Visual Exploration of Spatial-Temporal Dynamics of Air Quality using Volunteered Geographic Information
A Study Case of PM 2.5 in Minneapolis, United States

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INTRODUCTION

- **Air pollution** in urban areas poses significant environmental and public health challenges

- Understanding air quality dynamics as part of the broader goal of Climate Smart GIScience

- **Volunteered geographic information (VGI)** for real-time and historical air quality monitoring

- This study utilizes VGI and open data portals to explore the spatiotemporal patterns of PM 2.5 in connection with

Minneapolis air quality dips as morning commute's pollution is trapped at ground level

A wintertime inversion trapped fine particles close to the ground, but conditions improved through the day.

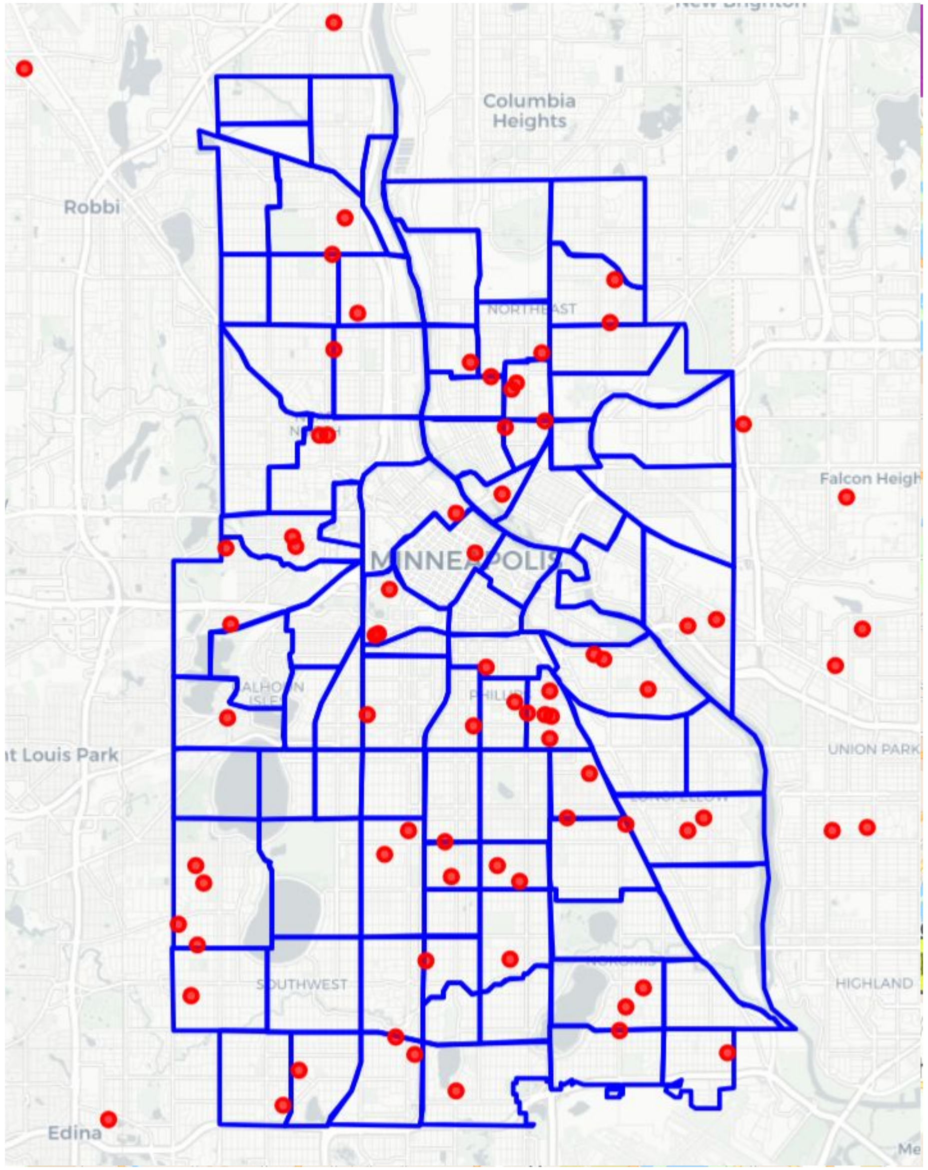
By Chloe Johnson Star Tribune | FEBRUARY 21, 2024 — 11:31AM

GLEN STUBBE, STAR TRIBUNE, STAR TRIBUNE

Source: StarTribune

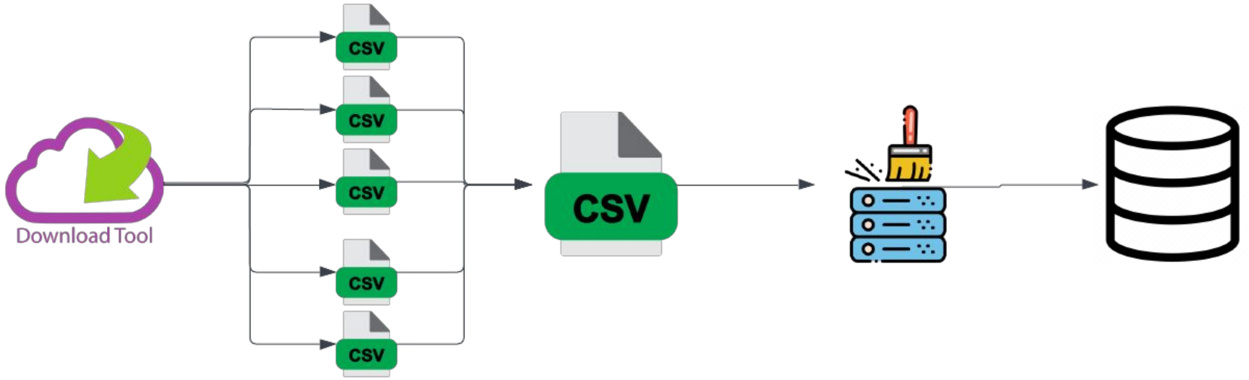
STUDY AREA AND DATA

- Location: Minneapolis, Minnesota, U.S.
- VGI Data Source: **Purple Air**
  - More than 100 sensors in Minneapolis
  - Real-time and historical readings
  - PM 2.5 and other indicators
- Study Case
  - PM 2.5
  - Apr., Jul., Oct., and Dec. in 2023
  - a few special weather events

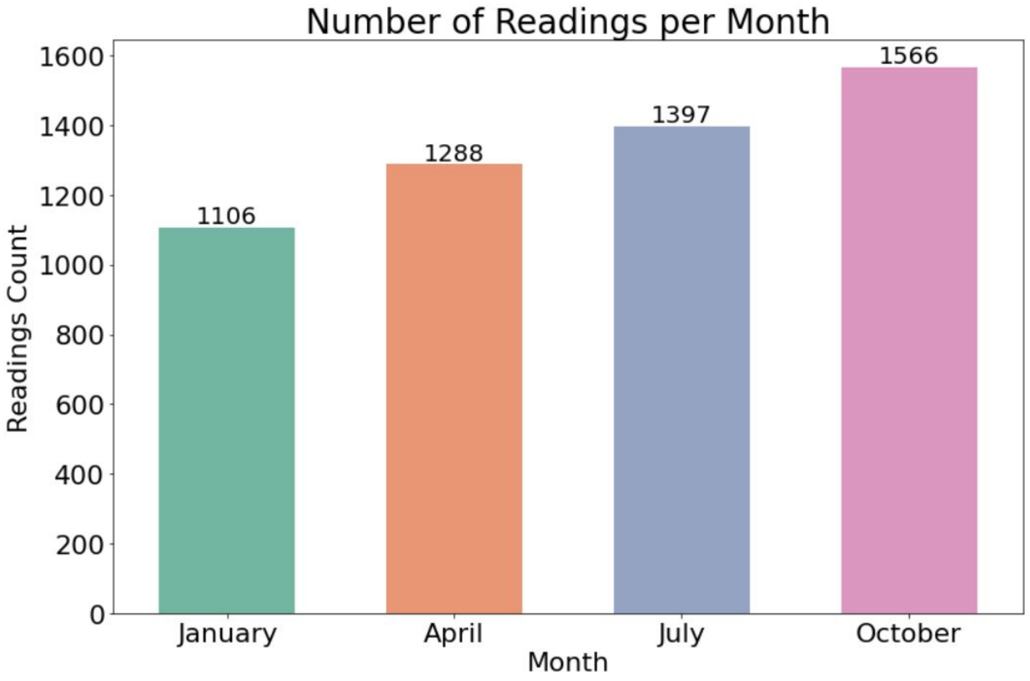


DATA PREPARATION

- Raw Data
  - PurpleAir API
  - 6-hour intervals (12am, 6am, 12pm, 6pm)
  - Combining individual CSV files

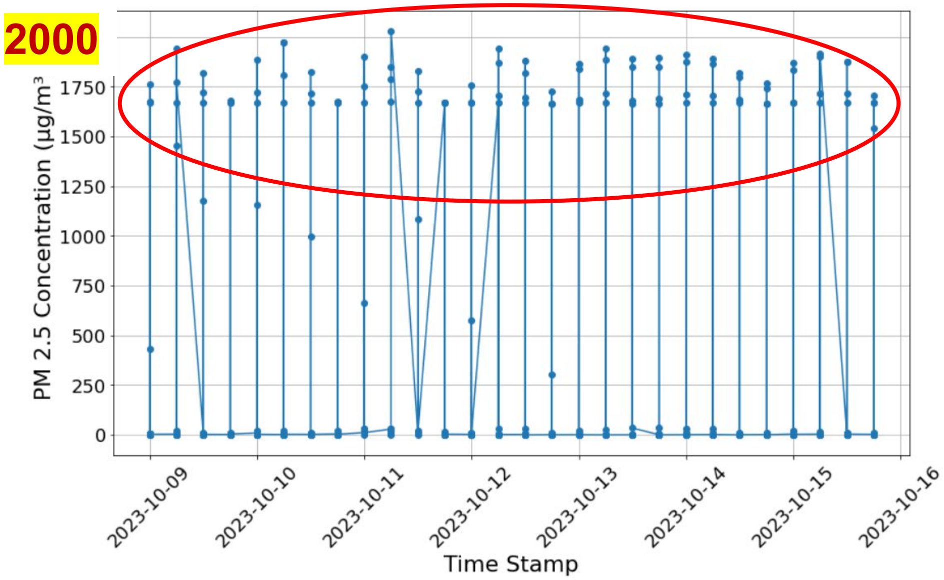


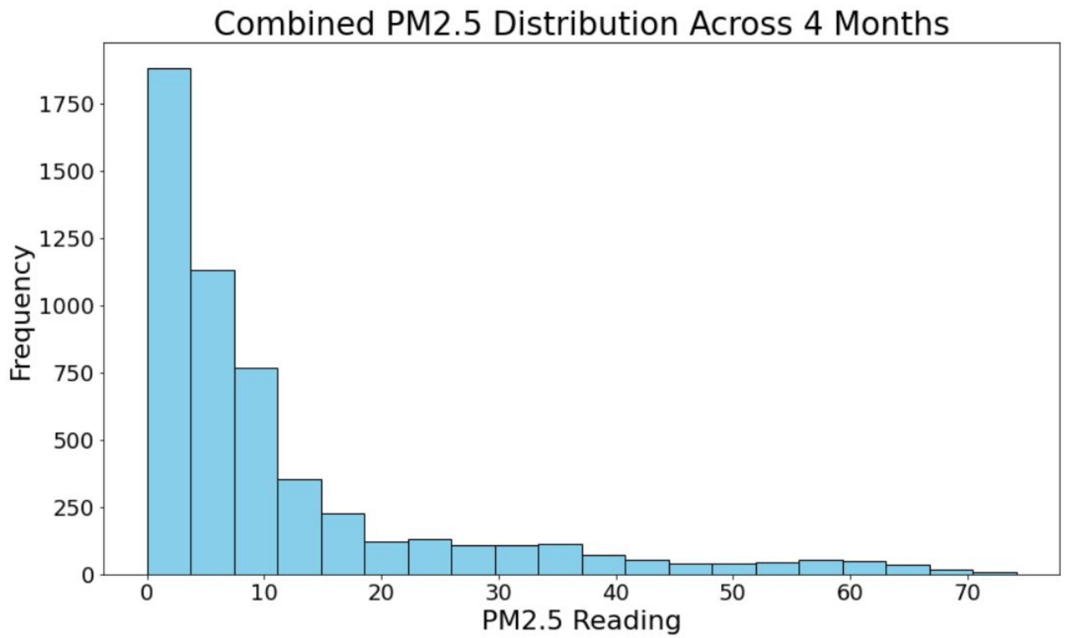
- Increasing number of readings
  - New sensors added across time
  - Keep sensors with data available across the entire study period

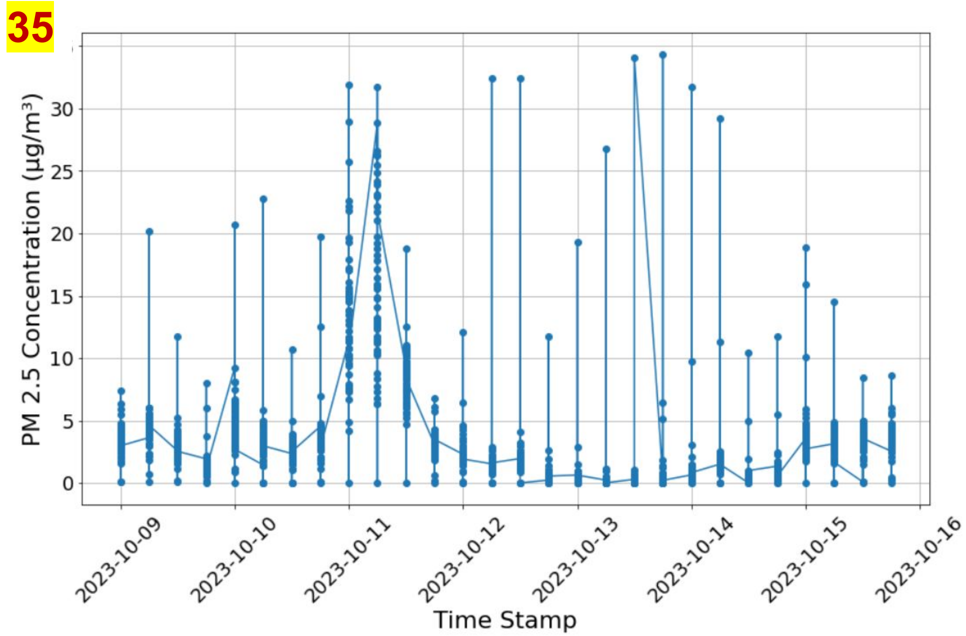


DATA PREPARATION

- Data Filtering Criteria
  - Average < 500 µg/m³ (potential defective sensor)
  - Highest < 1004 µg/m³ (reported in Tiruppur, India)



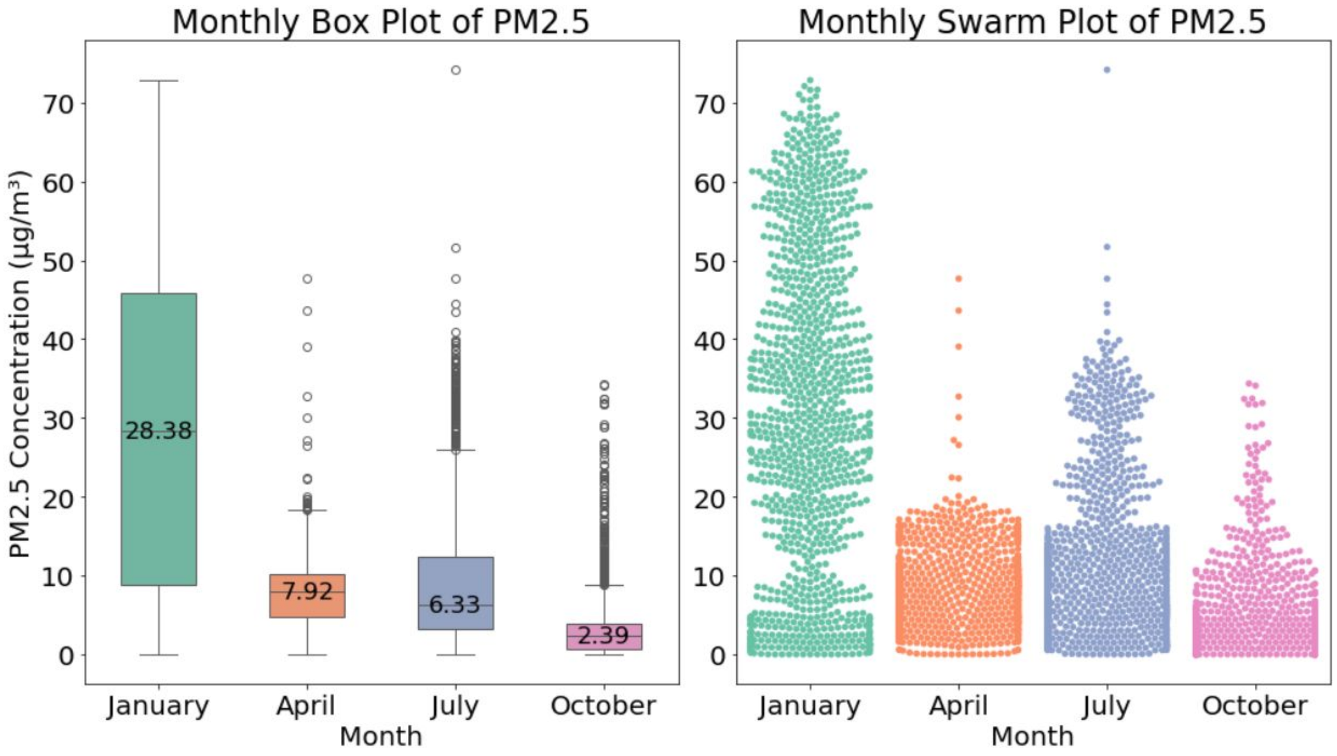


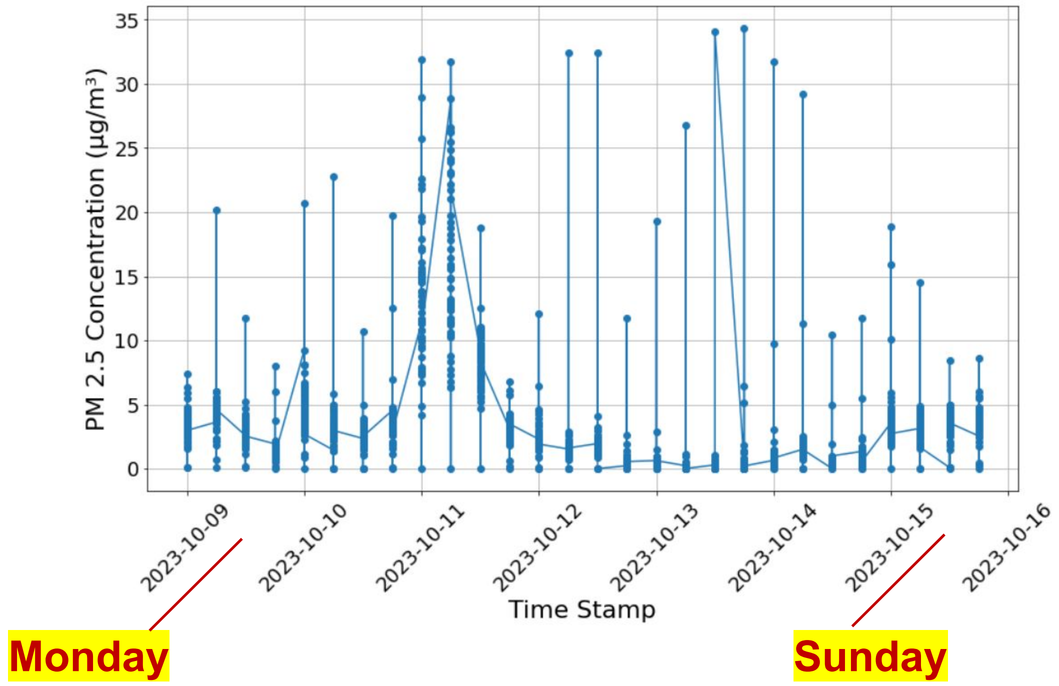


Spatial-Temporal Patterns

- Obvious seasonal patterns
  - January – worst
  - Median value reduced toward later months

- No obvious daily or hourly patterns
  - Wed. 10/11/2023 – worst
  - Occasional high readings





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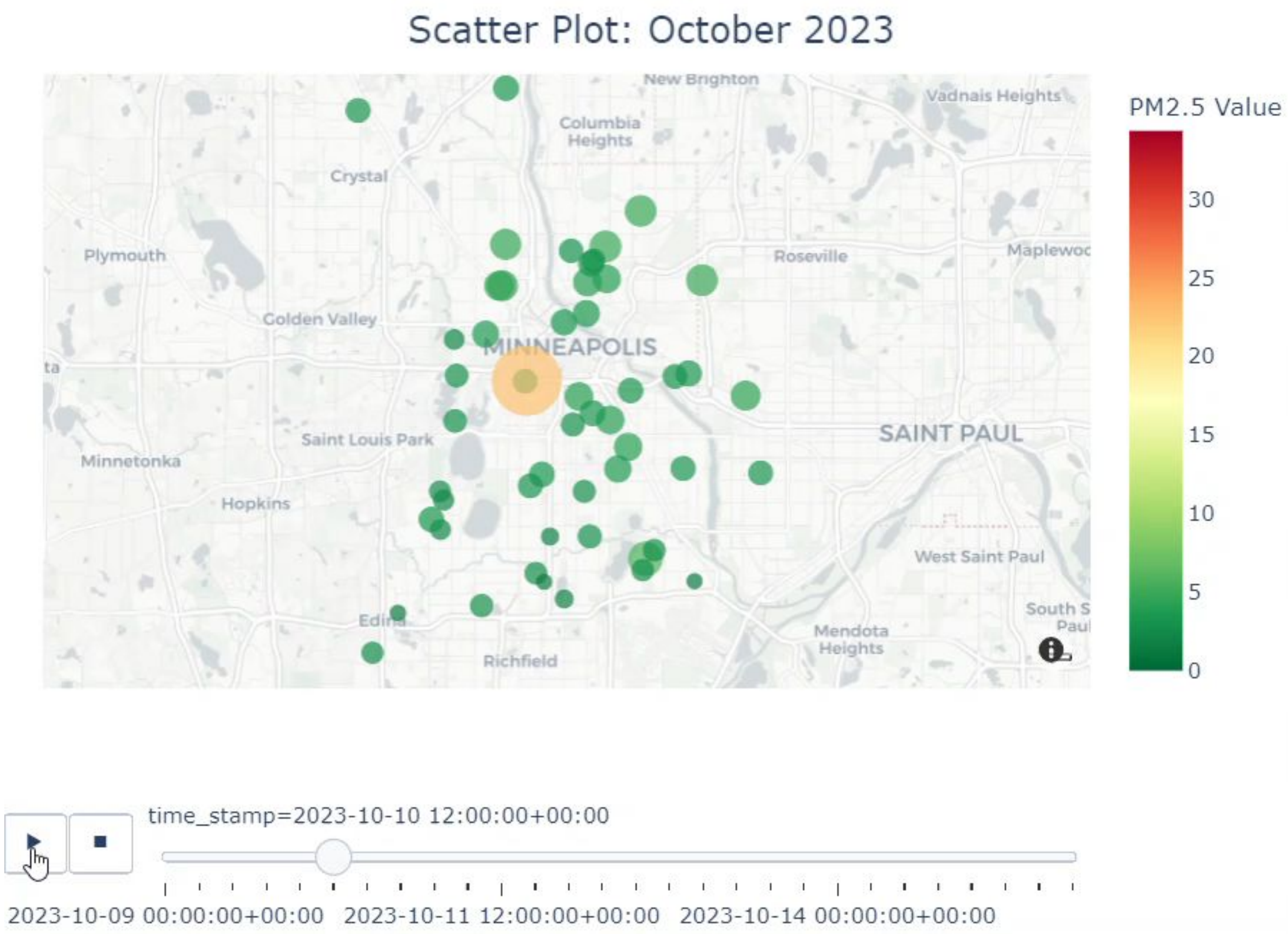
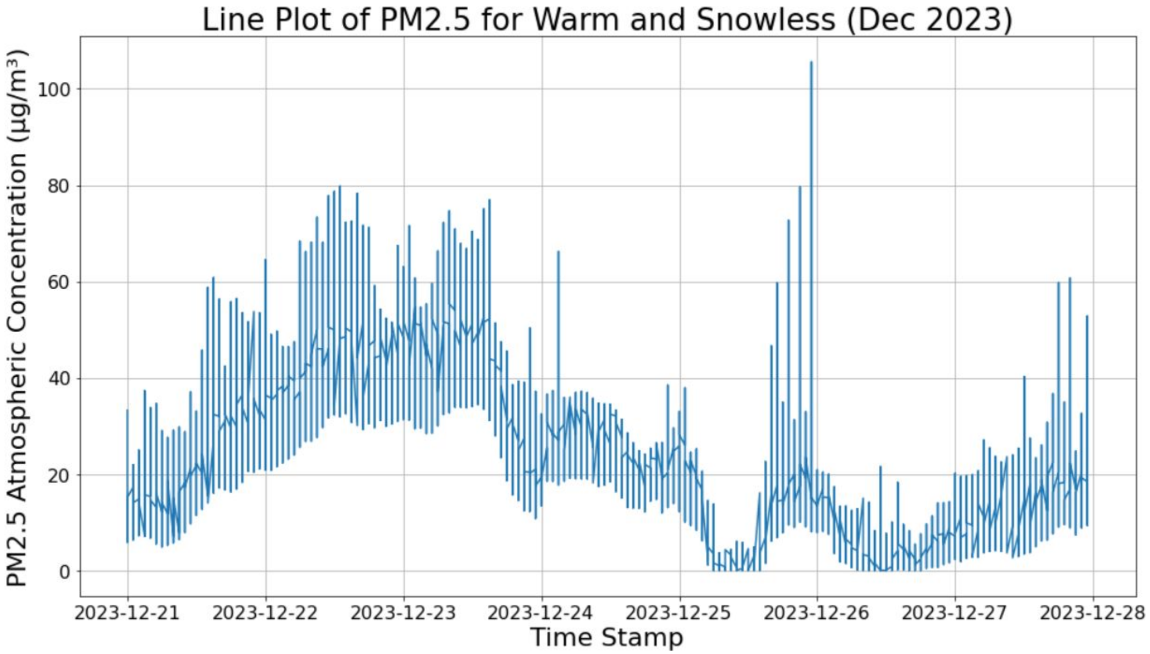


WEATHER EVENTS

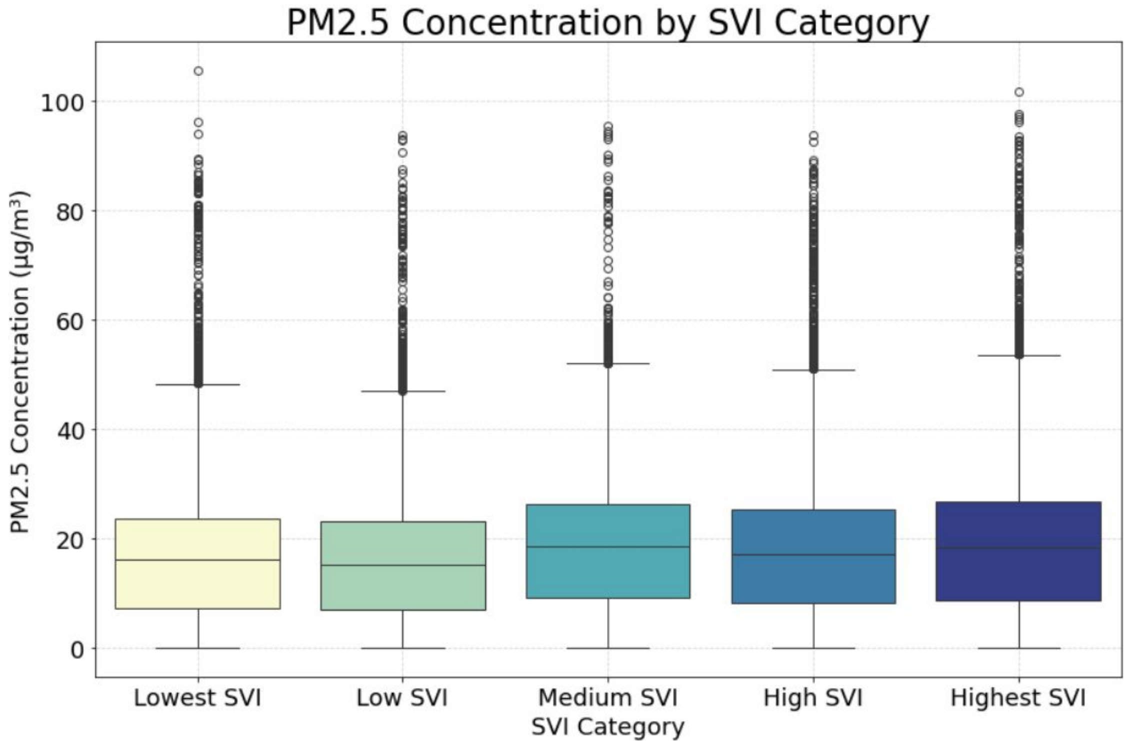
- DNR Alerts: https://www.dnr.state.mn.us/climate/journal/index.html
  1. Spring Storm (Again), April 14-17, 2023
  2. Smoke Event of July 14, 2023
  3. Intense Heat Wave, August 21-23, 2023
  4. Welcome Rains Douse Minnesota: September 23-25, 2023
  5. Twin Cities see biggest Halloween snowfall in over 30 years
  6. Warm and Snowless December 2023



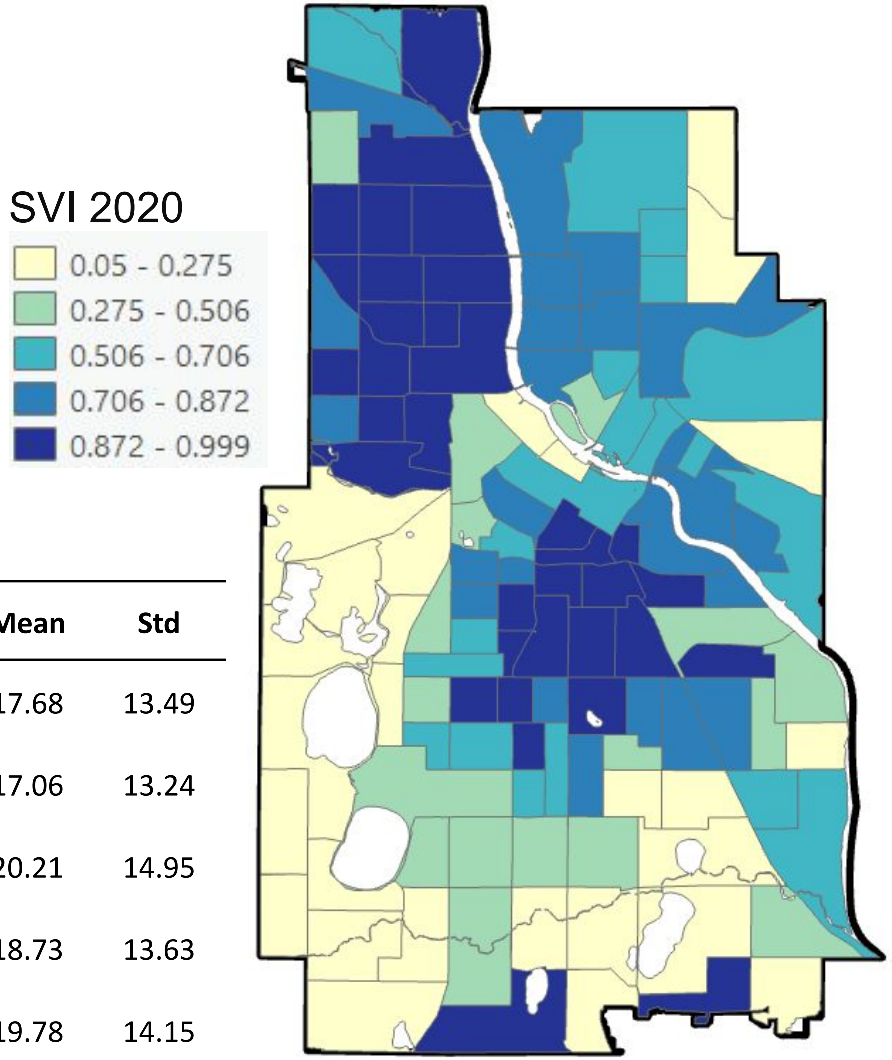
Impact of Social Vulnerability Index

- SVI and air quality sensor data are merged based on their intersection to analyze the relationship.

- A weak positive correlation between SVI and PM2.5



	Sensor Readings	Mean	Std
Lowest SVI (<= 0.2)	8762	17.68	13.49
Low SVI (<= 0.4)	6955	17.06	13.24
Medium SVI (<= 0.6)	2275	20.21	14.95
High SVI (<= 0.8)	9270	18.73	13.63
Highest SVI (>0.8)	11310	19.78	14.15

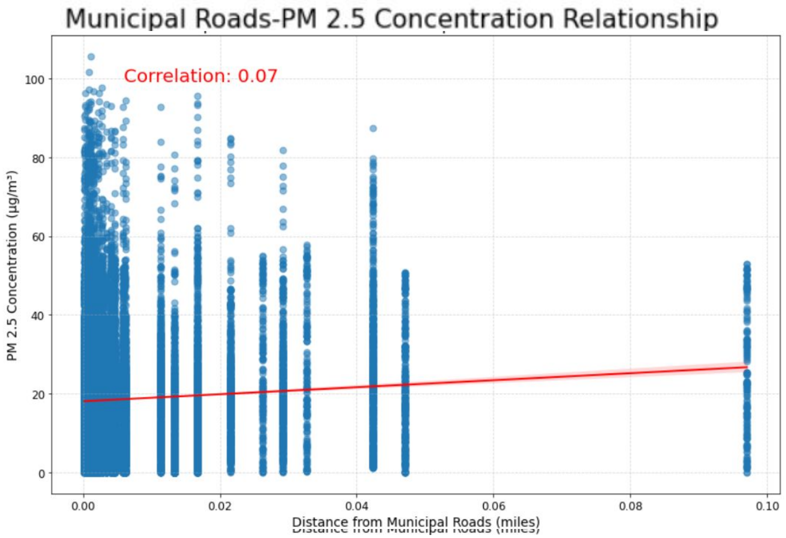


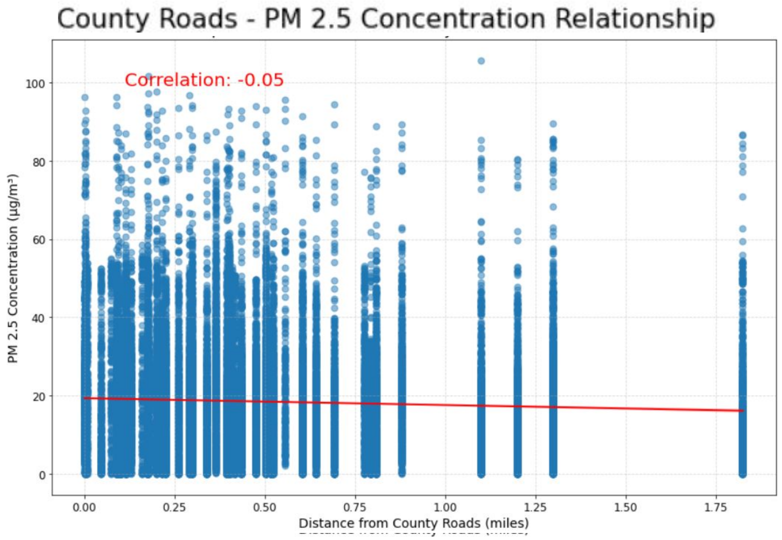
Source: ATSDR

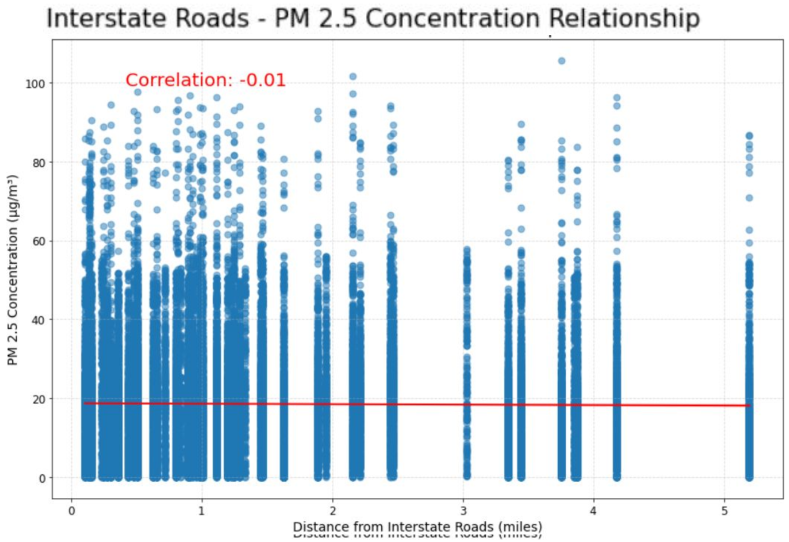
AQ Vs Distance from Roads

- Most sensors are in close proximity of road network.

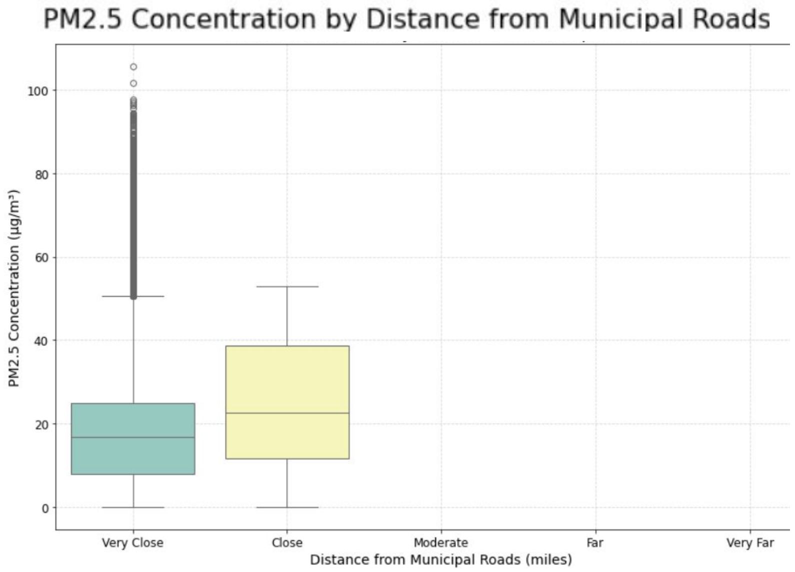
- Correlation analysis between PM2.5 values and proximity to roads.
  - Municipal roads: A weak positive correlation
  - County roads: A weak negative correlation
  - Interstate roads: Negligible correlation

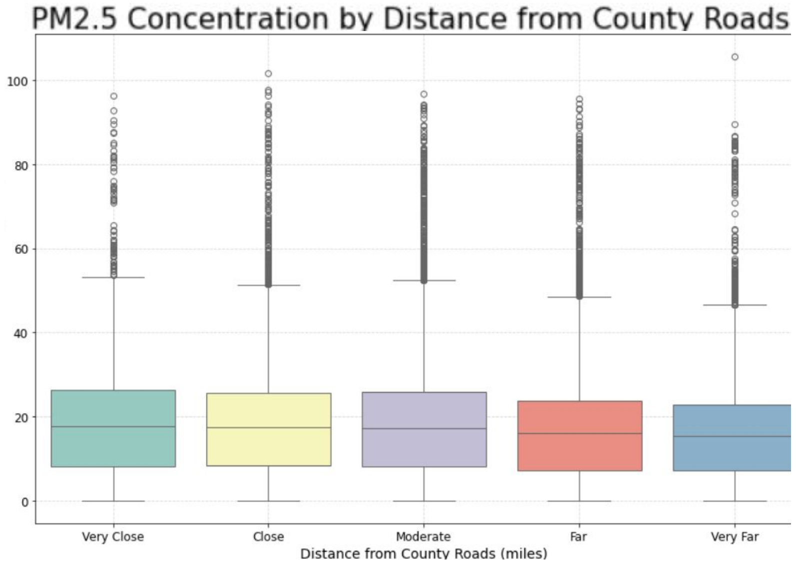


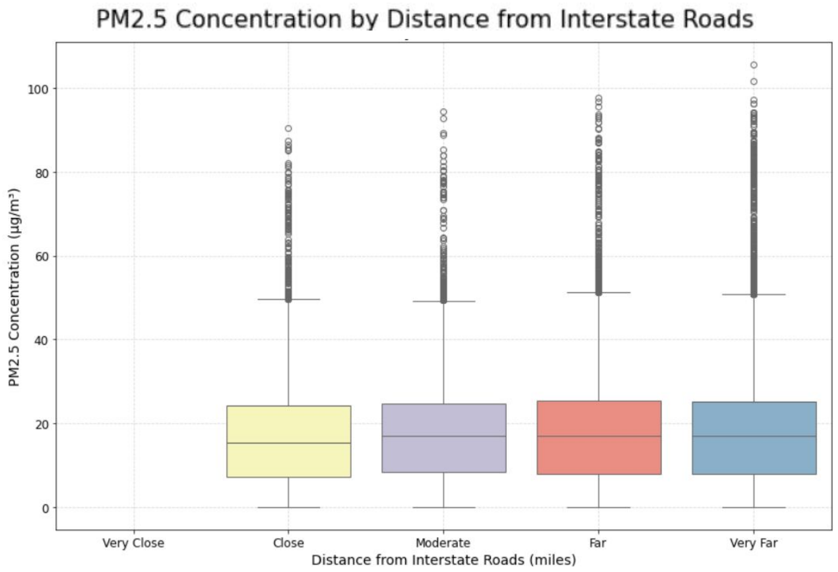




EXTRA SLIDE 10b – TO BE DELETED







Category	Municipal Roads			County Roads			Interstate Roads		
	Sensor Records	Mean	Std	Sensor Records	Mean	Std	Sensor Records	Mean	Std
Very Close (<= 0.05)	38407	18.56	13.79	4169	19.31	13.98	0	-	-
Close (0.05, 0.2]	165	25.05	15.98	8523	19.12	13.8	4448	17.73	13.91
Moderate (0.2, 0.5]	0	-	-	12370	19.12	14.05	5325	18.49	13.11
Far (0.5, 1]	0	-	-	9209	17.67	13.49	9507	18.81	13.89
Very Far (1, ∞):	0	-	-	4169	19.31	13.97	19292	18.7	13.92

FINAL REMARKS

- VGI
- Enhanced understanding of air quality dynamics through visually captivating exploration of temporal trends.
- meteorological factors; …
- Next steps?

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QUESTIONS?

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GitHub Repo: Spatial Temporal Dynamics of Air Quality using VGI