New York City Community Air Survey: benzene, formaldehyde and other toxic air pollutants in New York City

Spring 2011

Since its launch in 2008, the New York City Community Air Survey (NYCCAS), a PlaNYC initiative, has provided data to the public and to local policy-makers on how average levels of common air pollutants vary throughout the City and the sources that contribute to these differences. Ongoing NYCCAS monitoring and previous NYCCAS reports have focused on common 'criteria' pollutants which have the greatest public health impacts in NYC and are the focus of major federal, state and local emission control measures: fine particles ($PM_{2.5}$), oxides of nitrogen (NO_x), sulfur dioxide (SO_2), and ozone (O_3).

In a new study, the Health Department and Queens College measured benzene, formaldehyde, and other volatile organic compounds (VOCs) that are in a class of air pollutants known as "hazardous air pollutants" (HAPs) throughout New York City. These pollutants contribute to increased risk of cancer and other serious health effects and are common in cities and surrounding areas.

Though about four out of ten people will develop some type of cancer in their lifetime[1] from lifestyle, genetic, environmental, and unknown causes, elevations in cancer risk are a matter of public health concern. Benzene and formaldehyde are both classified by the International Agency for Research on Cancer as human carcinogens. Recent computer model analyses by the US EPA have estimated that almost half of New York City residents live where outdoor exposures to HAPs are high enough to produce a greater than 1 in 10,000 additional cancer risk if exposed over a lifetime. This compares to just 5% of the population nationwide. The majority of the elevated risk from HAPs is due to benzene and formaldehyde exposures. Benzene occurs naturally in crude oils and is used as an additive in gasoline. As a result, emissions from motor vehicles are the main contributor to ambient levels of benzene in New York City. Benzene is also used in a variety of solvents and evaporative emissions from these products as well as from petroleum storage also contribute to outdoor levels in urban air. Ambient formaldehyde is produced during the combustion of fuels in vehicles and buildings and formed secondarily by chemical reactions in the atmosphere among hydrocarbons and sunlight.

To evaluate levels of benzene and formaldehyde, in the spring of 2011 NYCCAS researchers monitored these pollutants as well as other common HAPs at 70 street-side and park sites across the city and analyzed the data using a modeling approach known as land-use regression. The results from the study, published in the journal *Environmental Health*, demonstrated differences in levels of these pollutants across the different neighborhoods of the city. The study found 6-fold differences in levels of benzene across monitoring sites and 2-fold differences in levels of formaldehyde. Land-use regression modeling found that indicators of traffic volume and congestion contributed most to differences in levels of both these pollutants while indicators of fuel combustion in buildings were also associated with formaldehyde levels.

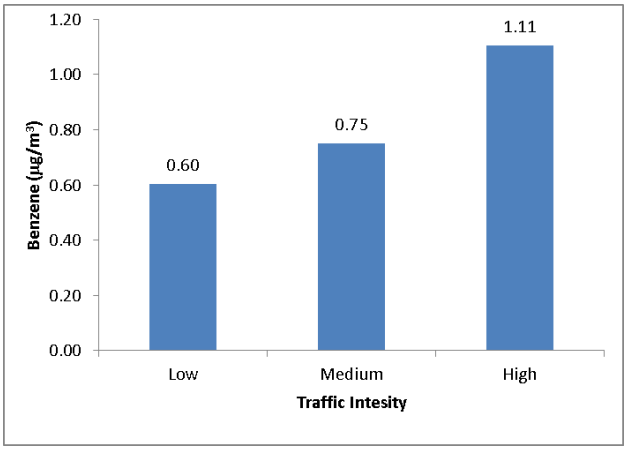
Monitoring sites in areas with the highest traffic intensity, indicated by a combination of roadway and traffic signal density, were found to have 83% higher benzene concentrations and 45% higher formaldehyde concentrations than those in areas of lower traffic intensity (Figure 1 and 2). Monitors in areas of high density of buildings (an indicator of fuel combustion) were found to have formaldehyde levels 44% higher than those in areas of low density of buildings (Figure 3). Locations with higher levels of benzene and formaldehyde also had higher average concentrations of combustion related pollutants such as NO_2 and $PM_{2.5}$ (Figures 4+5) because these HAPs share some sources with common criteria pollutants.

[1] http://seer.cancer.gov/csr/1975_2009_pops09/results_merged/topic_lifetime_risk.pdf

Limitations of this study include the fact that it describes a single season's worth of measurements; however city-wide patterns are likely to be similar from year to year due to consistent sources of these air pollutants, such as highways. Health department investigators are conducting additional HAPs measurements during the summer of 2012. Additionally, land-use regression models cannot evaluate the impacts of any single facility but are useful in identifying areas of the city with higher and lower levels of pollution and the common sources that affect these patterns. Finally, both formaldehyde and benzene are found in tobacco smoke, and exposures from secondhand smoke, especially indoors can be significantly higher than outdoor exposures. Formaldehyde has other indoor sources as well, such as through off-gassing of building materials.

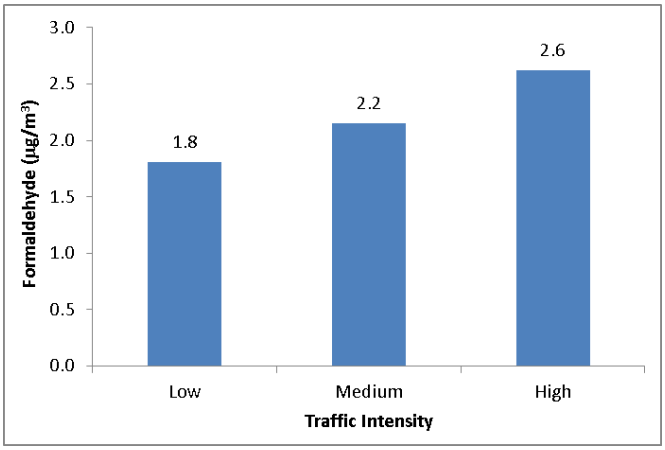
The findings of this study indicate that New Yorkers residing for long periods in close proximity to areas of high traffic volumes and congestion may be exposed to levels of benzene and formaldehyde that could contribute to increased risks of cancer and other adverse health effects. Recent action by the EPA to reduce levels of benzene and other compounds in vehicle fuels and from industrial emissions is projected to reduce ambient levels of hazardous air pollutants in the coming years. Nonetheless, the findings of this study demonstrate the need for continuing and expanding efforts aimed at reducing exposures to harmful emissions within the City, especially from motor vehicle traffic. Ongoing initiatives that will help include shifting city vehicle fleets and taxis to hybrids and other low emission vehicles, adding bike lanes and Bike Share to make cycling safer and more convenient, and pedestrian plazas that help separate people from tailpipe emissions. These measures along with reductions in building related emissions will produce the greatest benefits in the most polluted areas of the city which also tend to be the most densely populated with residents, visitors and commuters.

Figure 1. Average benzene levels in areas with higher traffic intensity are 83% higher than areas of lower traffic intensity[1]



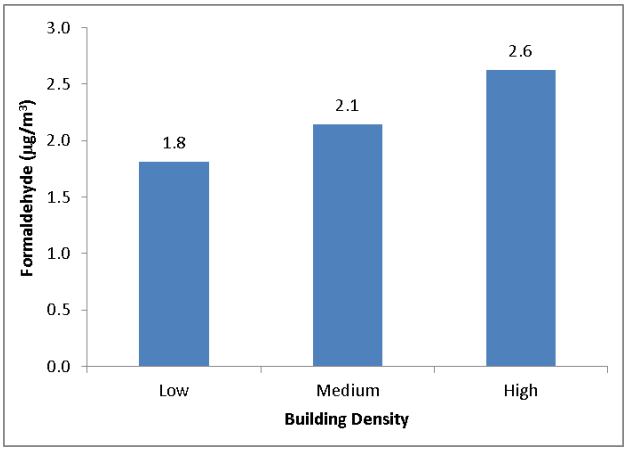
[1]Traffic intensity is estimated as sum of density of primary and secondary roads within 100 meters and signal density within 400 meters of monitoring site, each weighted by their regression coefficient in the land use regression (LUR) model. Each category includes one-third of sampling sites. Visit http://www.nyc.gov/health/nyccas for calculation methods.

Figure 2. Average formaldehyde levels in areas with higher traffic intensity are 45% higher than areas of lower traffic intensity[2]



[2]Traffic intensity is estimated as sum of road density within 100 meters and signal density within 400 meters of monitoring site, each weighted by their regression coefficient in the land use regression (LUR) model. Each category includes one-third of sampling sites. Visit http://www.nyc.gov/health/nyccas for calculation methods.

Figure 3. Average formaldehyde levels in areas with higher building density are 44% higher than areas of lower building density[3]



[3] Building density is estimated as the total interior built space within 100 meters. Each category includes one-third of sampling sites, with total interior built space of lower, 0-0.0086; medium 0.009-0.027; high, 0.027-0.30 square kilometers. Visit http://www.nyc.gov/health/nyccas for calculation methods.

Figure 4. Locations with higher measured benzene levels also exhibited higher levels of fine particulate matter and nitrogen dioxide.

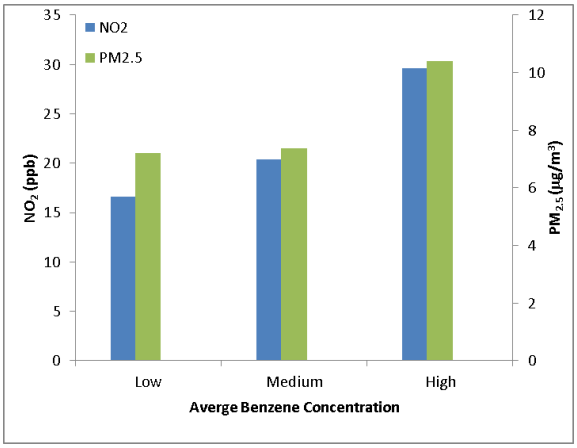


Figure 5. Locations with higher measured formaldehyde levels also exhibited higher levels of fine particulate matter and nitrogen dioxide.