EVERY BREATH YOU TAKE: Air Quality Monitoring Data in the US

OBJECTIVES

The student will do the following:

1. Collect data on air quality in two communities.
2. Collect air quality data from a state agency.
3. Graph results from the data collected.
4. Draw conclusions about air quality in the local area using data collected.

SUBJECTS: Science, Mathematics

TIME: 2 class periods, plus time to collect data on a daily basis

MATERIALS:

graph paper

NAAQS slide (master provided)

BACKGROUND INFORMATION

Monitoring air quality and providing the information to the general public is done for two major reasons. First, studies have shown a relationship between the severity of air pollution and health. Accurate, timely, and easily understandable information about daily levels of air pollution allows susceptible people to modify their activities and to take temporary measures to protect themselves. Second, government agencies are required to take steps that will prevent air pollution from reaching harmful levels.

For many years cities in North America developed and used their own indices for reporting air pollution levels to the public. Because no two of these were exactly the same, confusion in the general public resulted, especially for those with health problems aggravated by air pollution. The Environmental Protection Agency (EPA), in cooperation with the Council on Environmental Quality (CEQ) and other agencies, developed the Pollutant Standard Index (PSI) in 1976.

In June 2000, EPA updated the PSI and renamed it the Air Quality Index (AQI), though some agencies continue to refer to this as PSI. The AQI provides a standardized way to report daily air pollution levels to the public. AQI converts the levels of pollutants in a community to a number on a scale of 0 to 500. The scale intervals are related to potential health effects of measured daily levels of major pollutants. When the AQI is reported as 50 or less, it is said to be in the "Good" range. Between 51 and 100 is in the "Moderate" range. Above 100, the AQI is in the "Unhealthy for Sensitive Groups" range. Both the U.S. indices are based on the ambient air quality standards established by the EPA. They monitor the levels of carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and ozone. For more specific information, see the attached charts on ambient air quality standards/objectives.

The Clean Air Act, which was last amended in 1990, requires EPA to set National Ambient Air Quality Standards (40 CFR part 50) for pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of national ambient air quality standards (NAAQS). ***Primary standards*** provide public health protection, including protecting the health of "sensitive" populations such as asthmatics, children, and the elderly. ***Secondary standards*** provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings.

The EPA has set National Ambient Air Quality Standards for six principal pollutants, which are called "criteria" air pollutants. Periodically, the standards are reviewed and may be revised. The current standards are listed below. Units of measure for the standards are parts per million (ppm) by volume, parts per billion (ppb) by volume, and micrograms per cubic meter of air ($\mu g/m^3$).

PROCEDURE

I. Setting the Stage

A. Introduce the Criteria Pollutants (using notes from Background discussion)

B. Make an image (computer or transparency) showing the nation's air quality standards using the provided masters: "U.S. National Ambient Air Quality Standards". Show the image to the students, explaining that these standards are enforced nationally and that indices used to report air quality information to the public were derived from these standards. (You may wish to make photocopies for the students instead of using a projected image.)

C. Give each student a copy of the "U.S. Air Quality Index" table. Discuss the information given in the index, pointing out its usefulness to people, especially those with health conditions that make them particularly susceptible to air quality problems.

II. Activity

A. Divide the class into three groups:

1. Have one group of students contact the local agency responsible for air quality to determine where the air quality monitoring stations nearest them are located. Have the students collect and record air quality or air quality index readings every day for two weeks. Students should also record the type(s) of pollution (sulfur dioxide, ozone, etc.) each day. NOTE: You may wish to contact your local television station, radio station, or newspaper to determine if they obtain daily readings. Air quality information is often included in weather reports. Check www.AirNow.org

2. Have the second group identify the nearest large city and the local agency in that region responsible for air quality. Have them contact the agency to obtain information on the air quality or air quality index, collecting and recoding

index readings and type(s) of pollution every day for two weeks. If your students live in a metropolitan area, have them identify a less populated area to monitor the air quality.

3. Have the third group contact their state agency and obtain statewide information on air quality for the past year. Ask for quarterly (seasonal) readings, rather than daily readings. Have the students determine the type(s) of air pollution for each quarter.

B. Once the students have obtained the information, each group should draw two graphs on their data: (1) AQI index value and (2) AQI Category. Should we include an example?

C. Have each group present their findings to the class. Have the students draw conclusions from the information.

1. Does the day of the week, or the season of the year make a difference in pollutions levels? If yes, for which pollutants?

2. Compare the results of air quality in their town with the more (or less) populated area.

3. What was the most common type(s) of pollution? Does it change by day or by season?

III. Follow-up

A. Have the students add the health effects and cautionary statements to the two week graphs from both populated and less populated areas.

B. Have the students add the health effects and cautionary statements to the quarterly monitoring graph.

C. Have the students determine what the most common health effect was.

D. Discuss with the students ways that they as individuals and as a part of a family can help reduce air pollution.

RESOURCES

National Association of Clean Air Agencies (NACAA)
List of State and Local Air Agencies
http://www.4cleanair.org/agencies

US Environmental Protection Agency (USEPA)
Air Quality Data: www.airnow.gov

Air Now Resources for Kids:
https://www.airnow.gov/index.cfm?action=aqikids.index

Clean Air Act: www.epa.gov/clean-air-act-overview

Criteria Air Pollutants: www.epa.gov/criteria-air-pollutants

U.S. National Ambient Air Quality Standards

Pollutant	Primary/ Secondary	Averaging Time	Level	Form
Carbon Monoxide (CO)	primary	8 hours	9 ppm	Not to be exceeded more than once per year
		1 hour	35 ppm	
Lead (Pb)	primary and secondary	Rolling 3 month average	0.15 µg/m^3	Not to be exceeded
Nitrogen Dioxide (NO_2)	primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	primary and secondary	1 year	53 ppb	Annual Mean
Ozone (O_3)	primary and secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

U.S. National Ambient Air Quality Standards (continued)

Particulate Matter (PM)	$PM_{2.5}$	primary	1 year	12.0 $\mu g/m^3$	annual mean, averaged over 3 years
		secondary	1 year	15.0 $\mu g/m^3$	annual mean, averaged over 3 years
		primary and secondary	24 hours	35 $\mu g/m^3$	98th percentile, averaged over 3 years
	PM_{10}	primary and secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
Sulfur Dioxide (SO_2)		primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		secondary	3 hours	0.5 ppm	Not to be exceeded more than once per year

These Breakpoints equal this:						AQI & Category	
O_3 (ppm) 8-hour	$PM_{2.5}$ (ug/m3)24hr	PM_{10} (ug/m3)24hr	CO (ppm)1hr	SO_2 (ppB)1hr[3]	NO_2 (ppB)1hr[3]	AQI	Category
0.000-0.054	0.0 – 12.0	0 – 54	0.0 – 4.4	0 – 35	0 - 53	0 – 50	Good
0.055-0.070	12.1 – 35.4	55 – 154	4.5 – 9.4	36 – 75	54 - 100	51 – 100	Moderate
0.071-0.085	40.5 – 65.4	155 – 254	9.5 – 12.4	76 – 185	101 - 360	101 – 150	Unhealthy for sensitive groups
0.086 – 0.105	65.5 – 150.4[5]	255 – 354	12.5 – 15.4	186 – 304	361 - 649	151 – 200	Unhealthy
0.106 – 0.200	150.5[5] – 250-4[5]	355 – 424	15.5 – 30.4	305 –604	650 – 1249	201 – 300	Very Unhealthy
[4]	250.5[5] – 350.4[5]	425 – 504	30.5 – 40.4	605 –804	1250 – 1649	301 – 400	
[4]	350.5[5] – 500-4[5]	505 – 604	40.5 – 50.4	805 – 1004	1650 – 2049	401 – 500	Hazardous