



PROBLEM SOLVING ACTIVITY: HOW DO EARTH'S SPHERES INTERACT?



A **system** is a collection of interdependent parts enclosed within a defined boundary. Within the boundary of the Earth is a collection of four interdependent parts called "**spheres**": the lithosphere, hydrosphere, biosphere, and atmosphere. The spheres are so closely connected that a change in

one sphere often results in a change in one or more of the other spheres. Such changes that take place within an ecosystem are referred to as **events**.

Events can occur naturally, such as an earthquake or a hurricane, or they can be caused by humans, such as an oil spill or air pollution. An event can **cause changes** to occur in one or more of the spheres, and/or an event can be the **effect** of changes in one or more of Earth's four spheres. This two-way cause and effect relationship between an event and a sphere is called an **interaction**. Interactions also occur among the spheres. For example, a change in the atmosphere can cause a change in the hydrosphere, and vice versa. Below are a few examples:

- Humans (biosphere) built a dam out of rock materials (lithosphere).
- Water in the lake (hydrosphere) seeps into the cliff walls behind the dam, becoming groundwater (lithosphere), or evaporating into the air (atmosphere).
- Humans (biosphere) harness energy from the water (hydrosphere) by having it spin turbines (lithosphere) to produce electricity.

Understanding the interactions that occur in the Earth System also helps people to prepare for the effects of natural disasters such as volcanic eruptions, tsunamis, and severe storms. This understanding allows people to predict things like how far and in what direction the lava will flow or the storm surge will rise and help them to evaluate their options throughout the time period of the event.

Teacher Sheet 2

OBJECTIVE: Students will:

- ✓ Understand the concept of a "system" as it applies to Earth;
- ✓ Identify the 4 spheres of the Earth system;
- ✓ Identify and analyze how matter and energy change and cycle through the system as the spheres interact and
- ✓ Analyze an event and present their findings to the class.

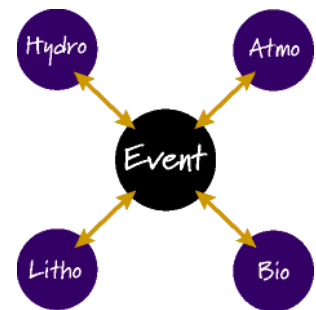
MATERIALS:

- ✓ Example image of Earth system
- ✓ List of cause and effect relationships
- ✓ Computer or research materials access
- ✓ Copies of images from Yellowstone Fire of 1988

PROCEDURE:

1. After discussing the information in the introduction section, give students an opportunity to put the process to work by analyzing a sample event. Images can be handed out or projected for the class.
2. Each pair/small group will select/be assigned/select an **EVENT** to evaluate from the list provided.
 - Students should work together will research the **EVENT** and decide how it may cause a change to each of the spheres (hydrosphere, lithosphere, atmosphere, biosphere) and how those spheres may impact the event.

Event < > lithosphere
Event < > hydrosphere
Event < > biosphere
Event < > atmosphere



3. Students will make a connection model like this one to show and **EXPLAIN** their ideas.

- ✓ Remind them that: The double-headed arrows (< >) indicate that the cause and effect relationships of these interactions go in both directions. For example, "event hydrosphere" refers to the effects of the event on the hydrosphere, and the effects of the hydrosphere on the event

Teacher Sheet 3

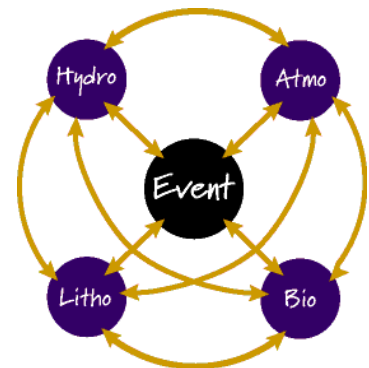
- ✓ Students should refer to the **GUIDE QUESTIONS** to help them evaluate the cause and effect relationships relating to their topic.

4. Next students evaluate and discuss the information they have acquired and write down how your events will connect the spheres to each other.

- ✓ lithosphere < > hydrosphere
- ✓ lithosphere < > biosphere
- ✓ lithosphere < > atmosphere
- ✓ hydrosphere < > biosphere
- ✓ hydrosphere < > atmosphere
- ✓ biosphere < > atmosphere

4. Remind students again that the double-headed arrows (< >) indicate that the cause and effect relationships of the interactions go in both directions. For example, "lithosphere hydrosphere" refers to the effects of the lithosphere on the hydrosphere, as well as the effects of the hydrosphere on the lithosphere.

5. Students will then complete their evaluations with a diagram like the one on the right with **EXPLANATIONS** for the connections.



6. Each group will then prepare a presentation for the class explaining their event and the effects on the Earth system.

GUIDE QUESTIONS FOR CAUSE AND EFFECT

1. How may each of the Earth's four spheres (hydrosphere, atmosphere, lithosphere, and biosphere) have caused the event to occur?

(These are sphere vs. event impacts.)

2. What are the effects of the event on each of the Earth's four spheres (hydrosphere, atmosphere, lithosphere, and biosphere)?

(These are the event vs. sphere impacts.)

3. What are the effects of changes in one of Earth's four spheres (hydrosphere, atmosphere, lithosphere, or biosphere) on each of the other spheres (hydrosphere, atmosphere, lithosphere, or biosphere)?

(These are the sphere-to-sphere interactions.)

NOTE: This approach of answering the questions above is performed during every analysis; simply replace the term "event" with the event you wish to investigate.

EARTH SYSTEM INTERACTION EXAMPLE



POSSIBLE EVENTS FOR ANALYSIS

1. European green crab invasion
2. BP oil spill
3. Iceland volcano
4. Mars biosphere
5. Photosynthesis/respiration
6. Pine beetle infestation
7. Acid rain
8. Amazon deforestation
9. Wildfires
10. Coal mining
11. Drought
12. Flooding
13. Ozone depletion
14. Phytoplankton bloom
15. Salt water intrusion
16. Sulfur dioxide
17. Sunspots
18. Thermal islands
19. Tsunami
20. Hurricanes
21. Wind farm development
22. Yellowstone fires
23. Yucatan meteor impact
24. El Nino/La Nina
25. Mt. St Helens eruption
26. CFCs
27. Yellowstone super-volcano eruption