Level 3: Traffic and Air Pollution in New York State

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❖ Background Information

When we think of air pollution, we often think of smog: dense clouds of grey, ashy particles suspended in the air above a city or near factories. In London in 1952, the smog was so thick people referred to the fog as a "pea souper," and 12,000 people died during or after the event because of the toxic fog. Going into many of our major cities often involved coming home covered in a fine layer of soot and dust, as the smog deposited particles on those who passed through.

Image of air pollution in London in 1952

While most places in the United States and Europe are no longer buried under blankets of smog, air pollution is still a major concern. Air pollution is not always visible; many gases and other pollutants in the air near the ground are colorless. Exposure to air pollution can cause asthma, heart disease, several different cancers, eye damage, and other respiratory problems. There are many different components of modern air pollution, including small particles of dust, as well as chemical pollutants.

Ozone, or, O_3, is a highly unstable form of molecular oxygen. In the upper atmosphere, in the ozone layer, it is formed when solar radiation breaks down three O_2 molecules and forms two O_3 molecules. Ozone in the upper atmosphere absorbs solar radiation, and is important in keeping our earth habitable.

Down on the ground, ozone is formed when nitrogen oxides, sulfur oxides, and volatile organic chemicals break down in the presence of regular sunlight and react with the O_2 in our atmosphere, forming O_3. Ozone, though, is highly unstable, and reacts with other molecules easily, oxidizing them. When ozone gets into plants and animals, it reacts with the molecules that are exposed to the ozone, damaging the underlying cells. This cellular damage can cause

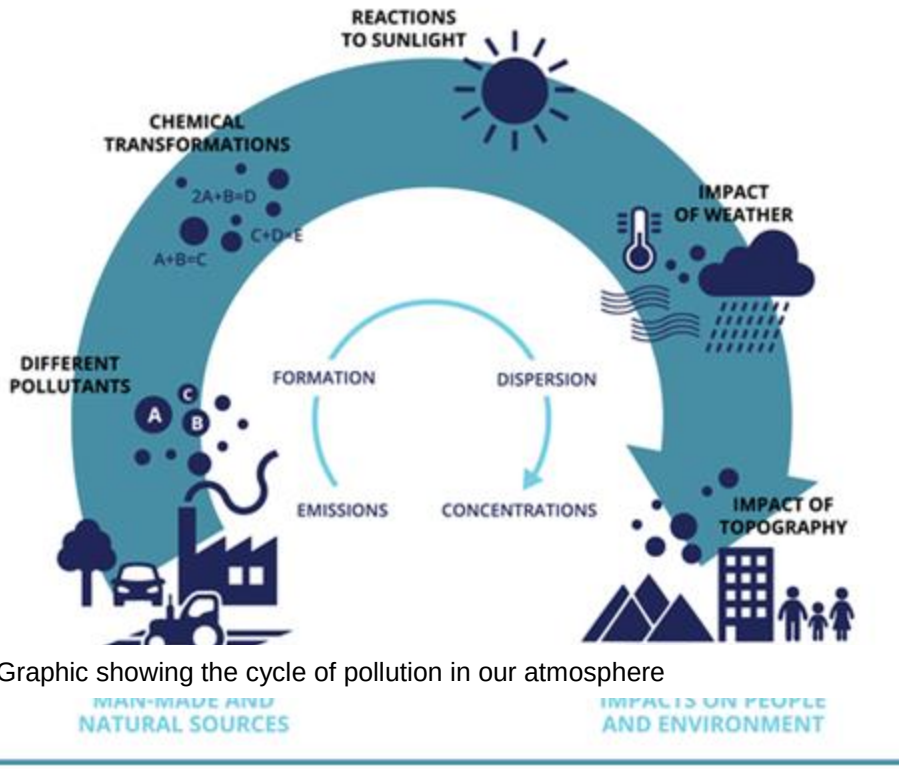
damage to human lungs when it's breathed in and contacts our alveoli, and can break down plant tissues when plants bring air into their leaves through their stomata.

Air pollution can also come in the form of small particles suspended in the air. Particles smaller than 2.5 microns in diameter are too small to be filtered by the human respiratory system's natural filtering mechanisms, and can accumulate in the lungs and cause problems. There are also many toxic chemicals that are gases, and can accumulate in the ground-level atmosphere and harm human health.

❖ Data Collection Information

Data in this set comes from various sources, and was collected using a variety of methodologies.

- ➢ Demographic data was collected by the U.S. Census Bureau's American Community 5-year Summary Survey (ACS) in 2015.
- ➢ Traffic proximity data was collected by the New York State Department of Transportation through car counts on roadways and other measures in 2014.
- ➢ Ozone, Particulate Matter ($PM_{2.5}$), and the chemical data that was used to develop the NATA indexes were collected by the EPA using passive air samplers and other data collection methods. The ozone and $PM_{2.5}$ data was collected in 2013, and the data used to develop the NATA indexes were collected in 2011.



Graphic showing the cycle of pollution in our atmosphere

There is data for New York State as a whole, and for Dutchess County individually. For the EPA's New York State data, locations were ranked by their proximity to traffic and assigned percentile ranks. For each percentile, the values were averaged to produce the final data set. The

Dutchess County Data is the direct measured and modeled data from EJSCREEN. For all variables, county averages are also available by county.

- **Data Set Variables**

NY Statewide Air Pollution Sheet

- **Traffic Congestion Rank:** The percentile rank (1-100) for an area with a given level of traffic, where 1 is the highest congestion of traffic and 100 is the lowest.
- **Concentration of Traffic (cars/day):** The count of the number of cars to pass on a given road in a day (as determined by the DOT), divided by the number of meters a location is from the roadway. Effectively, this is a measure of the concentration of vehicle traffic in a given area. A higher value on this measure indicates more traffic in an area.
- **Minority Percentage:** The proportion of the population within the traffic congestion rank area who are non-white.
- **Low Income Percentage:** The proportion of the population within the traffic congestion rank area whose income is less than two times the federal poverty limit
- **Diesel Particulate Matter ($\mu g/m^3$):** The presence of a variety of chemicals and particulates in air as a result of diesel fuel combustion, as measured by the National Air Toxics Assessment by the EPA.
- **NATA Cancer Risk Index:** The EPA's National Air Toxics Assessment estimation of cancer risk from inhaling air of this quality during a given lifetime.
- **NATA Respiratory Hazard:** The EPA's National Air Toxics Assessment Respiratory Hazard Index, which aggregates information on several different air pollutant chemicals and their toxicity to develop a measure of potential for human respiratory harm from air pollution
- **Ozone (ppb):** The average daily maximum 8-hour ozone concentration for a location from between May and September, when ozone is most prevalent. These values are in parts per billion (ppb). The EPA standard is not to exceed 70 ppb.
- **PM25 ($\mu g/m^3$):** The concentration of fine particulate matter in the air under 2.5 microns in diameter, expressed in the number of micrograms of particulate matter per cubic meter ($\mu g/m^3$)

Dutchess County Air Pollution Sheet

- **Census Tract:** the unit at which variables were measured, arbitrarily numbered 1-248. Each tract represents an area containing approximately 4,000 people.
- **All other variables are the same as the NY Statewide Air Pollution Sheet.**

County Averages Sheet

- **County:** The county in New York
- **All other variables are the same as the NY Statewide Air Pollution Sheet.**

❖ Data Sources

All data in this set were drawn from the Environmental Protection Agency's EJSCREEN, or Environmental Justice Screening and Mapping Tool as published in 2017.
In EJSCREEN: The NATA Respiratory Hazard, Lifetime Inhalation Cancer Risk, and Diesel Particulate Matter indexes are from the EPA's National-Scale Air Toxics Assessments. Ozone and $PM_{2.5}$ data is from EPA monitoring and modeling. Traffic proximity is based on the Department of Transportation's Highway Performance Monitoring System dataset, as accessed by the EPA. Demographic variables (income, minority status, etc.) were integrated by the EPA from U.S. census data.

❖ Inquiry Idea Starters

Here are some sample questions you could ask using these data. These are just suggestions, and we hope you'll come up with many interesting questions of your own!

- ➢ How does the concentration of diesel particulate matter relate to low income percentage in Dutchess County?
- ➢ Is there a relationship between the proportion of people in New York State who are from minority populations and the concentration of traffic in their area?
- ➢ What is the relationship between NATA Cancer Risk Index and Traffic Congestion Rank?

❖ Extension Ideas

- ➢ Fix the Problem: conduct experiments on plants to see how well different plants mitigate air pollution, and use this information to design buffer zones around roadways in your communities.
- ➢ What is the air quality near your school and home? What are the major causes of air pollution in your environment?
- ➢ Fix the Problem: design an intervention (advertisements, education campaign, legislation, advocacy, etc.) in your community to address human sources of air pollution

❖ Additional Information

- ➢ The Fog that Killed 12,000 people, video by SciShow https://www.youtube.com/watch?v=4fkcTA7YX44
- ➢ Ozone and Air Pollution, video by the Washington Department of Ecology https://www.youtube.com/watch?v=3yiJTcFp2Xc
- ➢ EJScreen Mapping Tool https://www.epa.gov/ejscreen
- ➢ Biodiversity, Air Quality, and Human Health report from the U.N. Environmental Program https://www.fs.fed.us/nrs/pubs/jrnl/2015/nrs_2015_nowak_001.pdf
- ➢ How Ozone Pollution Works https://science.howstuffworks.com/environmental/green-science/ozone-pollution.htm

❖ References

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❖ Extra: Information on Modeling

Many of the indexes included in this data set are not direct measurements, but are composite measurements based on lots of data collected in a given area. Statistical modeling in this way requires quite a bit of skill and research. Modeling requires a strong understanding of how the different variables in a system interrelate- if your understanding of the relationships in a system is incomplete, then your projected values for the rest of the system might be inaccurate. If the data you do collect for your system is poor, then even if the relationship is understood well, your modeled values are not likely to be accurate.