
# The EU funded SWIM-SM: developing capacity for Sustainable and Integrated Wastewater Treatment and Reuse

*Online Course on Natural Treatment Systems: Operation & Maintenance of Constructed Wetlands*

# Operation and maintenance of constructed wetlands

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# Contents

1. Standard O&M tasks and frequency
2. Particular O&M problems and troubleshooting
3. Monitoring and record keeping

# Basic maintenance

'natural', low-tech systems → require low but adequate maintenance

Vymazal (1998) recommends checking larger systems (> 500 PE) on a daily basis, including:

- pretreatment units
- inlet structures
- outlet structures

If maintenance ignored:

- uneven flow distribution
- local overloading
- deterioration of treatment efficiency in the long term

# Basic maintenance

Kadlec & Knight (1996) recommend:

Daily monitoring and adjustment of:

- flows
- water levels
- water quality
- biological parameters

Less frequent:

- repair of pumps, dikes and control structures
- vegetation management
- removal of solids
- cover estimates and observations on plant growth

# To harvest or not to harvest?

Advantages of harvesting:

- nutrient export
- prevention of thick layers of dead material with stagnant water which are ideal pest breeding places

Advantages of not harvesting:

- creation of an insulating layer of dead plant material
- provision of a detritus layer that can adsorb trace metals
- provision of a carbon source for denitrification
- no alteration of the ecological functioning of wetlands

**Recommendation: harvest every 2-3 years (in winter when applicable) in temperate climates; when biomass can be used and/or in warmer climates , the frequency of harvesting can be increased**

# Example of 1000 PE VF CW

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| Task | Frequency | Duration | Total (h year$^{-1}$) |
|---|---|---|---|
| Gate operation, control of siphons | 2 / week | 5 min | 9 |
| Preliminary treatment: bar screen | 1 / week | 10 min | 9 |
| General inspection of filters and weed control | 1 / week | 15 min | 13 |
| On-going operational records | 1 / week | 20 min | 18 |
| Vegetation cutting on dikes and surroundings | 6 / year | 8 hours | 48 |
| Check-up and cleaning of the distribution system | 2 / year | 3 hours | 6 |
| Cleaning of the manholes | 2 / year | 1.5 hours | 3 |
| Cutting and disposal of reeds | 1 / year | 80 hours | 80 |
| Extraction of sludge | 1 / 10 years | 60 hours | 6 |
| TOTAL | | | 192 |

From Liénard et al (2004)

# O&M problems

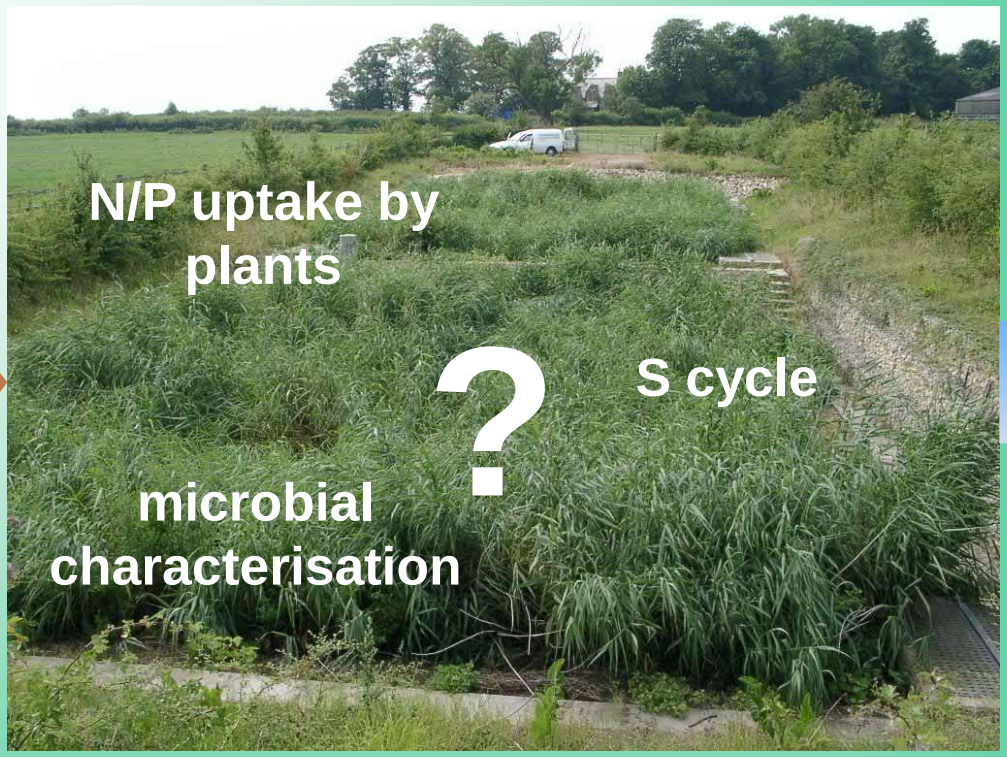
Possible causes:

1. Improper design or not properly built
2. Poor maintenance: faulty instructions to the owners, forgetfulness of the owners, erroneous view that natural systems can manage themselves

→ "build-and-forget" solution

→ excessive accumulation of solids
→ Clogging
→ Mosquitoes
→ Odor nuisance

# Design flaws – black box problem




**R. Gearheart: "*Basically, all we know is that they (=CW) work … But if you want to be able to say, for example, what happens if you double the loading rate, we're not there yet. We can't model it.*"**

# Construction flaws

too fine sand

wrong L/W ratio

# Lack of maintenance

excessive sludge accumulation due to organic overloading

# Examples

(DWF=dry weather flow)

**> 6 DWF**

**COPASAC™ (screening)**

**STORM REED BED (HSSF type)**

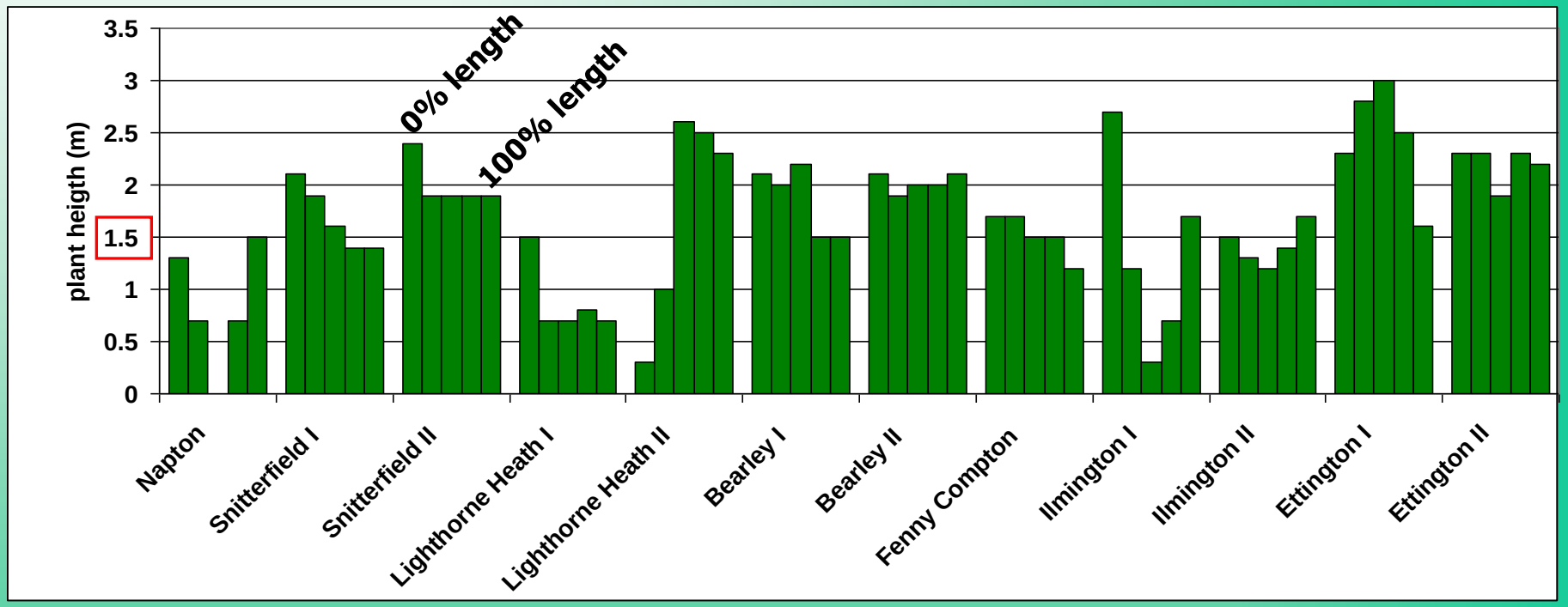
**< 6 DWF**


**BIOROTORS**

**TERTIARY REED BED (HSSF type)**

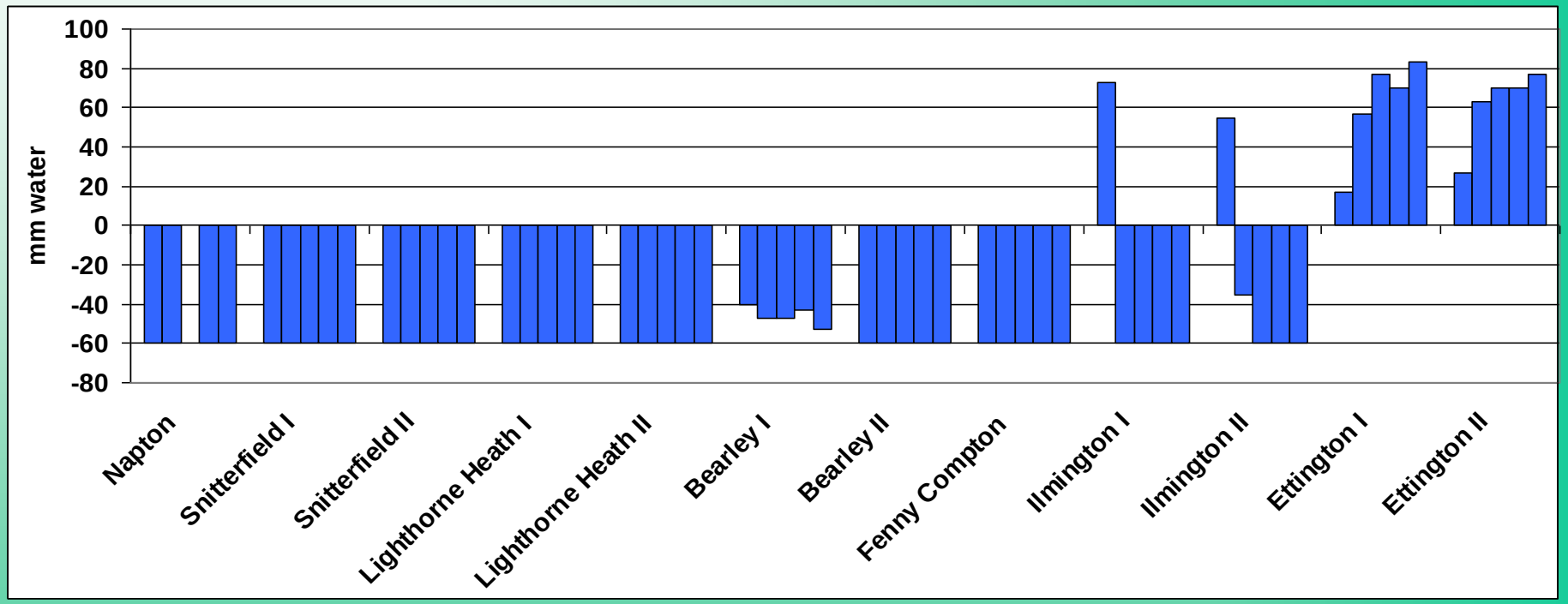
UNESCO-IHE Institute for Water Education

# Example: Stormwater treatment wetlands




Inhibited reed growth (< 1.5m) indicates problems with water level and/or nutrient supply (normal height at least 2m).

# Example: Stormwater treatment wetlands




Aboveground water points to clogging.

# Example: Survey of Tertiary treatment wetlands

- Problems with sludge deposition, inlet flow distributor problems, outlet collector problems, weed infestation, tree growth, above-ground flow
- Effluent consents still met, constructed wetlands are therefore called “very forgiving and abuse tolerant”
- Recommended to inspect at least once per month and more frequent if there are known problems
- Weeds should be removed at 6-month intervals, as is the case with saplings in order to avoid tree roots puncturing the liner
- < 2000 PE require only a few days maintenance per year.

# Clogging

Influenced by:

- Loading rates of BOD and SS
- Hydraulic loading rates
- Particle size distribution of sand/gravel and wastewater particles

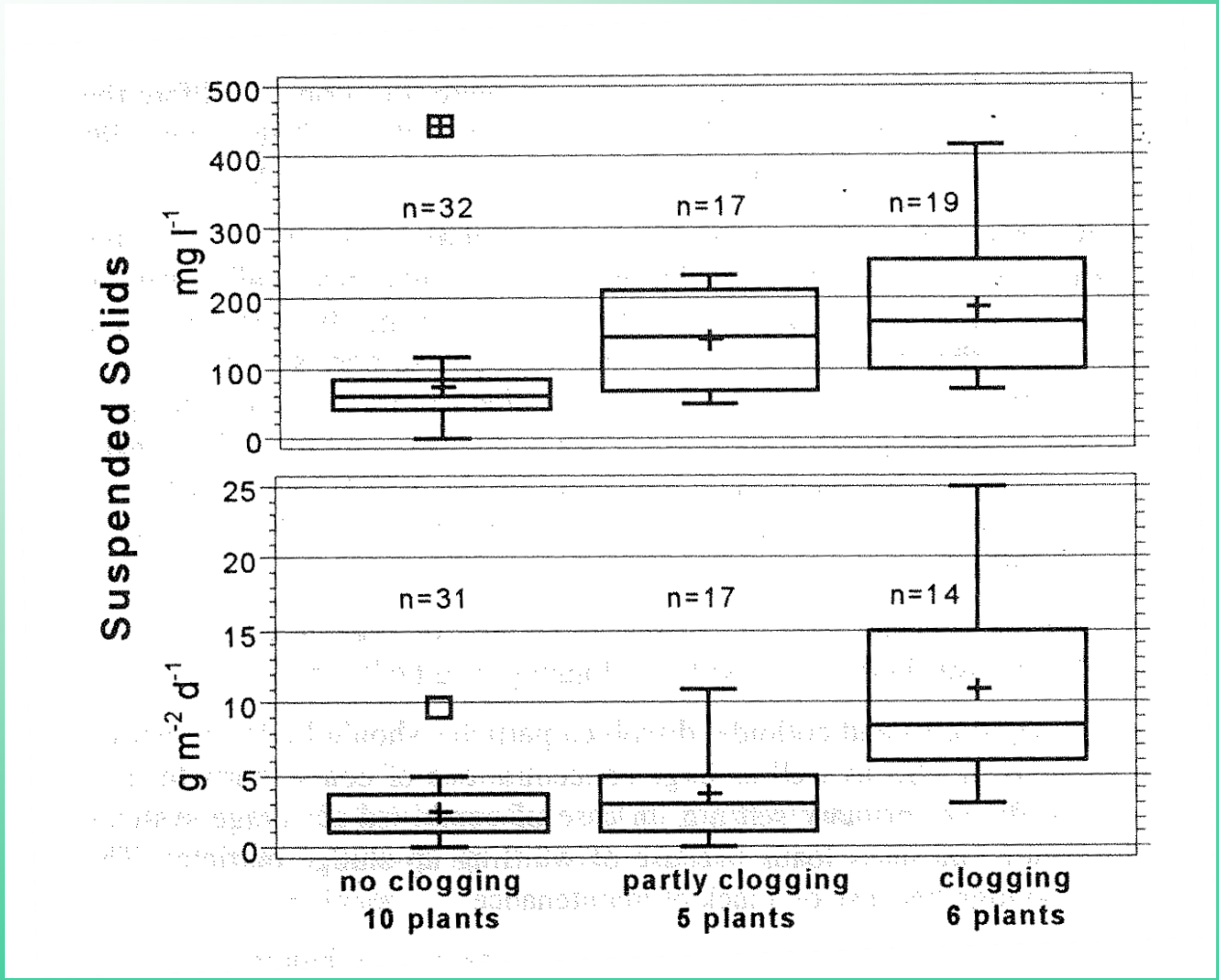
Major processes:

- Build-up of organic and inorganic solids in pockets
- Biofilm development

Measures:

- lower loading rates (pretreatment or larger surface area)
- Resting periods → composting of organic solids

# Clogging




**Relation between suspended solids and clogging of VF CW (Winter and Goetz, 2002)**

# The mosquito problem

Inversely related with biodiversity and complexity of food web

Solutions:

- No above-ground flow (SSF wetlands)
- Pretreatment to reduce organic loading rate
- Temporary drying the beds will eradicate larvae
- Lower water depths → higher stream velocity
- Open water areas support growth of predators (fish, invertebrates)
- Insecticides → not sustainable, very expensive
- Biological control agents: *Bacillus thuringiensis*, *Gambusia*

# Odor nuisance

Floating macrophyte ponds:

- Anaerobic conditions prevail → odor ($H_2S$, …)

# Odor nuisance

Floating macrophyte ponds:

- Anaerobic conditions prevail → odor ($H_2S$, …)
- Provide supplemental aeration
- Restrict harvest to keep lagoon completely covered
- Locate pond at least 400 m away from nearest housing

Wetlands:

- Odor also due to anaerobic conditions
- Reduce oxygen demand (BOD, $NH_4$) by pretreatment
- Shallower basins promote aerobic conditions

# Monitoring

| Recommended parameters | Recommended sample locations | Minimum sample frequency |
|---|---|---|
| Inflow and outflow water quality temperature, DO, pH, EC, $BOD_5$, TSS, $Cl^-$ and $SO_4$ (every system)<br>NOx, $NH_4$, TKN, TP (as required by permits)<br>metals, organics, toxicity (as required by permits) | Inflow(s) and outflow(s) | a. Weekly<br>b. Monthly<br>c. Quarterly |
| Flow | Inflow(s) and outflow(s) | Daily |
| Rainfall | Adjacent to wetland | Daily |
| Water stage | Within wetland | Daily |
| Plant cover for dominant species | Near inflow, near wetland centre, near outflow | Annually |

# References


- Kadlec, R.H. and R.L. Knight (1996). Treatment wetlands. CRC Press, Boca Raton, FL, USA. – A new edition will come out in 2007 or 2008.
- Liénard A., Boutin C., Molle P., Racault Y., Brissaud F. and Picot B. (2004). Constructed wetlands and waste stabilization ponds for municipal wastewater treatment in France: comparison of performance and maintenance operations in terms of durability and reliability. Proceedings of the joint 9th IWA International Conference on Wetland Systems for Water Pollution Control and 6th International Conference on Waste Stabilization Ponds, Avignon, France, 13-23.
- Vymazal J. (1998). Czech Republic. In: *Constructed wetlands for wastewater treatment in Europe*, J. Vymazal., H. Brix, P.F. Cooper, M.B. Green and R. Haberl (Eds), Backhuys Publishers, Leiden, The Netherlands, pp. 95-121.