Urban stormwater treatment at the Los Angeles Rory M. Shaw Wetlands Park (RRS6)

Smart managed aquifer recharge technologies (SMART)

Re-Inventing the Nation's Urban Water Infrastructure (ReNUWIt)


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Background

Urban stormwater runoff is a potential water source for water stressed cities, but can contain contaminants (e.g., metals, trace organic contaminants and pathogens) that threaten environmental and human health.

Geomedia can be used to remove some of the urban pollutants before recharging the captured stormwater to the aquifer. We propose a passive infiltration system that contains: i) Manganese oxide-coated sand (MnOx), which is know for its ability to oxidize trace organic contaminants and sorb metals.

ii) Biochar, a by-product of biomass pyrolysis, which has a very high surface areas an allows for contaminant sorption and bio-transformation to occur.

Objective

The purpose of this project is to evaluate contaminant removal capacity of a selection of low cost, widely accessible geomedia (e.g., sand, biochar, and MnOx-coated sand) at both laboratory and field scale. We aim to optimize stormwater treatment using a sequential biofilter system prior recharging the aquifer (Figure 1.1).

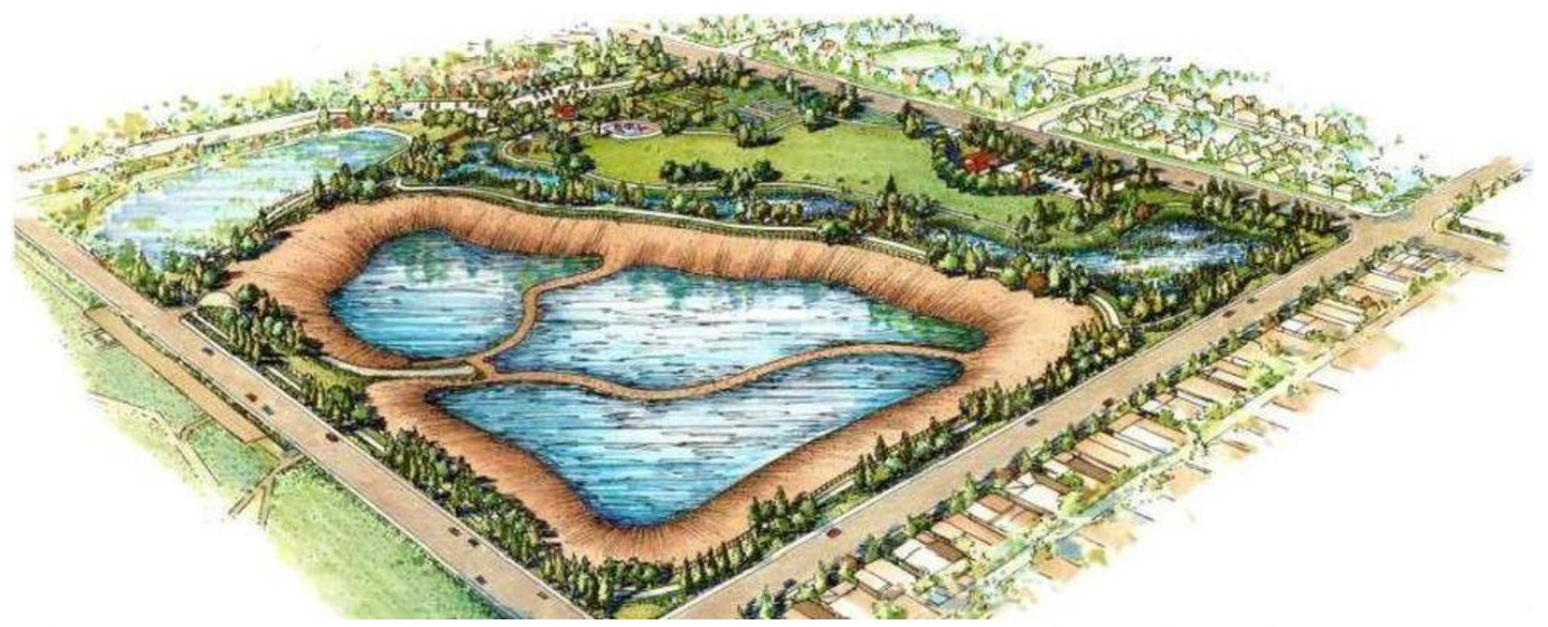

Figure 1.1 An overview of the Rory M. Shaw Wetlands Park Project

Approach

- **Upscaling the MnOx-coated sand synthesis:**

4 batches of MnOx-coated sand (4 kg/batch) were synthesized according to McKenzie method (1981). $KMnO_4$ was reduced with hydrochloric acid, then dried in the dark at room temperature. Once the material was dry, the solids were sieved with a 20-30 mesh and rinsed with Milli-Q water three times (Figure 1.2).

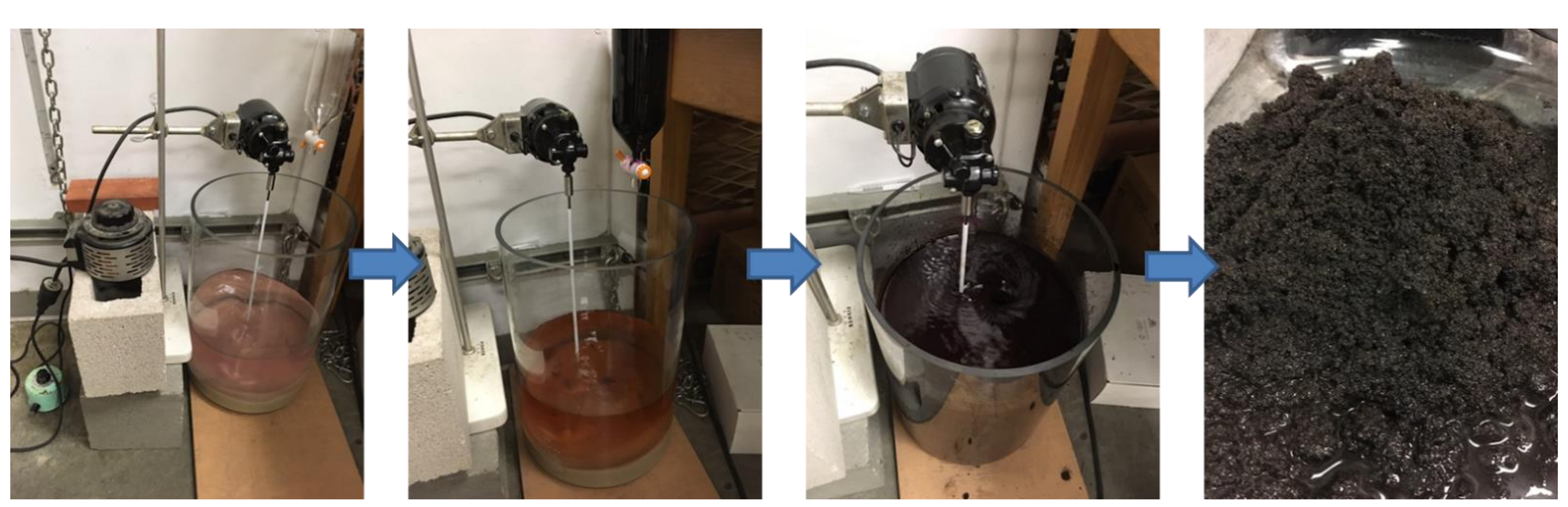

Figure 1.2 Up-scaled geomedia synthesis method (McKenzie, 1981)

- **Sorption/Oxidation batch experiments:**

Batch experiments were set up, performed, and analyzed to assess the sorption and oxidation capacity of the tested geomedia. Oxidation experiments were performed with the MnOx-coated sand. Sorption experiments were conducted with biochar (MCG). Synthetic stormwater (containing Ca^{2+},Mg^{2+},Na^{+}, NH_4^{+}, SO_4^{2-}, HCO_3^{-},Cl^{-},NO_3^{-},$H_2PO_4^{-}$, and Suwanee River DOC) at pH 7.5 was used in all experiments. Ratio solid-to-water were 50 g L^{-1} and 12.5 g L^{-1} for oxidation and sorption tests, respectively. The visual in Figure 1.3 is of the experiment in progress.

Figure 1.3 Batch sorption and oxidation experiments

Results

1. A successful upscale of the production of MnOx coated sand, seen with the creation of 16 kg of geomedia:

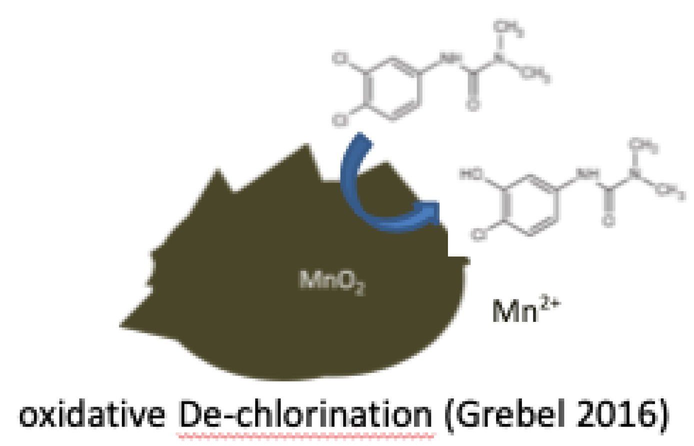

Figure 1.4 Oxidation of organic contaminants by MnOx

Figure 1.5 Final MnOx-coated sand

2. Upscaled MnOx-coated sand was highly reactive. Batch kinetic testing of the MnOx, showed an increase in removal of the bisphenol A (endocrine disruptor):

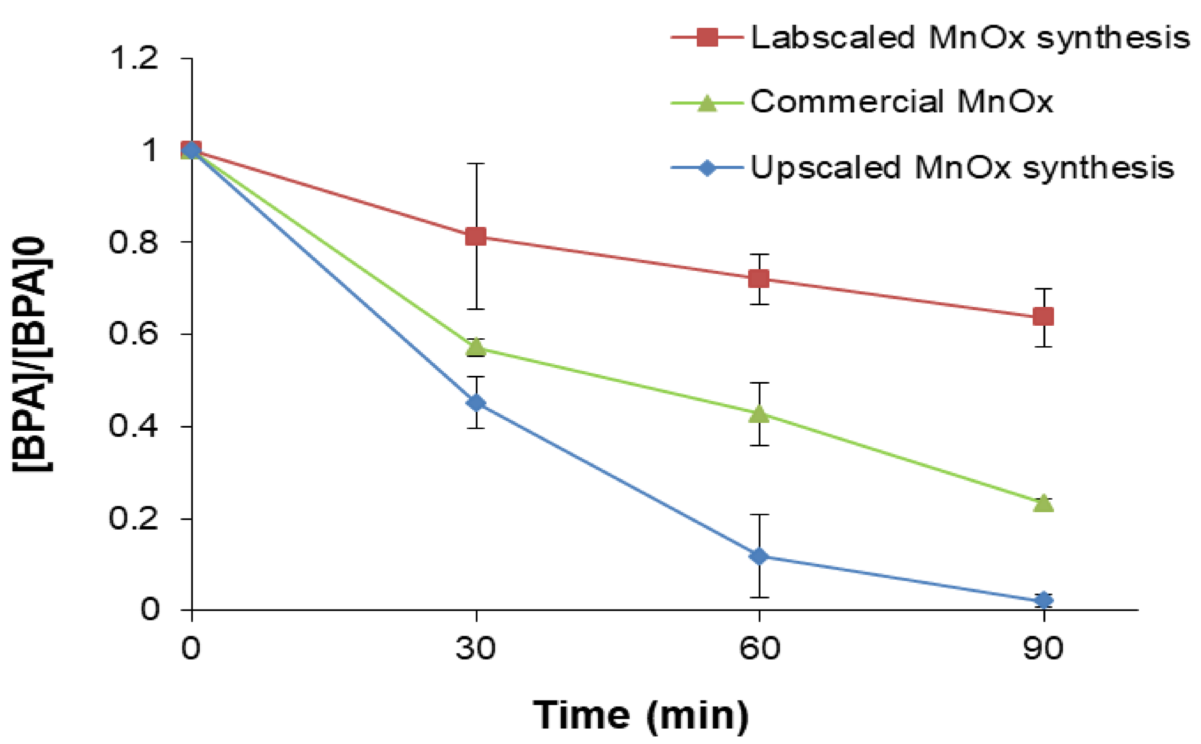

Figure 1.6 Reactivity test of Bisphenol A in synthetic stormwater (BPA initial concentration: 1 mg L^{-1})

3. Biochar and MnOx sand showed promising trace metal removal from the sorption batch experiments, specially compared to sand (most common filtration geomedia). In addition, MnOx could potentially be regenerated in the field.

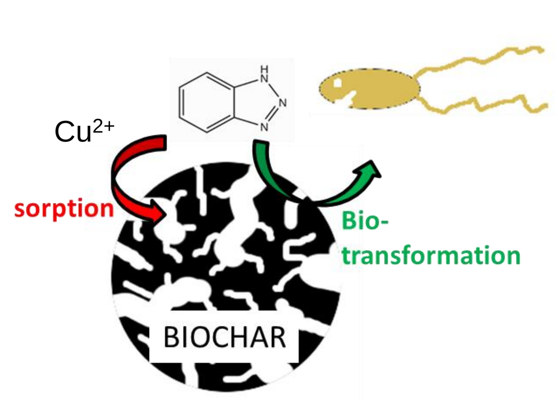

Figure 1.7 Biochar removal mechanisms

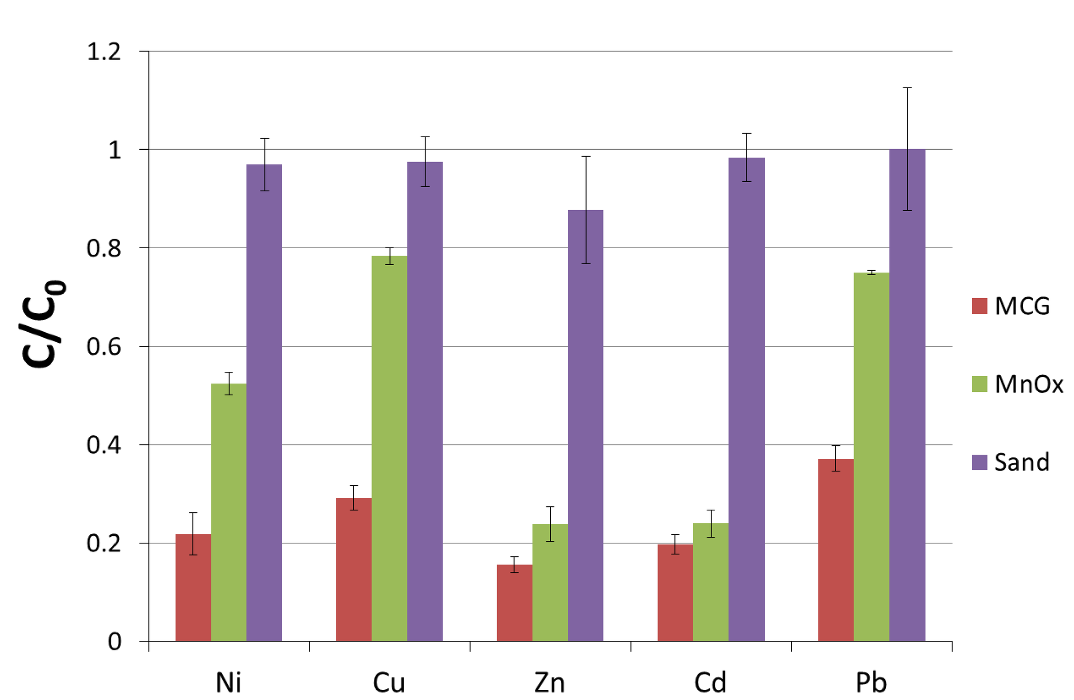

Figure 1.8 Batch sorption experiments results of trace metals for biochar (MCG) and MnOx sand in synthetic stormwater (at 50 µg L^{-1} metal initial conc.)

Conclusions

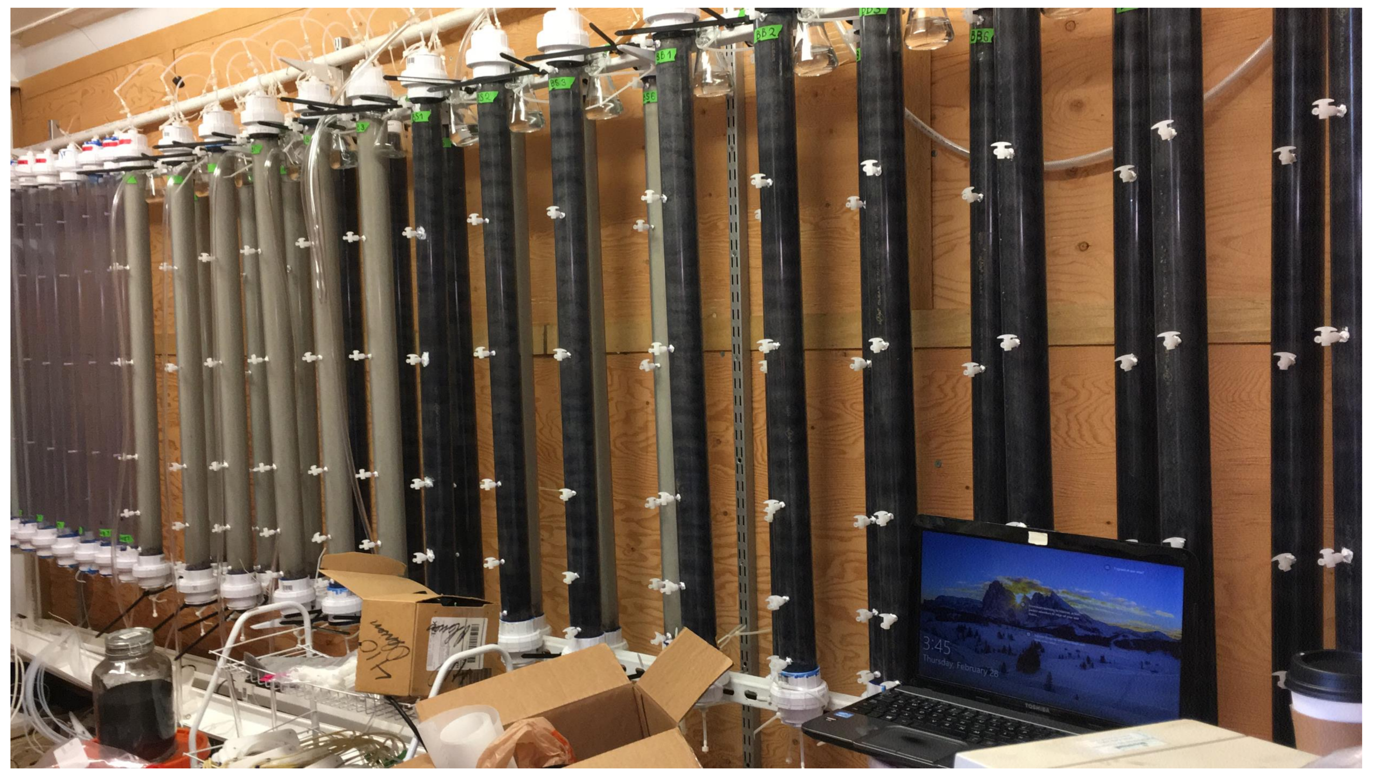

Figure 1.9 Field installation of upscaled MnOx

- We adapted the existing MnOx-coated sand synthesis method in the laboratory. The upscale of production of MnOx was a success. We were able to synthesize 16 kg of the MnOx geomedia (amount of MnOx geomedia required for use in the columns of our field site, Figure 1.9).
- Oxidation batch tests confirmed the good reactivity of the upscaled MnOx in comparison with other available MnOx's.
- With the sorption batch experiments, we were able to determine the removal of trace metal contaminants. Biochar and MnOx are good candidates to remove the stormwater contaminants in the field.

Next Steps

I'm excited to be continuing my work in this lab over the summer and beyond.

I will continue working to set up, perform and analyze an isotherm of the type of biochar used in the columns with synthetic stormwater, azide and Suwanee river, and perform BDOC tests on site samples (Figure 1.10).

Figure 1.10 Samples from mid April site visit

Acknowledgements

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