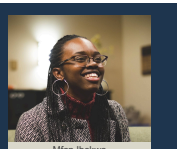
Comparison of the removal of fecal indicators *Enterococci* and *E.coli* in biochar-amended filters over time

Distributed stormwater treatment unit processes

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



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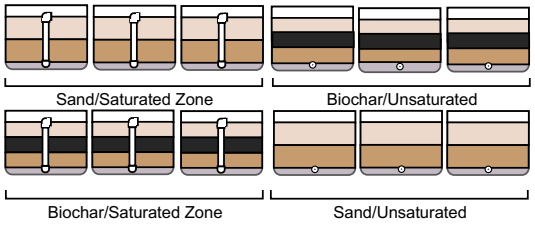
Background

Microbial contaminants in storm water present a significant public health risk to recreational waters. As a way to combat this issue, researchers have looked into ways to improve urban water infrastructures and safeguard public health. One of those ways has been through using traditional storm-water biofilters to improve water quality, but their effectiveness has been shown to be inconsistent and inadequate. Recent studies have shown that biochar, a substance comprised of pyrolized biomass, can improve the effectiveness of filters. Through this study, the effectiveness of the removal of fecal indicators *Enterococci* and *E.coli* will be compared before and after long-term field conditioning of the biofilters, in order to see how the filters perform under long-term conditions.

Methods and Materials

- This experiment was conducted at the Codiga Resource Recovery Center at Stanford University.
- Twelve biofilters were constructed in plastic basins representing four experimental conditions: sand/saturated zone, sand/unsaturated, biochar-amended/saturated zone, and biochar-amended/unsaturated
  - Biochar-amended filters consist of one layer of finely-pulverized biochar layered between two layers of locally-sourced sand
  - Standpipes are used to maintain saturation of the filter media in half of the biofilters
  - A screened PVC pipe drain was installed in the bottom of each biofilter for the purposes of collecting effluent

Sand Saturated Biofilters and Biochar Saturated Filters at the Codiga Resource Recovery Center



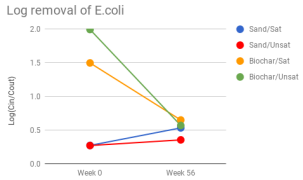
The filters four experimental conditions

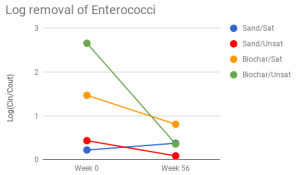
- During the dry season (March 2017 – October 2017), biofilters were wet by applying 2 pore volumes to each filter on a semi-weekly basis. During this interval, influent stormwater and pooled effluent from each filter was sampled monthly.
- During the wet season (October 2017 – Present), biofilters have been wet with 2 pore volumes on a weekly basis with influent and effluent sampling occurring on a semi-weekly basis.
- The filter's samples were assayed for the concentration of *E. coli* using IDEXX Colilert-18 assays.
- In in first week (March 2017) and 56th week of the experiment (April 2018), the concentration of *Enterococci* in each sample was quantified using IDEXX Colilert-18 assays.

Results

E.Coli Filter Experimental Conditions	Week 0 Log removal	Week 56 Log removal
Sand/Sat	0.28	0.54
Sand/Unsat	0.27	0.36
Biochar/Sat	1.50	0.65
Biochar/Unsat	2.00	0.57

Enterococci Filter Experimental Conditions	Week 0 Log removal	Week 56 Log removal
Sand/Sat	0.22	0.37
Sand/Unsat	0.43	0.08
Biochar/Sat	1.47	0.81
Biochar/Unsat	2.66	0.36



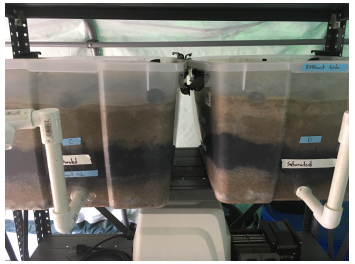


Log Removal of *E.coli* and *Enterococci* comparing Week 0 and Week 56

- The log removal of both *E.coli* and *Enterococci* in the biochar filters increased by about a factor of five when compared to the log removal of the fecal indicators in the traditional sand filters at week 0.
  - All log removal rates for the biochar filters were at or above 1.5
- The removal rate of *E.coli* and *Enterococci* in the biochar filters reduced notably over time (all were below 1), and their removal rate was not distinguishable from the removal rate from sand filters.

Conclusions

- The removal rates of both *E.coli* and *Enterococci* were similar before and after long-term field conditioning of the filters.
- For both the *E.coli* and the *Enterococci*, the log removal rates with the biochar filters were higher than the removal rates in the sand filters at the start of the experiment, but there was not a significant difference over time.
- A log removal value of 1 is equivalent to 90% of the removal of a target pathogen, a value of 2 equivalent to 99% removal and a value of 3 is equivalent to 99.9% removal.
- For these filters to have long-term use, steps need to be taken for the removal rate of fecal indicators to be of a significant value (a value larger than one).



Biochar Saturated Filters at the Codiga Resource Recovery Center

Next Steps

- Conduct tracer tests and challenge tests on the biofilters
  - The tracer test will analyze the flow of storm water through the filters in comparison to the flow at the start of the experiment
  - During the challenge tests, the filters will be wet with storm water spiked with sewage, and the effluent samples will be collected and assayed for *E. coli*, *Enterococcus*, and coliphage
- Investigate the removal of viruses in storm water.

Acknowledgements

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