

DETERMINING THE EFFECTS OF FILTRATION ON AIRBORNE PARTICULATE MATTER IN A NEW YORK CITY PUBLIC SCHOOL

Presented By:

Randy Garcia

Directed By:

Mauricio Gonzalez, M.Sc.

Marine Biologist

Frederick Douglass Academy

2010



Introduction

New York City is one of the most populated cities in the United States. With that being said, one should expect this great city to have high environmental awareness and sustainability. Unfortunately this isn't the case.

Introduction

Harlem has been targeted the worst when it comes to environmental safety. Asthma rates in Harlem and the South Bronx are far worse than for any other section of the city (25% according to R. Perez-Pena, 2003) and children are being born with lower I.Q.s (Hoepner, et. al., 2009). This is due to the high levels of particulate matter in our air that come from the same vehicles that bring us our goods (WeAct, 2009). If one thinks about it we are poisoning ourselves in order to obtain what we need.



Introduction

PM levels in Harlem schools is a sensitive issues that requires more attention. With one of the highest incidents of asthma the areas in which children attend on a daily basis have not been studied sufficiently. Children spend about 8 hours of the day, 5 times a week in school. If people are informed about their environment and their communities and what can harm them together we can come up with solutions to make our community better.

Particulate Matter

- Particulate Matter are solid and liquid particles suspended in the air. Most are hazardous. They can contain for instance dust, pollen, soot, smoke, liquid droplets, and carcinogenic chemicals.
- Particles that are smaller than 10 microns will impact human health – in particular their respiratory system.
- PM smaller than 3 microns cause cancer because they penetrate the body, its cells, and nuclei damaging the DNA.

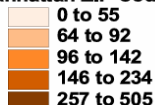
Particulate Matter

- PM smaller than 3 microns is a byproduct of diesel engines found on the very trucks that deliver our goods.
- Most places in Harlem have a high incidence of PM proven to be the cause of at least 1 cancer patient out of every 10,000 inhabitants.

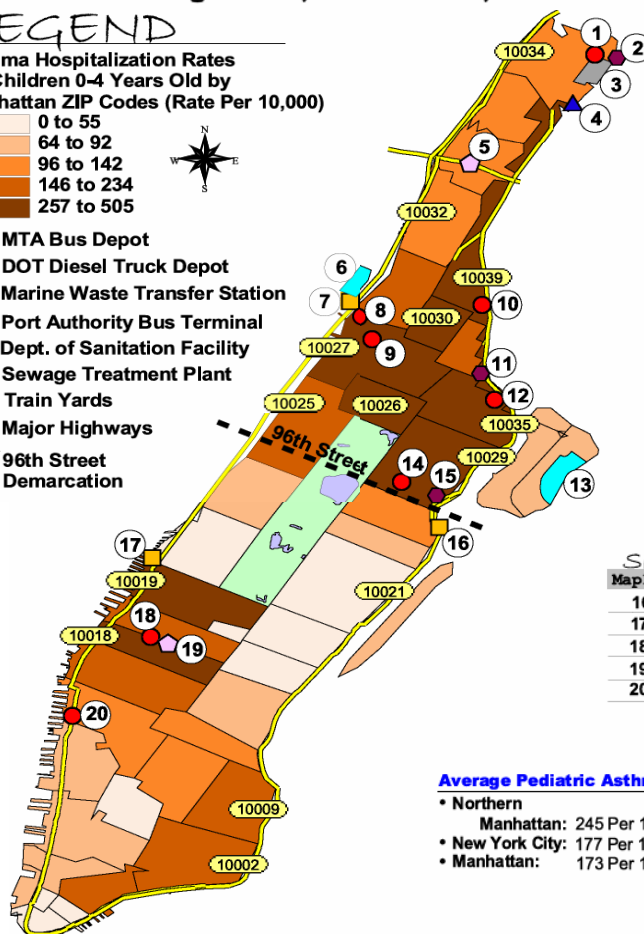
Asthma Hospitalizations Rates by ZIP Code Children Aged 0-4, Manhattan, 2000

LEGEND

Asthma Hospitalization Rates
for Children 0-4 Years Old by
Manhattan ZIP Codes (Rate Per 10,000)



- MTA Bus Depot
- ▲ DOT Diesel Truck Depot
- Marine Waste Transfer Station
- ◆ Port Authority Bus Terminal
- ◆ Dept. of Sanitation Facility
- Sewage Treatment Plant
- Train Yards
- Major Highways
- 96th Street Demarcation



Northern Manhattan Facilities

MapID	Facility Name
1	Kingsbridge MTA Bus Depot
2*	DOS Garbage Truck Depot (Two Large Depots, One Services Residents of the Upper East Side)
3	MTA Train Yards
4	Department of Transportation / Division of Highways Diesel Truck Depot
5	George Washington Bridge Port Authority Bus Terminal
6	North River Sewage Treatment Plant / Riverbank State Park
7	135th Street Marine Waste Transfer Station
8	Manhattanville MTA Bus Depot
9	Amsterdam MTA Bus Depot
10	Mother Clara Hale MTA Bus Depot (Scheduled to Expand)
11	DOS Garbage Truck Depot
12	126th Street MTA Bus Depot
13	Wards Island Sewage Treatment Plant
14	100th Street Bus Depot (Currently Expanding)
15	DOS Garbage Truck Parking Lot (Out Door Parking Lot)

Southern Manhattan Facilities

MapID	Facility Name
16	91st Street Marine Waste Transfer Station
17	59th Street Marine Waste Transfer Station
18	41st Street MTA Bus Depot
19	42nd Street Port Authority Bus Terminal
20	Hudson MTA Bus Depot (Scheduled to Close)

Average Pediatric Asthma Rates:

- Northern
Manhattan: 245 Per 10,000 Children
- New York City: 177 Per 10,000 Children
- Manhattan: 173 Per 10,000 Children

Source: NYC Department of Health SPARCS 2000 data on Asthma Admission Rates for children ages 0 to 4 years.

Map prepared by West Harlem Environmental Action, Inc. (WE ACT) with the Columbia Center for Children's Environmental Health (CCCEH), using ESRI ArcView® GIS v3.1.1. If you have any questions or concerns, please contact the WEACTION GIS Mapping Specialist, Carlos M. Jusino, at (212) 961-1000, ext. 307.

Funded in Part by W. Alton Jones and the National Institute of Environmental Health Sciences (NIEHS).



February 18, 2003
Release 2.25B - 4NR

Air Quality of Harlem (EPA, 2009)



Cancer Risks / Noncancer Risks



SCIENTIFIC PROBLEM

What are the differences in PM readings between a high school classroom with air filtration and a high school classroom with no air filtration?

HYPOTHESIS

The classroom with air filtration will have a significantly lower level of PM particularly for PM smaller than 3.0 microns than in the non filtered room because air filters are designed remove PM and are more effective towards smaller particles.

OBJECTIVES

Determine the PM levels in an high school classroom with air filtration and one with no filtration.

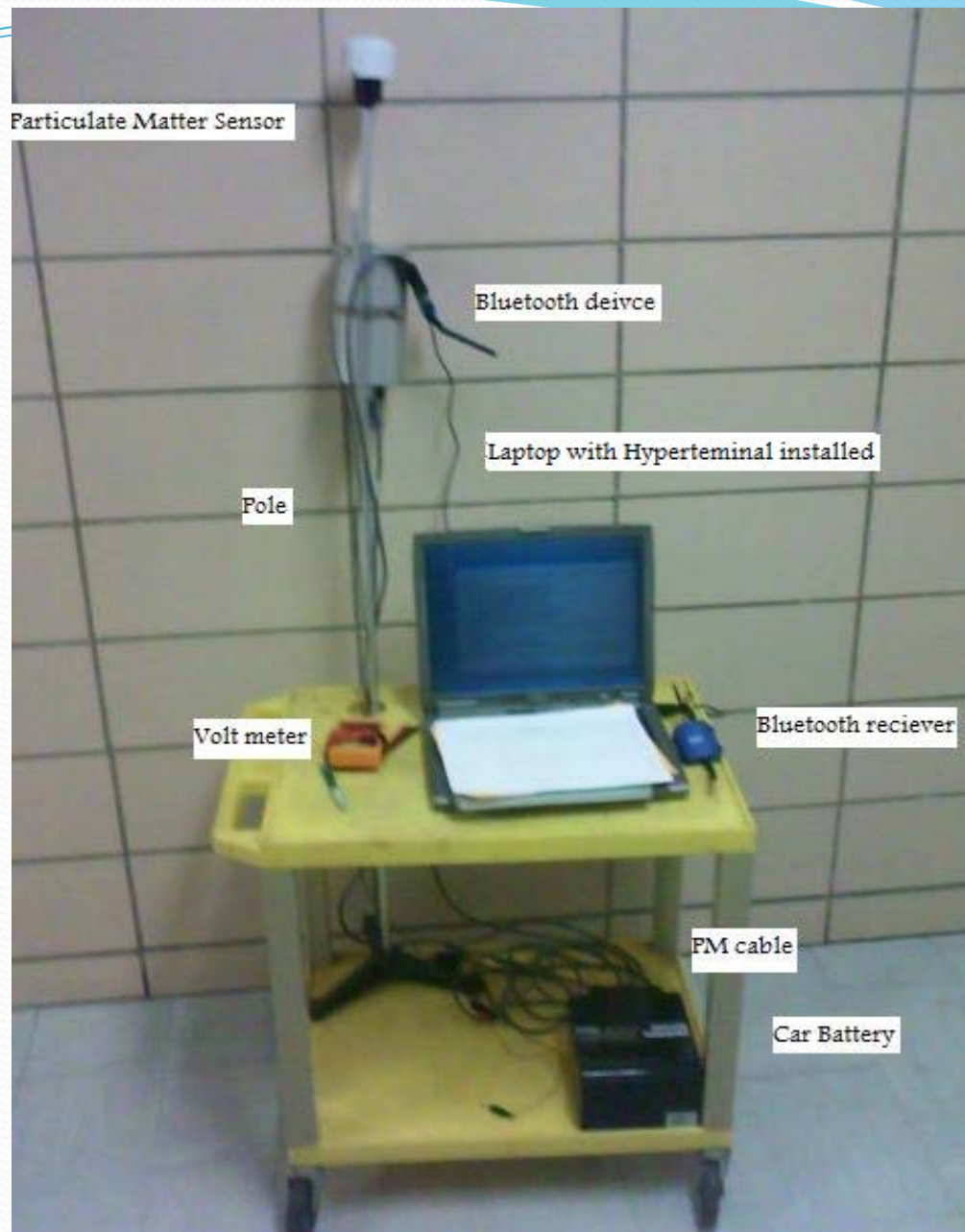
Determine if the levels found are up to EPA standards.

Propose improvements if needed.

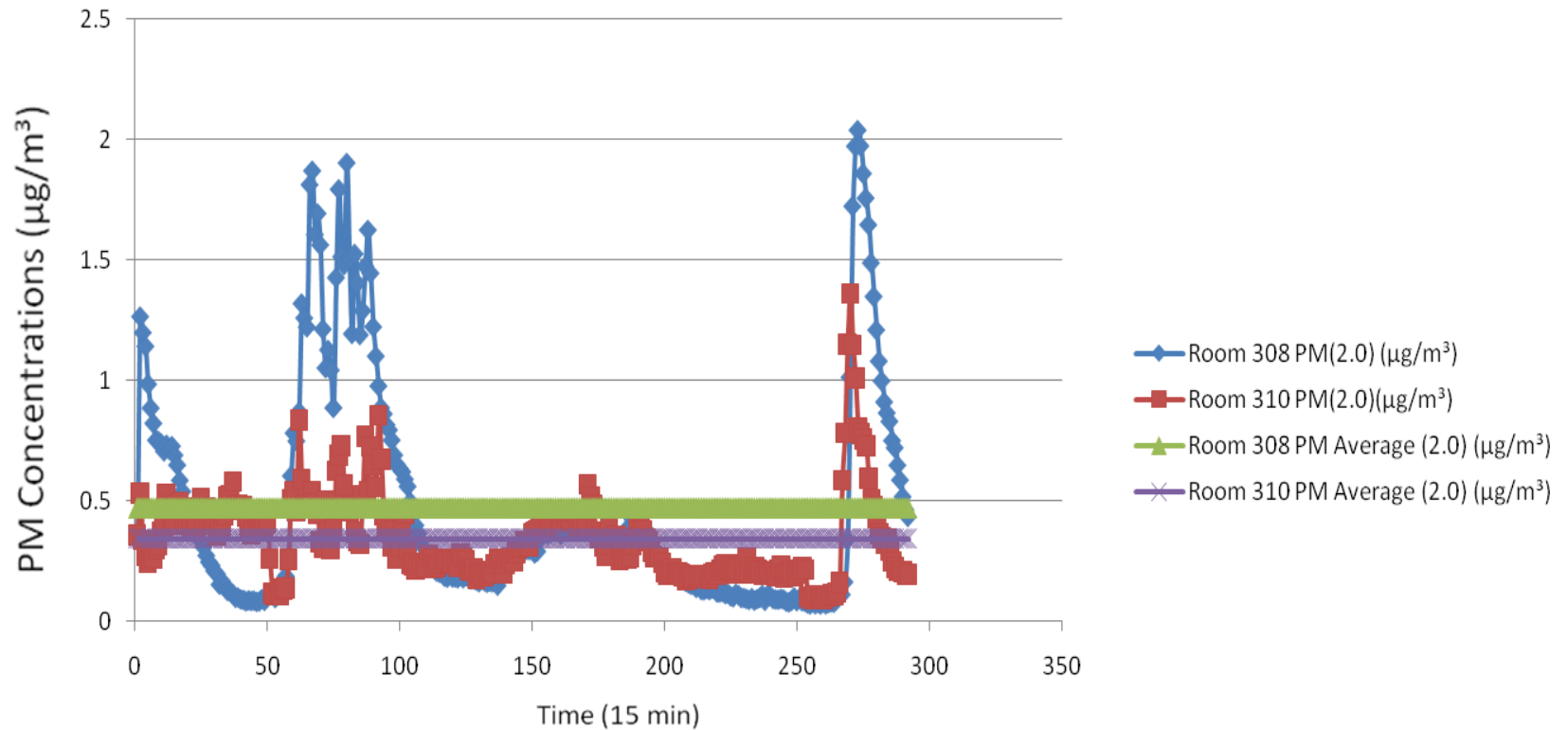
Materials	Quantity	Description
MET one Aero 212(PM sensor)	2	Used to collect Particulate Matter
Cart	2	Used to move the materials around
Universal Battery (Car Battery 12 Volt)	2	Used to power the PM sensor
Dell Latitude India	2	Used to hold the data that is collect by the Sensor
Spip4h(program)	1	The program used to display the data from the PM sensor
Microsoft Excel	1	To make graphs
Air Cable (Bluetooth device)	2	To collect data from the PM sensor
Volt meter	1	Used to find out the power level of the car battery
Air Cable (Bluetooth receiver)	2	To connect to the computer, so the data can be sent from the P.M. sensor to the computer so that data can be displayed on Spip4h
PM Sensor Wire Alligator clips	2	Used to power the P.M. sensor while using a Car Battery
BlueAir 503 model	1	Used to filter the air

Brief Procedures

Air samples in room 310 (air filtered room) and room 308 (non filtered room) were taken simultaneously between 4:38 PM on 02/04/10 and 2:55 PM on 02/10/10 using two Aero model 212 Particulate Matter sensors. Particulate matter data was recorded every 60 seconds and blue-toothed to a classroom computer and a classroom laptop. Spip4H, was used to handle and process the files. PM data was then converted from counts to concentrations.



Results



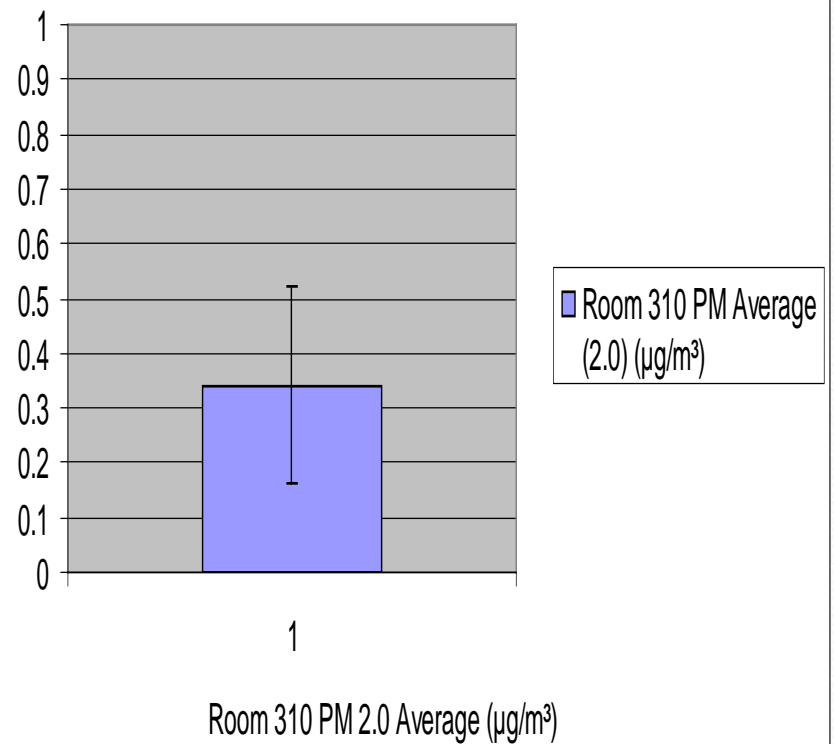
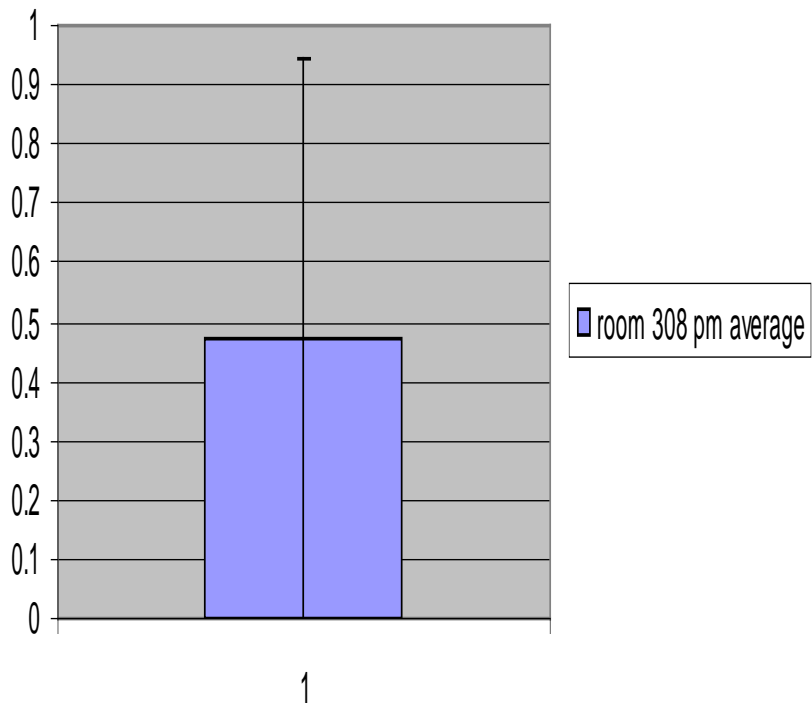
Room 310 and Room 308 PM (2.0) Comparison

Results

The room without an air filter had an average of $0.47 \mu\text{g}/\text{m}^3$. The room with air filtration had an average of $0.34 \mu\text{g}/\text{m}^3$. The graph shows that throughout the majority of the sampling the room with air filtration had lower levels of PM. The graph also shows how the average for the non filtered room was higher than the filtered room. The data was plotted in 15 minute intervals

Results

Room 308 PM_{2.0} Average ($\mu\text{g}/\text{m}^3$)



Analysis of Results

In the graph we see the difference an air filter makes in a classroom setting. The air filter was able to reduce the amount of PM 2.0 by about 30%. The spikes found on the graphs are mostly due to the entering and exiting of students during those times. The opening of the doors will lead to a fast increase in PM levels.

Analysis of Results

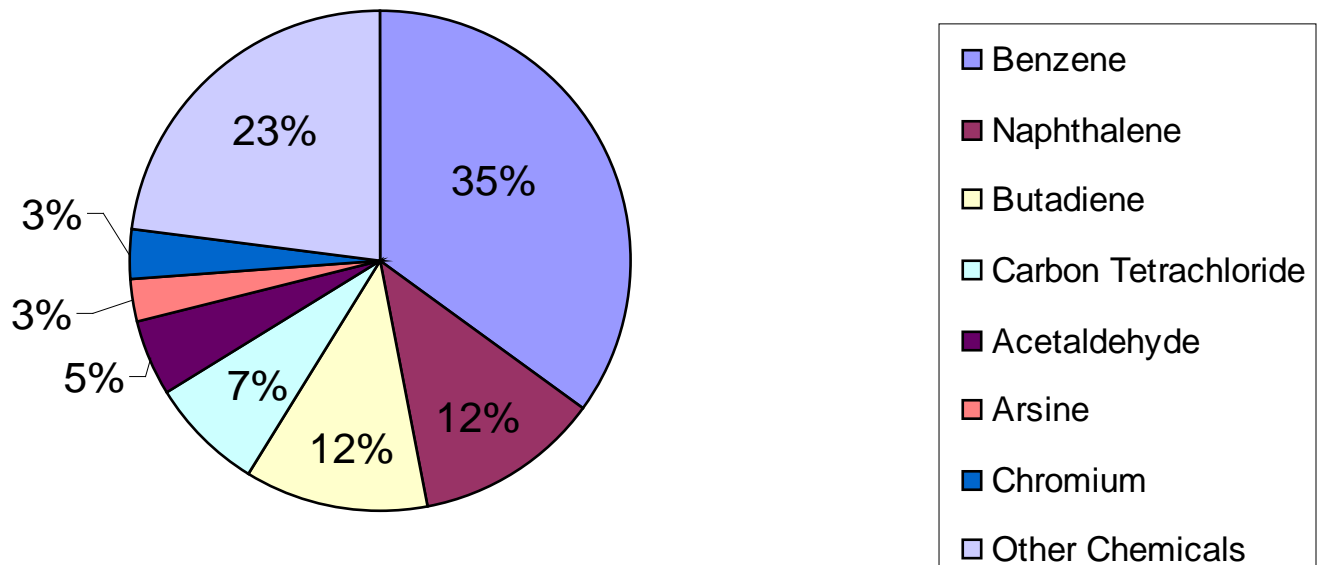
FDA is located just north of the Mother Clara Hale Bus Depot which stored diesel consuming buses that have been proven to be major sources of fine PM of the kind studied here. Prevailing southerly winds constantly blow the plume of particles to the school. However, this bus depot has recently been demolished for reconstruction in 2009. The demolition of the bus depot has most likely caused a significant drop in PM concentration levels in the surrounding area.

Analysis of Results

However according to EPA's B. Ligman indoor PM levels tend to be 59% higher than outdoor PM as found in an experiment conducted by the EPA's Indoor Environmental Division. In order to determine if these PM levels are safe or unsafe these particles need to be characterized in order to identify its composition.

Analysis of Results

Percentage of Total Pollution In Harlem



Conclusions

The hypothesis that PM concentration levels in Room 310, the filtered room, will be lower than the PM concentration levels in Room 308, the unfiltered room was correct. The average concentration level measured at any given time in room 310 was $0.34\mu\text{g}/\text{m}^3$ and in room 308 was $0.47\mu\text{g}/\text{m}^3$. Although these levels don't exceed the EPA yearly limit standard of $15\mu\text{g}/\text{m}^3$. Both standard deviations of the mean fall within each other. This signifies that the air filter didn't have a strong effect on particulate matter.



Conclusion

We still need to be concerned. These low levels can be attributed to the recent demolition of the Mother Clara Hale Bus Depot. In the past this bus depot has been known to be one of the primary sources of PM concentration levels in the surrounding area.

Future Research

For the future, PM levels in all rooms of FDA shall be measured. This will help in determining if overall the school is safe for students. If not we can pin point where the source of PM in the school is coming from. From there we can take action in improving the school.

Bibliography

- Clark, M.L., Reynolds, S.J., Burch, J.B., Conway, S., Bachand, A.M., Peel, J.L., et al. (2010). Indoor air pollution, cookstove quality, and housing characteristics in two Honduran communities. *Environmental Research*, 110(1), 12-18.
- EPA National Air Toxics Assessments. (18 August 2009) 18 August 2009 <http://www.epa.gov/ttn/atw/natamain/>
- EPA. "Particulate Matter" <http://www.epa.gov/oar/particlepollution/>
- EPA (2009) Frequently asked questions. 7 February 2009 . <http://www.epa.gov/reg3artd/faqs/APDFAQ.htm>
- Grass, D.S., Ross, J.M., Farnosh Family, Barbour, J., Simpson, H.J., Coulibaly, D., Hernandez, J., Chen, Y., Slavkovich, V., Li, Y., Graziano, J., Santella, R.M., Brandt-Rauf, P., Chillrud, S.N., et al. (2010). Airborne particulate metals in the New York City subway: A pilot study to assess the potential health impacts. *Environmental Research*, 110(1), 1-11.
- Hoepner, Lori, Frederica Perera, and Zhigang Li. (22 July 2009). Lower IQ In Children Linked To Pre Birth Air Pollution Exposure. Study.. 28 July 2009 <<http://www.medicalnewstoday.com/articles/158456.php>>.
- Ministry for the Environment (2009) http://www.mfe.govt.nz/environmental_reporting/freshwater/river/temperature-oxygen/ 10 August, 2009.
- National Air Toxics Assessments. 18 August 2009. 18 August 2009 <http://www.epa.gov/ttn/atw/natamain/>
- NYSDEC (2009) Particulate Matter. http://www.ohiomfg.com/AM/Template.cfm?Section=About_the_OMA&CONTENTID=20584TEMPLATE=/CM/ContentDisplay.cfm
- Particulate Matter: 1. What is Particulate Matter (PM)?. 28 July 2009. 28 July 2009 <<http://www.greenfacts.org/en/particulate-matter-pm/lev...>>.
- Perez-Pena, Richard (2003) Study Finds Asthma In 25% of Children In Central Harlem. New York Times. 01 November 2009. <http://www.nytimes.com/2003/04/19/nyregion/study-finds-asthma-in-25-of-children-in-centralharlem.html>
- Warbelow, C. (n.d.). Air Pollution, Health, and Environmental Justice in Harlem: Particulate Matter Monitoring, GIS, and Spatial Data Analysis for Policy and Planning. *Urban Planning Department Graduate School of Architecture, Planning, and Preservation Columbia University Contact Information:*, p. 1-89.
- WeAct 2009. www.weact.org. 28 July, 2009

Acknowledgements

Mauricio Gonzalez

Gregory Hodge, Ph.D

Jah-Vin Vaughan

Adam Turay

Frederick Douglass Academy

Robert Newton, Ph.D

Wade McGillis, Ph.D

Philip Orton, Ph.D

Lamont-Doherty Earth Observatory

Epics Program of Purdue University

Columbia University