Mass retention in a floating treatment wetland with varying root lengths

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Introduction

- Urban surface waters, such as channels and retention ponds, are important drainage structures for buffering rainstorm events, but they are not designed to improve water quality.
- The collected water that is drained to other rivers and tributaries can carry pollutants that harm the ecosystem health.
- With urban growth and more frequent flooding events, this problem tends to aggravate.
- Floating treatment wetlands are becoming a reliable nature-based solution that promotes several water treatment functions, such as filtration, sedimentation and uptake of nutrients directly from the water column.
- The treatment efficiency of a floating treatment wetland depends, among other factors, on how much untreated mass can actually be retained by the wetlands' root zone.

Objective

To measure the temporary retention of mass inside a floating treatment wetland, focusing on how the variation in root length affects mass retention.

Methods

- The relative root length (h/H) varied between 10% to 90% of the total water depth (Fig. 1).
- The study was performed numerically, using Computational Fluid Dynamics.
- A pulse of conservative tracer was injected at the channel entrance, from which it travelled the domain.
- The mass of tracer temporarily retained by the wetland was monitored for all root lengths tested.
- The wetland was represented by a porous media.

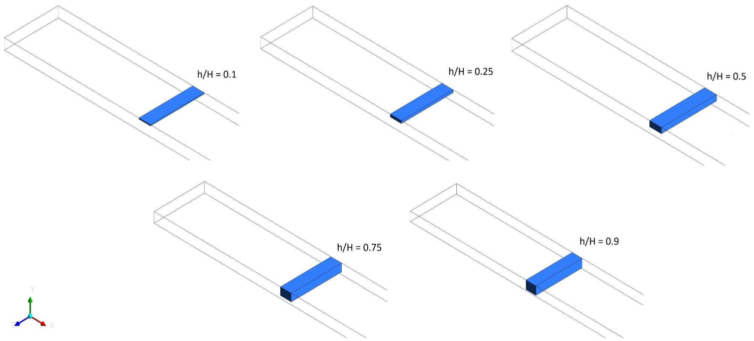

Fig. 1. Geometry of the model, showing the root lengths tested. The wetland (blue) is located in a channel.

Results and Conclusion

The residence time in the floating treatment wetland was plotted in Fig. 2. By increasing h/H from 0.1 to 0.9, the tracer left the wetland more rapidly because the velocity inside the wetland was higher. This caused a 70.2% reduction in the residence time, from h/H = 0.1 to 0.9. Counterbalancing this result, the tracer mass inside the wetland (M_{FTW}) increased with increasing h/H (Fig. 3), as the wetland occupied larger fractions of the channel depth. The peak in M_{FTW}/M_0 was 0.02 for h/H = 0.1, and 0.19 for h/H = 0.9, a 950% increase.

The results show that increasing the root length caused more tracer to pass through the wetland. A nine-fold increase in retained mass was measured between the shortest and the longest root length tested, which is good because more mass would be subjected to treatment (Fig. 3). It is concluded that in terms of mass retention, it is preferrable to use plant species that develop long roots when designing floating treatment wetlands.

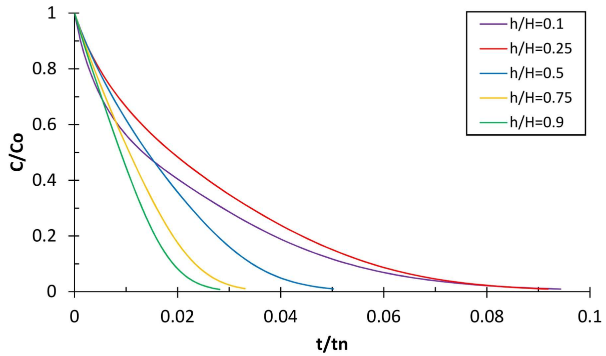

Fig. 2. Residence time curves in the wetland, obtained for each h/H. C/C_0 is the normalized concentration of tracer monitored at the wetland.

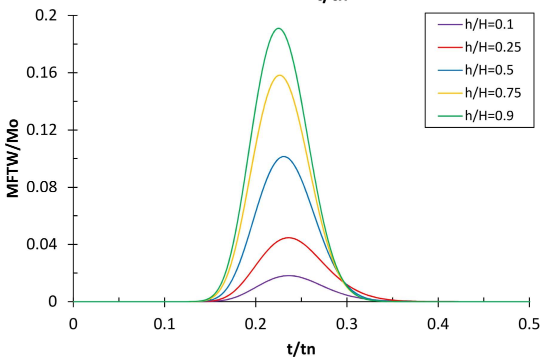

Fig. 3. Plots of tracer mass monitored inside the wetland (M_{FTW}) and normalized by the total mass.

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