Describing the mixture of air pollutants across Atlanta, Georgia and who is at risk

Adapted from: Characterizing the spatial distribution of multiple pollutants and populations at risk in Atlanta, Georgia

Conducted by **John Pearce** and colleagues including **Paige Tolbert, Stefanie Sarnat, Lance Waller and Howard Chang,** members of the HERCULES Exposome Research Center.

Introduction and Purpose

Air pollution has been associated with asthma, heart and lung disease, and preterm births. Location, pollution sources, local landscapes, and weather conditions influence air quality in urban areas. This makes modeling the air quality of urban environments difficult. Such challenges have often led scientists to focus on one pollutant at a time. However, many different air pollutants are in the air we breathe. This study developed a model that can describe the mix of air pollutants in different parts of an urban area, as well as the **demographic** characteristics of those living in each area.

How the Study Was Done (Methods)

This Atlanta-based study looked at air pollution data collected over seven years (2002–2008) in an area encompassing approximately 125 miles by 100 miles (see Fig. 1 in the original article, linked below). The data represented ten outdoor air pollutants and each data point was specific to a location and time.

The approach was to identify and describe locations in the study area that have similar mixtures of the ten air pollutants (for more details on these pollutants, see back of this page). This was achieved in four stages:

1. Divide the study area into approximately 7.5 x 7.5 mile grids.
2. Describe **pollutant categories** that represent the different mixtures of air pollutants within the grids.
3. Map each grid with its **pollutant category**.
4. Describe the **demographic** characteristics of the populations residing in the areas defined by each **pollutant category**.

Key Words

Demographic: General information about a population, such as average age, race, income, education, etc.

Pollutant categories: Referred to in the study as "Multipollutant Spatial Types" or "MSTs", these are categories that describe mixtures of the 10 pollutants observed within the same location (e.g., one category has above average levels of all 10 pollutants while another category below average levels of all 10).

Direct emissions: Also known as primary pollutants, these come directly from an emission source. For example, emissions from highway traffic.

Indirect emissions: Also known as secondary pollutants, these occur the when direct emissions react with the atmosphere and create a new pollutant and/or a by-product.

Results of Study

The mix of air pollutants across the study area were summarized into six **pollutant categories** (for more on this, see next page). The categories formed clear regions of varying air quality across the Atlanta area:

- The **urban** and **suburban** region experienced higher overall levels of air pollution, with more **direct emissions** than **indirect emissions**.
- The outer suburban areas had more variety in **pollutant categories**.
  - The **western outer suburban** area had the highest levels of one particular direct pollutant (Sulfur Dioxide, SO_2), which was likely from a nearby coal-fired power plant.
  - The **northeast outer suburban** area had higher levels of **indirect emissions** than **direct emissions**.
  - The **other outer suburban** areas had overall lower levels of pollutant exposure.

The model showed that most of the population, as well as most children, nonwhite persons, and children in poverty, lived in areas with relatively high levels of **direct emissions**.

Limitations (Why we can't draw stronger conclusions)

While the grid resolution of 7.5 miles x 7.5 miles is smaller than previous studies, having an even smaller grid size could provide a more detailed picture of what is happening. For example, the **demographics** within a grid can vary greatly. Additionally, using six **pollutant categories** was somewhat subjective and we may learn more from having additional categories.

What does this mean?

This study provides a new technique to model mixtures of multiple air pollutants within specific locations. This is an important tool for future studies examining how air pollution mixtures impact health. While it is hard to draw strong conclusions from one study, this Atlanta-based study suggests that more exposure to air pollution occurs in urban areas with large populations. Neighborhood-specific air pollution data is needed so that communities can be aware of their pollutant exposure levels.

Read the full article here: https://www.ncbi.nlm.nih.gov/pubmed/27494956

The study was funded by US EPA Grant R834799 NIEHS Award K99/R00ES023475

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Pollutant Categories

The **pollutant categories** were created by comparing pollutant levels to the overall mean (average across all grid cells for each individual pollutant). The table below describes the six **pollutant categories** and what the level of each pollutant was compared to the overall mean. The color coding is as follows:

Approximate percentage above overall mean:	Approximate percentage below overall mean:
1%-75% over (slightly above average)	**1%-25% below** (slightly below average)
75% - 150% over (moderately above average)	**25% - 50% below** (moderately below average)
150% - 250% over (greatly above average)	

Pollutant category locations [and name*]	**CO Level**	**NO_2 Level**	**NO_x Level**	**O_3 Level**	**SO_2 Level**	**EC Level**	**OC Level**	**NH_4 Level**	**NO_3 Level**	**SO_4 Level**
Western Outer Suburbs [1,2]										
Suburban [2,2]										
Urban [3,2]										
Other Outer Suburbs 1 [1,1]										
Other Outer Suburbs 2 [2,1]										
Northeastern Outer Suburbs [3,1]										

*Bracketed numbers indicate the pollutant category name used in the original scientific article.

Direct (Primary) Pollutants:

Name	Main Sources	Environmental and Health Effects
Carbon monoxide (CO)	Car exhaust, poorly maintained gas boilers, stoves, or fuel-burning appliances	Headache, dizziness, vomiting, and nausea. Breathing CO over long periods of time has also been linked to increased risk of heart disease.
Sulfur dioxide (SO_2)	Coal-fired power plants	Smog, acid rain, and health problems that include lung disease.
Nitrogen dioxide (NO_2) and Nitrous oxides (NO_x)	Vehicle engines and power plants	Acid rain, ozone, smog, and health problems such as causing or worsening of respiratory diseases (ex. asthma). May lead to coughing, wheezing, difficulty breathing, or hospital admissions and visits to emergency rooms.
Elemental carbon (EC)	Diesel engines and other combustion sources	There is current research underway to clearly understand the amount of EC in the atmosphere and its impact on health.

Indirect (Secondary) Pollutants:

Name	Main Sources	Environmental and Health Effects
Ozone (O_3)	Forms when sunlight hits a mixture of pollution	In the atmosphere, the ozone layer protects us by blocking the sun's harmful UV radiation. At ground level, it's a toxic pollutant, a key ingredient of smog, and can damage health.
Organic carbon (OC)	A complex mixture of particles from combustion	Research studies are currently looking at the relationship between total organic carbon and a variety of health effects including respiratory and cardiovascular irritation.
Ammonium (NH_4)	Agricultural practices (fertilizer emits ammonia into atmosphere)	The harmfulness of airborne NH_4 is currently being studied, but a suspected health effect is cardiovascular disease.
Sulfate (SO_4)	Combustion of gasoline and diesel fuel that contain sulfur, chemical reactions in the atmosphere	Acidification of surface water and soil, acid rain, and fog. May reduce lung function, worsen asthmatic symptoms, and increase risk of emergency department visits, hospitalizations, and death in people who have chronic heart or lung diseases.
Nitrate (NO_3)	Lightning, industrial processes, motor vehicles and intensive agriculture	There is a current research underway to clearly understand the effects of NO_3 in the atmosphere on health. The following sources were used for the tables above:

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1. http://www.explainthatstuff.com/air-pollution-introduction.html
2. https://www.epa.gov/no2-pollution/basic-information-about-no2#Effects
3 https://www.nature.com/articles/7500298
4 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4516868/
5 https://link.springer.com/chapter/10.1007/978-94-007-7557-2_12
6 https://www.arb.ca.gov/research/aaqs/common-pollutants/sulfate/sulfate.htm
7 http://www.who.int/water_sanitation_health/dwq/chemicals/nitratenitrite2ndadd.pdf

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