# GREEN INFRASTRUCTURE FOR SUSTAINABLE WATER MANAGEMENT CASE STUDY : FLOOD RESERVOIR PODUTIK

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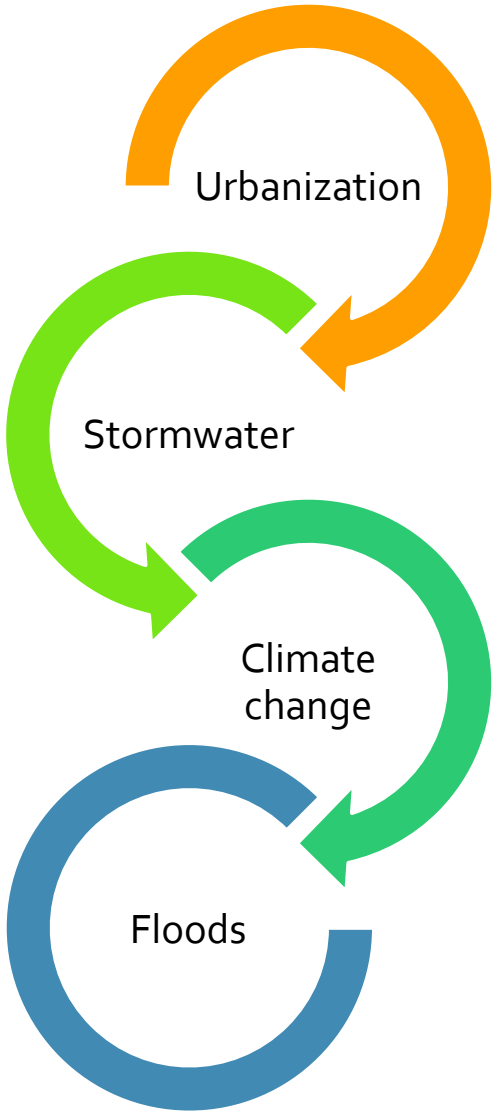
# Urban interaction with water ecosystems

- Stormwater runoff
- Pollutant loads
  - wastewater discharges, CSO
- Increasing floods
- Increasing droughts
- Increasing urbanization

- Need to improve resilience

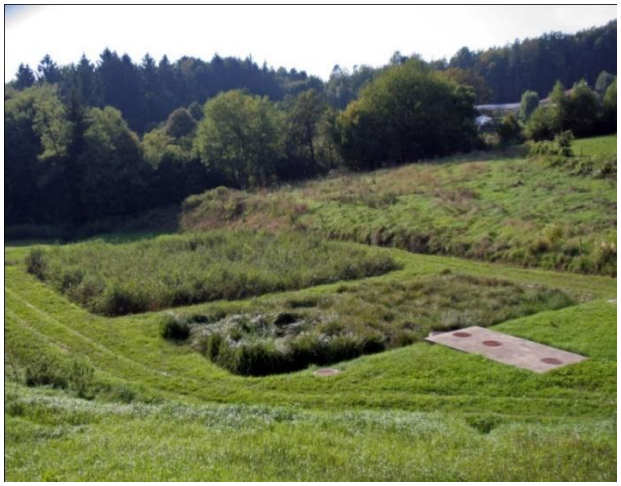
and act towards sustainable water management

- Use of green (blue) infrastructure

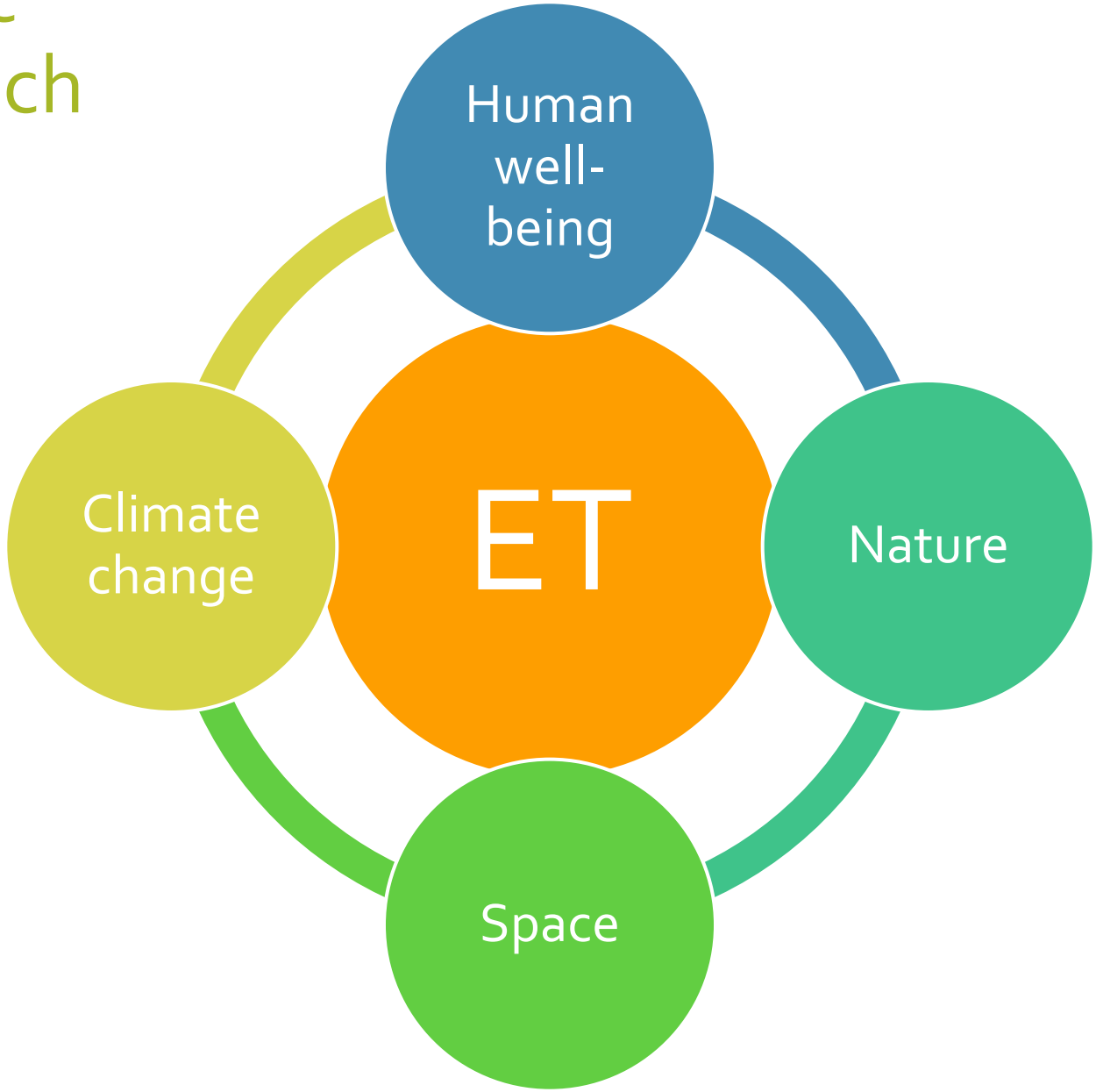


# Sustainable water management with green infrastructure

- With green infrastructure we can
  - mitigate the flood wave / retain the water on the site of its origin - REUSE
  - Increase ecosystem services of flood reservoirs and stormwater retention ponds
- Integration of technical and green/ecological measures (ecosystem technologies)



# Holistic approach



# Green infrastructure for flood resilience

- Stormwater management
  - Dry detention ponds
  - Wet detention ponds
  - Swales
  - Infiltration ditches
  - Sand filters
  - Porous pavement

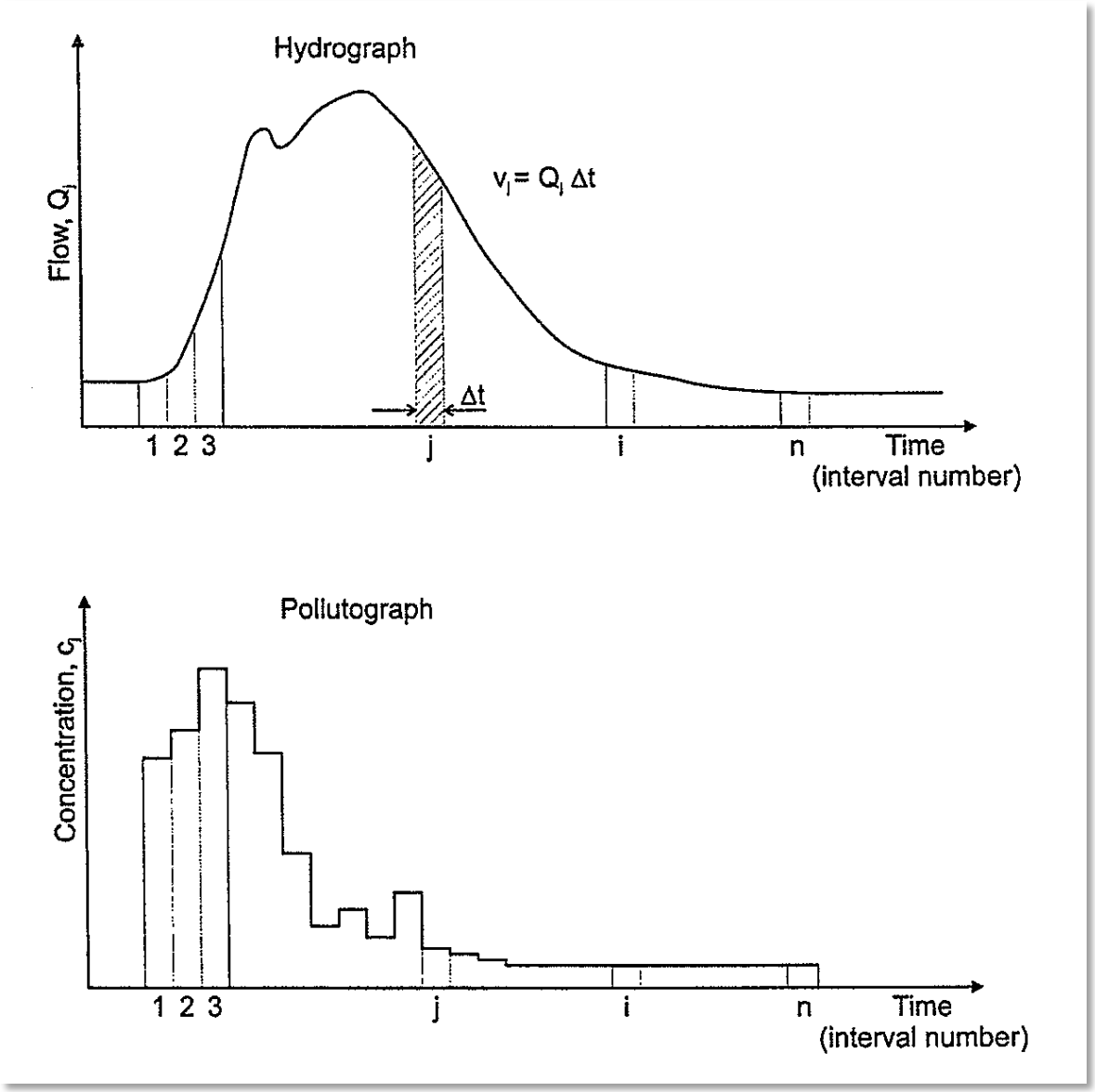
# Stormwater characteristics

- Types and concentrations of pollutants depend on the type of catchment area (residential area, highway, industrial area etc.)




- Suspended solids, nutrients, organic micro-pollutants, heavy metals, pathogens
- Quantitative and qualitative loading

# Stormwater characteristics



# Case study: Flood reservoir Podutik

- Green infrastructure is a part of reservoir Podutik (Ljubljana, Slovenia) which was built to retain flood wave and protect a nearby settlement in 1986.
- Reservoir Podutik is a wet reservoir
  - permanently flooded wetland
  - wetland areas that are occasionally flooded during heavy rainfall
- Receives waters from Glinščica river and stormwater from the nearby settlements
  - Occasional oveflows from septic tanks
  - Polluted tributaries
  - Surface runoff from gardens, parking lots etc.

# Case study: Flood reservoir Podutik

- A part of the reservoir was re-designed into a multi-functional flood reservoir with ecosystem technologies (7FP Turas project)
- ET system: reservoir + constructed wetland + new river bed with meanders

www.turas-cities.eu

**Value:**
**8.9 mil. €**

**Time scale:**
**1.10.2011 - 30.09.2016 (60 M)**

**Lead partner:**
**University College Dublin**

**Slovene partners: UL, LUR**

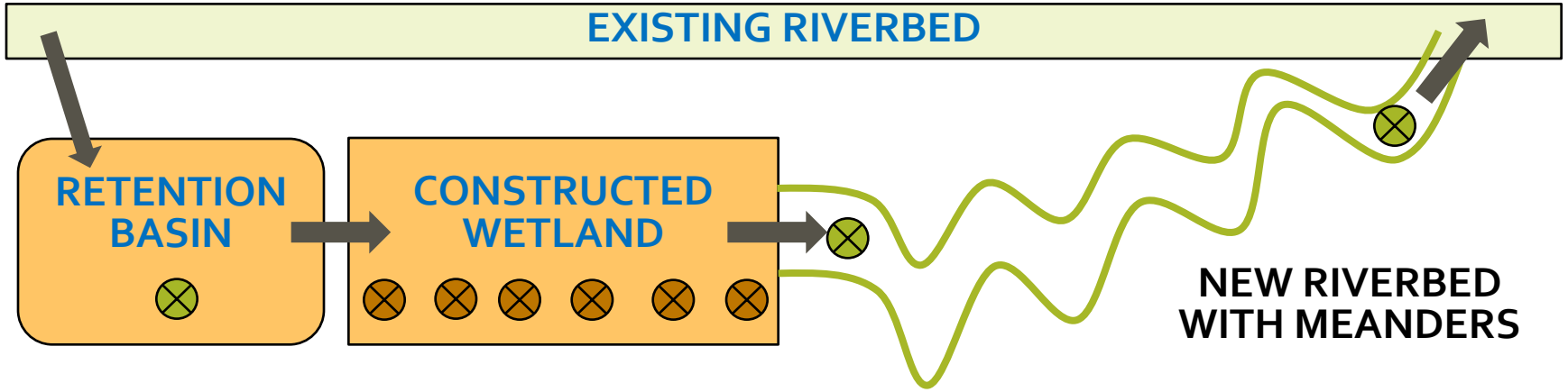
**28 partners:**
**9 Universites / Institutes**
**9 Cities / Regions**
**10 Companies**

*Transitioning Urban Resilience and Sustainability*

**Enabling positive responses to unpredictable changes in the space and environment**

TURAS

# Case study: Flood reservoir Podutik







On-site sampling

On-site sampling + sampling for lab analyses

water flow

# Ecosystem services of the new ET

**1. HYDRAULIC FUNCTION**

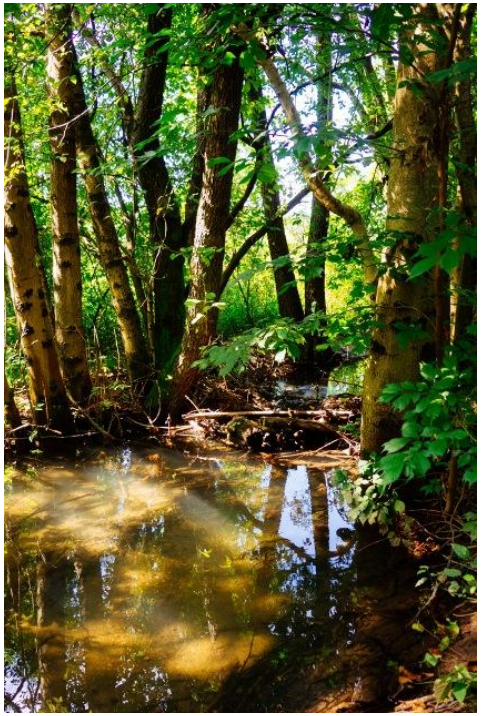
- Increasing flood resilience
- Water retention

**2. TREATMENT FUNCTION**

- Water pollution mitigation
- Increased self-cleaning capacity

**3. BIODIVERSITY FUNCTION**

**4. EDUCATIONAL/RECREATIONAL FUNCTION**



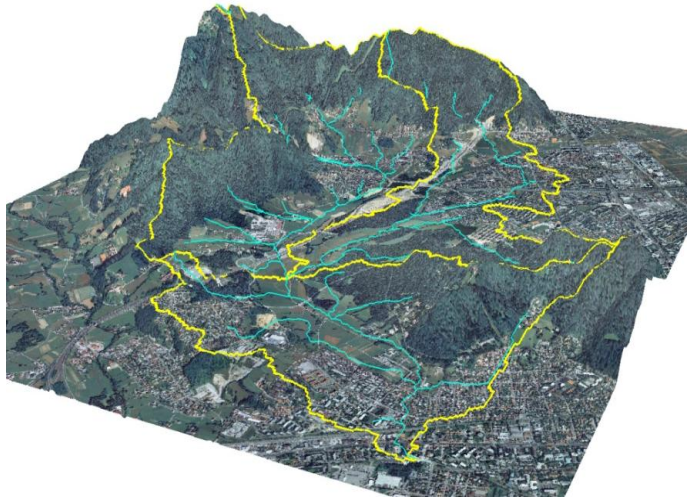
# Evaluation of the system

- Estimation of hydraulic function by hydraulic-hydrological (mathematical) models
- Estimation of self-cleaning function:
  - Physical and chemical parameters: EC, $O_2$, ORP, T, pH, TSS, COD, $BOD_5$, $NH_4$-N, $NO_2$-N, $NO_3$-N, TP/ortho-P, TN, TKN, ON
  - microbiology: TBC at 22°C and 37°C, total coliforms, faecal coliforms
- Assessment of biodiversity (algae, vegetation and birds)
- Assessment of educational/recreational function

# Results – HYDRAULIC FUNCTION

- Retention capacity corresponds to the events with return period of 10 years, but not to the events with return period of 100 years
- Retention capacity has decreased in the last 5 years due to vegetation overgrowth and flow deposits

**Regulated river bed of Glinščica River**



**Digital terrain model of Glinščica River basin (Pestotnik, 2011; Kovačec, 2012)**


Pestotnik, S. 2011. Hydrologic model of Glinščica watershed with program Flo-2D. Graduation Thesis. University of Ljubljana, Faculty of Civil and Geodetic Engineering.

Kovačec, M. 2012. Hydrologic model of Glinščica watershed with SWAT program. Graduation Thesis. University of Ljubljana, Faculty of Civil and Geodetic Engineering.

# Results – SELF-CLEANING FUNCTION

## Physical and chemical parameters

- On-site measurements: EC, O2, pH, ORP, T were within limits for biological processes of water treatment
- Laboratory analyses:

| Parameter | Unit | Measured values | | | | | | Legislative limits [mg/L]* |
|---|---|---|---|---|---|---|---|---|
| | | Year 2013 | | | Year 2014 | | | |
| | | CW in | CW out | RBM out | CW in | CW out | RBM out | |
| COD | mg/L | 37 | 22 | 16 | 41.25 | 39.5 | 3.5 | 120 |
| $BOD_5$ | mg/L | 19 | 1 | 5 | 21.5 | 8 | 5 | 25 |
| TSS | mg/L | 56 | 16 | 9 | **110** | **98** | **97** | 80 |
| $NH_4$-N | mg/L | 2.05 | 0.15 | 0.26 | 3.44 | 5.62 | 0.24 | 10 |
| $NO_3$-N | mg/L | 2.6 | 2.2 | 0.6 | 4.17 | 3.39 | 1.88 | 20 |
| $NO_2$-N | µg/L | 10 | 2 | 13 | 254.5 | 104.5 | 96.5 | 1000 |
| TKN | mg/L | 7.5 | 11.3 | 3.8 | / | / | / | / |
| TN | mg/L | 10.11 | 13.50 | 4.41 | 9.75 | 10.4 | 2.5 | / |
| ON | mg/L | 5.45 | 11.15 | 3.54 | / | / | / | / |
| TP | mg/L | 1.5 | 1.03 | 0.93 | 0.76 | 0.85 | 0.16 | 2 |

CW - contructed wetland, IN - inflow, OUT – outflow, RBM – river bed with meanders

*Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewers, Ur.l. RS No. 64/2012 dated 24.8.2012

# Results – SELF-CLEANING FUNCTION

## Microbiological parameters

| Parameter | Unit | Measured values | | | Legislative limits [CFU/mL]* |
|---|---|---|---|---|---|
| | | CW IN | CW OUT | RBM OUT | |
| **TBC 22 °C** | CFU/mL | 3500 | 800 | 1500 | / |
| **TBC 37 °C** | CFU/mL | 3000 | 700 | 1000 | / |
| **TC** | CFU/100 mL | **140.000** | **40.000** | **50.000** | 10.000 |
| **FC** | CFU/100 mL | 20.000 | 0 | 0 | 2.000 |

TBC – total bacterial count, TC – total coliforms, FC – faecal coliforms

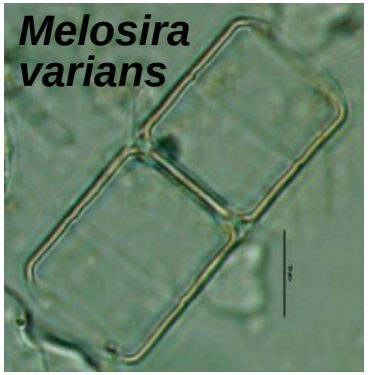
CW - constructed wetland, IN - inflow, OUT – outflow, RBM – river bed with meanders

**Decree on the emission of substances and heat in the discharge of wastewater into waters and public sewers, Ur.l. RS No. 64/2012 dated 24.8.2012

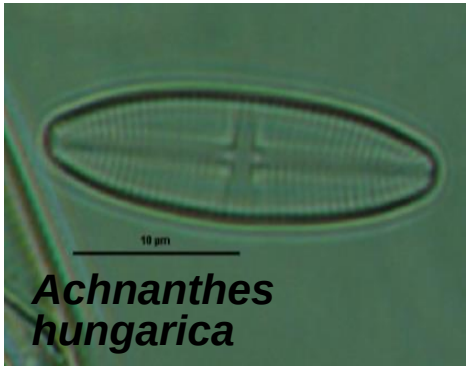
# Results – BIODIVERSITY FUNCTION

Algal community

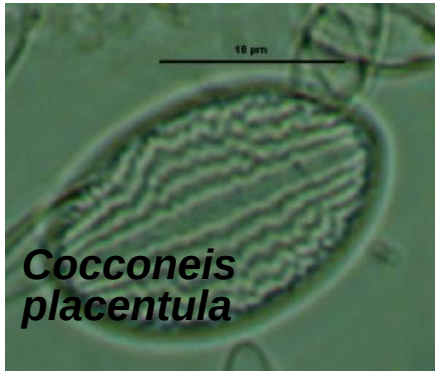
- High or good ecological status of the ET system
- High biodiversity of algae (> 50 taxa) with dominance of diatoms









# Results – BIODIVERSITY FUNCTION

## Vegetation and birds inventory

- Diverse hygrophilous and marsh plant communities
  - 70 plant species (5 invasive)
  - Willows (*Salix* sp.), elders (*Alnus* sp.), ash (*Fraxinus* sp.)




***Photos: Ivana Leskovar Stamcar***

- Potentially suitable habitat for endangered species and rare birds

***Picus viridis (photo: M. Perušek)***

***Motacilla cinerea (www.gnezdilnice.si)***

***Phylloscopus collybita (photo: DOPPS)***

# Results – EDUCATIONAL/RECREATIONAL FUNCTION

- An upgrade of the existing educational trail displaying diverse habitats within flood reservoir and their functions (planned)
- Recreational path for local residents, playground for children and new informational boards (planned)


LEARNING PATH OVERVIEW

FOOTBRIDGE

BRIDGE

# Conclusions

- Today flood reservoir Podutik with ET system provides all 4 mentioned ecosystem services, especially water treatment and biodiversity function.
- In the future maintenance work has to be done to increase retention capacity of the flood reservoir - hydraulic function.
- An upgrade of the existing learning and recreational path is planned in the near future to enhance educational and recreational function of the flood reservoir for local community and visitors.

# Acknowledgements

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