Analysis of Particulate Matter in the Macatawa Watershed Air

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Air Pollution and Particulates Overview

- **Air pollution** is the presence of biological matter, particulates, and any other harmful substance expelled into the air.
  - particulates that make up air pollution cause harm to the natural and built environment, as well as to humans.

- "**Particulate matter,**" also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. It is made up of a number of components, including acids, organic chemicals, metals, and soil or dust particles
  - PM2.5 and PM10 refer to the diameter in microns of the particulates.

- The World Health Organization estimates that **particulate matter air pollution results in about 800,000 premature deaths each year,** making it the 13th leading cause of mortality worldwide.
Air Pollution and Particulates

- **Major sources of particulate matter**
  - human combustion of fossil fuels  
    - coal industry, steel industry, and power generation  
  - biomass burning  
  - vehicle exhausts  
    - diesel, gasoline, and propane  
  - pesticides  
  - dust, mold, pollen

![Figure 1: A comparison of particulate matter sizes in reference to a single strand of hair](image)

Ottawa County Air Quality

- **Average of all particulate matter is 27 µg/m³ in Ottawa County, versus 23 µg/m³ as the national average**
  - Lake Michigan, topography, and wind pattern have major impacts  
  - PM10 particles can stay in the air for minutes or hours can travel as little as much as 30 miles  
  - PM2.5 particles can stay in the air for days or weeks, and travel up to many hundreds of miles.

- **Early 2000s the county had high PM levels, peaking at 37 ug/m³ in 2005**
  - attainment level is 35 ug/m³, set by the EPA  
  - In 2008 Ottawa County reached “attainment” levels, and particulate matter levels have not risen above standards on record since 2007

- **Particulate matter poses many health risks to the human body**

![Figure 2: A diagram showing where each size of PM is found most commonly accumulated in the body](image)
Our Project

Our research centered around looking at the variation of particulate matter based on geographic variation from three test sites. **We focused on determining:**

1. the *composition* of particulates in the air
2. concentration/density of particulates in the air

Methods: Study Sites

Three experimental sites within the Macatawa Watershed
- Each chosen for their relationship to the surround environment.

**Schaap Science Center:**
- (42.787, -86.105)
- Site near urbanized area
- Many anthropogenic sites near by

**Outdoor Discovery Center:**
- (42.726, -86.103)
- Rural area
- Located by agricultural fields and farms

**Tunnel Park:**
- (42.798, -86.209)
- Shoreline, coastal region
Methods: sample collection

- Altered a Buchner funnel to fit a Stanley Shop Vac
- Whatman 5 filter paper
- Ran vacuums for average of 10 hours
- Added Scotch tape across funnel mouth
- Stored in sterile petri dishes

Figure 3: The experimental set-up replicate for the Schaap Science Center

Methods: processing & analysis data

- Carbon coated samples with a Cressington carbon coater 108
  - reduce charging in the scanning electron microscope
- TM3000 Scanning Electron Microscope was used for analysis
  - obtain the chemical composition of the particulates in the air.
- Measurements were taken using Quantax 50 software on the computer, system
  - performs elemental qualitative and quantitative analyses of materials
  - three rows, twelve frames per row for a total of 36 frames per sample
  - 90 individual particles were analyzed from each sample

Figure 4: The Scanning Electron Microscope (SEM) at Hope College
Methods: processing & analysis

Output Sample:

Classifications

- (Organic)- Absence of elements
- (K) Potassium Feldspar - Mixture of Al, <30% Silicate, >30% Potassium
- (Fe Metal) - Most prevalent element was Iron
- (Cu Metal) - Most prevalent element was Copper
- Low Silicate Dust - <30% Silicate
- Silicate Dust - >30% Silicate
- Calcium Feldspars- Mixture of Al, <30% Silicate, >30% Calcium
- Sodium Feldspars- Mixture of Al, <30% Silicate, >30% Sodium
Identification

A sample output of a particulate high in iron

Comparison of Sample Sites
Tunnel Park Sample Analysis

- All five days have a high concentration of silicate dust particles.
- The metal concentrations vary throughout the five days, this includes some days having a deficiency in metals.
- All five days have concentrations of feldspars, which is typically seen in sand particles and common on the beach front.

Outdoor Discovery Center Sample Analysis

- All five days have a high concentrations of feldspar (soil dust) and silicate dust (dunes).
- The metal concentrations vary throughout the five days, this includes some days having a deficiency in metals.
Science Center Sample Analysis

- All five days have a high concentration of Fe-Metal particles.
- The feldspar concentrations vary throughout the five days, this includes some days having a deficiency in feldspars.
- All five days have concentrations of feldspars, silicate dusts, and other metals.

What the Data Means

- There is a definite difference in particulate matter from site to site:
  - Tunnel Park is high in silicate dust due to the sand.
  - Schaap Science Center is quite high in iron due to the close proximity to industrial activity.
  - The ODC high frequencies in feldspars is consistent with the amount of soil dust from surrounding agriculture.
Future of the Macatawa Watershed Air

- The research is not a closed-circuit study, just preliminary work on air quality
  - We are all affected by air quality, as well as the environment

- Due to the small sampling window, air quality testing should be done during each season in the watershed and more thoroughly analyzed

- Hope College implementing sampling at points within the watershed for lab analysis

Figure 5: Devices that can be used in residential homes to sample air quality

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References


