Evaluating Biofilter Performance in Improving Roof Runoff Water Quality

Payton Fischer, Cass Newman, Cara Poor, Ph.D., P.E., Jordyn Wolfand, Ph.D., P.E.
The University of Portland, Department of Civil & Environmental Engineering

UNIVERSITY of PORTLAND | SHILEY SCHOOL OF ENGINEERING

Background

Pollutant influx into water bodies via stormwater has become an increasingly serious environmental concern, particularly in regions with high rainfall. Roof runoff, a major component of stormwater, presents an elevated risk of pollutant accumulation due to the natural settling of airborne contaminants, known as atmospheric deposition, as rooftops tend to remain more undisturbed than other impervious surfaces. Installing roof runoff filters on buildings helps mitigate stormwater pollution at the source, protecting drinking water supplies and nearby ecosystems for safe public use.

Introduction

Study Purpose
- Evaluate filter performance based on roof material type and filter type.
- Analyze microplastic concentrations in atmospheric deposition samples.
- Measure removal efficiency of:
  - Nutrients: Phosphate, Nitrate, Total Phosphorus
  - Heavy Metals: Zinc, Copper
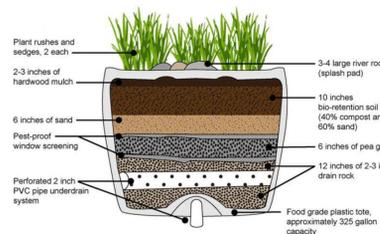 - Microplastics: 106µm – 5000µm

Biofilters Tested
- Grattix Filter
  - Developed by Port of Vancouver
  - Uses established vegetation and a bioretention soil mix (compost + sand)
  - Low-cost stormwater treatment option
- Zeolite Filter
  - Proprietary filter
  - Contains positively charged zeolite, biochar, and peat
  - Commercially available
- Shale Filter
  - Proprietary filter
  - Made of shale, biochar, and peat
  - Commercially available

Proprietary Filters
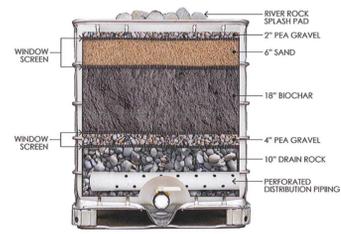
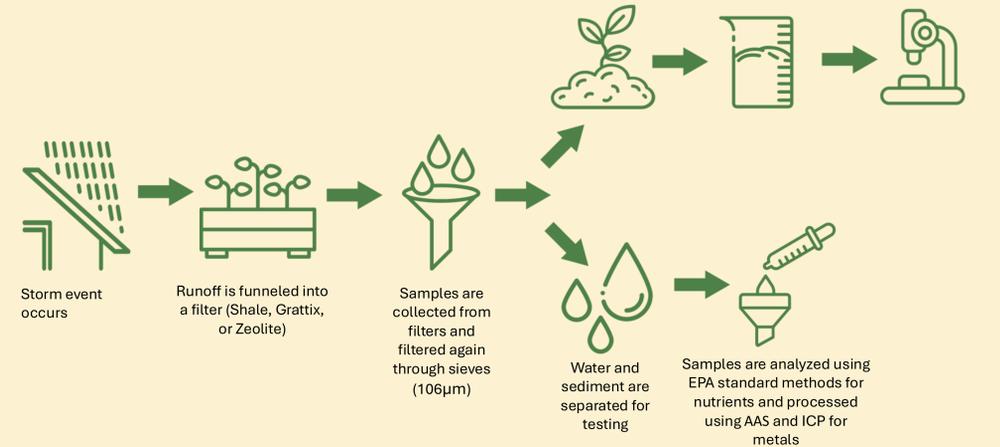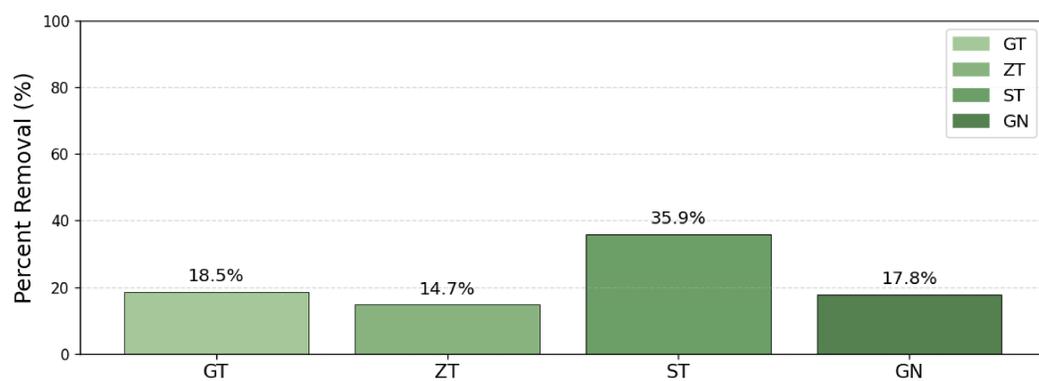Proprietary Filter Design with Shale or Zeolite

Grattix Box

'Grattix Box' Filter Design

Methods

Methods Flow Chart for Microplastics, Metals, and Nutrients:

Sample Collection & Analysis
- Samples from 60 storm events were collected
  - Each was analyzed for microplastics, nutrients, and metals

Filter Installations:
- Tennis Center:
  - Grattix (GT)
  - Shale (ST)
  - Zeolite (ZT)
- Nursing Annex:
  - Grattix (GN)

Installation Overview
- Study Sites: Three locations on the University of Portland campus
  - Tennis Center: Runoff from galvanized metal roof
    - Influent Sample: IT
  - Nursing Annex: Runoff from asphalt shingle roof
    - Influent Sample: IN
  - Shiley Green Roof: Used to gather atmospheric deposition samples of microplastics (no filtration)

Microplastic Average Percent Removal by Site

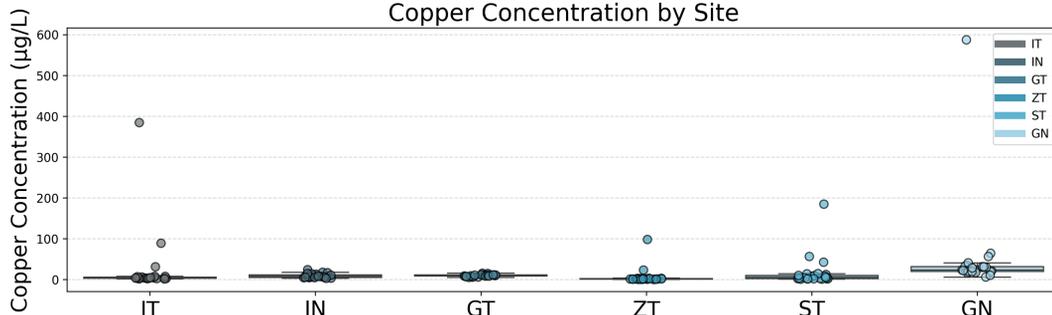## Nutrient and Metal Average Percent Removal by Site
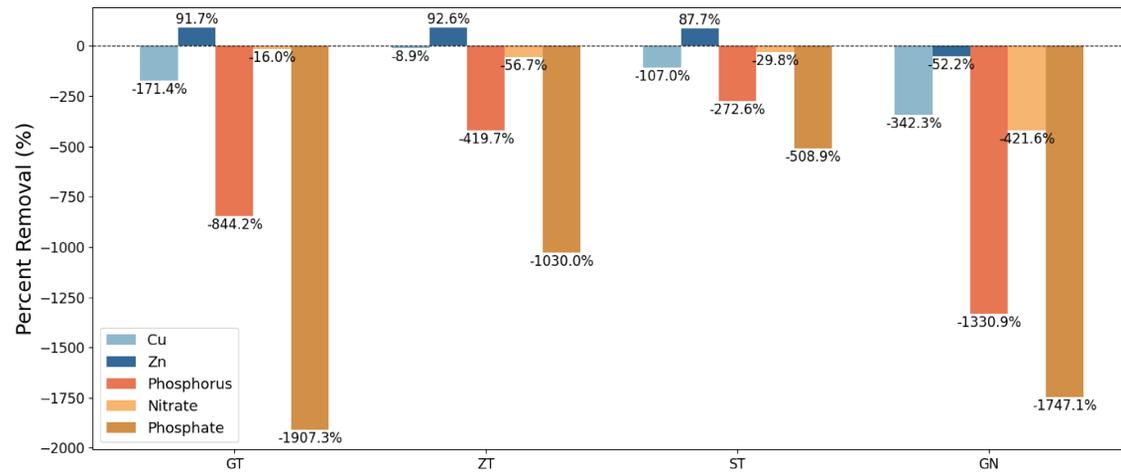
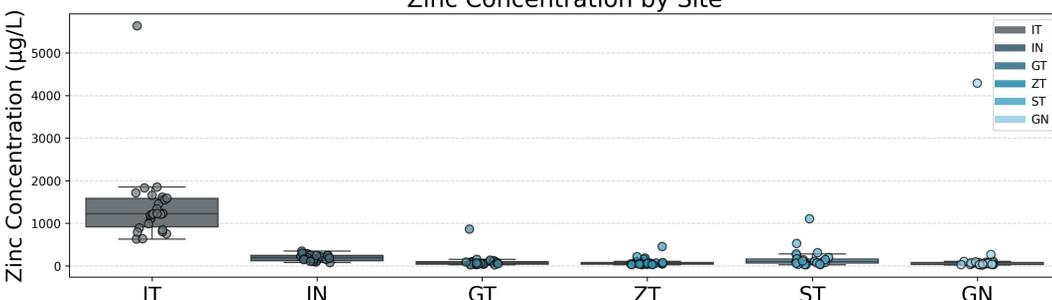## Metal Concentrations by Site

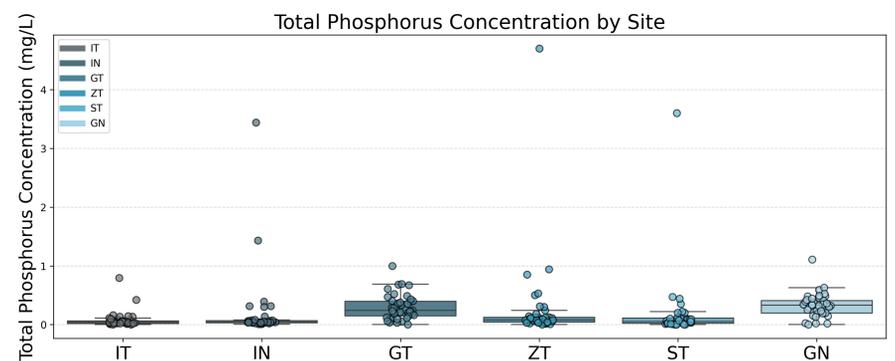

Nutrient Concentrations by Site
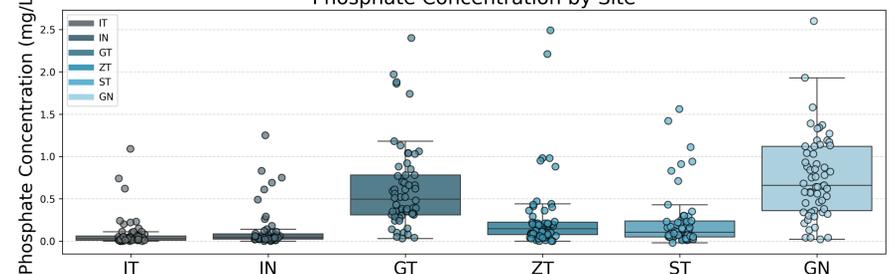
Discussion

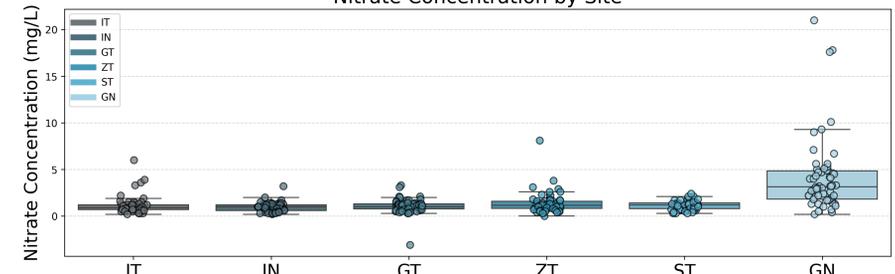**Zinc**
- All three filters at the Tennis Center demonstrated strong zinc removal, though initial influent concentrations were higher than those at the Nursing Annex.

Copper
- ZT leached the least Copper (–8.9%).
- GT and ST leached significantly more Copper
- GN, with an asphalt roof, had the worst Copper leaching.

Microplastics
- Microplastic analysis is still ongoing. However, with preliminary data analysis, ST seems to be removing microplastics the most effectively.

Nitrate
- GT performed the best by leaching the least nitrate (–16.0%).
- GN performed the worst, likely due to organic debris from its forested location.

Phosphorus & Phosphate
- All sites leached phosphorus and phosphate, demonstrating poor performance overall in nutrient retention.
- ST showed the lowest phosphorus and phosphate leaching among all sites:
- Both Grattix boxes, GT and GN, had the worst nutrient leaching:
  - GT: Highest phosphate leaching
  - GN: Highest phosphorus leaching

Acknowledgments

Conclusions

While microplastic analysis is still ongoing, ST and ZT appear to be the most effective filters overall when considering average percent removal of nutrients, metals, and microplastics. Grattix boxes show promising results, particularly for nitrate removal, when paired with a metal roof, and microplastic removal.