabilising banks and trapping sediments, restored floodplains minimise sheet, rill, and gully erosion. This protects **adjacent structures, drainage systems, and water supply reservoirs** from sediment accumulation and structural damage.
- **Water Quality Enhancement:** natural filtration within floodplains removes pollutants and excess nutrients from runoff, ensuring cleaner waterways. This reduces strain on **water treatment facilities** and improves **public water supplies**.
- **Drought Resilience:** floodplains enhance groundwater recharge and maintain soil moisture, improving water availability during dry periods. This supports agricultural irrigation, **urban water networks**, and **reservoirs**.
- **Temperature Regulation:** the vegetation in floodplains moderates local microclimates, reducing heat extremes. This helps lessen thermal stress on **buildings** and **transportation systems**.
- **Wildfire Risk Reduction:** healthy floodplains are less prone to wildfires, reducing the risk of fire spread and protecting nearby communities, **electric power lines**, and **communication infrastructure**.
- **Debris Flow Mitigation:** restored floodplain slopes absorb and dissipate the energy of debris flows, protecting **roads, railways**, and **residential areas** from associated damages.
- **Overall Ecosystem Resilience:** enhanced floodplain connectivity supports broader landscape resilience, indirectly reducing the vulnerability of infrastructure to multiple hazards and facilitating faster recovery after extreme events.

Site suitability, scale and coverage

Floodplain restoration is best suited for low-lying areas along rivers, streams, and coastal zones where flooding, erosion, and sediment deposition are common. The following considerations can be made:

- **Infrastructure Integration:** regions where water quality, flood risk management, and bank stabilisation are critical, protecting nearby roads, bridges, and drainage systems.
- **Scalable Implementation:** projects can range from small tributary restorations to large-scale river basin interventions.
- **Tailored to Local Conditions:** designs are customised based on local hydrology, soil type, and flood frequency to maximise water retention, sediment capture, and overall resilience.

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Ecosystem services

- **Carbon sequestration:** CO_2 capture and storage in biomass increases significantly, especially with trees, shrubs, and reeds. Rewetting soil enhances CO_2 capture to higher, sustained levels, creating valuable carbon sinks.
- **Biodiversity support:** restored floodplains provide habitat for a wide range of plant and animal species (Turkelboom et al., 2021).
- **Water quality improvement:** natural filtration processes in restored floodplains help purify water.
- **Nutrient cycling:** floodplains facilitate nutrient retention (Perosa et al., 2021) and cycling, enhancing soil fertility and supporting plant growth.
- **Cultural and recreational benefits:** restored floodplains offer space for outdoor recreation, and cultural activities, and enhance the wellbeing of local communities (Perosa et al., 2021).
- **Groundwater Recharge:** promote water infiltration, enhancing the recharge of groundwater reserves and sustaining water supplies during dry periods.
- **Microclimate Regulation:** dense vegetation moderates local temperatures and humidity, creating a more stable and cooler microclimate.

Cost-benefit profile

Floodplain restoration is a cost-effective alternative to traditional flood control measures, reducing the need for expensive levees, dams, and drainage infrastructure while providing long-term resilience. By absorbing and storing floodwater, restored floodplains lower flood damage costs to infrastructure, homes, and businesses. Additionally, they enhance water quality, recharge groundwater, and support biodiversity, offering economic, environmental, and social benefits. Studies show that the benefits of floodplain protection outweigh implementation costs, particularly in areas prone to recurrent flooding, making it a sustainable investment for climate adaptation and disaster risk reduction (Schiff et al., 2015).

The costs associated with floodplain restoration projects in Europe vary significantly based on factors such as land acquisition expenses, project scale, and regional economic conditions. Reported costs range from approximately €9,000 to €720,000 per hectare. For instance, the Sigma plan floodplain restoration project in the Scheldt Estuary reported land acquisition costs of €700,000 per hectare for residential areas and €10,000 per hectare for high-value crops (EU-NWRM, 2013). Additionally, a comprehensive analysis of European river restoration projects indicated that the average cost of restoring one hectare of river was approximately €310,000, with a range from €99,000 to €353,000 per hectare. Excluding outliers, the average unit restoration cost was around €195,000 per hectare (Szałkiewicz et al., 2018).

Environmental impacts
(EU taxonomy)

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

Main components

- **Hydrological Connectivity:** reconnecting rivers with their floodplains restores natural flooding processes, improving water distribution, reducing channelisation, and enhancing groundwater recharge.
- **Levee Removal:** modifying or removing levees restores natural flow to oxbows, wetlands, and side channels, allowing floodplains to function as intended.
- **Drainage Modification:** adjusting or eliminating artificial drainage systems minimises excessive water diversion and re-establishes natural hydrological patterns.
- **Topography:** varied elevations—such as terraces, depressions, and side channels—facilitate water retention, slow floodwaters, and support diverse habitats.
- **Vegetation & Soil Permeability:** native riparian and floodplain vegetation stabilise soil, enhance infiltration, and improve water retention, reducing flood peaks and erosion.

Example of installation

- **Project:** Revitalisation of the Elster-Luppe Floodplain
- **Location:** Leipzig and Schkeuditz, Saxony, Germany
- **Implemented by:** Cities of Leipzig and Schkeuditz in collaboration with NABU Sachsen, the Helmholtz Centre for Environmental Research (UFZ), and the University of Leipzig (Lebendige Luppe, 2012).
- **Description and results:**
  - Reconnected former watercourses of the Luppe to restore natural floodplain functions
  - Initiated phased restoration of a 16 km long stretch in the southern area, reintroducing vital floodwater into the floodplain
  - Improved water distribution and groundwater recharge, counteracting drying trends in the floodplain
  - Enhanced biodiversity and ecosystem services, while raising public awareness of the floodplain's ecological and economic importance

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