WHAT’S UP IN THE AIR?

INTRODUCTION

Clean air is necessary for the survival and health of human beings and the Earth. Yet in many parts of the world, especially in large cities in less developed countries, the air is far from clean. Created mostly by people, air pollution is considered any substance that humans introduce into the atmosphere that has negative effects on living things and the environment. Air pollution takes many forms but most commonly comes from the burning of fossil fuels such as coal and natural gas, and emissions from factories, cars, agriculture, and power plants. These emissions threaten public health and release greenhouse gases which trap heat in the atmosphere. In the United States, governmental agencies and systems are in place to help keep harmful levels of chemicals and gases out of our air, but this isn’t the case all over the world. As our global population grows, we are likely to increase the amount of fossil fuel emissions. There are things we can do on a personal level, such as driving less and recycling for example, to reduce our impact on the air. However, large-scale changes, such as government limits on emissions of harmful chemicals and gases, are also necessary.

MATERIALS

• Student Worksheets 1 & 2
• Story: “Donora Death Fog” (provided)
• Donora Photo Bank (provided)
• Multiple computers/tablets with internet access

PART 1: THE DONORA DEATH FOG

PROCEDURE

Donora, Pennsylvania was the site of the Donora Death Fog, which killed 20 people in 1948 and was the first major air pollution incident in the United States. The events that took place in Donora helped spur national concern over the state of our air.

CONCEPT

Human activities contribute to air pollution, which has negative impacts on the environment and public health.

OBJECTIVES

Students will be able to:
• Interpret information from photographs.
• Identify cause-and-effect relationships between air pollution and its impacts on human health and the environment.
• Distinguish between ozone and particle pollution and identify specific causes of air pollution.
• Consider solutions to reduce human impact on air quality.

SUBJECTS

Science (Earth and environmental), social studies (geography, history, civics)

SKILLS

Analyzing and interpreting visual sources, researching, listening comprehension, critical thinking

METHOD

Students interpret photos, along with historical accounts and online research, to deduce what human activities contribute to air pollution and suggest possible solutions.
1. Before class, hang a sign at the entry of the classroom that reads, “The year is 1948 and the air quality index of this classroom is rated hazardous.”

2. Start a discussion on air pollution with your students by asking the following questions:
   a. Why is the air so important to us?
      Answer: Air contains oxygen which is essential to life.
   b. What do you think of when you hear the words air quality and air pollution?
   c. What do you think the sign at the entry-way means?
   d. What do you think the air quality index is?
      Answers will vary. But be sure to tell students that the AQI is an index for reporting daily air quality. It tells us how clean or polluted the air is, and what associated health effects might be a concern. The higher the AQI value, the greater the level of air pollution and the greater the health concern.
   e. What do you think the air quality is in the place where you live? How can you tell? Has the air always been this way?

3. Tell your students that they will be going through a set of questions (Student Worksheet 1) using the Think-Pair-Share strategy. Your students will be using three photos from Donora, PA as clues to determine what happened in the town and to ultimately understand the importance of clean air for both people and the environment.

4. Distribute Student Worksheet 1 and ask your students to get into pairs.

5. Display the three photos found in Donora Photo Bank. Do not give your students any other information. Explain to students that using these photos as clues, it is their job to answer the following question: “What happened in the town of Donora, Pennsylvania?” For each photo, students should think to themselves about what they are seeing and then discuss their thoughts in their pairs, using Student Worksheet 1 to help guide their thinking and note their thoughts. Then, with their partner, they should write a one sentence caption for each of the photos.

6. As a class, go over Student Worksheet 1. How did students caption the photos and what do they think happened in Donora? What clues led them to their conclusions?

7. Read the story “Donora Death Fog” aloud to the class. Alternatively, you can have the students round-robin read but in that case, cover, white out, or cut out the questions/answers within the story.

   Note: For more background on the Donora Death Fog – Play NPR’s ‘Smog Deaths In 1948 Led To Clean Air Laws’ (Optional)
Answers to Student Worksheet 1
Possible photo captions. Student answers will vary.
Photo 1 - Donora Zinc Works of the U.S. Steel Corporation is dimly seen through fume-laden smoke and fog.
Photo 2 - Noontime smog on a street in Donora during the Donora Death Smog, 1948.
Photo 3 - Patient resting in an oxygen tent Donora, PA, 1948.

PART 2:
AIR POLLUTION: A GLOBAL PROBLEM

Large cities in less developed countries tend to have higher levels of air pollution than large cities in developed countries. According to the World Health Organization, some of the world's most polluted cities are: Karachi, Pakistan; New Delhi, India; Beijing, China; Lima, Peru; Cairo, Egypt; Los Angeles, California.

PROCEDURE

1. Instruct your students to form their pairs from earlier and find a computer.

2. Distribute Student Worksheet 2 to each pair. If printing in black and white, it may be helpful to project the photos found in Student Worksheet 2 so students are better able to recognize them. Students could also visit the source link to get more information.

3. Students will complete Worksheet 2 by looking at photographs and conducting online research around different sources of air pollution.

4. As students complete their Worksheets, ask some of them to share what they came up with for captions and what they thought the photos were showing. Then go through the Discussion Questions as a class.

Answers to Student Worksheet 2

Photo 1 – Delhi, India
Possible photo caption: Burning garbage piles contribute to air pollution in Delhi.
1. Burning garbage. As our population increases so does the amount of waste produced.
2. Both. Burning trash emits carbon dioxide (ozone pollution) and particulate matter.
3. Carbon dioxide
4. Carbon dioxide is a greenhouse gas and a major driver of climate change. Fine particulate matter, tiny particles 2.5 micrometers in diameter or smaller, can harm human lungs and lead to respiratory issues and in some cases lung cancer.
5. Answers will vary.

Photo 2 – Lima, Peru
Possible photo caption: Commuters in Lima are affected by automobile emissions.
1. Automobiles. Growing population leads to an increased need for transportation. This comes in the form of both personal vehicles and public transportation, both of which burn fossil fuels and contribute to air pollution.
2. Ozone pollution
3. Nitrogen oxides such as nitric oxide or nitrogen dioxide, or volatile organic compounds (VOCs) which are emitted as gases from certain solids or liquids.
4. Ozone can irritate the respiratory system (coughing, throat irritation) and reduce lung function. The more pollution a person breathes, the more permanent damage it can cause.
5. Answers will vary.

Photo 3 – Beijing, China
Possible photo caption: Cooling towers of a coal-fired power plant emit harmful pollution into the air in Beijing.
1. Coal burning. This is a coal-fired power plant. The demand for energy will increase as more people are added to the population and require energy to heat and cool their homes, cook, and keep the lights on.
2. Ozone pollution
3. Same answer as Photo 2.
4. Same answer as Photo 2.
5. Answers will vary.

DISCUSSION QUESTIONS

1. What do all three of these activities have in common?

   They are all creating air pollution and are all human-driven activities.

2. What effect does the growing human population have on air quality?

   As more people are added to the planet their activities, such as driving and heating their homes, contribute to fossil fuel use and the emission of CO2 into the air.

3. Where does our pollution come from?

   Answers may include: exhaust fumes from cars, emissions from factories, agricultural practices, mining operations, fires or burning trash, and other human actions.

4. Does the quality of our air matter? Is clean air important?

   Yes, polluted air can cause serious environmental problems such as ozone depletion, acid rain, and global warming. It can also have negative effects on public health, especially vulnerable populations, such as reducing lung function, aggravating asthma and irritating the respiratory system.

5. What could happen if you breathe polluted air?

   Polluted air can cause itchy eyes, coughing, asthma, and other illnesses. Prolonged exposure can have serious health impacts and even lead to death.

6. How can historic events, such as the Donora Death Smog, help us tackle environmental issues we face today?

   A historical event like the Donora Death Smog tell us how and why things happened in the past. These accounts are valuable to us as we move forward to try and protect and prevent the damage of our natural resources such as air, water, and land.
ASSESSMENT

Review answers to Student Worksheet 2 to assess understanding.

FOLLOW-UP ACTIVITIES

1. Using the information collected on Student Worksheet 2, have your students choose one of the three countries. They will then write a letter to a government official of that country persuading them to take action on air pollution. Students should look into the environmental agency for the country and research what is already being done. Encourage your students to come up with ways the country’s citizens and government can take action on air pollution.

2. Have students write a short journal entry describing how the Donora Death Smog helped pave the way for modern air quality laws in the U.S. Entries should include the following: how the citizens of Donora advocated for their right to clean air, and the outcome in regards to both the industry (what happened to the power plants?) and government policies (were any enacted as a result?).
STORY: DONORA DEATH FOG

In late October, 1948 the town of Donora, Pennsylvania was the site of a lethal air pollution disaster unprecedented in American history. The skies over Donora turned black with pollution and for five straight days the people of Donora endured a thick fog that cloaked the town in a toxic cloud of carbon monoxide, sulfur dioxide, and metal dust pollution.

Donora was home to the U.S. Steel Corporation’s Donora Zinc Works and American Steel and Wire Company, both of which constantly emitted streams of unregulated toxic smoke. The citizens of Donora were accustomed to the clouds of smog that often hung around until late morning.

• What is smog?  
  Answer: Fog or haze combined with smoke and other atmospheric pollutants.

• Can you name any other air pollutants and their sources?  
  Answers may include: carbon dioxide (CO2) from burning fossil fuels such as gas from cars, cigarette smoke, and methane from agricultural processes.

• Are there any local sources of pollution near you?

However, the Donora Death Smog was unlike anything Donora’s citizens had ever seen before. On October 27, 1948 the pollution from both the zinc and steel factories combined with a temperature inversion (a naturally occurring weather event in which air stops circulating and is trapped close to the ground) to create the deadly smog that claimed the lives of 20 people (mostly elderly with respiratory illnesses) and hospitalized over half of the town. After five days the lethal smog began to scatter thanks to the zinc and steel mill temporarily shutting down and to rain showers. In the coming years, this event would set the stage for substantial changes in how we manage our air.

• Who or what was responsible for the deadly smog?  
  Answers may include: people, industry, the zinc and steel mill, the temperature inversion.

Following the deadly episode, Donora residents began to advocate for clean air and demanded that the zinc and steel factories shut down. In fact, the residents of Donora sued American Steel & Wire, and in June 1962 the steel mill closed permanently. This tragic disaster helped persuade members of the scientific and medical communities, as well as the public, that air pollution is a major threat to human health and can result in death. The events that took place in Donora have been credited for the adoption of air quality regulations and modern air pollution laws in the United States.

• Did your predictions match this account? Now that you have this information, do the three photos make more sense?

• Do we have any agencies in the U.S. dedicated to the protection of human health and the environment?  
  Answer: Yes, the Environmental Protection Agency.

• Are there any laws in place to protect our shared resources and environment? Do you know of any environmental laws or governmental agencies that we have in the U.S. to help protect our environment?  
  Answers may include: Clean Air Act, Clean Water Act, and the EPA.
Today, air quality is much better in the United States. After the events in Donora came several important policies such as The Air Pollution Control Act of 1955 which was the first piece of federal legislation involving air pollution. Next came the U.S. Clean Air Act of 1963 which, for the first time, aimed to control air pollution. This was followed by the Air Quality Act of 1967 which enabled the federal government to investigate and enforce interstate air pollution transport, and, for the first time, to carry out far-reaching ambient monitoring studies and stationary source inspections.

- What is meant by interstate air pollution transport?
  Answer: Also referred to as air transport, this is the transport of air pollution across state boundaries.

- What is a stationary source of pollution?
  Answer: A fixed, non-moving emitter of air pollution. For example, factories, power plants, food processing plants, etc.

Then in 1970, the Clean Air Act was established to set regulations to limit emissions from both stationary and mobile sources such as factories and power plants or cars, trucks, and buses. In order to implement the various requirements of all of these acts, the U.S. Environmental Protection Agency (EPA) was established in 1970. These laws helped to drastically improve air quality in the U.S. However, air pollution still exists and not just in the U.S., but all over the world and is a very real threat. The World Health Organization estimates that outdoor air pollution in both cities and rural areas was estimated to cause 3.7 million premature deaths worldwide in 2012.¹

WHAT'S UP IN THE AIR?
STUDENT WORKSHEET 1

Name: ____________________________ Date: __________________

Use the questions below to help you figure out what happened in the town of Donora. Then come up with a one sentence caption for each photo.

1. What is happening in these photos?

2. What do you see that makes you say that?

3. What more can you tell from these photos?

4. What/who do you think caused what is happening in these photos?

5. Are there any indications in each photo that something good or bad is happening? If so, is it good or bad for humans? The environment? Why?

Photo 1 Caption:

________________________________________________________________________

________________________________________________________________________

Photo 2 Caption:

________________________________________________________________________

________________________________________________________________________

Photo 3 Caption:

________________________________________________________________________

________________________________________________________________________
WHAT’S UP IN THE AIR?
STUDENT WORKSHEET 2

Name: __________________________________________ Date: ______________________

For each photo, come up with a descriptive caption and answer the questions that follow. To answer the questions, go to: www.AirNow.gov and scroll down to the bottom of the homepage. You'll find the Health, Ozone, and Particle Pollution links helpful.

Photo 1: Delhi, India

Caption:

1. Identify the activity that is causing air pollution in this photo. How is this activity influenced by population growth? ________________________________

2. Is this an example of particle pollution, ozone pollution, or both? ____________________________

3. Name at least one harmful chemical or gas that is released into the air through this activity. _________ ________________________________

4. What impacts does this form of pollution (from question #3) have on human health and the environment? ________________________________

5. What can the people and government of India do to prevent this form of pollution? ________________
WHAT'S UP IN THE AIR?
STUDENT WORKSHEET 2 - PAGE 2

Photo 2: Lima, Peru

Caption:

1. Identify the activity that is causing air pollution in this photo. How is this activity influenced by population growth?

2. Is this an example of particle pollution, ozone pollution, or both?

3. Name at least one harmful chemical or gas that is released into the air through this activity.

4. What impacts does this form of pollution (from question #3) have on human health and the environment?

5. What can the people and government of Peru do to prevent this form of pollution?
1. Identify the activity that is causing air pollution in this photo. How is this activity influenced by population growth? ____________________________________________

2. Is this an example of particle pollution, ozone pollution, or both? ____________________________________________

3. Name at least one harmful chemical or gas that is released into the air through this activity. ____________

4. What impacts does this form of pollution (from question #3) have on human health and the environment? ____________________________________________

5. What can the people and government of China do to prevent this form of pollution? ________________________
WHAT'S UP IN THE AIR?
DONORA PHOTO BANK

Photo 1:

Photo 2:

Photo 3: