



Earth Science Education Activity

How Wildfires Change Soil and Water Movement

Background: Soil plays a critical role in controlling how water moves through the environment. Wildfires can change soil in two key ways: they remove vegetation that normally helps absorb water, and they can create hydrophobic (water-repelling) soil that limits infiltration. During a fire, organic material in and on the soil is heated, causing it to vaporize and move downward. As it cools, it forms a thin, waxy coating on soil particles. This coating repels water, preventing it from soaking into the ground and instead causing it to move across the surface as runoff. These changes can increase erosion and make landscapes more susceptible to flooding and mudslides after rainfall.

Key Question: How do soil properties affect how water moves, and how can these interactions lead to hazards?

STANDARDS

NGSS: MS-ESS2-2, MS-ESS3-2

SDG 11: Sustainable cities and communities

SDG 13: Climate action

SDG 15: Life on land

Learn more about the United Nation's Sustainable Development Goals (SDGs) and [explore resources for educators from UNESCO](#).

MATERIALS

- ◆ tray that is big enough to hold a clipboard
- ◆ pipette or dropper
- ◆ magnifying glass
- ◆ collection of 3–5 hydrophobic items (wax paper, parafilm, vinyl fabric and/or other waterproof fabric)
- ◆ collection of 3–5 hydrophilic items (cotton ball, sponge, paper towel, gauze, cotton fabric)
- ◆ foam sheet ([Primary Foam Sheets](#))
- ◆ strip of terrycloth towel
- ◆ clipboard
- ◆ blocks (to prop up clipboard in the tray)
- ◆ dry soil
- ◆ spray bottle



After a wildfire, soil develops a hydrophobic layer which causes water droplets to “ball up” on top of the soil.

Credit: USFS, Wildland Fire in Ecosystems,
Photo by DeBano, 1981

PROCEDURE

1. Create a data table with three columns to record the names of the provided materials on your tray, initial observations, and interactions with water.
2. Observe the materials provided on your tray, first by looking, then using a magnifying glass. Record initial observations in the data table.
3. Using a pipette or dropper, place a few drops of water on each material. Record what happens to the water:
 - ▶ Does the water move into the material, or does it form beads on the surface?
 - ▶ Does the droplet spread out or stay rounded?
 - ▶ Does the water move or stay in place?
4. Sort the materials into two or three groups based on how they interact with water.
5. Watch this video (www.youtube.com/watch?v=JbaScpYu8Vs) up until 1:21.
 - a. Discuss the terms introduced in the video with your group.
 - b. Revisit your material groupings. How do your groupings compare with the concepts described on the video?
 - c. Organize the items based on what you learned in the video and label the groups using the new vocabulary.
6. Consider why it might be important to know how materials interact with water in the natural world.
7. Set up a model to examine how soil and water move on different surfaces:
 - a. Secure a piece of terrycloth towel or gauze to a clipboard using the clip.
 - b. Place blocks on one end of a tray or prop up on the side. Set the end of the clipboard with the clip on the blocks to prop it up on the blocks, then lower the other end of the clipboard into the tray.
 - c. Sprinkle a thin layer of soil on top of the terrycloth until it is mostly covered. This is a model hillside.
 - d. Predict what you think will happen if you were to spray water over the model to simulate rain on the model hillside.
 - e. Use a spray bottle to simulate rainfall over the soil by spraying the soil 10 times. Record observations of the soil every 10 sprays. Repeat until the soil is very wet.
 - f. Remove the cloth with the soil from the clipboard and wipe it off.
 - g. Make another hillside model by repeating steps a–e using a foam sheet instead of terrycloth.



Model setup with a terrycloth towel (left) and with soil added (right).

Credit: L. Brase, AGI

ANALYSIS

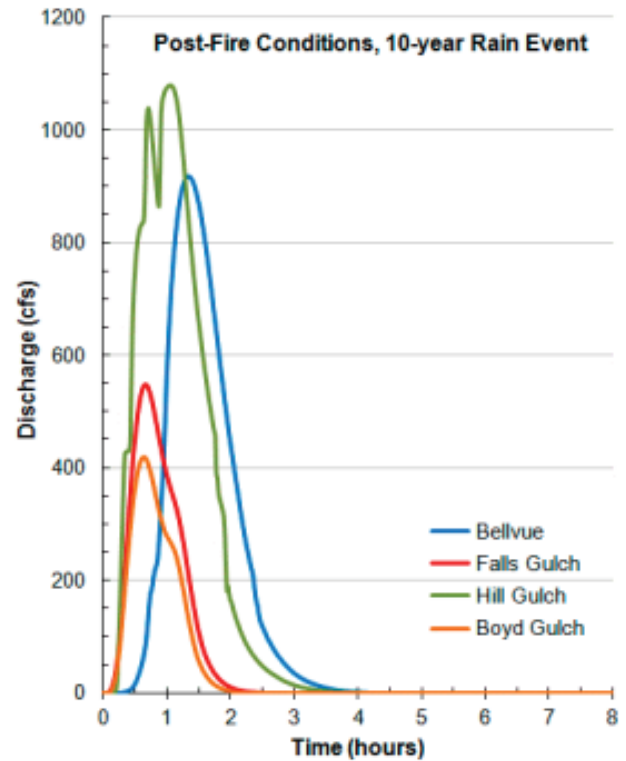
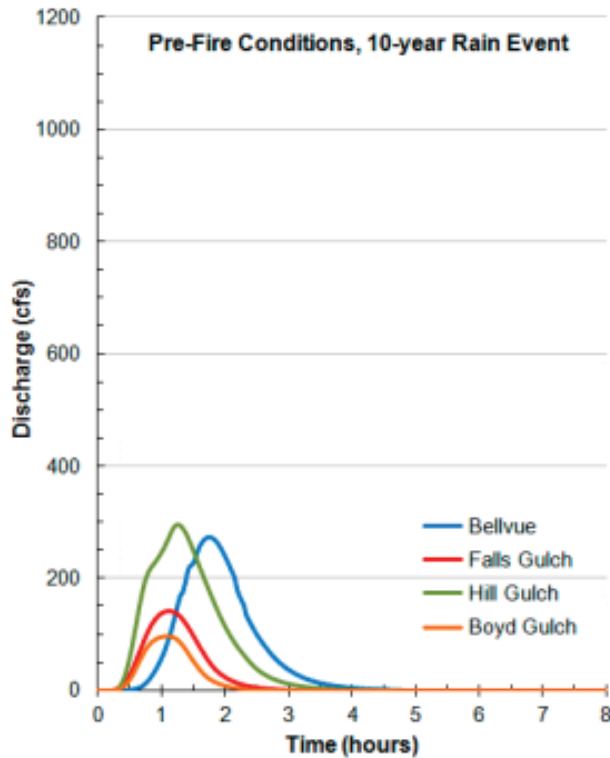
1. How did you initially sort the objects before watching the video?
 - a. What do the materials in each group have in common?
 - b. How are they different from the other group or groups you made?
 - c. How did your groupings change after learning new concepts and terms from the video? Why?
 - d. What are some other objects that could be in each group?
2. Explain what happened in each model when water was sprayed over the soil, referencing observations you made. Was this similar to your prediction you made before spraying the water?
3. Read the article, <https://bit.ly/RainOnBurnScar> and make comparisons to the clipboard models your group explored.

SYNTHESIS

1. During a wildfire, intense heat burns vegetation and organic material on and within the soil. As this organic matter heats up, it can vaporize and the vapors can move downward into the soil. When the vapor cools, it condenses and coats soil particles, forming a thin, waxy layer. Using evidence from the investigation, explain how this change influences the way water interacts with the soil. Then, describe how these interactions could lead to larger changes on the landscape and large-scale hazards. You may use words, diagrams, or a flow chart in your response.

EXTENSION

1. Analyze the graphs below showing streamflow discharge before and after a wildfire for different streams during the same rainfall event. Discharge is the volume of water flowing through a river at a specific location. Compare how peak flow and timing differ and use evidence to explain how water movement changes after a fire. Connect these patterns to your investigation of soil on the two hillside models by describing how hydrophobic soil may influence runoff. How might loss of vegetation from a fire affect what happens to water on a hillside? Based on your analysis, explain how the changes in soils and vegetation increase the risk of flooding and mudslides.



Estimated streamflow before and after a wildfire during a major storm (10-year event), showing how water moves through a watershed under different conditions.

Credit: Dr. Steven E. Yochum, US Forest Service