Assessment of Changes in Gross Solids Mass Collected from Rain Gardens in Areas Undergoing Structured Ash Tree Removal

Natalie Narváez, advised by Dr. Grace Wilson, Dr. Jacques Finlay, and Dr. John Chapman

University of Minnesota - Twin Cities, Department of Bioproducts and Biosystems Engineering

Abstract

A structured ash tree removal process throughout Saint Paul, Minnesota began in 2021 and will continue through 2024 as part of a targeted emerald ash borer (EAB) management plan. This UROP project aimed to assess the effects that the structured ash tree removal would have on gross solids collected in rain gardens located in the Como neighborhood. Solids were collected from five rain gardens throughout the summer and the estimated dry mass of each sample was gathered. The data collected suggests that structured ash tree removal did have an impact on the overall amount of mass collected. Further analysis could reveal more gross solids trends affected by structured ash tree removal.

Introduction

Due to the limited success of insecticide treatments administered to ash trees to control the spread of EAB, a structured removal plan has been implemented to remove all ash trees, indiscriminate of age and variety, on boulevards within the City of Saint Paul, between 2021 and 2024.

These removals are likely to have a significant impact on the amount of leaf material and gross solids mass that collects in stormwater due to the reduction in canopy cover and thus leaf litter in areas with higher numbers of boulevard ash trees. As the amount of leaf litter is correlated to amounts of nitrogen (N) and phosphorous (P), these removals are also likely to have an impact on N and P inputs within urban watersheds.

The focus of this UROP project was to assess the effect that the structured removal of boulevard ash trees would have on the mass of gross solids that collect in rain gardens over the summer of 2023 near areas with significant tree removals. It was hypothesized that the gross solids mass collected at the rain garden site located down-slope from three city blocks targeted for strategic ash tree removal in the summer of 2023 would show a significant reduction in comparison to the gross solids mass collected from the rain garden sites that were not located down-slope from any significant structured ash tree removal.

Methodology

- Five rain gardens within the Como neighborhood were sampled seven times throughout the summer of 2023. Four of these sites were not located down-slope from any structured ash tree removal and one of them – Frankson-McKinley East – was located downslope from three blocks receiving structured ash tree removal over the summer of 2023.
- All locations were fitted with monitoring equipment from previous stormwater solids research that collected a representative amount of the gross solids that enter each rain garden while allowing water to flow freely out of mesh sampler bags.
- Gross solids were collected from all five sites once every two weeks.
  - The total wet mass of every sample was recorded before a smaller representative portion of each sample was separated into a metal tin (pre-weighed), weighed, and then oven-dried for a minimum of one week.
  - The dried portions of each sample were then re-weighed, and the prerecorded weights of their respective drying tins were subtracted.
  - The moisture content of each sample was derived by dividing the difference between the wet and dry mass by the initial wet mass.
  - The total dry mass of each sample was estimated by multiplying the total wet mass by the moisture content and then subtracting the resulting value from the total dry mass.
- The total dry mass of gross solids collected from each site over the summer was then analyzed to assess the effects of the structured ash tree removal. Comparisons were also made with cumulative dry mass estimates of samples collected at the same sites in 2022 and 2021 from previous stormwater solids research.

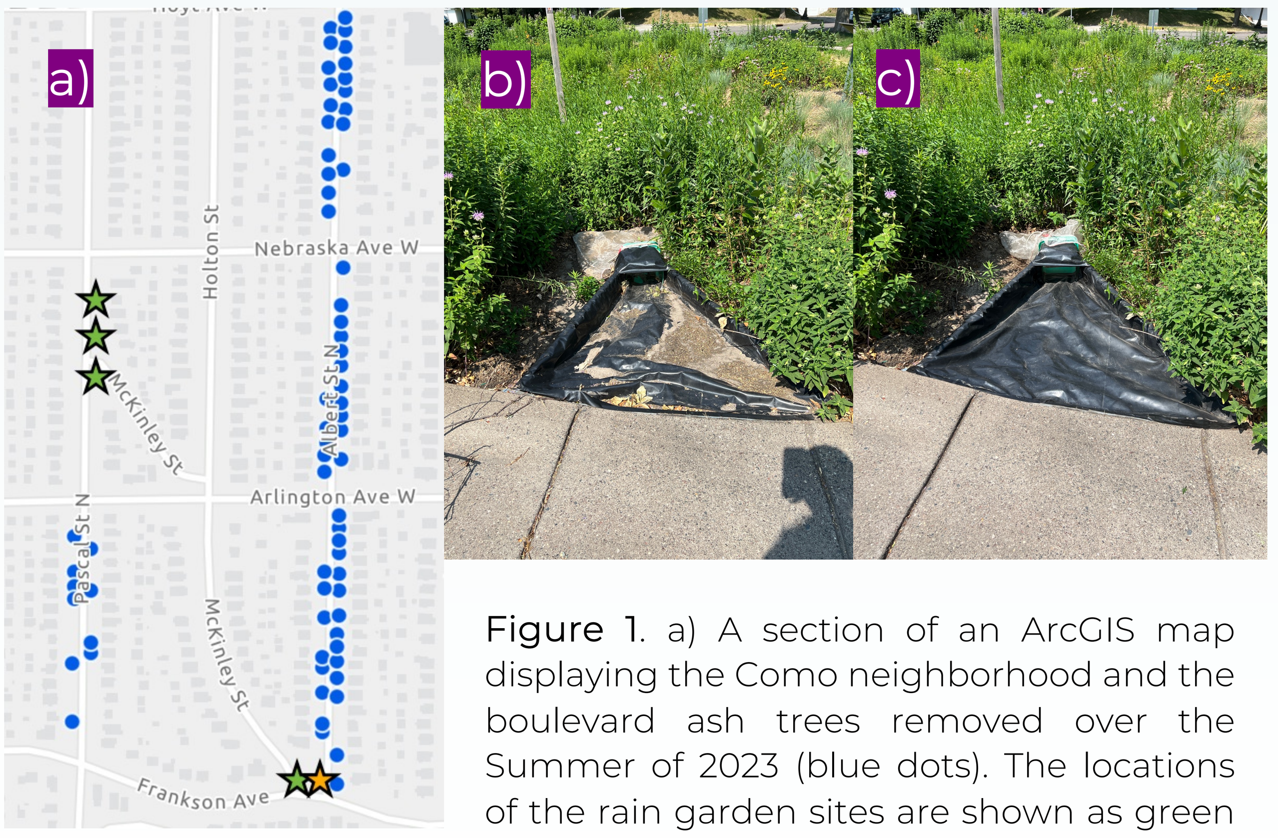

Figure 1. a) A section of an ArcGIS map displaying the Como neighborhood and the boulevard ash trees removed over the Summer of 2023 (blue dots). The locations of the rain garden sites are shown as green stars, and the Frankson-McKinley East site is represented by an orange star to denote its location downslope from a significant number of removals. b) A photo of the Frankson-McKinley East site before the sample was collected on July 10th, 2023. c) A photo of the Frankson-McKinley East site after the sample was collected on July 10th, 2023.

Results

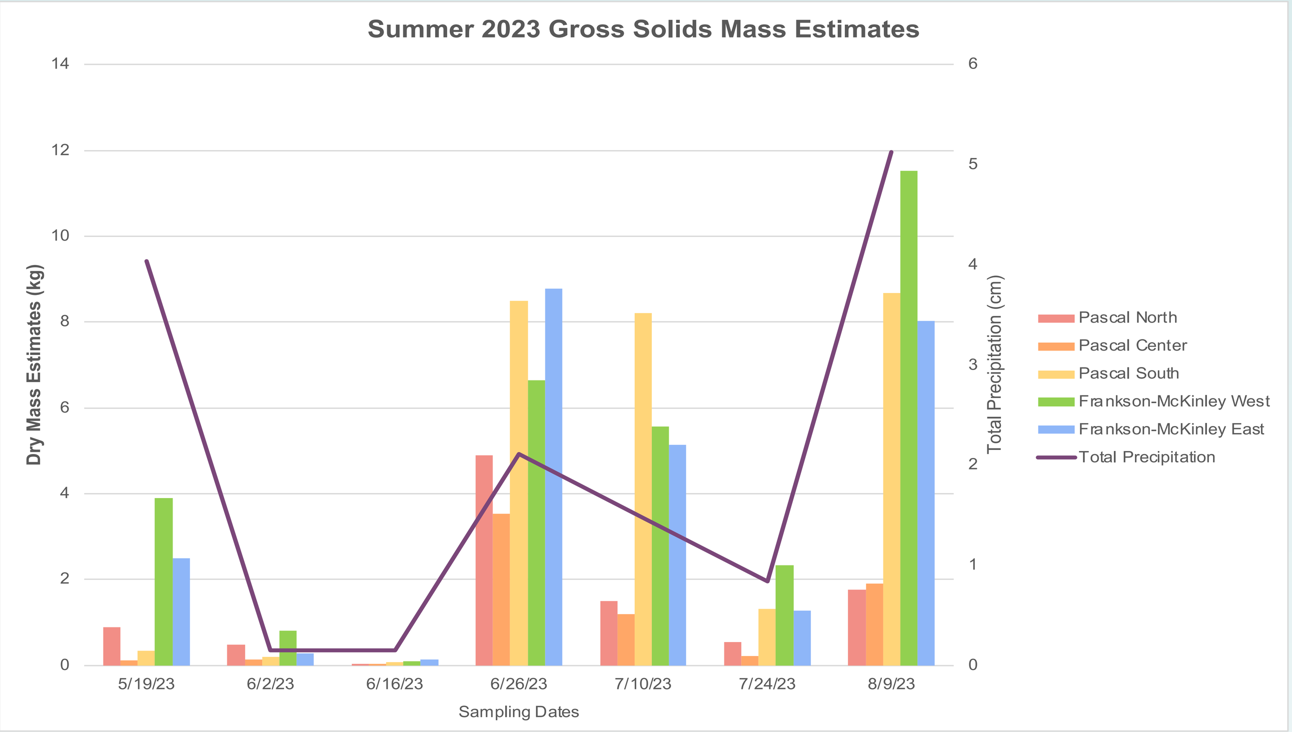

Figure 2. The gross solids mass estimates (kg) from each site on each sampling date. The Frankson-McKinley East site is depicted in blue. The total accumulated precipitation between sampling dates is represented by the purple line. Precipitation from May 1st through May 19th was used for total precipitation value for the May 19th sampling date.

Rain Garden	Summer 2023 Cummulative Dry Mass Estimate (kg)
Pascal North	10.12
Pascal Center	7.17
Pascal South	27.34
Frankson-McKinley West	30.89
Frankson-McKinley East	26.15

Figure 3. The summer 2023 cumulative dry mass estimates (kg) from all five rain garden sites.

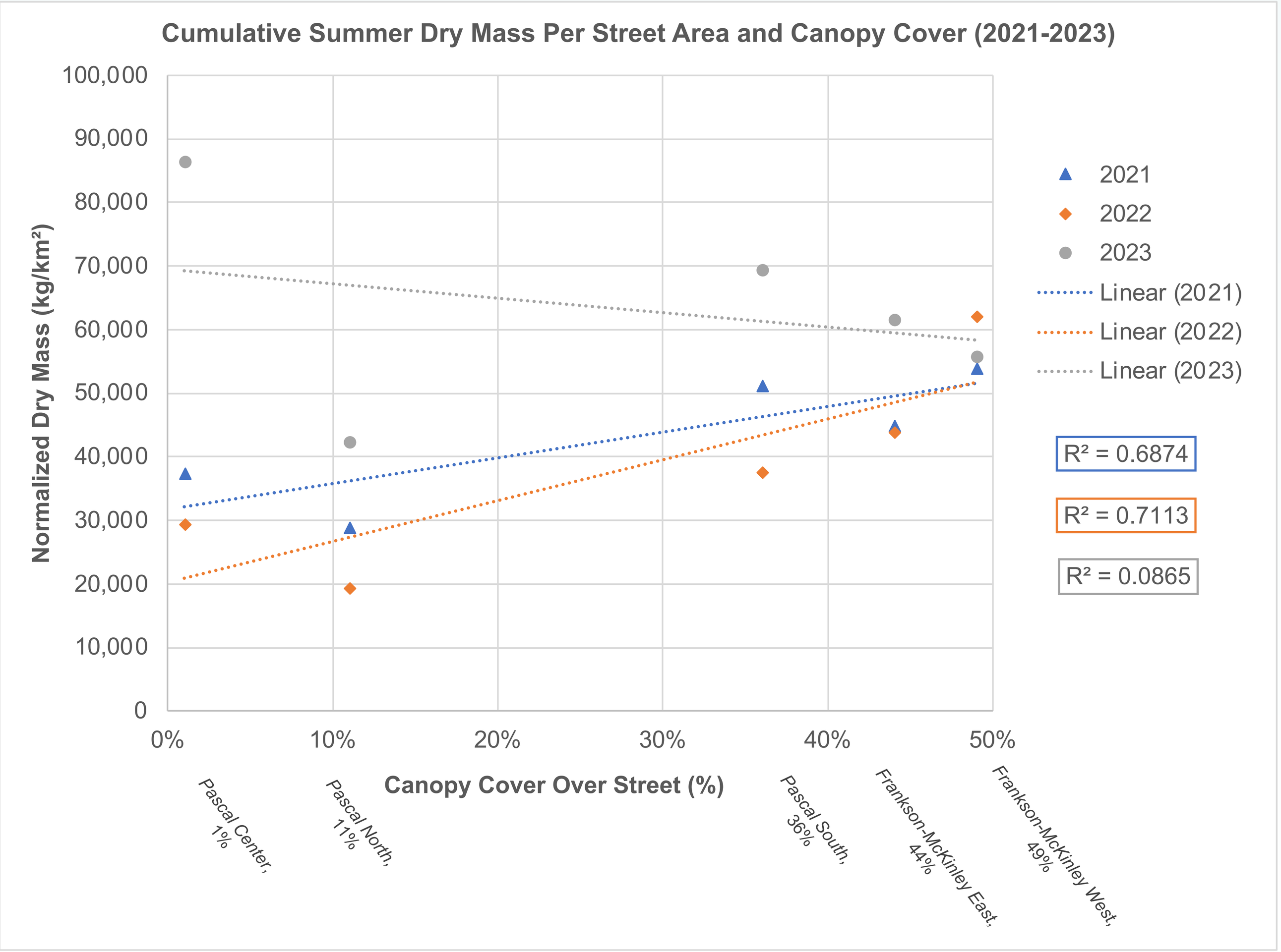

Figure 4. The cumulative dry mass normalized for ½ street area (km²) and displayed with the corresponding canopy cover (%) for each rain garden site in the summer of 2023 (gray circles), 2022 (orange diamonds), and 2021 (blue triangles). The linear relationships for each year are also plotted and the corresponding R^2 values are displayed below the legend, and canopy cover for each site is noted under the x-axis.

Conclusion

- The mass of gross solids collected on each sampling date generally increased or decreased with the trend of total precipitation between sampling dates.
- The cumulative dry mass estimate for the Frankson-McKinley East site was the median of all five sites in the summer of 2023, representing a decrease relative to the cumulative dry mass estimates in the summer of 2022.
- The R^2 value for 2023 was closer to zero than the R^2 values for 2022 and 2021, suggesting that the ash tree removal did impact the amount of mass collected.

Future Directions

- The results disproved the initial hypothesis but still showed that the structured ash tree removal did have an impact on the mass of gross solids collected, thus further data analysis is recommended to control for more confounding variables.
  - Any changes to the canopy cover for the Frankson-McKinley East site should be reevaluated to reflect the loss caused by the ash tree removal.
  - The effects of phenological cycles on gross solids dropped by ash trees should be compared to the data collected, and wind patterns throughout the summer should also be considered in conjunction with precipitation for all three years of summer data.
  - The exact dates of ash tree removal on Albert Street North should be requested from the city for comparison with the observed gross solids data.
- These steps could provide a clearer perspective of the impact of structured ash tree removal on the amount of gross solids mass collected by rain gardens.

Acknowledgments

I would like to thank Dr. Grace Wilson, Dr. John Chapman, and Dr. Jacques Finlay for mentoring and advising me throughout this process. I would also like to thank Kathryn Hoffman for her guidance, and Andrew Ratz and Katie RempelEwert for their help with the sampling effort on June 26th.

References

City of Saint Paul. (2023, January 31). *Saint Paul Boulevard Ash Tree Management Program.* Saint Paul ArcGIS Maps. https://stpaul.maps.arcgis.com/apps/webappviewer/index.html?id=f9d56f2cc231474c81dc2ef45c45136f

Minnesota Department of Natural Resources. (2023, August 25). *Daily Data.* Minnesota Department of Natural Resources. https://www.dnr.state.mn.us/climate/historical/daily-data.html?sid=217370&sname=ST.+PAUL+DOWNTOWN+AIRPORT&sdate=2023-05-01&edate=2023-08-31

University of Minnesota
Driven to Discover®