

## **Environmental Justice: Investigating What We Breathe, and Where We Breathe It**

Lesson plan for grades: 9-12

Length of lesson: 60 minutes

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### **SOURCES AND RESOURCES:**

- *Hot Science: Cool Talks* - Environmental Justice: Progress Towards Sustainability by Dr. Robert Bullard  
<http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/environmental-justice-progress-towards-sustainability>
- Six Common Air-Pollutants  
<http://www.epa.gov/air/urbanair/>
- Zip Code Mapping Website  
<http://maps.huge.info/zip.htm>
- Asthma and Air-Pollution  
<http://www.arb.ca.gov/research/asthma/asthma.htm>
- Environmental Justice  
[http://en.wikipedia.org/wiki/Environmental\\_justice](http://en.wikipedia.org/wiki/Environmental_justice)
- Asthma Animation  
<http://www.youtube.com/watch?v=JHLajTxFPU>
- Centers of Disease Control and Prevention  
<http://www.cdc.gov/nchs/fastats/asthma.htm>

### **POTENTIAL CONCEPTS TEKS ADDRESSED THROUGH THIS LESSON:**

§112.34. Biology, Grade 9-12: 12F

§112.35. Chemistry, Grade 9-12: 3E

§112.37. Environmental Systems, Grade 9-12: 3C

§112.37. Environmental Systems, Grade 9-12: 9A, 9B, 9I

### **PERFORMANCE OBJECTIVES:**

Students will be able to:

- Recognize the 6 major categories of air pollutants
- Understand how urban development and industrial expansion play a significant role in environmental conditions

- Explore associations with factors like income level pollution levels, and incidents of asthma.

#### **MATERIALS:**

- The Air We Breathe PowerPoint Slide Show: this slide show is used as a visual guide for the students throughout the lesson lectures and discussions. ATTACHED AT THE END OF THIS FILE
- The Air We Breathe Worksheet (one per student): This worksheet will be used to guide the students through the exploration, elaboration, and the evaluation portions of the lesson. It is segmented into parts 1-3 which correspond to each of the above sections. ATTACHED AT THE END OF THIS FILE
- Computer Stations with Internet Access to:
  - U.S. EPA Air Quality Data Plotter: [http://www.epa.gov/airdata/ad\\_viz\\_plotaqi.html](http://www.epa.gov/airdata/ad_viz_plotaqi.html)
  - U.S. City Rankings for Air Pollution: <http://www.stateoftheair.org/2013/city-rankings/>
  - Per Capita Income Plots for U.S. Cities: <http://www.economagic.com/beaci.htm>
- Particle Size Chart: <http://commons.wikimedia.org/wiki/File:Airborne-particulate-size-chart.jpg>

#### **CONCEPTS:**

**Urban Sprawl:** The uncontrollable growth of population in urban settings. This dilemma is what often leads to increases in population density that can eventually be followed by poverty and resource strain.

**Genetic Predisposition:** The genetic factors that account for the likelihood of a change occurring in an organism. This means that an individual's genetic background can make them susceptible to various diseases and mutations.

**Environmental Justice:** The first and more common usage describes a social movement in the United States whose focus is on the fair distribution of environmental benefits and burdens. Second, it is an interdisciplinary body of social science literature that includes (but is not limited to) theories of the environment, theories of justice, environmental law and governance, environmental policy and planning, development, sustainability, and political ecology. (Source: Wikipedia.com)

**Organic:** Compounds or substances that contain carbon, oxygen, hydrogen, phosphorus, or other halogen molecules are chemically classified as organic. Organic matter often refers to the fact that they are or once originated from a living thing.

#### **BACKGROUND:**

Environmental Justice is a social movement and body of social science that originated during the 1980's when people organized social movements in the United States to challenge industries and governing officials to provide fair and equal access to a safe and healthy environment for all its citizens. As cities continued their

rapid growth, waste management companies, industrial organizations, energy providers and city officials were left with the task of determining where to locate facilities that generated pollution. Officials decided to locate them in places that disproportionately affected poor people and racial minorities. The Environmental Justice movement (see Concepts section) occurred as a reaction to this form of “Environmental Racism.”

Air contamination is form of pollution in that can rapidly spread from one particular location to another. The immediate effects of air pollution from stationary sources (such as industrial sites) are noticed by people living in the immediate area; however winds can carry the pollution miles away to nearby towns and cities. When considering all of the sources of air pollution, it is ultimately everyone’s problem; it is produced from a car that drives by or from the large coal refinery 40 miles away (see minute mark 39:51 of Robert Bullard’s Hot Science Cool Talks lecture; linked in Sources and Resources section).

In order to understand how harmful air pollution can be, it is vital to first learn about the various types of pollutants that can be emitted. Some types of air contaminants are more harmful to the health of humans than others. That is why people who are exposed to air pollution in the immediate vicinity of an energy plant or factory are more likely to be diagnosed with a respiratory complication such as asthma or bronchitis (Source?) than people who live far away from industrial sites. As the population of the United States grows, so do the incidents of asthma and bronchitis in both children and adults. Population growth can only be sustained through a steady increase in industrial manufacturing and energy (power) supply. This often leads to reckless and unchecked pollution in order to meet the rapidly growing needs of the population.

### **PREPARATION:**

- Use “The Air We Breathe” slide show (see Materials section) as visual aid throughout the lesson. Go to each slide that corresponds to the (slide #) that are placed throughout the lesson plan.
- Use the webcast time markers (example: “minute reference XX:XX”) placed throughout the lesson plan to view relevant portions of Dr. Bullard’s lecture (see Sources and Resources section)
- Have worksheets (see Materials section) printed and ready so that each student has one.

### **ENGAGE:**

Teacher Says: One of the most overlooked aspects of our environment is the very air that we breathe.

Teacher (action): *Takes a white napkin or towel and rubs it across some dusty surface in the classroom for the entire class to see. The teacher then presents the cloth to the class to show how much dark filth has been cleaned up on a common surface in that very classroom.*

Teacher Says: What does everyone see on this napkin? What kinds of things do you think are on here that are also floating around in the air?

Possible student responses:

- I think there are germs and bacteria in the air and on that napkin.
- There should be lots of dust from dirt and debris that gets kicked up into the air.

Teacher Asks: Interesting responses. What do you think are the potential sources of the particles that are on this napkin?

Possible Student responses:

- Pollution from automobiles
- Germs from people
- Dirt from the ground that has become airborne

Teacher Says: Those are all great responses. There are actually thousands of different things in the air around us (slide 2). These include a wide variety of different bacteria, viruses, debris (dirt, ash, etc.), and ultimately chemicals (slide 3); many of these we cannot even see with the naked eye. Our focus today is going to be on the chemicals that float around in our air that are not there by natural means. Natural disasters and drastic global phenomenon such as volcanic eruptions and asteroid strikes can dramatically affect air quality, however today we shall talk about how industrial activities and their associated facilities have a direct impact on air quality (slide 4).

Before the 1800's, when the United States and other European countries were hitting the peak of the Industrial Revolution, air quality was not a topic of controversy and discussion. There had been no reason to worry because levels of urbanization and industrial expansion were too low to cause noticeable changes in air quality. However, from the 1840's to the 1870's, around the American Northeastern industrial belt, clear skies became shrouded by thick industrial smog (slide 5). Soon, nearly every surface was covered by dark soot and the respiratory health of the adjacent populations was observed to decline.

These problems are still prevalent in the US today, however they exist in a more complicated and potentially more hazardous manner. To better understand what pollutants industrial activities are putting into the air, one must learn about the 6 major categories of air pollutants.

**EXPLORE:**

Teacher Says: (slide 6) The 6 major categories of air pollutants are:

- [Particulate Matter](#)
- [Carbon Monoxide](#)
- [Nitrogen Oxides](#)
- [Sulfur Dioxide](#)
- [Lead](#)
- [Ozone](#)

We will briefly go through each and discuss what types of chemicals the categories include as well as where they specifically come from. (Teacher can use “Particle Size Chart” in Materials section to help show the relative sizes of the pollutants when compared to each other)

-(slide 7) Particulate matter is a complicated mixture of extremely small particles and liquid droplets. This form of pollution often consists of **organic** chemicals, various metals, soil and dust particles, as well as certain acids. The EPA has officially acknowledged that particulate pollution is a cause for serious health concern. Particles that range from 2.5 micrometers to 10 micrometers are categorized by the EPA to “inhalable coarse particles” and can be found near roadways and dusty industries. Particles that are smaller than 2.5 micrometers in diameter are referred to as “fine particles” and most commonly come from forest fires or the gases emitted from automobiles, power plants, and industries. Both of these are extremely hazardous to human health as they can travel easily through the mouth or nose and cause serious damage to the heart and lungs.

-(slide 8) Carbon monoxide, recognized by its empirical formula CO, is a dangerous gas that most commonly is byproduct of combustion reactions in automobile engines and industries/plants. Though colorless and odorless, it can cause death if an individual is exposed to enough of it. The EPA regulates carbon monoxide emission be using the measurement 'parts per million' (ppm) to determine CO content in the air.

Fact: It is dangerous to sit in most cars with the engine running for long periods of time due to the buildup of carbon monoxide. Initial symptoms of poisoning include drowsiness and it can eventually be fatal.

-(slide 9) Nitrogen Oxides, such as Nitrogen Dioxide (NO<sub>2</sub>), are very reactive (reactive meaning that these molecules interact very readily and rapidly combine with other molecules) gases that are under the EPA's strict regulatory guidelines. Most of these gases reside in the emissions of automobiles, powerplants, and most off-road equipment. Studies have shown that the inhalation of these chemical compounds can have serious effects on the respiratory system of a healthy individual such as the deterioration of sensitive pulmonary (lung) tissues. These compounds have also shown to have particularly negative impacts on people who already have asthma and other respiratory conditions.

-(slide 10) Sulfur Oxides, such as Sulfur Dioxide (SO<sub>2</sub>), are highly reactive gases that have detrimental effects on the respiratory health of humans. Approximately 70% of these compounds come from the combustion of

fossil fuels at power plants while 20% comes from by-products of industrial work. Perhaps the most dangerous aspect of the compound is how easily it can enter the respiratory tract of individuals. There have been many reported cases of people having been exposed to the gas for short periods of time (sometimes days and even hours) and have to be hospitalized or have developed/worsened bronchitis and asthma. The EPA also has set guidelines on the emission of these gases. These guidelines include having the building, factory, or company monitor and record their emissions over time, keeping their emissions under a set and predetermined standard, and abiding to necessary and agreed changes that the EPA requests.

-(slide 11) Lead, commonly recognized by its empirical formula Pb, is a metal that exists naturally in the environment as well as in industrial products. The largest source of lead emissions/pollution was caused by automobile exhaust during the mid-1900's. Thankfully, due to the EPA's strict regulation of lead based gasoline, lead pollution decreased by 95% in the span of a decade. That is why gas stations put the term "unleaded" on all of their signs to signify that lead particles are not present in the fuel.

-(slide 12) Ozone is the 6<sup>th</sup> category of major air pollutants and is currently under great dispute. Ozone consists of carbon based molecules that change in structure. The interesting fact about this compound is that for every molecule of ozone that drifts up into the atmosphere, several atmospheric molecules can be mechanistically altered and neutralized. In other words, a single molecule of ozone can do lots of damage to the protective layers of the atmosphere by altering the structure and function of other gases there. However, the direct health effects of ozone are inconclusive and under further research.

Teacher Says: Based on these 6 categories, each of you is to use your Air-Pollution worksheet (see Materials) to complete section 1 contained within. Follow the written instructions and stop once the first section is completed. If you have any questions, raise your hand and I will come and assist you.

**EXPLAIN :**

Teacher says: What were some of the things you guys noticed in terms of the origin of many of these pollutants?

Industry and power plants play a significant role in emitting a majority of these air based pollutants. As discussed earlier, many of these chemicals don't naturally occur or don't naturally exist in the massive quantities that we can measure today. What are some reasons why air pollution is becoming such a large concern and why it seems to be fluctuating throughout the years?

Possible Student Responses:

- Industries are using a larger variety of chemicals than before, which is why we are dealing with more types of air-pollutants than a century ago.
- Population growth in the United States has risen dramatically compared to several decades ago. This means that there is a greater need for industry, urbanization, and power plants to accommodate for this growth
- As there is an increase in industrial and power plant pollution, there are more regulations to constrain it. That's why it fluctuates.

Teacher Says: Excellent responses! Urbanization and population growth definitely are pivotal when trying to explain the emissions patterns over the last century (slide 13). As the population grows, there is a greater need for space, material, power, and fossil fuels to meet the needs of the families and individuals. Logically, emissions have a positive correlation with urban growth. Let us now talk a little about the political aspects behind industrial growth and **urban sprawl**.

When urban growth occurs at high enough rates, city planning may be insufficient to accommodate for the basic needs of certain regions. Thus, industries and power plants can occasionally be found in "inconvenient" locations (slide 14). It is important to note that from the industry's perspective, cost often outweighs moral decisions. This means that city planners, civil engineers, and industrial managers often choose the cheapest locations to establish as well as locations in which local citizens will have the most difficult time protesting establishment. More often than not, factories and power plants have negative effects on their local environments that outrage local residents (minute mark 12:01 of Robert Bullard's Hot Science Cool Talks lecture; linked in Sources and Resources section).

The impacts of an industrial setting are tremendous. Not only are the buildings an eye sore for the community, but there are also many health risks associated with their existence. To better understand this, let's explore some of the health complications that come about from the emitted air pollutants.

The last question of part 1 in the worksheet asked you to talk about source of air pollution in your local area. Did anyone have any answers for this part? Let's discuss them by talking about what those sources are and how they affect us directly. (**This section can be improvised and adjusted by the teacher to conduct a more applicable discussion**)

**ELABORATE:**

Teacher Says: Can anyone think of some common respiratory problems that might be influenced by some of the air contaminants that we discussed above? Asthma and bronchitis are probably the most common. How many of you have or still suffer from any of those conditions? In fact, 18.9 million adults and 7.1 million

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## **The Air We Breathe Worksheet**

**Part 1:** Proceed to this website: [http://www.epa.gov/airdata/ad\\_viz\\_plotaqi.html](http://www.epa.gov/airdata/ad_viz_plotaqi.html) and first select two different types of pollutants from the list provided. The only two on that list that you may be unfamiliar with are PM10 and PN2.5, both which are another way of describing specific categories of particulate matter. Next, select your own city or region from the list and the current year. Finally, hit the “plot” button to retrieve a data trend for the pollution emissions over that year in your local area.

Describe the graph that was obtained. In what categories did the emissions fall under during the year (good, moderate, unhealthy, etc...) During what months did the emissions seem to increase or decrease? Why do you suppose that was?

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Now, using the same settings from your last plot, change the location to one of the following cities. The following cities are ranked as some of the most polluted in the nation (source: <http://www.stateoftheair.org/2013/city-rankings/>) and will serve as a good way to compare your local area.

Bakersfield, CA; Louisville, KY; Pittsburgh, PA; Los Angeles, CA; Cincinnati, OH ; Birmingham, AL.

Compare and contrast these two plots. What condition is your city's air quality when compared to one of these polluted states?

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Now proceed to the following website: <http://www.economagic.com/beaci.htm> Look up and compare the PCPI (Per Capita Personal Income) of the two cities/regions you looked at in the previous exercise. How are they different or similar? Do you believe there is any relationship between air quality and the average personal income level (measured by PCPI) of a region? If so, describe what you think that association might be.

**NOTE TO STUDENTS AND TEACHERS:** Be very careful about making statements as to whether personal income *directly* affects air quality, or vice-versa. This lesson is NOT intended to imply that one factor causes the other.

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Answer the following questions below:

- 1) Pick one of the air pollution identified from your city air pollution analysis above. Research and describe the health effects of having been exposed to or inhaled it for long periods of time.

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- 2) One of the best determining factors of an individual's future health can be their Zip-code. Are there any major sources of air pollution in your home's zip code, or the zip codes that border yours? **Use this website to map your zip code and inventory potential sources of pollution: <http://maps.huge.info/zip.htm>**

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List and describe potential pollution sources that you can recall based on your zip code boundaries. Have the effects of the pollution been reported in the news?

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**Part 2:** Using your knowledge about the particles from the above activity, make some assumptions about why some pollutants are more hazardous to health than others. Answer the following questions:

- 1) Particulate matter was explained to be from 1 to 10 micrometers in diameter. How do you think the size of these pollutants plays a role in how they cause respiratory complications for humans?

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- 2) Look at the following diagram:



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Describe to the best of your ability the differences between the three scenarios. What would be some of the conditions for each of them to occur?

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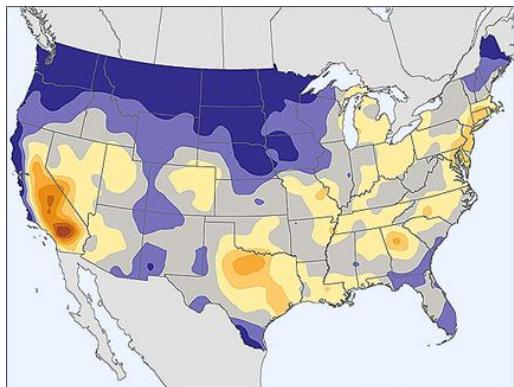
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**Part 3:** The first image below shows where the most air pollution exists in the United States, the more tan or red the color, the more air pollution exists. The second image on the next page shows the locations of major categories of industrial activity.



< 64	75 - 80	90 - 95	> 110
65 - 70	80 - 85	95 - 100	
70 - 75	85 - 90	100 - 110	

What is characteristic of the most polluted regions in the U.S.? What is the industrial nature in the vicinity of these pollution “hot spots”?

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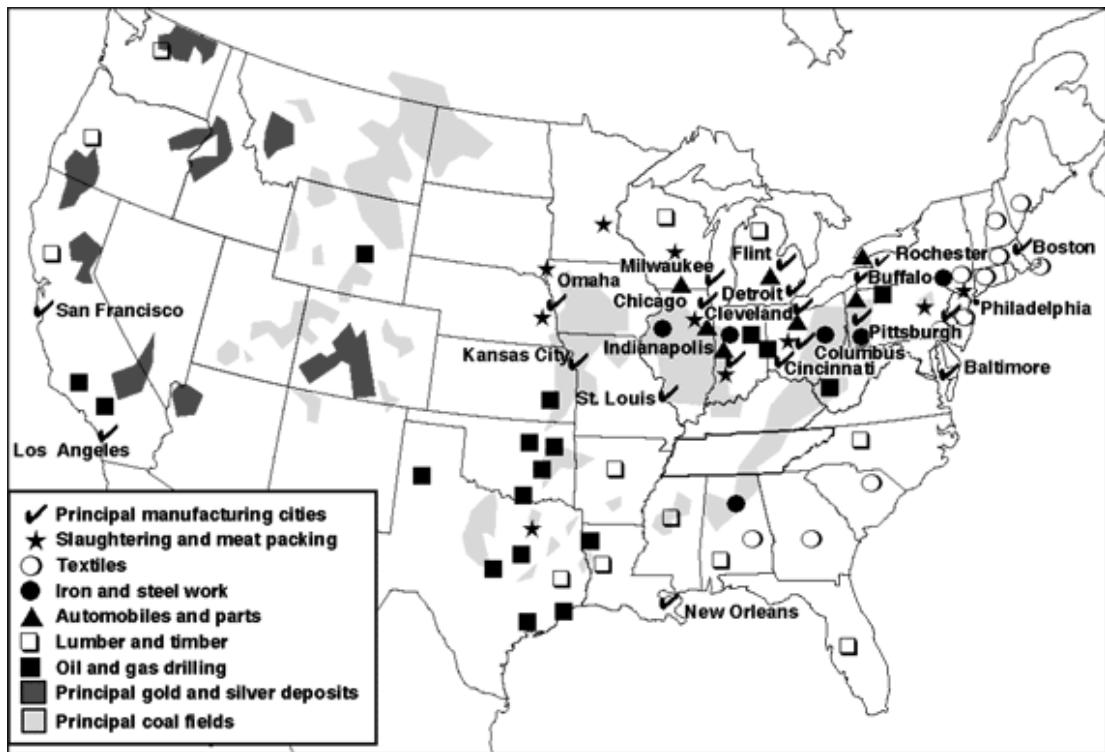
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