Microplastics in the Urban Environment

Exploratory Study of Freshwater Microplastics in Athens, GA

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This document will be my final manuscript for the MADA project. I am keeping these draft sections for structure now, until I edit them later.

# 1 Summary/Abstract

*Write a summary of your project.*

# 2 Introduction

In the past two decades, the study of microplastics has expanded exponentially. Since the earliest paper mentioning small plastic particles in the ocean was published in the 1970s, before the term “microplastics” even existed, researchers across the globe have quantified microplastic particle levels in both marine and freshwater environments, assessed potential drivers and predictors of microplastic pollution, examined the presence of microplastics in the food chain, and explored the potential human health impacts of ingested microplastics [1]. Though the body of research on microplastics has grown in recent years, many knowledge gaps remain regarding this pollutant. The term microplastics was first coined in 2004, and today microplastics are defined as plastic particles smaller in size than 5 mm, though some studies examine particles as large as 20 mm [2]. Years of sampling, experimentation, and progress in research methods tell researchers that microplastics are a persistent class of pollutant and are found worldwide in a diverse assemblage of forms [3].

Through decades of research, the scientific community proves that microplastics are ubiquitous, having identified microplastics in oceans, rivers, lakes, and other water bodies across the globe, including remote mountain lakes, the bottom of the ocean, and in ocean sediments offshore of Antarctica [4–6]. Modeling of current and future plastic production and pollution indicates that plastics are so pervasive that they have been considered as a geological indicator of the proposed Anthropocene era [7]. These models also suggest that microplastic concentrations will only increase in the future [3,8–10]. In a 2018 paper, Barboza and collaborators state that the increase in environmental microplastics is particularly concerning due to the contaminants’ small size, the limited technology for quantifying their presence, and their potential for adversely affecting both marine biota and humans [3]. Further, research shows that microplastic pollution is largely due to land-based sources; ocean-based sources such as commercial fishing, vessels, and other activities, contribute only 20% of the total plastic debris, while terrestrial activity contributes the other 80% of pollution in the marine environment [11,12]. Microplastics with various terrestrial origins mainly enter the marine environment via rivers, releasing most microplastics to the ocean and retaining some in freshwater systems [4,12–14]. However, a majority of microplastics research to date has focused on marine settings rather than freshwater, indicating that more studies are required in this area [15,16]. Examining freshwater systems as the dominant source of microplastics will lead to a better overall understanding of microplastics pollution input and therefore insight into the scale of the issue and mitigation strategies [14].

## 2.1 Description of data and data source

The data that I am using for this project is from my personal undergraduate research project on freshwater microplastics in Athens, GA. The study is ongoing and was conducted in collaboration with the Upper Oconee Watershed Network (UOWN) via their quarterly sampling events. There is one year’s worth of quarterly data, with the following sample dates: November 2020, February 2021, April 2021, and July 2021. The data include variables such as sample site, latitude and longitude, watershed location, and duplicate A and B counts of microplastics observed per filter. For the most recent sampling date, July 2021, there is additional data where a second counting session was performed, in order to assess the comparability of parallel counts. There are about 136 observations of ~10 variables in total in the dataset. The independent variables – site location, coordinates, watershed location, etc – were retrieved from UOWN. Values for microplastic counts were recorded based on visual identification via a dissecting microscope, performed by myself and by a small team of <10 volunteers.

Additional data [write up further explanation]: - small area population via census zipcode - UOWN bacteria level data - local land cover - distance from water reclamation facility (WRF)

## 2.2 Questions/Hypotheses to be addressed

The questions that I want to answer with this data include the following: - Can we characterize microplastics in Athens, GA using a citizen science approach? - What are the levels of microplastics like in Athens, GA overall? - How do microplastic levels differ based on location within the region?

Questions that I want to answer that will require gathering more data using coordinates/watershed info include: - Is microplastic concentration impacted by local land use? - Is microplastic concentration impacted by localized population levels in specific neighborhoods? - Does wastewater treatment plant effluent from nearby facilities increase microplastic concentration at affected sites? - Are microplastic levels correlated to bacteria levels measured at the same sites? These questions also relate to hypothesized predictors of microplastic pollution: population level, land use, wastewater treatment plant effluent, and microbial water quality.

My ideas for how to analyze this data include using non-parametric statistical tests, correlation matrices, and modeling (?) to characterize and compare observations.

# 3 Methods and Results

*In most research papers, results and methods are separate. You can combine them here if you find it easier. You are also welcome to structure things such that those are separate sections.*

## 3.1 Data aquisition

*As applicable, explain where and how you got the data. If you directly import the data from an online source, you can combine this section with the next.*

* Methods for sample collection and processing for UOWN MP water samples

## 3.2 Data import and cleaning

*Write code that reads in the file and cleans it so it’s ready for analysis. Since this will be fairly long code for most datasets, it might be a good idea to have it in one or several R scripts. If that is the case, explain here briefly what kind of cleaning/processing you do, and provide more details and well documented code somewhere (e.g. as supplement in a paper). All materials, including files that contain code, should be commented well so everyone can follow along.*

Since I am performing importing and cleaning in a separate document, in this section I will provide an overview of my steps/methods for wrangling the data, without actual code in this section.

Import of additional data - census - American Community Survey - NGIS land cover - zip code - Bing reverse geocoding - WRF locations: located on Google Maps, coordinates recorded in Excel spreadsheet - UOWN bacteria data (citation/attribution available on UOWN.org)

## 3.3 Exploratory analysis

This section will contain the key products of my exploratory analysis (located in exploration.Rmd) when complete. Since I am keeping this document in manuscript style, I will keep processing/exploration/analysis code separate. *Use a combination of text/tables/figures to explore and describe your data. You should produce plots or tables or other summary quantities for the most interesting/important quantities in your data. Depending on the total number of variables in your dataset, explore all or some of the others. FIgures produced here might be histograms or density plots, correlation plots, etc. Tables might summarize your data.*

*Continue by creating plots or tables of the outcome(s) of interest and the predictor/exposure/input variables you are most interested in. If your dataset is small, you can do that for all variables. Plots produced here can be scatterplots, boxplots, violinplots, etc. Tables can be simple 2x2 tables or larger ones.*

*To get some further insight into your data, if reasonable you could compute simple statistics (e.g. t-tests, simple regression model with 1 predictor, etc.) to look for associations between your outcome(s) and each individual predictor variable. Though note that unless you pre-specified the outcome and main exposure, any “p<0.05 means statistical significance” interpretation is not valid.*

Table ?? shows a table summarizing the data.

Figure ?? shows a scatterplot figure produced by one of the R scripts.

## 3.4 Full analysis

*Use one or several suitable statistical/machine learning methods to analyze your data and to produce meaningful figures, tables, etc. This might again be code that is best placed in one or several separate R scripts that need to be well documented. You want the code to produce figures and data ready for display as tables, and save those. Then you load them here.*

Example table ?? shows a table summarizing a linear model fit.

# 4 Discussion

## 4.1 Summary and Interpretation

*Summarize what you did, what you found and what it means.*

## 4.2 Strengths and Limitations

*Discuss what you perceive as strengths and limitations of your analysis.*

## 4.3 Conclusions

*What are the main take-home messages?*

# References

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