NATIONAL GEOGRAPHIC
Activity*engage*

Measuring Air Quality

What are the causes and effects of poor air quality?

Overview

Students explore the air quality index and factors that contribute to poor air quality events.

For the complete activity with media resources, visit:
http://education.nationalgeographic.org/activity/measuring-air-quality/

Directions

1. Activate students' prior knowledge about air quality.

Show the **Highland Park Optimist Club banquet in 1954** image. (Click on the link in the media carousel above and download using the arrow in the lower right corner of the window.) Tell students that bad air quality has a negative effect on human health. Air quality was poor in the United States before Clean Air Act regulations went into effect in 1970. Many areas around the world still experience very poor air quality. Ask:

- *Why do you think air quality is better in the United States today than it was before 1970?* (Air quality is better because the Clean Air Act set air quality standards that states and localities had to meet. They reduced their emissions to meet the standards, and the air quality improved.)
- *What causes poor air quality events?* (There are many causes of poor air quality events. Human actions [burning fuels and using volatile organic compounds] put pollutants into the air. Natural events [forest fires and volcanic eruptions] can also affect air quality.)
- *Are human processes the only causes of air pollution?* (Humans are not the only causes of air pollution. Forest fires and volcanic eruptions are two natural causes of poor air quality.)

Tell students that air quality is measured by the air quality index. Show students the **Air Quality Index,** and then access the **Air Now: Today's AQI Forecast** website and show the air quality forecast map for the United States. Ask:

- *Where is the air quality forecast to be the worst in the United States today?* (Answers will vary depending on the day.)
- *What do you think is the cause for the poor air quality in the United States today?* (Depending on the area of the country, the poor air quality could be due to fires, emissions from power plants and factories, and/or emissions from vehicles. Stagnant weather patterns can contribute to poor air quality events.)

- *How do you think scientists forecast air quality?* (Scientists use data from real-time monitoring stations to measure the level of pollutants in particular areas and weather forecasts to predict where wind will blow pollutants (or leave pollutants over a particular location).)

2. Discuss the role of uncertainty in the scientific process.

Tell students that science is a process of learning how the world works and that scientists do not know the "right" answers when they start to investigate a question. Let students know that they can see examples of scientists' uncertainty in forecasting air quality. Show the **Forecast of Air Quality on December 10, 2013** image and **Air Quality on December 10, 2013** image. (Click on the link in the media carousel above and download using the arrow in the lower right corner of the window.) Tell students that these are snapshots of the air quality forecast and the real-time air quality in the United States on December 10, 2013. Ask:

- *Did the forecast accurately predict which areas would have poor quality air?* (The forecast air quality overlaps with many of the poor air quality areas, but it does not cover all of them. The air quality in some areas (Northern California) is much worse than the forecast predicted.)
- *Why do you think scientists did not accurately predict the air quality for more of the United States?* (Student answers will vary. The air quality forecast is affected by human activities that may not be easily predicted.)

Tell students they will be asked questions about the certainty of their predictions. Let students know they should think about what scientific data is available as they assess their certainty with their answers, and encourage them to discuss the scientific evidence with each other to better assess their level of certainty with their predictions.

3. Have students launch the Measuring Air Quality interactive.

Provide students with the link to the Measuring Air Quality interactive. Divide students into groups of two or three, with two being the ideal grouping to allow groups to share a computer workstation. Tell students that they will be working through a series of pages of data with questions related to the data. Ask students to work through the activity in their groups, discussing and responding to questions as they go.

Tell students that this is Activity 1 of the **Will the Air Be Clean Enough to Breathe?** lesson.

4. Discuss the issues.

After students have completed the activity, bring the groups back together and lead a discussion focusing on these questions:

- *What groups of people are most at risk from poor air quality?* People who work outdoors are most at risk, followed by those with breathing problems, such as asthma, emphysema, and COPD (chronic obstructive pulmonary disease).

- *What do officials suggest people do when bad air quality is forecast?* (When bad air quality is forecast, officials suggest limiting outdoor activities.)

- *What might happen to air quality if the population continues to grow?* (If the population continues to grow, air quality might decrease, especially in areas of the world where air quality is already bad a lot of the time.)

- *How might humans mitigate bad air quality events in the future?* (Humans might be able to mitigate bad air quality events through technology. Technology could be developed that removes more emissions from cars, factories, and power plants. Technology could also change so that manufacturing and transportation methods don't require burning of fuels that release pollutants into the air.)

TipTeacher Tip

If you want to save students' data for grading online, register your class for free at the High-Adventure Science portal page.

TipTeacher Tip

This activity is part of a sequence of activities in the **Will the Air Be Clean Enough to Breathe?** lesson. The activities work best if used in sequence.

Modification

This activity may be used individually or in groups of two or three students. It may also be modified for a whole-class format. If using as a whole-class activity, use an LCD projector or interactive whiteboard to project the activity. Turn embedded questions into class discussions. Uncertainty items allow for classroom debates over the evidence.

Informal Assessment

1. Check students' comprehension by asking students the following questions:

- What factors contribute to poor air quality events?
- What effects can air pollution regulations have on air quality?
- What can be done to reduce or manage pollutant emissions?

2. Use the answer key to check students' answers on embedded assessments.

Objectives

Subjects & Disciplines

Science

- Earth science
- General science

Learning Objectives

Students will:

- explain the link between human and ecosystem health and air pollution
- describe natural and anthropogenic sources of air pollution

Teaching Approach

- Learning-for-use

Teaching Methods

- Discussions
- Multimedia instruction
- Self-paced learning
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Information, Media, and Technology Skills
    - Information, Communications, and Technology Literacy
  - Learning and Innovation Skills
    - Critical Thinking and Problem Solving
- 21st Century Themes
  - Global Awareness
- Critical Thinking Skills
  - Analyzing
  - Evaluating
  - Understanding

National Standards, Principles, and Practices

National Science Education Standards

• (5-8) Standard A-1:

Abilities necessary to do scientific inquiry

• **(5-8) Standard D-1:**
Structure of the earth system
• **(5-8) Standard F-1:**
Personal health
• **(5-8) Standard F-4:**
Risks and benefits
• **(9-12) Standard A-1:**
Abilities necessary to do scientific inquiry
• **(9-12) Standard C-5:**
Matter, energy, and organization in living systems
• **(9-12) Standard F-1:**
Personal and community health
• **(9-12) Standard F-2:**
Population growth
• **(9-12) Standard F-4:**
Environmental quality
• **(9-12) Standard F-5:**
Natural and human-induced hazards

Common Core State Standards for English Language Arts & Literacy

• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.9-10.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.6-8.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.6-8.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Craft and Structure, RST.11-12.4
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.3
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.11-12.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.1
• **Reading Standards for Literacy in Science and Technical Subjects 6-12:**
Key Ideas and Details, RST.9-10.3

ISTE Standards for Students (ISTE Standards*S)

• **Standard 3:**
Research and Information Fluency
• **Standard 4:**

Critical Thinking, Problem Solving, and Decision Making

Next Generation Science Standards

• Crosscutting Concept 1:
Patterns
• Crosscutting Concept 2:
Cause and effect: Mechanism and prediction
• Crosscutting Concept 3:
Scale, proportion, and quantity
• Crosscutting Concept 5:
Energy and matter: Flows, cycles, and conservation
• Crosscutting Concept 7:
Stability and change
• Science and Engineering Practice 1:
Asking questions and defining problems
• Science and Engineering Practice 4:
Analyzing and interpreting data
• Science and Engineering Practice 6:
Constructing explanations and designing solutions
• Science and Engineering Practice 7:
Engaging in argument from evidence
• Science and Engineering Practice 8:
Obtaining, evaluating, and communicating information

Preparation

What You'll Need

Required Technology

- Internet Access: Required
- Tech Setup: 1 computer per learner, 1 computer per small group, Interactive whiteboard, Projector

Physical Space

- Classroom
- Computer lab
- Media Center/Library

Grouping

- Heterogeneous grouping
- Homogeneous grouping
- Large-group instruction
- Small-group instruction

Resources Provided: Websites

- Air Quality Index (AQI) Basics

Resources Provided: Handouts & Worksheets

- Answer Key - Measuring Air Quality

Resources Provided: Interactives

- Measuring Air Quality interactive

Resources Provided: Images

- Highland Park Optimist Club banquet
- Forecast of Air Quality, December 10, 2013
- Air Quality on December 10, 2013

Background & Vocabulary

Background Information

Poor air quality can negatively affect human and environmental health. Air quality can suffer due to both natural and anthropogenic (human-caused) events. Anthropogenic emissions can be controlled. Air quality has improved in the United States since the passage of the first Clean Air Act in 1970.

The Clean Air Act set national ambient air quality standards for six common pollutants: particulates, ozone, sulfur dioxide, nitrogen oxides, carbon monoxide, and lead. States were required to develop plans to achieve good air standards and to control emissions drifting across state lines. Pollution control devices were developed for stationary (power plant, factory) and mobile (vehicle) pollution sources. The Clean Air Act has been updated several times since the initial law was passed in 1970.

As a result, air quality in the United States is better today than it has been in the past 50 years. Poor air quality events are still common in many other countries around the world. Global air movements can bring pollutants from other countries to the United States. A system of local air measurement stations provides a real-time look at air quality around the United States. Based on these measurements and on weather forecasts, scientists can provide air quality forecasts. You can see the current and forecast air quality at AirNow.gov. Air quality is defined into six categories: Good, Moderate, Unhealthy for Sensitive Groups (USG), Unhealthy, Very Unhealthy, and Hazardous. (See the Air Quality Index (AQI) chart from the Environmental Protection Agency (EPA) in the resource carousel.)

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
air quality	*noun*	measurement of pollutants and other harmful materials in the air.
atmosphere	*noun*	layers of gases surrounding a planet or other celestial body.
model, computational	*noun*	a mathematical model that requires extensive computational resources to study the behavior of a complex system by computer simulation.
particulate	*adjective, noun*	microscopic solid or liquid particle, often suspended in the atmosphere as pollution.
pollutant	*noun*	chemical or other substance that harms a natural resource.
smog	*noun*	type of air pollution common in manufacturing areas or areas with high traffic.
system	*noun*	collection of items or organisms that are linked and related, functioning as a whole.

For Further Exploration

Websites

- National Geographic Encyclopedic Entry: air pollution
- National Geographic Encyclopedic Entry: smog
- National Geographic Encyclopedic Entry: Volcanic Ash
- National Geographic Environment: Air Pollution

Partner

The Concord Consortium

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