Mean Streets: An analysis on street level pollution in NYC

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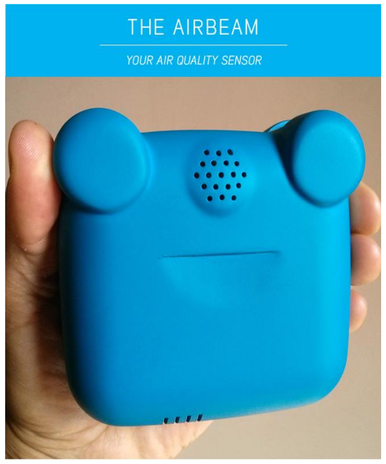
Introduction

The overarching objective of this study is to quantify the spatial and temporal variability in particulate matter concentration (PM 2.5) along crowded streets in New York City. Due to their fine size and low density PM 2.5 stays longer in the atmosphere and could bypass human nose and throat and penetrate deep in to the lungs and even enter the circulatory system. PM 2.5 is a by-product of automobile combustion and is a primary cause of respiratory malfunction in NYC. Our goal is to study street level concentration of PM2.5 across three different routes that witness significant pedestrian traffic; observations will be conducted along these three routes at different time periods. The study will use the AirBeam community air quality monitor. The monitor tracks PM 2.5 concentration along with GPS, air temperature and relative humidity.

Impact of PM2.5 on Health

PM 2.5 is any particulate matter in the air with a width of 2.5 microns or less. These fine particles can come from many sources, including car exhausts, food carts, burning wood and other materials, or from reactions of chemicals from power plants. Many times, these particles can be carried away from the original source to a place that is very far from it. Heavy concentration of PM 2.5 in air can cause a variety of health effects which damage your lungs. The effects of PM 2.5 are awfully reminiscent of the costly impact that smoking has on smokers. Depending on the person, it is possible that they may be more affected by certain concentration levels of PM 2.5. In a densely populated area like New York City it is important that PM 2.5 is not only monitored but actively reduced so the air that millions of New Yorkers share is clean and will not cause harm.



Air Quality Index Levels of Health Concern	PM 2.5 (ug/m^, 24-hour average)	Numerical Value	Meaning
Good	0.0 - 12.0	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	12.1 - 35.4	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	35.5 – 55.4	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	55.5 – 150.4	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	150.5 – 250.4	201 to 300	Health alert: everyone may experience more serious health effects.
Hazardous	250.5 - 500	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

The AirBeam measures light scattering in the atmosphere, and uses this to measure the amount of PM2.5 in the air. It connects via Bluetooth to an android phone, which takes measurements once a second. The data is open source, which allows anyone to see the data taken.

Results

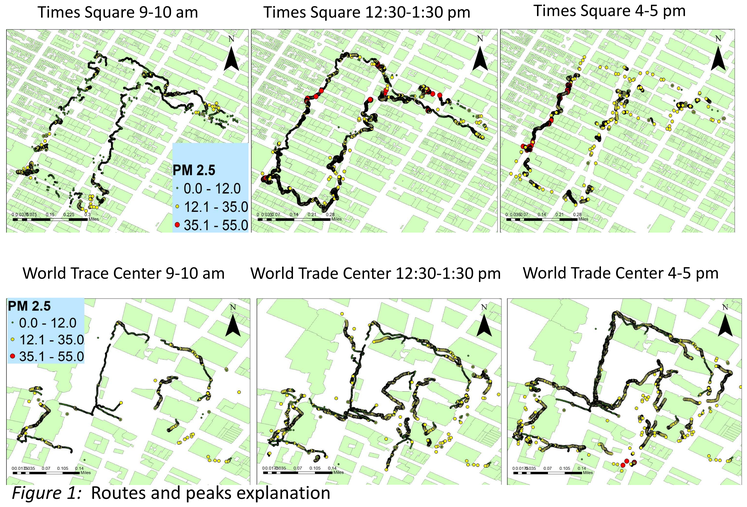
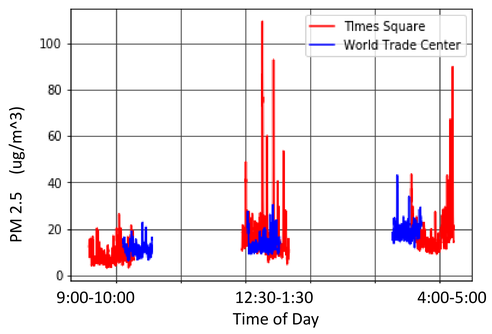


Figure 1: Routes and peaks explanation

These maps show that there is an increase in PM 2.5 variation in the Times Square Area compared to the World Trade Area. Even though both areas are congested with pedestrians, the World Trade Area reaches PM 2.5 concentration levels in the range of about 0-35 (ug/m^3) rather than Times Square which has concentration levels ranging from 0-55 (ug/m^3). Between 9 am and 10 am, the PM2.5 levels were consistently low, staying at a level of about 0-12(ug/m^3). The afternoon readings rose significantly for both areas, though Times Square had a much faster increase. However the readings in the World Trade area rose immensely in the evening compared to Times Square. Nonetheless there is an evident increase in PM 2.5 levels over time.

This graph shows the PM 2.5 (ug/m^3) for different times in the Times Square area and World Trade Center area



As it got later in the day, the PM 2.5 levels increased steadily. There were also a few peaks within our route. The highest one in the afternoon in Times Square reached 109 (ug/m^3) due to smoke from a food cart, but there were others during this time. In the evening in Times Square the highest point was 89 (ug/m^3). The World Trade Center showed some peaks, although they were not as big.

This graph shows the Average PM 2.5 (ug/m^3) for Times Square area and World Trade Center area

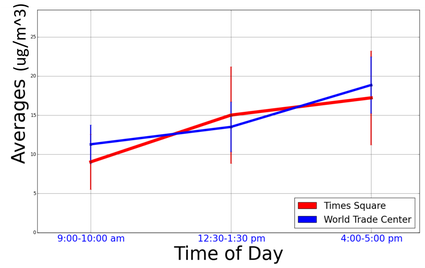


Figure 3: Average PM 2.5 for Times Square and World Trade Center

This graph shows that there is a continuous increase in PM 2.5 readings from 9 AM to 5 PM. Also the source of error for Times Square is much greater error deviation than the World Trade Area. This is due to the peaks cause by the vehicles and food carts throughout Times Square Area.

Conclusion/Future Work

Our analysis found reasonable temporal variability in PM2.5 concentration at the 2 routes. The results indicate critical hot-spots in both the routes; particularly food carts were a major source of PM 2.5. Overall the PM 2.5 concentration at all time periods in these streets breached the regulated safe limits.

Our results also show that the PM 2.5 concentration builds steadily at both the sites all through the day. The build up is related to lack of ventilation in deep urban street canyons.

Apart from pedestrians, street vendors and traffic police who spend majority of their day on the busy streets will be exposed to harmful levels of PM2.5.

Future work

- Correlate street level variability with atmospheric conditions.
- Overall PM2.5 emission from food carts.
- Modeling PM 2.5 pollution in New York City

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