Data-driven Monitoring of Green Stormwater Infrastructure using Remote Sensing and AI Techniques

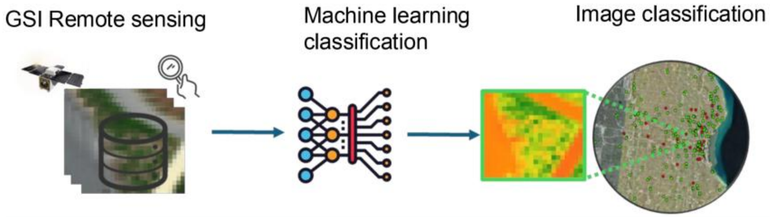
Abhiram S.P. Pamula, Omar Hegazy, Walter McDonald
Department of Civil, Construction, and Environmental Engineering – Marquette University, Milwaukee, WI
Presenting author: abhiramsivaprasad.Pamula@marquette.edu, Correspondence: walter.mcdonald@marquette.edu

Problem

Green Stormwater Infrastructure (GSI) provides essential services such as flood control, pollutant removal, urban heat reduction, and habitat support. These functions can decline if maintenance is neglected, as issues like sediment buildup, erosion, and clogged inlets often remain undetected until performance deteriorates. Field inspections are time-consuming and limited in scope, and while satellite remote sensing offers wide coverage, it is still rarely used to assess the condition of Best Management Practices (BMPs). There is a clear need for remote sensing approaches that combine drone and satellite imagery to enable more efficient and comprehensive monitoring of urban stormwater infrastructure.

Goals

This project aims to assess **supervised and unsupervised** machine learning methods for monitoring GSI BMPs using drone imagery, focusing on indicators like **vegetation cover, surface clogging, sediment buildup, and hydrologic changes** that signal **maintenance** needs.



Background

Degraded GSI **inhibits** effective **stormwater management**

- Reduced infiltration
- Reduced evapotranspiration
- Reduced pollutant removal
- Aesthetic impairments
- Degraded habitat quality

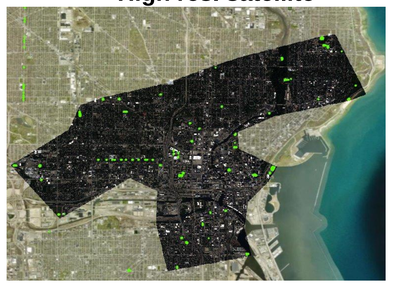
Current GSI monitoring and maintenance efforts are **costly and time-intensive**

Data Collection

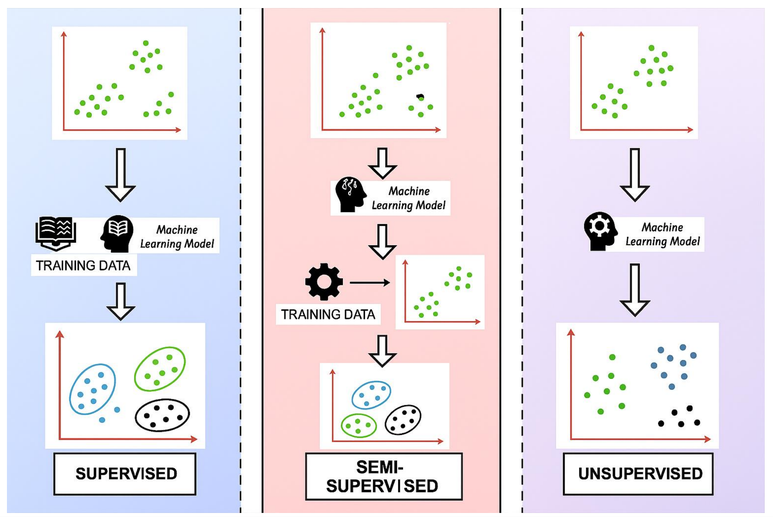
Drone

+

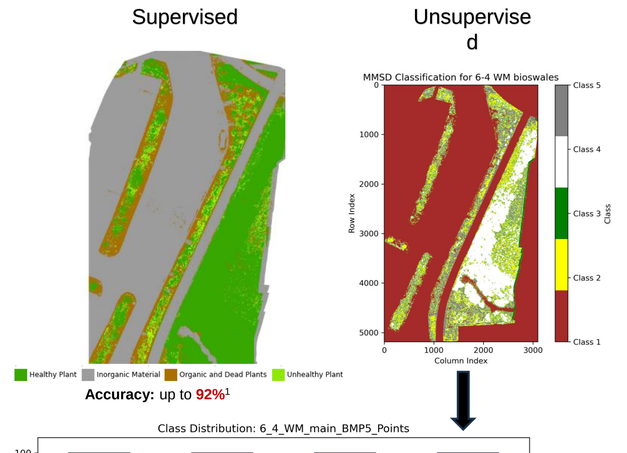
High res. satellite



Machine learning approaches



Results



Accuracy: up to **92%**[1]

Key Takeaways

- Supervised machine learning able to detect plants
- Unsupervised machine learning effectively delineates non-plant organic matter
- Future work exploring further classification of invasive weeds
- Supervised learning requires the creation of a comprehensive training library; whereas unsupervised learning requires more computational resources.
- Unsupervised learning may produce classes that can be used for training instead of the training library, making it suitable for semi-supervised learning.

Future work

- Label the classes produced through unsupervised learning to identify GSI systems health.
- Fine-tune the models to identify and map weeds across the GSI systems.

Acknowledgements

This work was supported by the Department of Army award (“Novel Technologies to Mitigate Water Contamination for Resilient Infrastructure”; Federal Award Identification Number: W9132T2220001) issued by the U. S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC). The United States Government has a royalty-free license throughout the world in all copyrightable material contained herein. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of USACE-ERDC.