GEO STAC Teaching Guide

Lesson Developer: Jim Tyser, Springfield High School
Subject Area: Chemistry
Grade Level: Senior High (grades 11, 12)
Lesson Description:

- Acid precipitation will be defined. At different points in the lesson students will write balanced reactions for the formation acid precipitation from atmospheric sulfur and nitrogen oxides and the neutralization of acids by limestone.
- Students will determine which states are most at risk from acid precipitation and assess how that risk has changed from 1996 to 2006.
- Sources of atmospheric sulfur (burning of high-sulfur coal) and nitrogen oxides (automobile exhaust) will be listed.
- The buffering effect of limestone soils and its mitigating effect on acid precipitation will be discussed.
- Students will correlate these areas with sulfur and nitrogen oxide production, population, composition of coal fields, and soil composition.

This lesson makes liberal use of the ideas presented in "Exploring Acid Precipitation" GIS activity created by Gary Mort and Lynn Songer.

Recommended Time to Teach: (50 minutes—additional time outside of class as needed)

Education Standards:

Common Core Standard English Language Arts Standards: English language Arts Standards ».History / Social Studies » Grade 12

CCSS.ELA-Literacy.RH.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem**.**

Common Core Standard English Language Arts Standards: English Language Arts Standards » Science & Technical Subjects » Grade 11-12

CCSS.ELA-Literacy.RST.11-12.3: Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

ITSE National Technology:
3. Research and Information Fluency
a. Plan strategies to guide inquiry
b..Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media

c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks

d. Process data and report results

4. Critical Thinking, Problem Solving, and Decision Making

c. Collect and analyze data to identify solutions and/or make informed decisions

5. Digital Citizenship

b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity

6. Technology Operations and Concepts

a. Understand and use technology systems

b. Select and use applications effectively and productively

National Geography Standards

1) How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information

2) How to analyze the spatial organization of people, places, and environments on Earth's surface

3) How to apply geography to interpret the present and plan for the future

Learning Objectives:

Geospatial Concepts:

Aura – Students will identify the effect that prevailing winds, the presence of coal deposits, the location of population centers, and existence of limestone soils will likely have on the environmental effects of acid precipitation.

Diffusion – Students will observe how the presence of acid precipitation diffuses from west to east across the U.S.

Pattern –Students will identify "clusters" where acid precipitation seems to be particularly problematic.

Other Discipline:

Geology – The geology of land forms can affect the generation of acid precipitation (from the combustion of sulfurous coal), patterns of precipitation, and the buffering capacity of soils and surface waters to mitigate the effects of acid precipitation..

Meteorology - Weather processes directly influence acid precipitation, influencing the amount and patterns of precipitation.

Career Connection:

Environmental chemists create and study maps of the data acquired to develop remediation programs and advocate for changes in current practice. They also assist policy development, design and coordinate research, facilitate information sharing among agencies, and create computer models to predict future trends.

Web-based GIS Tools:

    Zoom In – This tool will be used to closely examine "hot spots" for acid precipitation.

    Identify - Students will identify names of cities and details about coal fields using this tool.

Learning Objectives:

Students will be able to:

- Define acid precipitation.[1]

- Given a nonmetallic oxide atmospheric gas, complete and balance the reaction with water vapor to form an acid.[1]

- Use GIS technology to describe the diffusion of acid precipitation across the U.S.[2,3,4]

- Use GIS technology to indicate any patterns of acid precipitation deposition.[2,3,4]

- Use GIS technology to associate acid precipitation with population centers the presence of coal fields.[2,3,4]

- Place regions in a "risk hierarchy" using the mitigating presence of limestone soils to that neutralize acid precipitation.[2,3,4]

- Given an acid, complete and balance the reaction with limestone ($CaCO_3$) to neutralize the acid.[1]

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[1]Objective relating to science instruction.　　　　[2]Objective relating to social studies instruction

\　[3]Objective relating to technology instruction.　　　　[4]Objective addressing geospatial concepts.

During the GIS lesson, students will identify the way acid precipitation diffuses across the United States. Students will then identify regions where acid rain could cause environmental damage. The existence of these regions will be examined to see if they are associated with population centers (NO_x production) and/or the existence of coal fields (SO_2 production). Students will determine if regions of increased acid precipitation could have environmental effects offset by the presence of limestone soils.
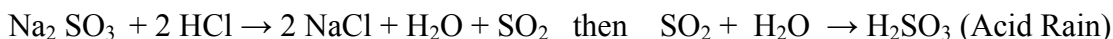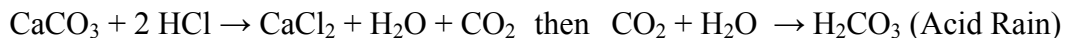
Materials: Acid Precipitation Background Reading, Acid Precipitation Lesson, Answer Sheets, Pen/Pencil, Rulers.

Prerequisites: What must students know before they begin this lesson? How does the lesson fit into the course?

Beginning the Lesson

Acid Rain Lab / Demonstration – Students generate acid rain in the following reactions. Reactions occur in a plastic bag, so as to avoid Nasty Smells!

$$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2O + CO_2 \ \ \text{then} \ \ CO_2 + H_2O \ \rightarrow H_2CO_3 \ (\text{Acid Rain})$$
$$Na_2\ SO_3\ + 2\ HCl \rightarrow 2\ NaCl + H_2O + SO_2 \ \ \text{then} \ \ \ SO_2 +\ H_2O \ \rightarrow H_2SO_3 \ (\text{Acid Rain})$$

Developing the Lesson

Students will perform the following before performing the GIS activity:

1. Complete the background reading on Acid Precipitation Theory, Sources of Acid Precipitation, and Buffering of Acid Precipitation.

2. Perform the Acid Rain Lab / Demonstration

3. Complete the mini lesson acid precipitation to introduce them to the module and the GIS tools.

Concluding the Lesson

Career Connections:

As a post-lab activity, a video will be shown that will make career connections explicit. The video shows biologists monitoring forests and plants affected by acid precipitation. University research groups studying methods for mitigating the effects of decreased pH of surface waters are featured. Engineering solutions in power generation plants and automobile exhaust that decrease the amounts gases causing acid rain are illustrated.

Assessment/Evaluation:

Assessment will occur for learning will occur in a variety of ways:

*   reading / discussion / lab (demonstration) questions before the GIS activity

*   successful completion of GIS tutorial activity

*   evaluation of GIS Acid Precipitation Activity (See scoring guide.)

*   unit test questions

Scoring Guide:

Acid Precipitation GIS Activity	Answers to Questions • Complete? (+1) • Correct? (+1) • Shows a Deep Level of Understanding? (+1)	Reactions • Correct Reactants / Products (+1) • Reactions Balanced (+1)	Quality of Graphs • Correct Graphing Technique? (+2) • Relationships Between Variables Correct? (+2)
Overview			N/A
Acid Precipitation, Population, and Car Exhaust			(2 graphs in this section)
Acid Precipitation and High-Sulfur Coal			
Acid Precipitation and Lime Stone Deposits			N/A

Total Points (26 Possible) = _____