

Greening the Danube Region

Nature-based Solutions for Wastewater and **Stormwater**
Management in Small Settlements

Webinar

19 October 2026, 13:30 – 15:00 (CET)

Presenter

Matej Radinja, Dr.

Stormwater challenges in (small) settlements

- **Stormwater quality → pollution of the receiving water bodies**

SWO in EU represent¹: 126 mio PE / 708.8 mio PE; 17.8 % of total load and 66 % of the remaining untreated load.

- **Extreme weather events (floods and droughts)**

Climate change

- **Depleting water resources**

Over-extraction & droughts → alternative water resources

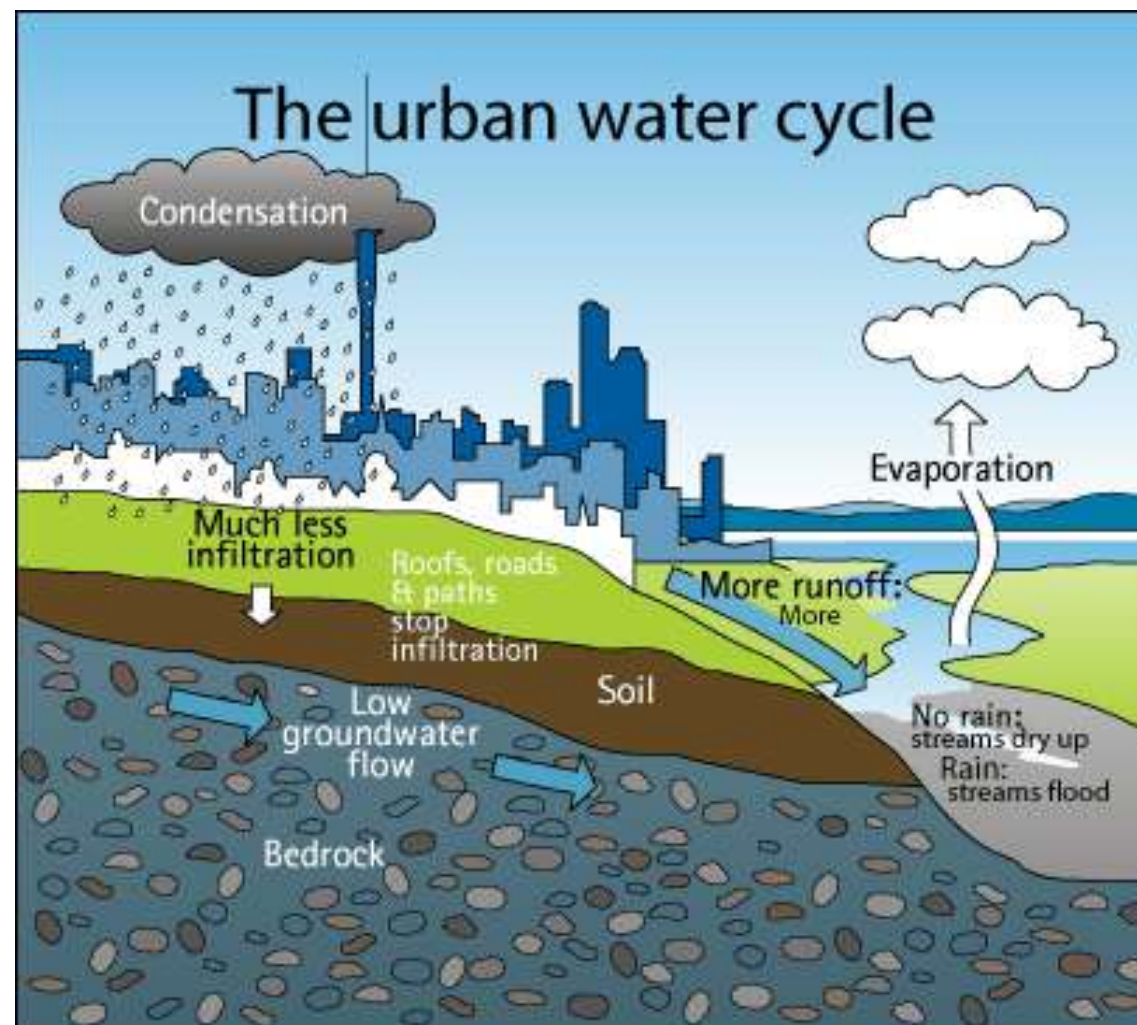


¹[Impact Assessment_Proposal for UWWTD recast_2022](#)

*Impacts of Combined Sewer Overflow (CSO)
in Ljubljana, Slovenia.*

NbS for stormwater management

- Use NBS to restore hydrological processes typical for natural water cycle.



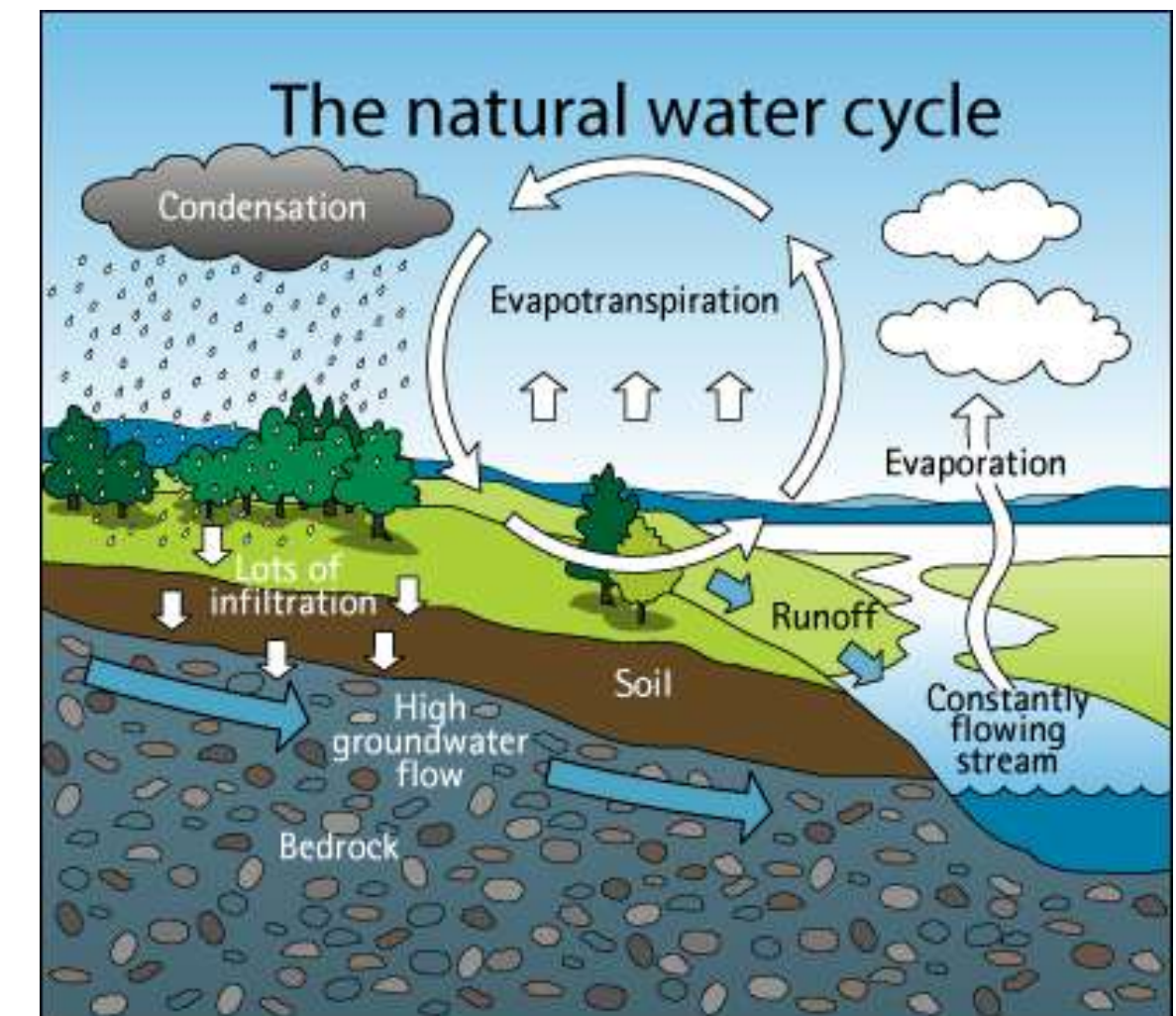
Implement NBS

↑ infiltration
(groundwater recharge)

↑ evapotranspiration

↑ treatment
(mechanical and biological)

↓ surface runoff



D-CLEAN BIORETENTION SYSTEMS

- **Engineered, shallow landscaped depressions.**
- Designed to **manage and treat stormwater runoff** from surrounding impervious surfaces.
- **Runoff temporarily pools on the surface** before filtering down thorough filtering media.



Reduce stormwater runoff and improve water quality; easily adaptable to urban layouts.



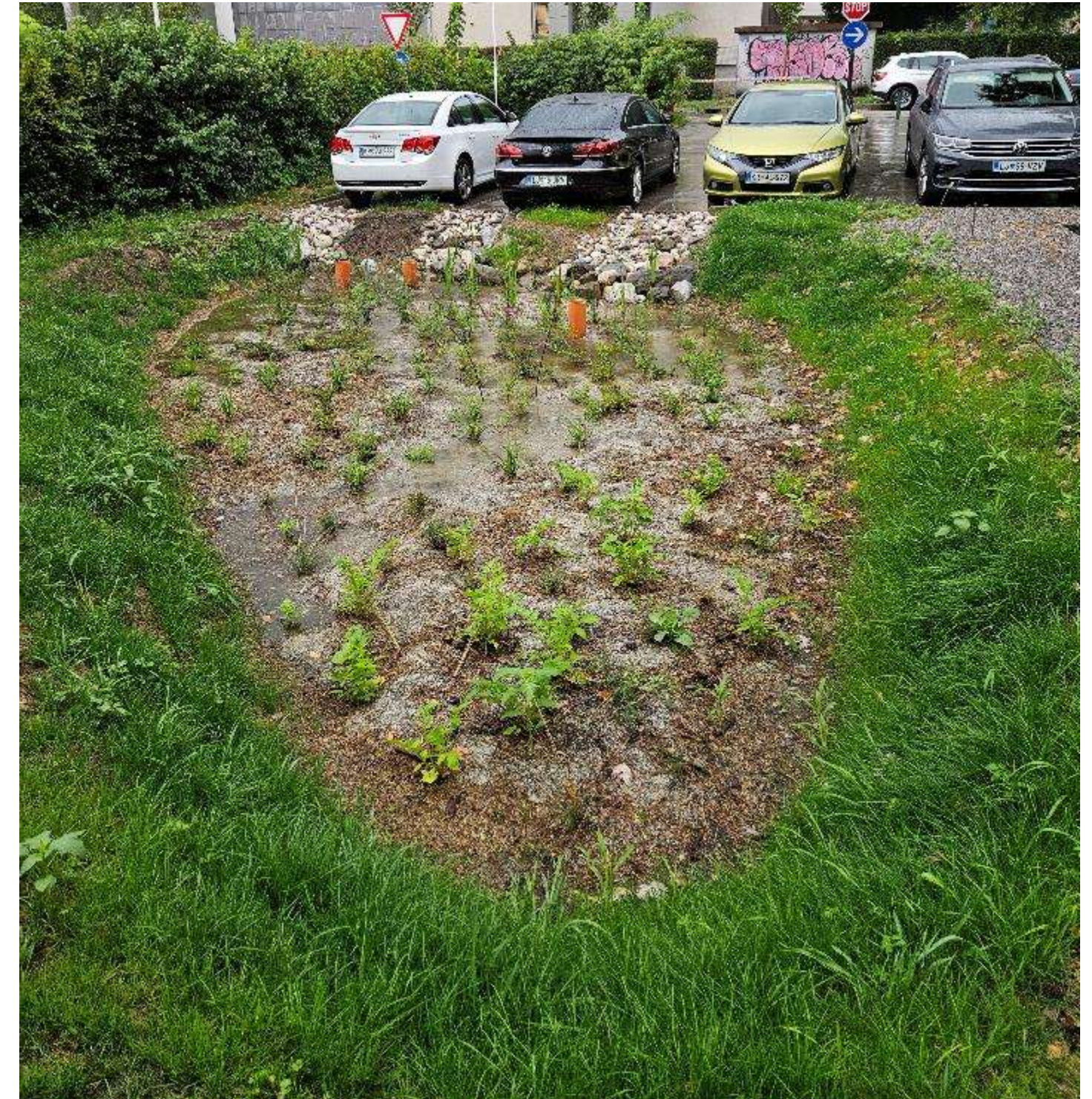
Often limited by site constraints such as soil permeability and requires a specific sand or aggregate mix

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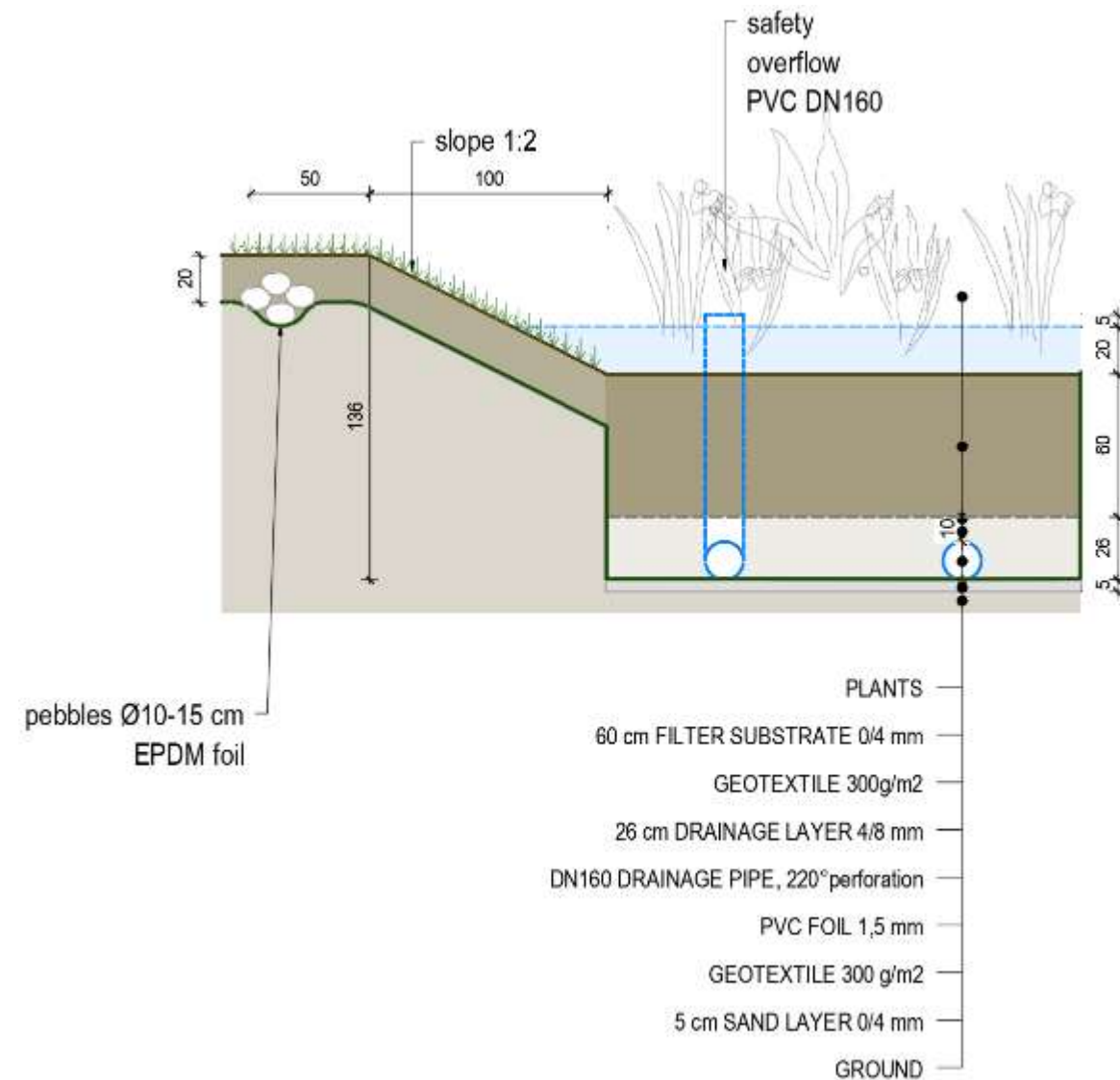
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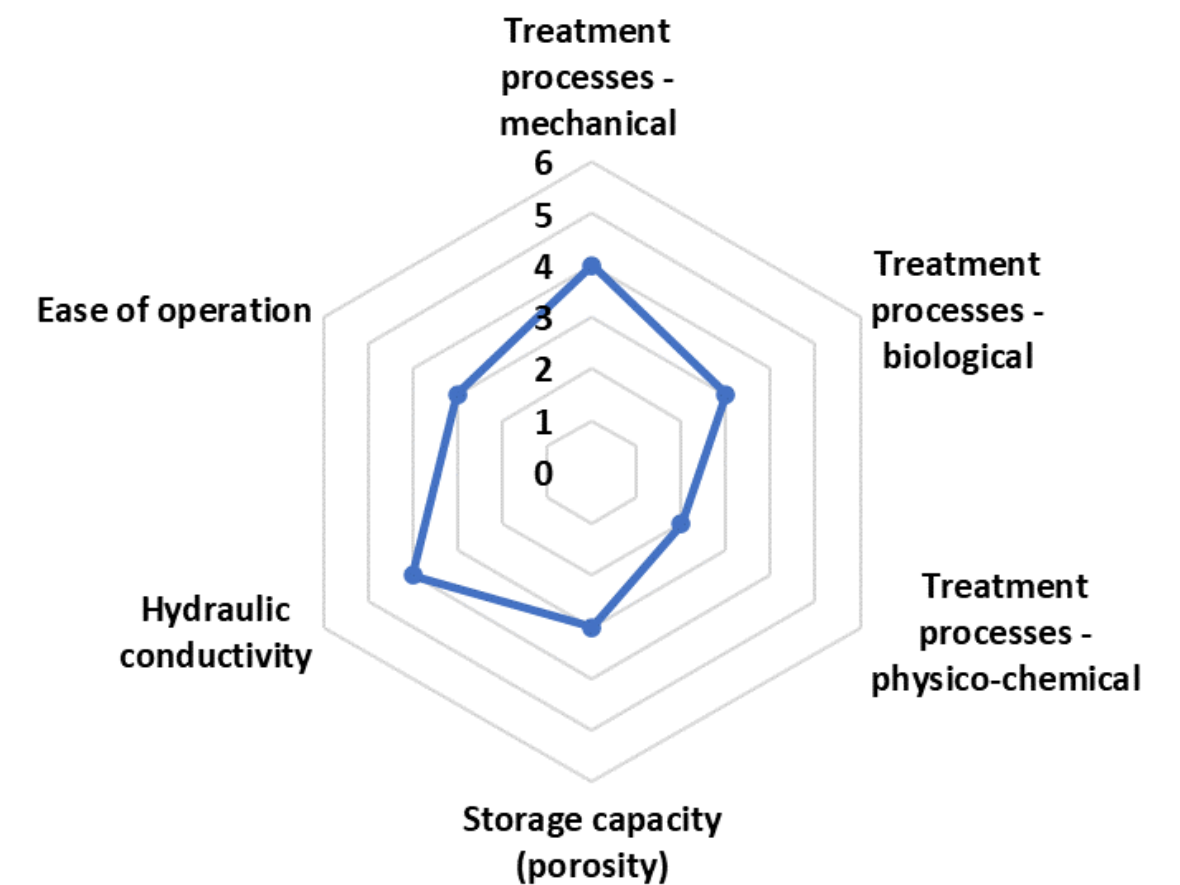


Stormwater bioretention system at the Faculty of Civil and Geodetic Engineering; University of Ljubljana; Slovenia.

D-CLEAN BIORETENTION SYSTEMS



Cross-section of a bioretention system at the Faculty of Civil and Geodetic Engineering; University of Ljubljana; Slovenia.



Co-benefits

High: Flood mitigation, CSO mitigation

Medium: Biodiversity (flora and fauna), temperature regulation, carbon sequestration, aesthetic value, pollination

D-CLEAN RAIN GARDEN

- **A simple** form of bioretention system (less technical).
- **Small-scale** systems designed to capture runoff from a **single property**.



Simple, low-cost systems for stormwater management that manage stormwater at its source



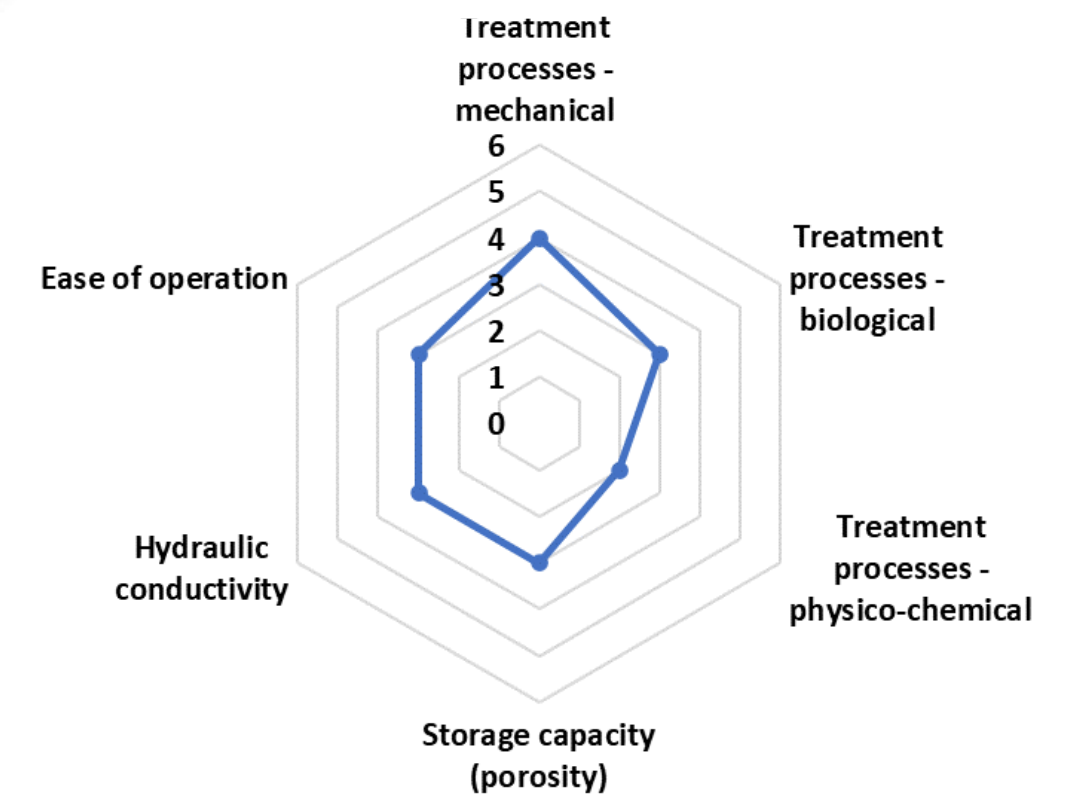
They have limited hydraulic capacity and may overflow during heavy rainfall events

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Co-benefits

High: Flood mitigation, CSO mitigation

Medium: Biodiversity (flora), temperature regulation, aesthetic value, pollination

D-CLEAN INFILTRATION BASIN

- Shallow, **flat bottomed landscape depressions** designed to collect surface water runoff and temporarily hold it while it soaks into the ground.
- Local **groundwater recharge points**.
- Easy to maintain.



*Enable groundwater recharge;
no structure or fill required.*



*Only suitable where permeable
soils exist and not appropriate
for contaminated sites or in
close proximity to buildings*

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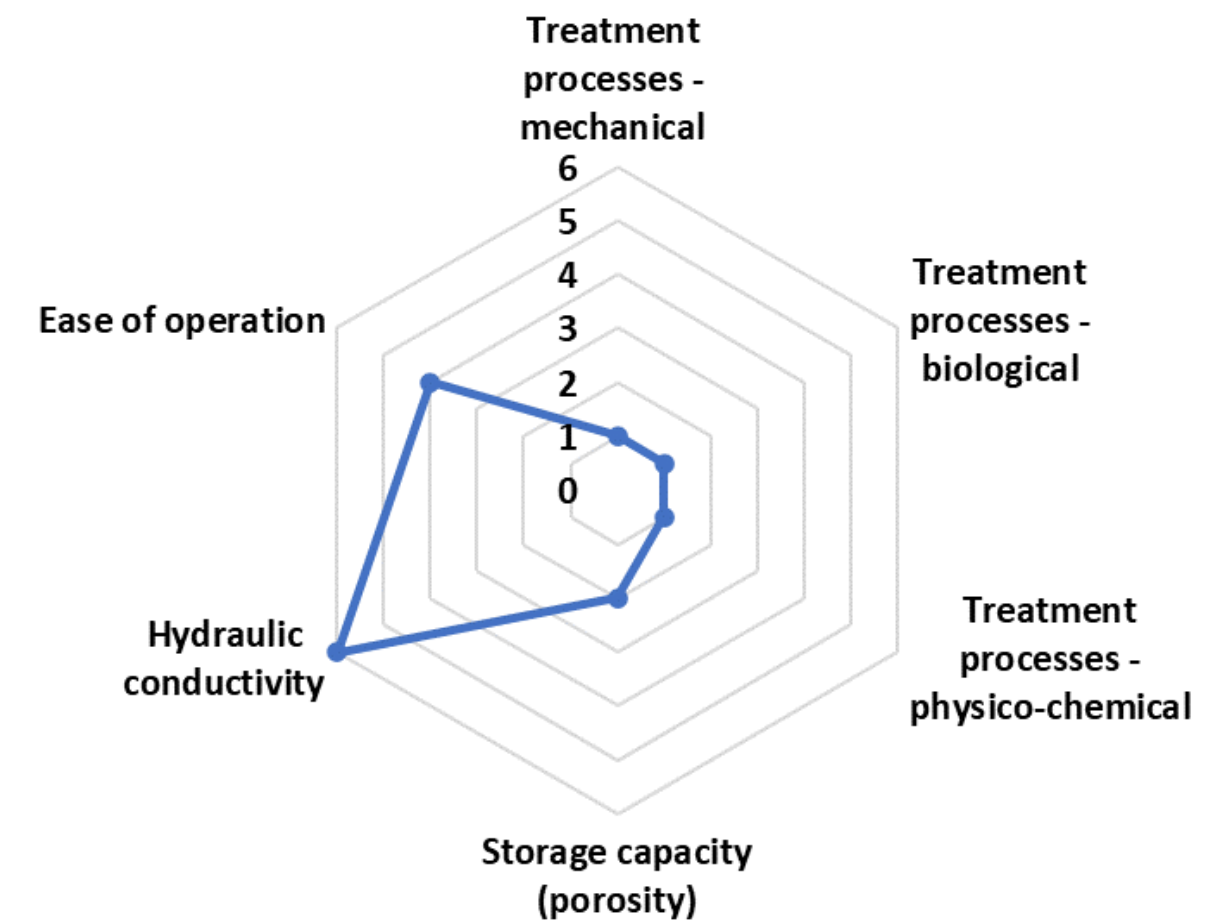


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Infiltration basin at P+R Stanežiče, Ljubljana, Slovenia.



Co-benefits

High: Flood mitigation, CSO mitigation

Medium: Biodiversity (flora), temperature regulation, aesthetic value, pollination

D-CLEAN INFILTRATION TRENCH

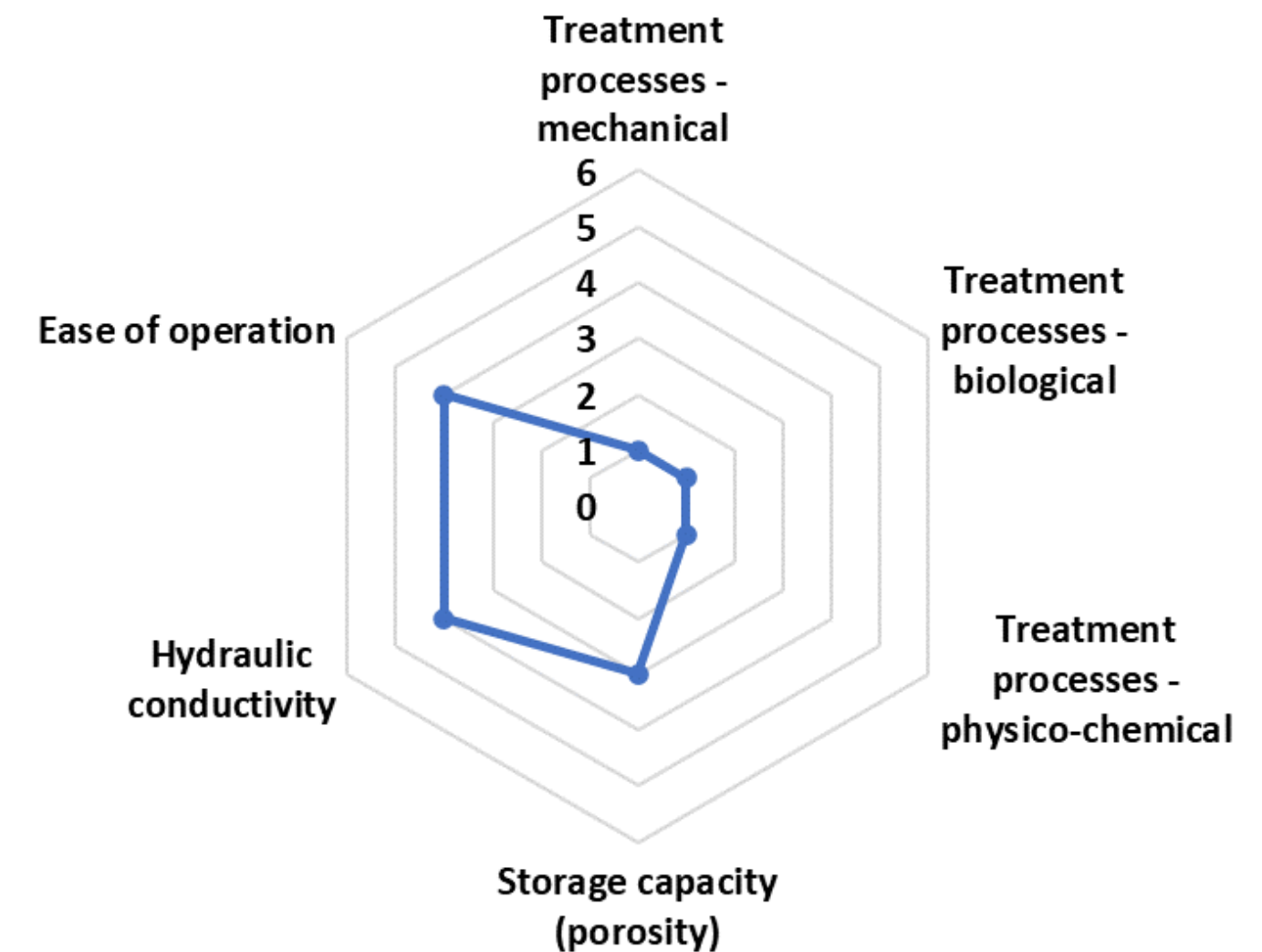
- A **linear excavation filled with clean aggregate**.
- It captures surface water runoff and temporarily stores it in the **void space** of the fill as it **infiltrates** through the sides and base into the surrounding native soil.



Minimal land intake; effective across variable soil profiles.



Highly susceptible to clogging from fine sediment: effective pre-treatment is necessary; monitoring wells are essential



Co-benefits

High: Flood mitigation, CSO mitigation

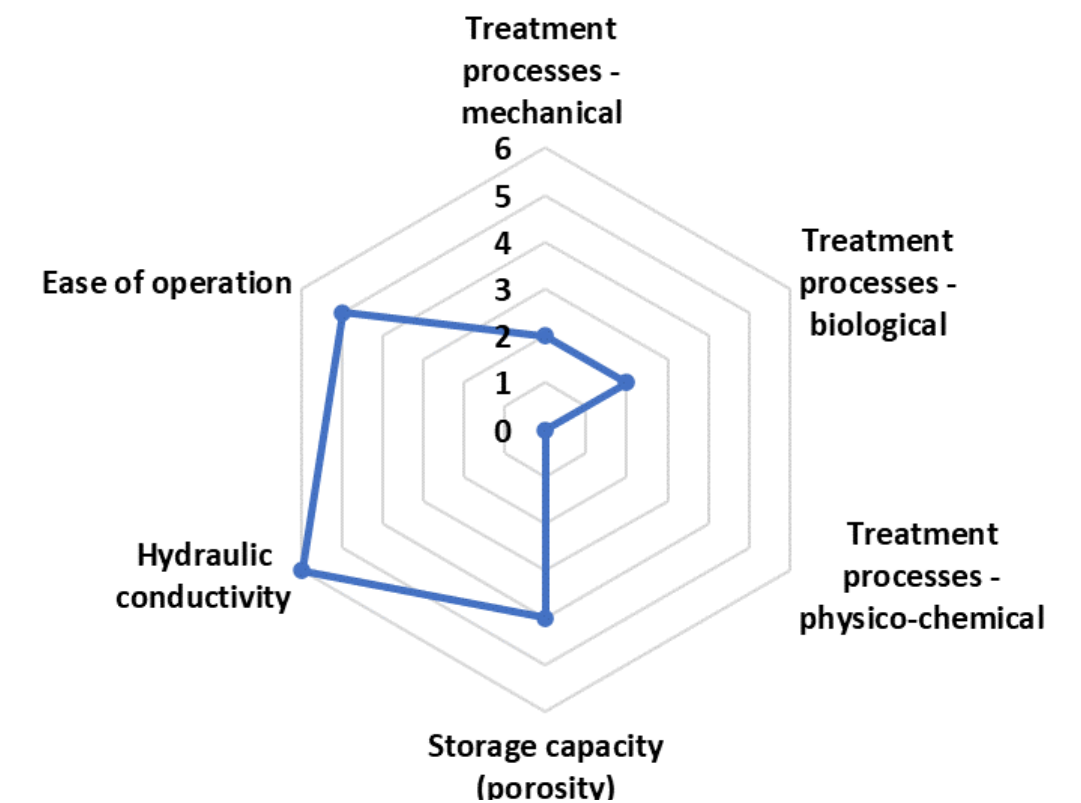
Medium: Biodiversity (flora), temperature regulation, aesthetic value

D-CLEAN DRY DETENTION BASIN

- Also known as detention ponds or dry ponds.
- Engineered stormwater depressions designed to **temporarily store runoff during rainfall events and release it at a controlled rate.**
- **Completely dry under normal** conditions and only fills up during and immediately after a storm.
- Low-effort solution.



Dry detention basin in Celje, Slovenia.

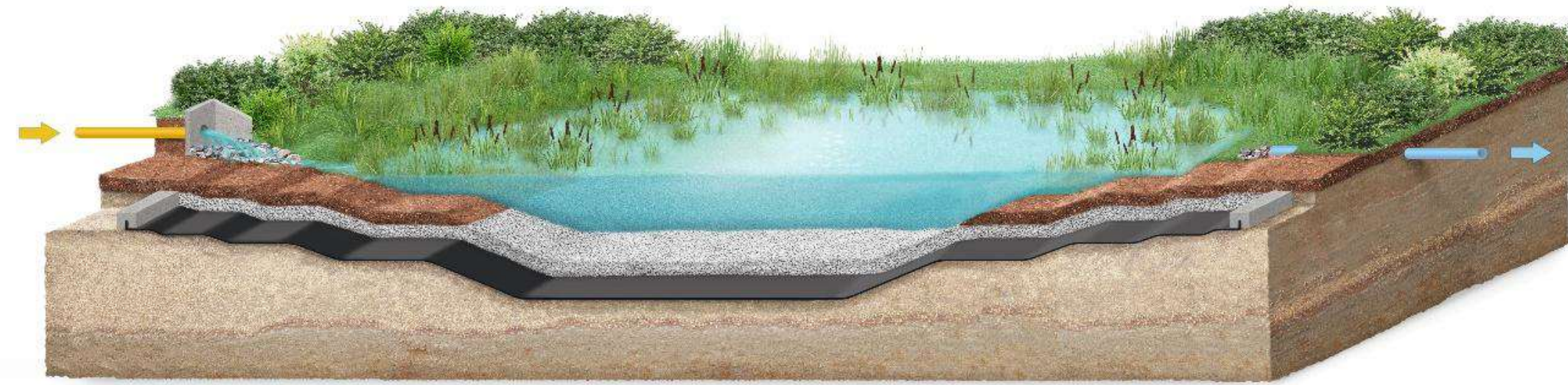


Co-benefits

High: Biodiversity (fauna and flora); Temperature regulation; Flood mitigation; CSO mitigation; Carbon sequestration; aesthetic value; recreation; pollination

Medium: Biomass production

WET DETENTION PONDS AND POND RETROFITS



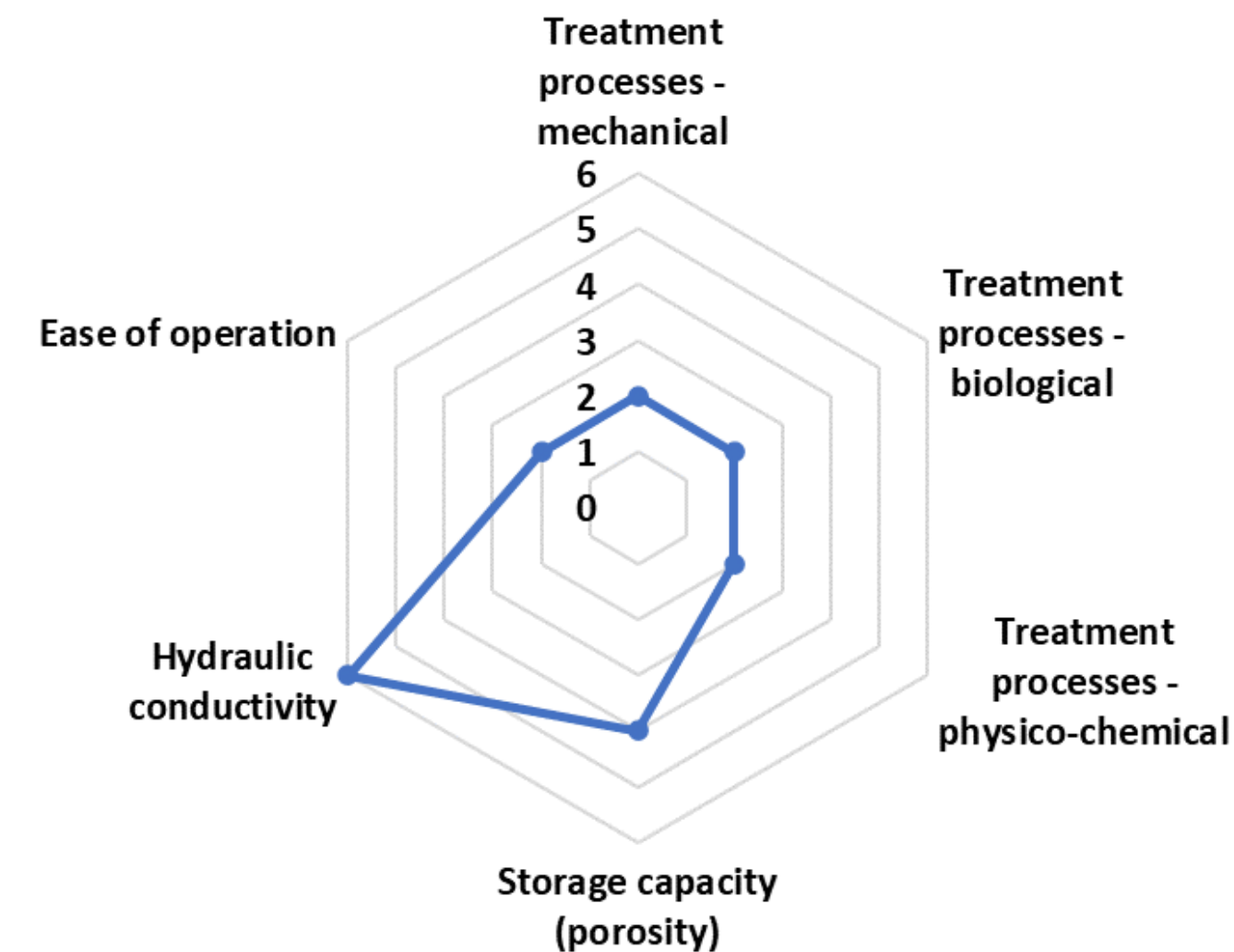
- Permanent water bodies designed to temporarily **store stormwater runoff during rain events** and **release it in a controlled manner**.
- Removal of pollutants through enhanced **sedimentation, microbial processes, and plant nutrient uptake**.
- **Polishing elements** at the end of stormwater treatment train, before discharge into the environment.



Pond retrofits can significantly enhance system performance while being more cost-effective and less resource-intensive than building new



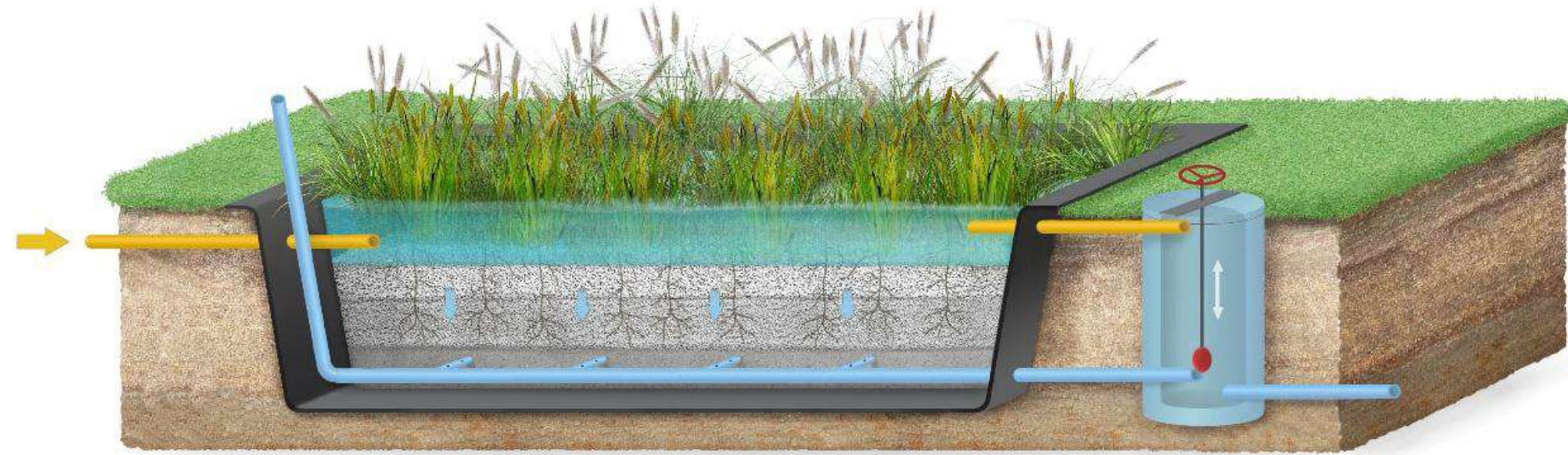
They are constrained by the existing space and infrastructure



Co-benefits

High: Biodiversity (flora and fauna), temperature regulation, flood mitigation, CSO mitigation, carbon sequestration, biomass production, aesthetic value, recreation, pollination.

D-CLEAN COMBINED SEWER OVERFLOW WETLAND



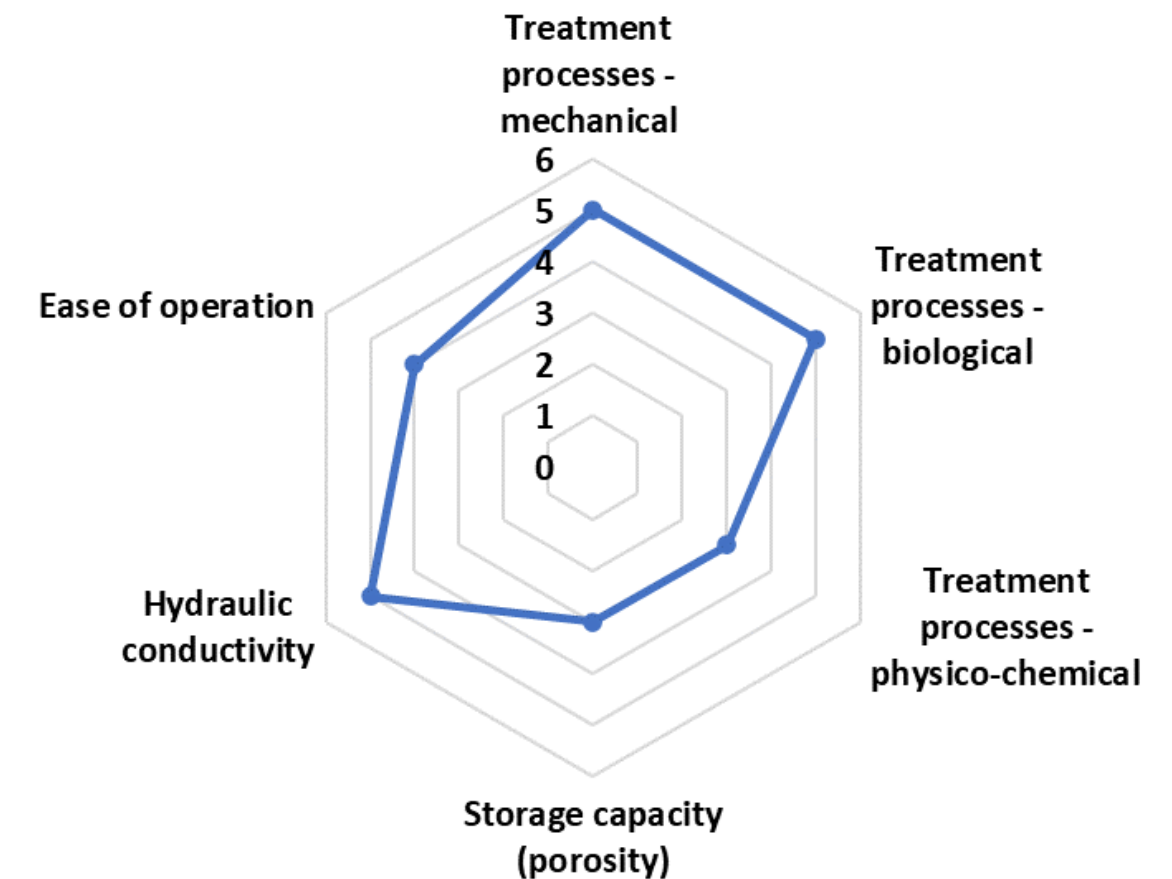
- Engineered to **manage and treat excess wastewater discharged during heavy rainfall events.**
- Typically designed as **vertical-flow CW.**
- Suspended solids are **physically filtered** out while dissolved pollutants are **degraded by robust biological processes.**
- **Wetlands mitigate** downstream **peak flows** and **protect aquatic ecosystems** from **untreated mixture of WW and SW.**



Effectively absorbs storm fluctuations and treats highly irregular overflows; gravity-fed



Extended dry periods can compromise the health of wetland vegetation



Co-benefits

High: Water reuse, CSO mitigation

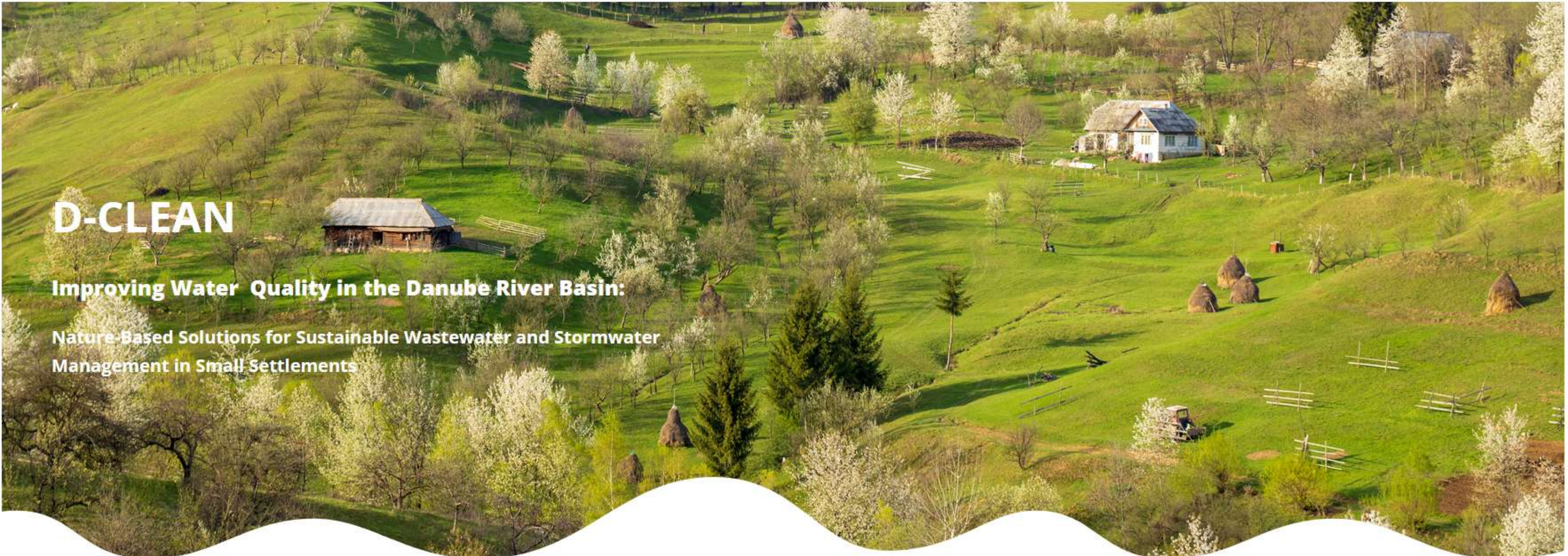
Medium: Biodiversity (fauna), biomass production

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Improving Water Quality in the Danube River Basin:

**Nature-Based Solutions for Sustainable Wastewater and Stormwater
Management in Small Settlements**

**Thank you for
attending!!**

<https://interreg-danube.eu/projects/d-clean>

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Discussion Questions

Q1: Which stormwater challenges are most pressing in your area?

Q2: Which Nature-Based Solutions presented today appear most promising?

Q3: What barriers do you foresee for implementation?

Q4: What support would municipalities and utilities need to implement these solutions?