# Plants in the City: Wetlands

Wetlands are areas of land that, due to their position in the landscape, are periodically or continuously wet throughout the year. They form in response to wet conditions and serve to control water flows, as well as to improve or maintain water quality. Critical ecosystem services provided by wetlands include:

- **Protection and improvement of water quality**
- **Regulation of water flows – storage of floodwaters and maintenance of water flow during dry periods**
- **Provision of habitat for fish and wildlife**

Wetlands also provide recreational and educational opportunities for people of all ages. The ecological importance of wetlands, as well as their aesthetic and recreational appeal, highlight the need for wetland conservation, restoration and construction. In the last 300 years, 87% of the world's wetlands have been lost to land degradation with 54% of wetland loss occurring since 1900[1].

***Water Quality Protection and Improvement***

Wetlands filter incoming water and can capture and store or transform many environmental pollutants, making wetland function in the landscape similar to that of kidneys in the human body. The processes via which wetlands remove pollutants vary depending on the specific wetland type or design and the pollutant(s) being removed. Several different physical, chemical and biological processes may be at work simultaneously to remove pollutants from waters entering wetlands, such as:

| **Pollutant** | **Removal mechanism** | | |
|---|---|---|---|
| | **Physical** | **Chemical** | **Biological** |
| Carbonaceous Organic Matter (BOD†) | Sedimentation | | Microbial degradation (aerobic and anaerobic) |
| Nitrogen | Adsorption | Nitrification<br>Denitrification<br>Ammonia volatilisation | Plant uptake<br>Microbial uptake |
| Phosphorus | Adsorption<br>Filtration<br>Sedimentation | Precipitation | Plant uptake<br>Microbial uptake |
| Pathogens | Sedimentation<br>Filtration | UV radiation | Natural die-off<br>Excretion of antibiotics from macrophytes roots<br>Predation |
| Heavy Metals | Sedimentation<br>Adsorption | Precipitation | Plant uptake<br>Microbial uptake |
| Organic Contaminants | Adsorption<br>Sedimentation | Volatilisation<br>Photolysis | Plant uptake<br>Microbial degradation |

[1] Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), 2018. The IPBES assessment report on land degradation and restoration. Montanarella, L., Scholes, R., and Brainich, A. (eds.). Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany. 744 pages. https://www.ipbes.net/assessment-reports/ldr

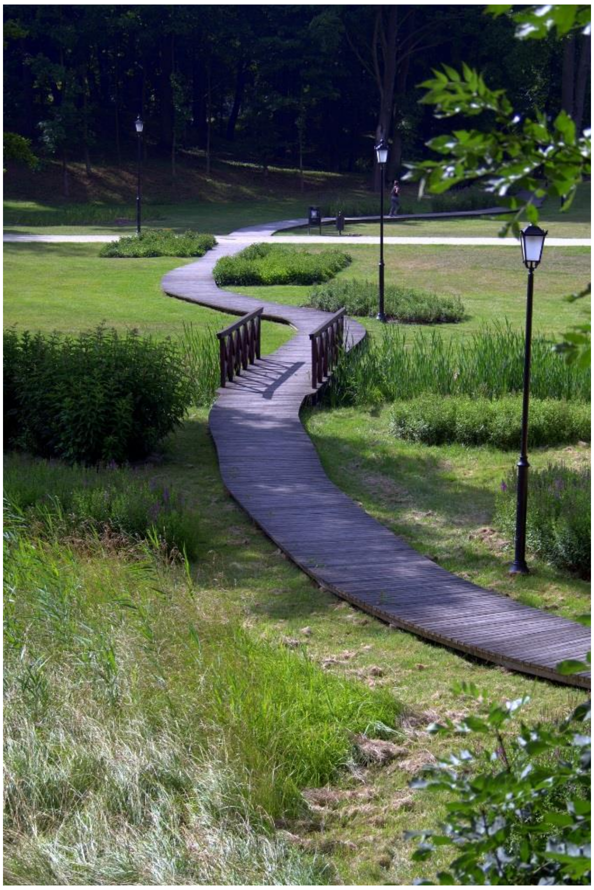
| | | | |
|---|---|---|---|
| | | Hydrolysis | |
| Suspended Solids | Sedimentation<br>Filtration | | |

† *BOD = biochemical oxygen demand, a measure of how much oxygen is needed by microbes to break down organic matter*

Constructed wetlands are specifically designed to suit local environmental conditions as well as the type and quality of the water to be treated. Constructed wetlands can range from small, single-house installations for runoff filtration, to larger wetlands for treatment of domestic or industrial wastewaters from whole communities, or even very large-scale wetland systems that act as filters for entire catchments. Constructed wetlands are most commonly used to treat the following types of water:

- Municipal wastewater, for example polishing of treated sewage effluent;
- Landfill leachate including removal of metals, organic compounds and nitrogen;
- Industrial wastewater, such as removal of metals and nutrients from metallurgic wastewater and removal of nutrients and organics from tannery wastewater;
- Mine drainage, for example neutralisation of acidic drainage and/or removal of metals;
- Agricultural runoff;
- Agricultural wastewater such as swine, dairy, livestock, and winery wastewaters;
- Stormwater runoff; and,
- Polluted surface water in rivers and lakes.

***Regulation of Water Flows***



Wetlands, whether natural or constructed, act as a hydrological buffer by slowing the flow of water as it moves across the landscape. By capturing, storing and slowly releasing rainfall and snowmelt, wetlands reduce flooding, flood hazards and the associated costs, and reduce soil erosion. Wetlands also help to maintain base flows during dry periods.

The water flow regulation function of wetlands may become increasingly important in the future as climate change intensifies the global water cycle and demand for freshwater increases to support the world's growing population. Periodic flooding frequently coincides with over-exploitation of available freshwater resources and water scarcity due to temporal misalignment between water supply and demand. Flood and drought events are expected to increase both in frequency and in severity in the future. Parts of Eastern Europe and Scandinavia are among those considered subject to the greatest flood risk. At the same time, meteorological and hydrological droughts are expected to increase in frequency, duration and severity across most of Europe, but particularly in South-Eastern Europe[2].

Their role in the natural ecosystem as regulators of water flows means that conserving, restoring or constructing wetlands contributes to reducing disaster rick. From 1980-2016, EEA member countries experienced total economic

[2] EEA 2017. Climate change, impacts and vulnerability in Europe 2016. Report No 1/2017.

losses of €410 billion attributed to climate-related extremes, with more than one-third of losses due to flood and drought[3]. The predicted increase in heavy precipitation events will yield an estimated five-fold increase in mean annual economic losses due to flooding across Europe, increasing from an average cost of €4.6 billion (2000-2012) to approximately €23.5 billion by 2050[4].

***Provision of Habitat + Recreational Opportunities***

Wetlands can contribute a great deal to biodiversity enhancement by providing essential habitat for many species of plants, fish, mammals, birds, amphibians, reptiles, invertebrates and other wildlife. Hundreds of different species of plants and animals depend on wetlands for their survival, with many using wetlands as nurseries for their young. A variety of factors can influence the diversity of wildlife and benefit of wetlands on the surrounding environment, such as wetland size, water level control, variation in water depth across the wetland, the diversity of wetland plants and the length of edges between plant zones.

| **Wildlife Habitat Considerations** | |
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| Design flexibility to control water levels | Water level control is the principal tool available to control pant growth and water quality in treatment wetlands |
| Incorporation of deep-water zones without creating hydraulic short circuits | Deep water zones serve multiple purposes including improved hydraulic mixing, increased hydraulic residence time, a sump for solids storage, and perennial habitat for fish and ducks |
| Utilization of a diversity of plant species | Polyculture will provide greater reliance to pests and operational upsets |
| Utilization of plant species with known benefit to wildlife species | Each plant species has benefits to different wildlife species/groups |
| Incorporation of vertical structure by planting herbaceous, shrub, and tree strata | Structural diversity equates to habitat variety for feeding, roosting, and nesting wildlife |
| Incorporation of horizontal structure by use of littoral shelves and benches, as well as deep zones | Plant diversity is promoted by varying water regimes that correspond to specific plant preferences |
| Inclusion of structural density by use of irregular shorelines | Irregular shorelines and “fingers” provide visual cover and greater ecotone (edge) length |
| Inclusion of islands in open water areas | Islands provide a refuge for birds and reptiles in wetlands where predation is a potential problem |
| Installation of dead snags and nesting platforms | Nesting habitat is frequently limiting in newly constructed wetlands |

[3] EEA 2018. National climate change vulnerability and risk assessments in Europe, 2018. Report No 1/2018.
[4] Jongman et al. 2014. *Nature Climate Change* 4:264-8.

The species richness typical of wetlands contributes to their recreational and aesthetic appeal. One of the more critical aspects of wetland conservation, restoration or construction is determining the optimal level of accessibility that supports a high level of ecosystem service provision as well as strongly supporting recreational and educational opportunities. Co-creating wetland conservation, restoration or construction plans with stakeholders can help to ensure that the factors of greatest significance to the local population are considered when designing constructed wetlands to be beneficial for both wildlife and recreational use. Examples of considerations include:

| **Recreational & Educational Use Considerations** | |
|---|---|
| Provision of parking and safe access to wetlands | People will find wetlands appealing if they have access and feel safe |
| Provision of boardwalks and observation points | Boardwalks provide opportunity for people to get closer to the wetland environment without damaging the environment |
| Incorporation of interpretive displays | Interpretive displays provide opportunity for the public to learn more about the structure and function of wetlands |
| Stakeholder co-creation<br><br>Collection of public comment and incorporation in design/operation modifications | Stakeholders will provide helpful suggestions for wetland design and ongoing improvements that increase the site's recreational / amenity value |
| Stakeholder co-implementation | Working together to create a recreational space enhances stakeholders' sense ownership and contributes to community building |
| Provision of blinds for wildlife study | Observing wildlife without disturbing it will optimise both habitat and public uses |
| Establishment of accessible monitoring points | Treatment wetlands provide excellent classrooms for environmental study |
| Provision of monitoring records for public | Providing water quantity and quality information, along with information about species richness and diversity, provides evidence of the value of wetlands |