UNIVERSITY of SOUTH FLORIDA
College of Engineering
Department of Civil and Environmental Engineering

Comparison of Biochar-Enhanced Bioretention Systems with Free- and Elevated-Drainage for Nitrogen Removal from Urban Stormwater Runoff

Vicky Lopez; Julia Manser; Joshelyn Guimaray; Sarina Ergas, PhD; Mahmood Nachabe, PhD

Background

- Urban stormwater runoff:
  - Can carry excessive nutrients like nitrogen.
  - Can cause eutrophication, leading to algal blooms, fish kills, sea grass mortality.
  - Nitrogen is difficult to remove from stormwater due to low concentrations and intermittent loading.
- Bioretention has the potential to remove nitrogen from urban stormwater runoff.
- Biochar can enhance nitrogen removal in stormwater bioretention systems.
- Elevating the bioretention system outlet creates two zones, one with oxygen (nitrification) and one with little to no oxygen (denitrification).

Objective

This study investigated the effect of biochar amendment and outlet elevation on nitrogen removal in bioretention systems utilizing HPM across different scales

Methods

Adsorption Kinetic Studies:

Determines how much dissolved inorganic nitrogen species can be adsorbed by biochar over time

Column Studies:

Four columns were set up to test the effect of biochar addition and outlet elevation on nitrogen removal.

Determines how much of NH_4^+-N and NO_x-N is removed through denitrification, nitrification, and adsorption with the use of biochar

Adsorption Isotherm Studies:

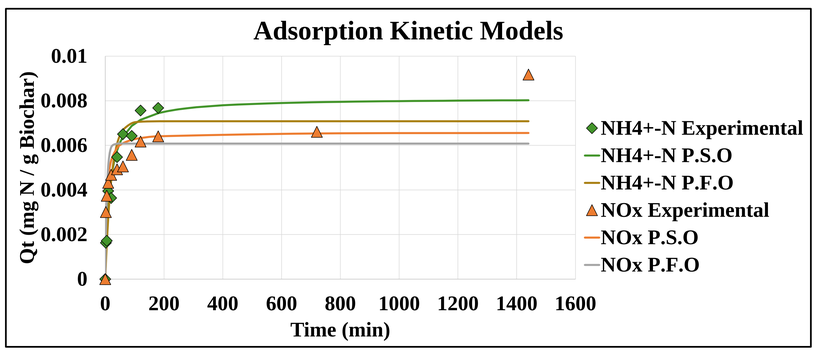
Determines how much biochar alone can adsorb NH_4^+-N and NO_x-N at different concentrations

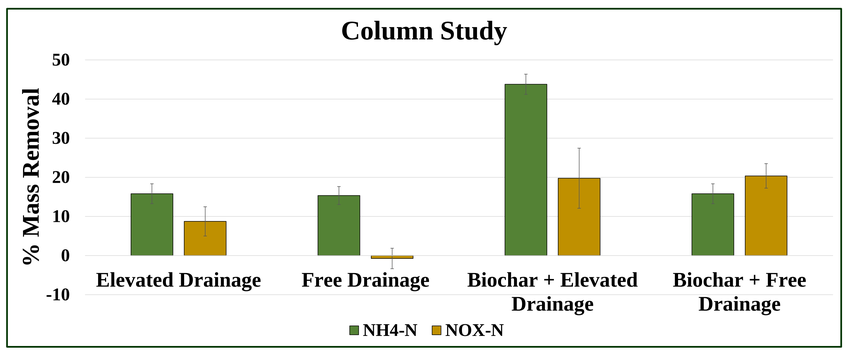
Pilot Studies:

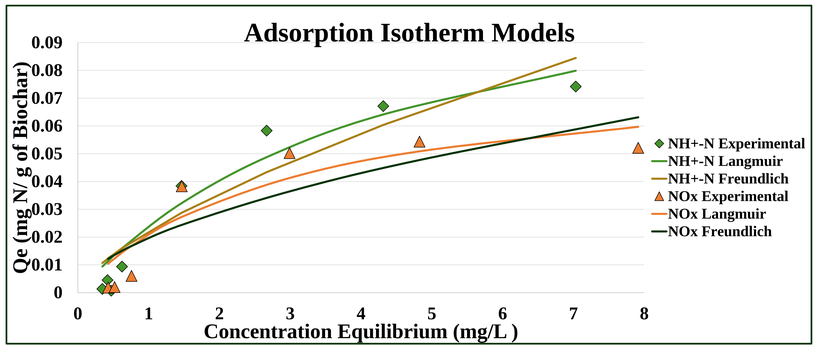
Two pilot scale systems, both with media containing biochar, were used to test the effect of outlet elevation, mulch addition and plant addition on nitrogen removal.

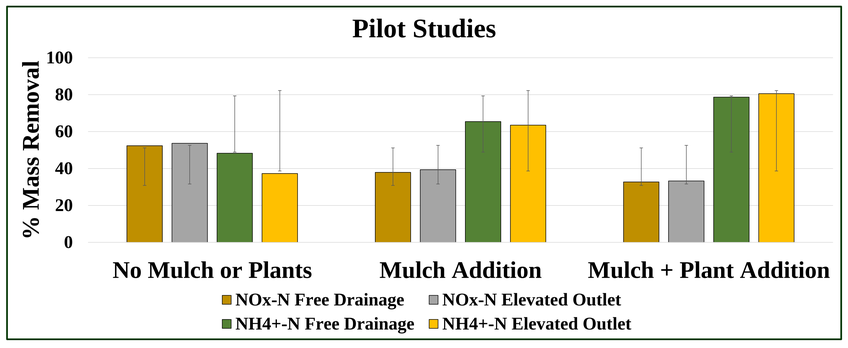
- Mulch addition was used to enhance denitrification, support plant growth, and prevent clogging
- Plants were introduced to stabilize the soil, uptake nutrients, and improve microbial activity

Results









Conclusion

- Adsorption kinetic studies showed some removal efficiency for NH_4^+-N and little to none for NO_x-N at low concentrations
- The adsorption isotherm studies showed higher removal efficiency of NH_4^+-N and NO_x-N at higher concentrations
- Both columns with biochar performed better with NH_4^+-N and NO_x-N removal with the elevated drainage with biochar doing the best
- The addition of mulch and plants had the highest percent mass removal of NH_4^+-N and NO_x-N in the pilot studies

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement number MX-02D47623 to the University of South Florida. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does the EPA endorse trade names or recommend the use of commercial products mentioned in this document. Biochar Now donated adsorbent materials for testing.