Air Quality
Info Sheet

Activity Overview

1. Go over the questions on the background information with the students.
2. Speculate on differences in pollutant concentrations in Pittsburgh.
3. Go over the paper plate/Vaseline pollution experiment.
4. Use the Pittsburgh air quality map to explore actual differences in and around Pittsburgh: http://www.pghairquality.com/pollution_map/map
5. Discuss why there may be differences in air quality throughout one city and the surrounding areas.
6. Perform the diffusion experiment with the water, food storage container/bowl, food coloring/dye, and cardboard scraps.
7. Discuss the conclusion questions.

Air Quality Background

- PM = Particle Pollution and is a "mixture of air-bourne particles and liquid droplets composed of acids (such as nitrates and sulfates), ammonium, water, black carbon, organic chemicals, metals and soil material." [2]
- The US EPA regulates certain air pollutants through the National Ambient Air Quality Standards (NAAQS).
- There are NAAQS for gases (such as SO_2, CO, NO_2, and O_3) as well as for particles. (PM_{10} and $PM_{2.5}$)
- $PM_{2.5}$ are particles with a diameter of less than 2.5 micrometers (that's 20 times smaller than the diameter of a human hair!)
- PM_{10} are particles with diameters less than 10 micrometers (~ 5 times smaller than the diameter of a human hair.)
- Allegheny county has been in at least partial non-attainment for $PM_{2.5}$ and SO_2 for the past many years (meaning the concentrations for these pollutants are above the NAAQS levels.)
- $PM_{2.5}$ has important negative impacts on human health and the environment
  - Health: $PM_{2.5}$ is small enough to be inhaled and penetrate through the lungs and even into the blood stream, it has been linked to both short and long term respiratory and cardiovascular diseases.

- o Environment: small particles emitted into the atmosphere linger over long timescales, can react with other compounds, and alter the radiative forcing of the atmosphere which leads to climate change. Some effects of climate change include glacier loss, wildfires, elevated water levels, and increased frequency of severe weather events.
- $PM_{2.5}$ has very varied sources, so it comes in many different sizes, compositions, shapes, and mixtures.
- $PM_{2.5}$ has both anthropogenic (man-made) and biogenic (formed in nature) sources. Some source examples include but are not limited to:
  - o Anthropogenic: factories, man made fires, cooking emissions, car tail-pipe emissions, tire wear, power plants.
  - o Biogenic sources: sea-spray, forests, naturally occurring fires.
- Some of the biggest emitters in Pittsburgh and Allegheny County as a whole are the remaining steel facilities, most notably is the Clairton Coke Works plant in Clairton PA (~20 miles south of the city) which is the largest coke plant in the US.

Air Particulate Collector Experiment

If students performed this pre-activity experiment, they will have varying results based on their location.

Discussion point: Additional factors for why they may have collected the number of particulates that they did can be due to weather (wind is a great example here), local pollution, depending on time of year neighborhoods could be burning leaves, etc.

Prompt students to think of potential reasons for their results.

Images below are from a collection from 11/13/20-11/15/20 in the south hills area of Pittsburgh.

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Pollution in Pittsburgh & Pittsburgh Air Quality Website

- Historically, the steel mills and surrounding industry have been major sources of air pollution in Pittsburgh. Even though many steel mills have closed, they are still major sources of gasses and particles that pollute our air.
- In addition to the industry sources, other areas that experience higher levels of $PM_{2.5}$ than the average Pittsburgh concentrations are areas with high traffic (i.e. downtown, along major highways like 375, and near restaurants.)
- Downtown there are differences in pollutant concentrations from street to street, there are features like "urban street canyons" that trap pollutants and lead to higher pollutant concentrations along certain streets downtown.

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The last portion of this section will use the following website:
http://www.pghairquality.com/pollution_map/map

- The data for the map comes from the sensors that CAPS (https://particulate-matter.cmu.edu/) has deployed throughout the city.
- These sensors are called Realtime Affordable Multi-Pollutant (RAMP) sensors and they measure both gases and particles.
- The RAMPs have SIM cards in them that report wirelessly to our database.
- Machine learning techniques are used to convert the sensor data into pollutant concentrations.
- The machine learning corrected concentrations are then displayed on the map.

Diffusion Experiment

1. Discuss what do the students think will happen when they place a few drops of food coloring in the water. Then what they think will happen with the cold water vs. hot water.
   NOTE: Hot tap water should be washing hands temperature.
2. Place a few drops of food coloring in the water.
3. Watch as the color disperses throughout the water.
4. Notice how the color gets less intense as it moves away from the original source.
5. Stir the water to see how disturbing it effects the spread of the color.
6. Add in a piece of cardboard.
7. Add a few more drops of cardboard.
8. Note differences between two experiments.

In the hot water, the particles are moving more quickly, which means diffusion happens more quickly and the "pollution" spreads more quickly and evenly.

In the cold water, the opposite happens, and food coloring bleeds onto the cardboard edges, much like particulates in water would do to shores along streams.

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Notes on making an impact with air quality

The less energy we use the less pollutants are emitted to create that energy so anyone can make a difference if you make choices such as
- o Turning off lights that you're not using
- o Unplugging appliances that draw energy when not using
- o Turn up the heat temperature or turn down the AC to save energy
- o Choosing to bike or walk instead of driving
- o etc.
- Can you name some more examples?

Sources

1. *https://www.epa.gov/criteria-air-pollutants/naaqs-table*
2. *https://www3.epa.gov/region1/airquality/pm-what-is.html*

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