Using recycled construction wastes as wetland substrates for pollutant removal in cold climate

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Background

- Cheap and easy-to-operate nature-based decentralized wastewater treatment process through biodegradation, sorption, plant uptake, photodegradation.
- The substrate material provides binding sites for biofilm development and support for aquatic plants. Generally, natural materials (such as gravels) are used, this study proposes **recycling construction and demolition waste as substrate material**.
- The use of low-cost recycled aggregates in wetlands would benefit for saving natural geological resources, reducing the adverse effects of waste disposal, minimizing carbon footprint of construction materials, and enhancing nutrient removal due to improved adsorption efficiency.

Research questions

- Is using recycled construction and demolition waste as wetland substrate technically, economically, and environmentally feasible in Iceland?
- How well can recycled aggregate-based constructed wetlands remove pollutants in cold climate?
- What design and operation parameters are associated with pollutant removals in the recycled aggregates-based constructed wetlands in cold climate?

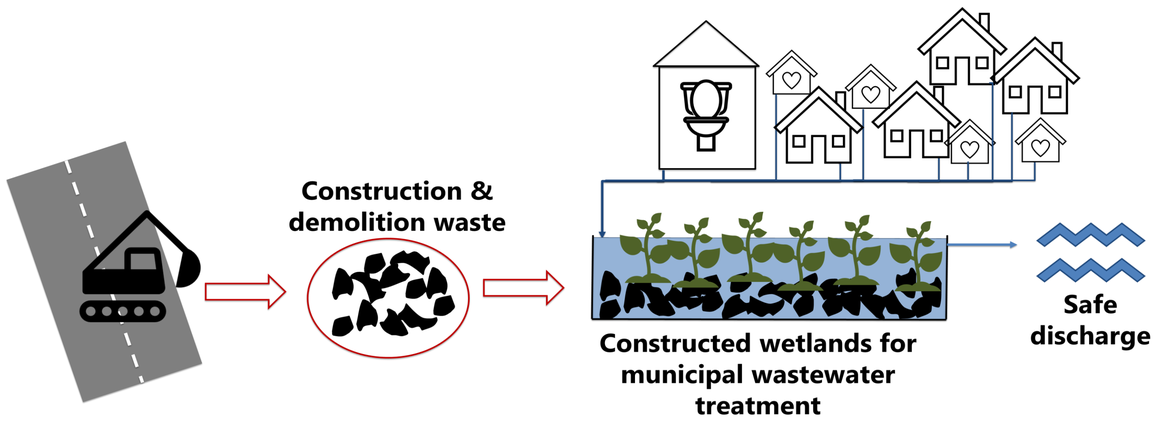
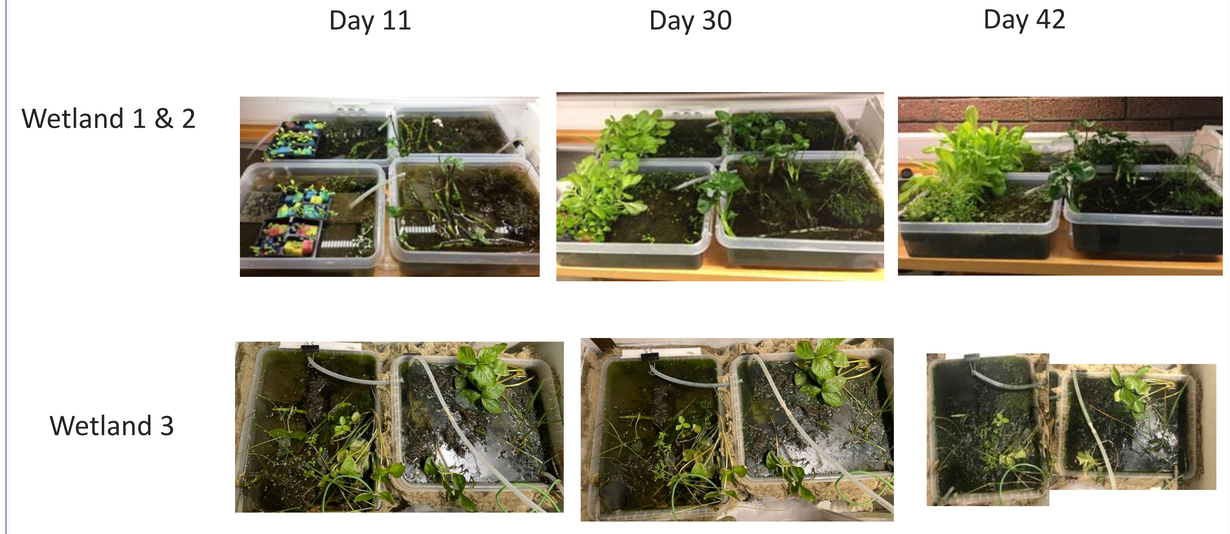


Figure 1. Construction waste as constructed wetlands substrate for decentralized wastewater treatment

Materials and methods

- Three lab-scale 2-stage constructed wetlands (~14 L) were operated with a hydraulic retention time of ~50 h, for treating primary wastewater collected at the municipal wastewater treatment plant in Klettagarður, Reykjavík.

Time	Substrate (25% packing density)	Temp/Light	Plants
Wetland 1 (Day 0-60)	Lava stone	22°C (12 h on-12 h off)	Stage I: Menyanthes trifoliata; Icelandic moss Stage II: Java Mosi (Vesicularia dubyana), Ceratophyllum demersum, Java Fern (Ceratophyllum demersum), basil (Ocimum basilicum), lettuce (Lactuca sativa)
Wetland 2 (Day 0-60)	Cement blocks		
Wetland 3 (Day 61-120)	Cement blocks	5°C (12 h on-12 h off)	Stage I and II: Menyanthes trifoliata; Icelandic moss



Results and Discussion

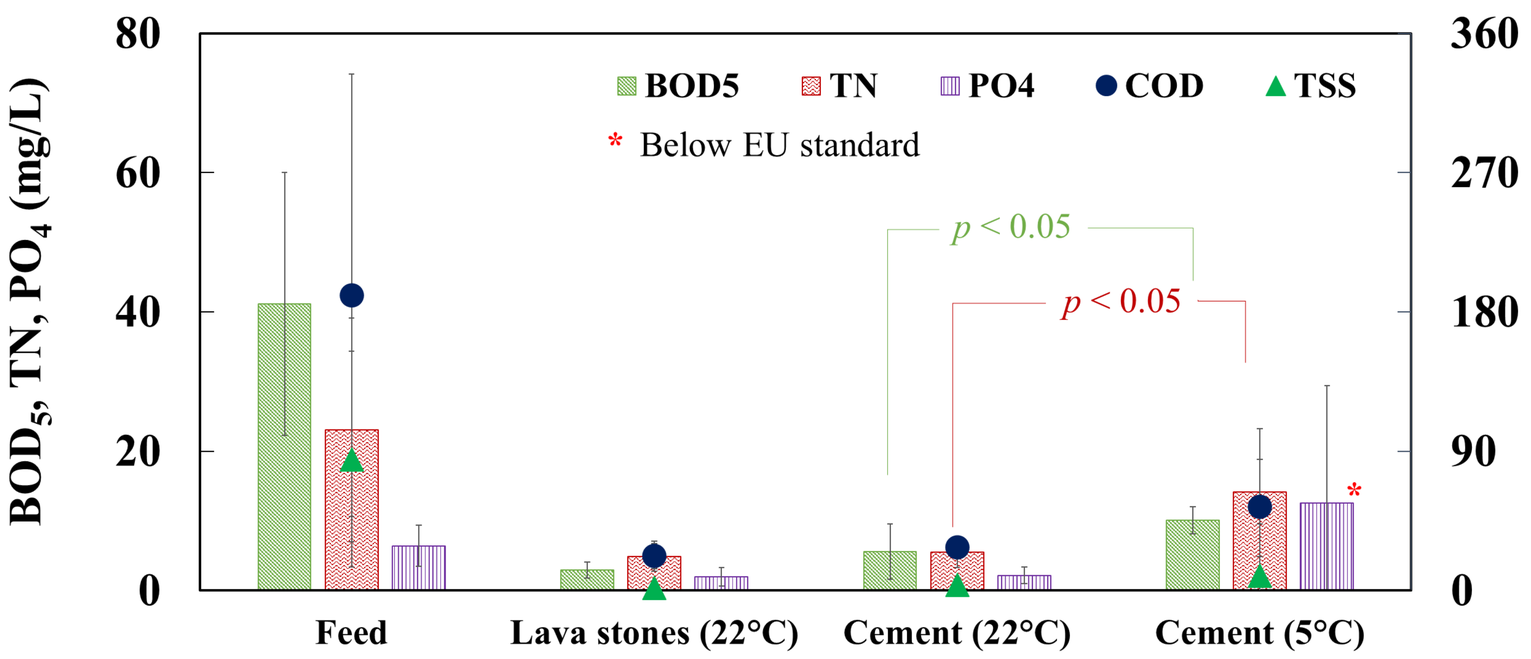


Figure 2. Pollutant removal in constructed wetlands with different substrates

- Cement waste material as biocarriers achieved similar pollutant removal effectiveness as lava stones: 85-88% of COD removal; 80-90% of BOD_5 removal; 67-70% of TN removal; 58-63% of PO_4 removal; 94-98% of TSS removal at warm temperature.
- The wetland at cold temperature produced the effluent with significantly higher BOD_5 and TN concentrations than that at a warm temperature, possibly due to limited plant sorption and biodegradation.
- The treated water met European discharge standards, except the treated water at cold temperature didn't fulfill the nutrient standard for sensitive areas.

Future work

- Heavy metal removal and plant uptake in the wetlands will be investigated.
- Effects of plant types on wastewater treatment efficiencies in the wetlands will be examined.
- Economic and life cycle assessment for comparison with alternative decentralized wastewater treatment processes will be performed.

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