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ICPDR IKSD
International Commission for the Protection of the Danube River

IAWD DANUBE WATER PROGRAM
Smart policies, strong utilities, sustainable services

CONSTRUCTED WETLANDS IN SLOVENIA

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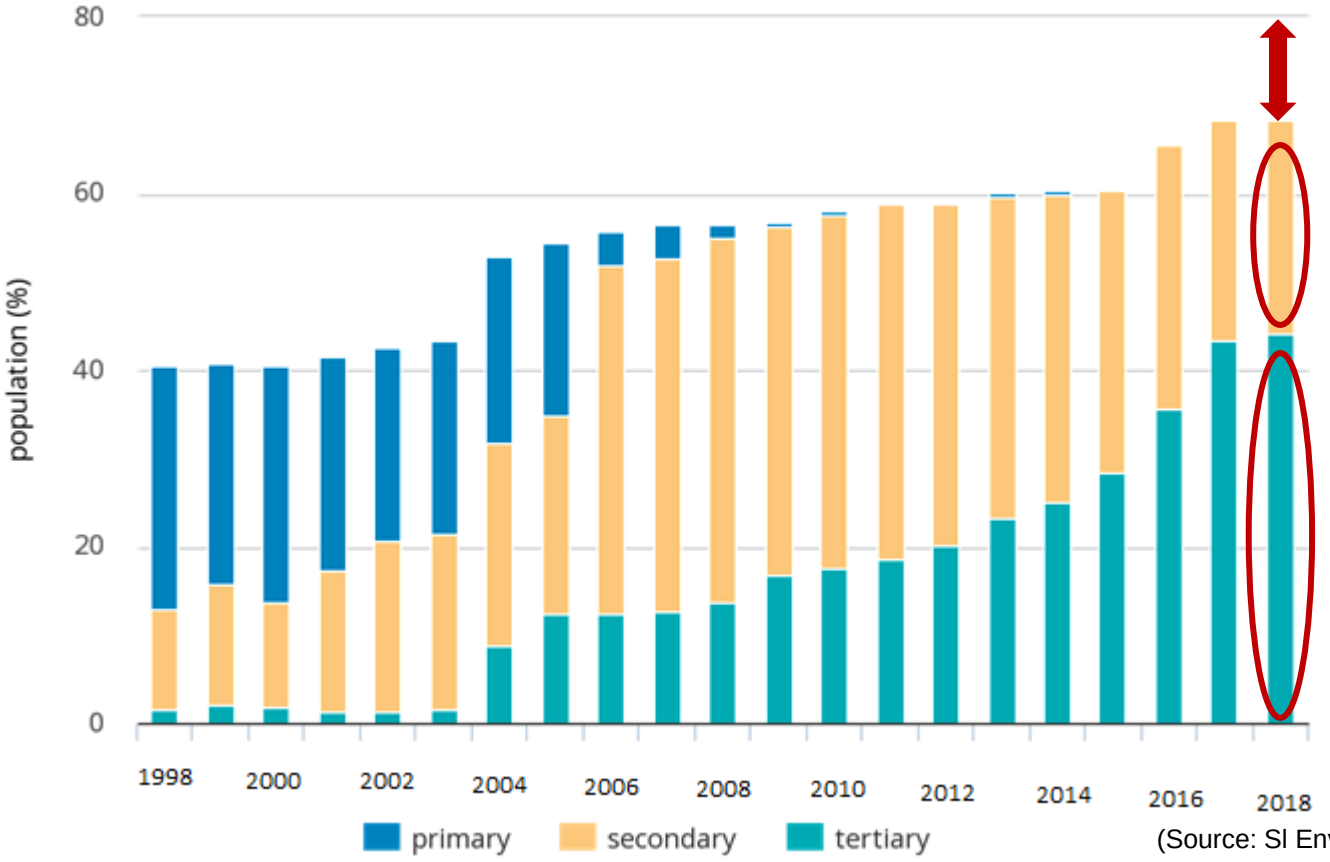
LIMNOS

RWWT WORKSHOP, January 20th 2021
Technical solutions and developments in rural wastewater management

Wastewater treatment in Slovenia



(Source: Sl Enviornment Agency, 2020)

1.533 agglomerations

- **123 agglomerations > 2.000 PE**
- **1.410 agglomerations < 2.000 PE – 53 % REMAINS UNSOLVED**

254.806 PE

Areas outside agglomerations – 81 % REMAINS UNSOLVED

Wastewater treatment in Slovenia

A dispersed settlement pattern

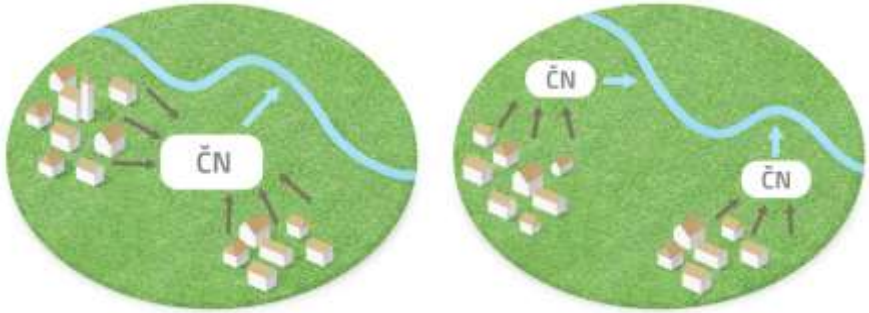
- 44 % of inhabitants live in settlements < 1000 people
- 61 % of inhabitants live in settlements < 5.000 people

(Source: SI Statistical office, 2020)

(Source: Google)

Typical Slovenian countryside

Centralized vs. Decentralized system



(Source: Limnos Ltd.)

Constructed wetlands?

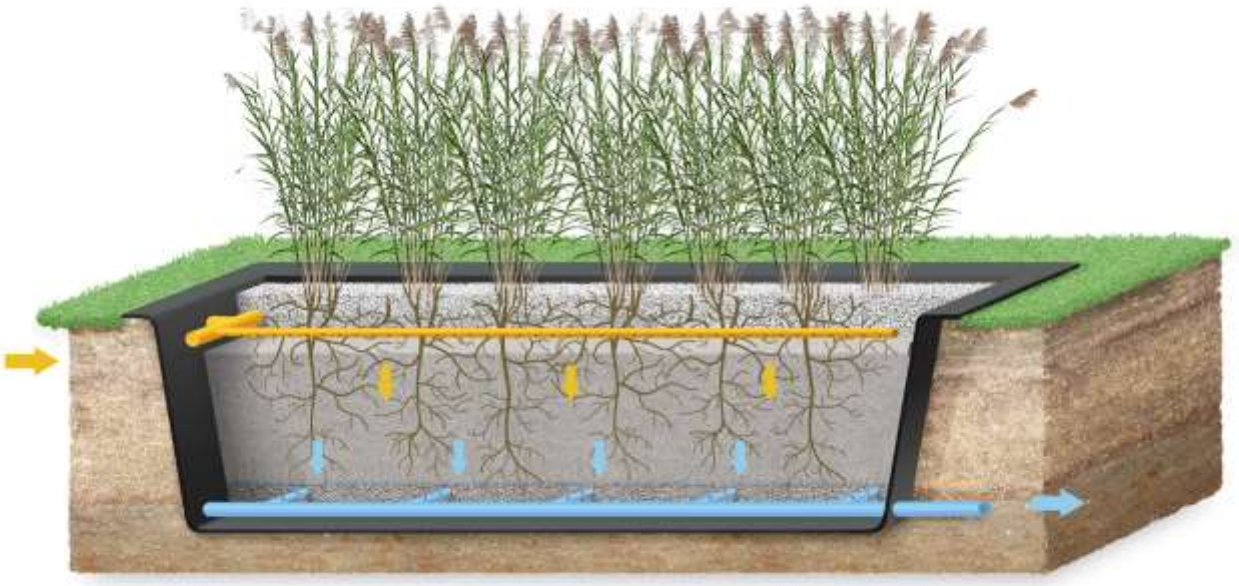
NBS for wastewater treatment

CONSTRUCTED WETLANDS (CW)

PLANTS

SUBSTRATE

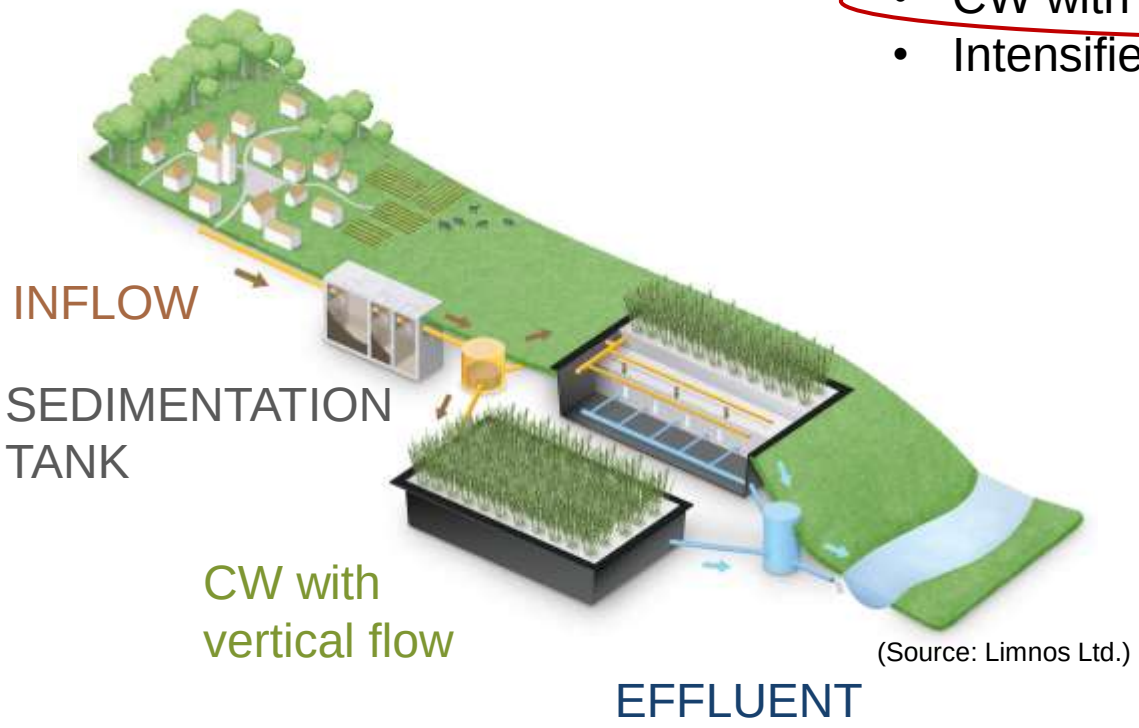
MICROORGANISMS



(Source: Limnos Ltd.)

The CW imitates nature's self-cleaning capacities to purify water.

NBS for wastewater treatment



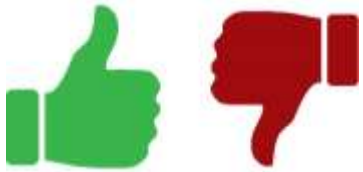
(Source: Limnos Ltd.)

CONSTRUCTED WETLANDS TYPES

- CW with surface flow
- CW with subsurface flow (horizontal, vertical)
- Intensified wetlands

- **PRIMARY TREATMENT:**
  - Screens
  - Sedimentation tank

- **TREATMENT PROCESSES**
  - Filtration bed
  - Treatment bed
  - Polishing bed
  - Additional treatment units



- Low costs of operation and maintenance
- Passive technology
- Simple construction
- High treatment efficiency
- Landscape attractiveness
- High buffering capacity
- CO2 uptake

- Large area requirements
- Clogging of the system
- Less control on the treatment processes

First CW in Slovenia (1991)

PONIKVA (350 PE)

(Source: Limnos Ltd.)

CW for households (WWTP < 50 PE)

5 PE

(Source: Limnos Ltd.)

10 PE

(Source: Limnos Ltd.)

CW for small settlements

(Source: Limnos Ltd.)

Experience from Slovenia

Bazga (500 PE) (Source: Limnos Ltd.)

Holistic approach to wastewater management

Municipality of Ormož in north east Slovenia

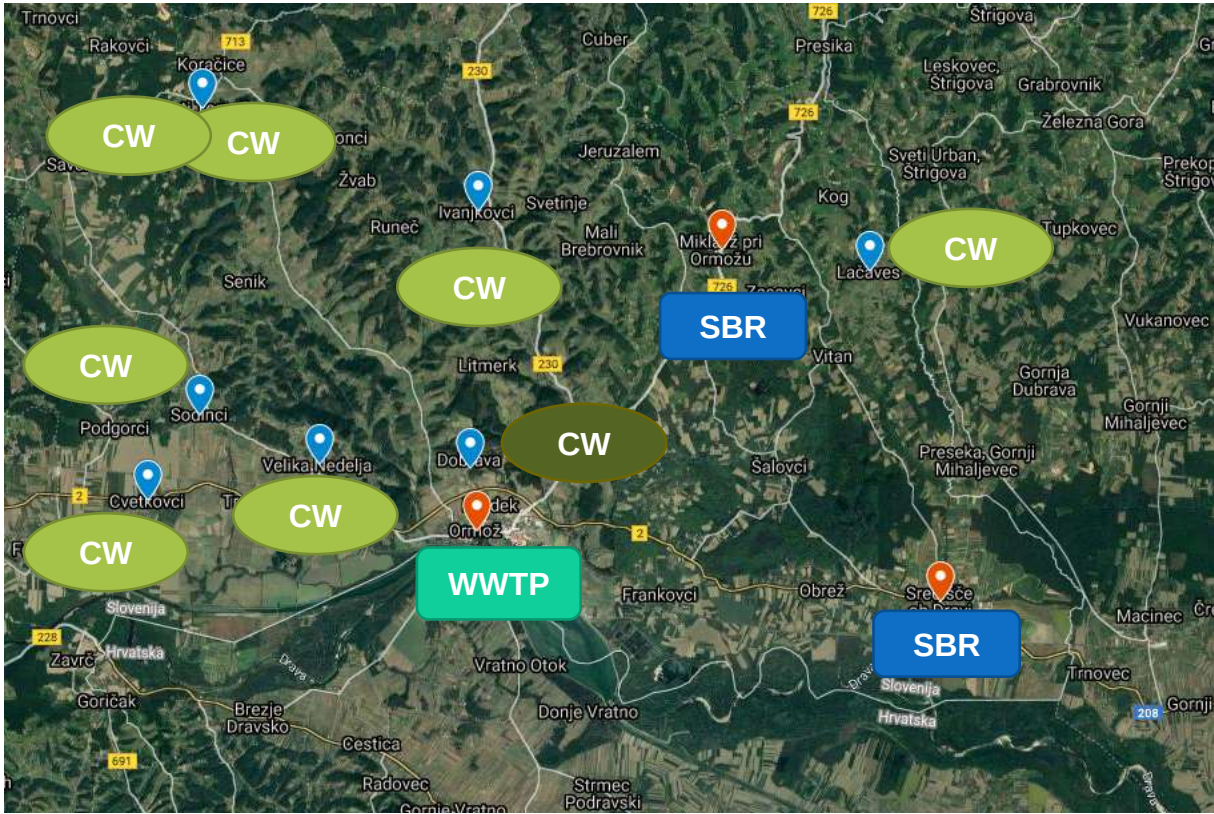
7 CWs (in total for 3.950 PE)

1 CW for landfill leachate

2 SBR (in total for 2.450 PE)

1 central WWTP (4000 PE → 8000 PE)

(Source: Limnos Ltd.)



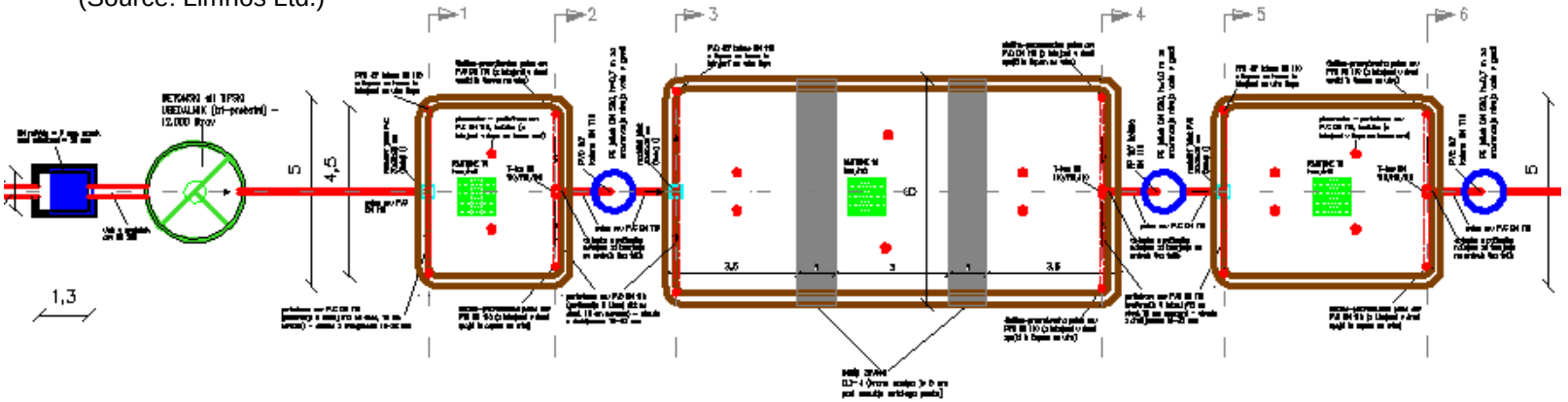
Municipality – local community collaboration

Municipality of Sevnica and local community Kamenica

(Source: Limnos Ltd.)

CW for 49 PE

- Coarse screens
- Sedimentation tank
- Filtration bed
- Treatment bed
- Polishing bed
- Effluent to recipient



CW for food processing industry (industrial WWTP)

Gosad

(Source: Limnos Ltd.)

(Source: Limnos Ltd.)

(Source: Ahac)

(Source: Ahac)

CW for agricultural run-off

(Source: Limnos Ltd.)

System efficiency:

- COD, inflow=16.610 mg/l, outflow=1.924 mg/l
- NH_4^+-N, inflow=81 mg/l, outflow=21 mg/l
- $PO4^{3-}$-P, inflow=73 mg/l, outflow= 15 mg/l

CW for Alpine/mountain cottages and camping sites

Mountain Razor (70 PE)

- 1.300 m
- Seasonal loadings

(Source: Limnos Ltd.)

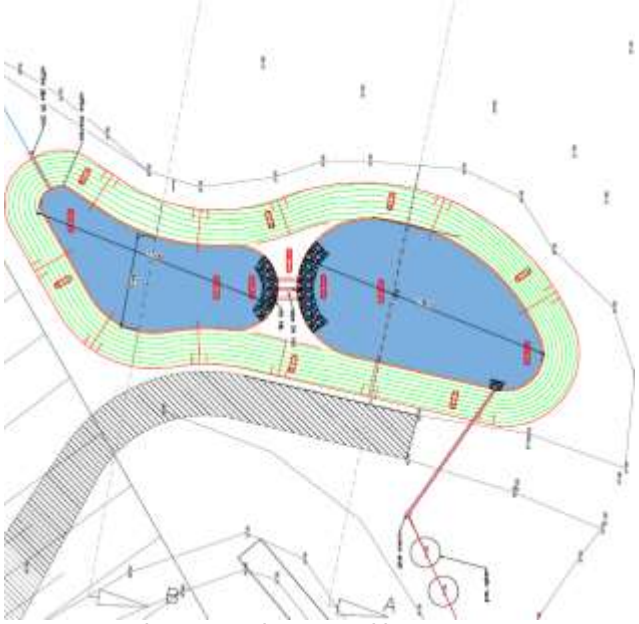
Vršič (1.630 m) (Source: Limnos Ltd.)

Mojstrana (for 15 tents)

CW for landfill leachate

Landfill Bukovžlak, Celje

(Source: Vodar Ltd.)



(Source: Limnos Ltd.)

Landfill Devoll, Albania

(Source: Limnos Ltd.)

Closing the loops: resource recovery

Kaštelir Labinci, Croatia (1.900 PE)

(Source: Limnos Ltd.)

(Source: Limnos Ltd.)

(Source: Hidroprojekt-ing)

Construction I.

(Source: Limnos Ltd.)

Construction II.

(Source: Limnos Ltd.)

Operation and maintenance

Regular maintenance:

- Emptying sludge from sedimentation tank
  - Few times per year or
  - min. once per 3 years
- Visual inspections
  - Once per week
- Reed mowing
  - Once per year

If necessary:

- Pump service and replacement – only if pump needed
- Replacement of substrate – only if clogged

Lifespan:

- 30 years or more

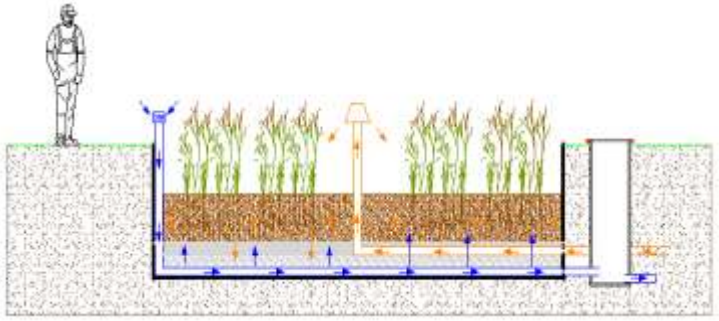
SIMPLE ROBUST SYSTEM (low tech)

SIMPLE MAINTENANCE AND OPERATION

Sludge drying reed beds (SDRBs)

- Reliable sustainable technology for **sludge drying and stabilization**
- **Microbial mineralization** of organic matter - volume reduction
- **Biosolids reuse**

Aerobic conditions



(Source: Limnos Ltd.)

Scheme of SDRBs

(Source: Limnos Ltd.)

Sludge drying reed beds in Mojkovac (2.500 PE), Montenegro

Why SDRBs?

EFFECTIVE VOLUME REDUCTION

- The final product contains from 25 to 40% of dry matter
- Volume reduction by 95 %
- Due to mineralization up to 40 % less organic matter

Lower volume means lower disposal costs!

NO CHEMICALS

- Without the use of floccultants for sludge thickening

ENERGY SAVINGS

- Reduction in electrical consumption form 20 to 60 %
- Consumption related only to pumps and control system

BIOSOLIDS USE

- The Sewage Sludge Directive 86/278/EEC seeks to encourage the use of sewage sludge in agriculture

(Source: Melbourne Water)

Phosphorous is a limited resource!

Small WWTP + Sludg drying reed beds

- Heavy metals in sludge within re-use limits (confirmed by analysis)
- Long-term sludge solution
- Sludge transport to the central WWTP is not needed
- An economically acceptable solution

(Source: Limnos Ltd.)

WWTP Karbinci (1.100 PE), Makedonija

(Source: Limnos Ltd.)

WWTP Mrkopalj (1.400 PE), Croatia

(Source: SECO)

WWTP Kucicino (700 PE), Makedonija

Conclusions

- Robust and simple technology
- Investment comparable to other technologies
- Energy efficient systems - savings in the long run
- Green area - an aesthetic element supporting ecosystem services

(Source: Limnos Ltd.)