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Soot Happens: Educating K-12 Students on the Effects of Wildfires on Soil Erosion and Water Quality Through Hands-On Demonstration (Resource Exchange)

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SOOT HAPPENS

Educating K-12 Students on the Effects of Wildfires on Soil Erosion and Water Quality Through Hands-On Demonstration

What is soil erosion and how does it connect to wildfires?

Wildfires are a recurring disturbance in New Mexico's arid landscapes. One such example is the 2022 Hermit's Peak-Calf Canyon Wildfire, the largest fire in the state's history that burned upwards of 300,000 acres. While wildfires are a natural part of many ecosystems, they have become more intense, frequent, and destructive. The loss of vegetation and organic matter after a fire dramatically alters soil stability and runoff processes. When heavy rains occur after a fire, the soil that was once anchored by roots, grass, and other organic matter can detach and wash downslope, carrying ash, soot, and fine sediments into natural streams and rivers. This results in highly turbid, sediment-saturated water that threatens aquatic life, clogs reservoirs, and presents challenges to drinking water treatment. These post-fire runoff events can degrade water quality for communities already impacted by drought and limited clean water supplies, not only in New Mexico, but in every wildfire-prone environment. For example, the residents of Las Vegas, New Mexico, have faced contamination of their water resources due to wildfire destruction. The mudslides and runoff carry loose soil and debris with them to the downslope watersheds and water storage reservoirs.

Soil erosion demonstration description

We developed a physical demo relating soil erosion to water quality. This setup features three simulated mini watersheds, each packed with soil. One simulates real grass growth (Box 3), another simulates soil with stones and gravel, but no vegetation (Box 2), and the last simulates the ground after a fire, which is only soil (Box 1). As water flows down into the clear collection containers, participants can visually observe differences in runoff clarity, sediment load, and filtration. The vegetated side produces relatively clear water as roots and leaf litter slow the flow and trap particles; the rocky side shows a slight decrease in water quality, and the soil side releases darker, turbid water. Our soil erosion display offers a tangible way to see how nature acts as a filter and how wildfire can remove that protection.

Materials

- 3 clear acetate boxes
- Soil
- Mulch (mix of soil, stones, and gravel)
- Grass seeds
- Flexible tubing
- Valves to control water flow from the visualization reservoir to the drainage reservoir
- 3 clear 1-L bottles or similar, with bottoms cut
- Large containers to hold drainage water
- Silicone or hot glue for sealing
- Gallon jug with water
- Cart or table for display and transportation

Figure 1: Soil Erosion Demonstration. *Box 1 contains only soil, Box 2 contains mulch, and Box 3 contains grass. Runoff is captured by tubing and visualized in bottles for turbidity*

Connection to next-generation science standards

ESS1 Engineering Design

Elementary School, K-2-ETS 1-1, 1-2, 1-3; 3-5-ETS 1-1

Middle School, MS-ETS 1-1, 1-3, 1-4

High School, HS-ETS 1-1, 1-2, 1-3

Key Concepts

- Ask questions about a major global challenge
- Develop a physical model and design a solution to a complex real-world problem, including criteria for success and relevant constraints
- Analyze data from tests to identify a solution

Using the engineering design process to create and test a physical model for water quality after a wildfire

The activity can be facilitated by guiding participants through the steps of the engineering design cycle. This facilitation method can be performed in both classroom and museum event settings.

Ask	Wildfires burn natural landscapes and homes. Sometimes after a fire, the municipal water system is shut down, and water quality visually declines. What happens to water quality after a wildfire?
Research	Nature-based solutions like mulching, seeding and sediment management are being explored for revitalizing soils affected by fires to improve resilience.
Imagine	How can we create an experiment to observe changes in water quality after a wildfire and during natural restoration for years afterwards to determine what situations improve or worsens the quality of the water?
Plan	Create physical models to test water quality on 3 landscapes: (1) immediately post wildfire, (2) vegetation is regrowing, and (3) vegetation has regenerated.
Create	Pour clean water over boxes with soil, mulch, and grass, and collect the runoff water in clear containers for viewing.
Experiment	Visually observe water clarity or use a turbidity meter to measure the turbidity of water runoff from each box. Record the data and compare the results between the 3 boxes.
Improve	Apply these observations and data collections to create potential engineered and natural solutions to post wildfire water quality issues.

Data collection from outreach at local science museum

This activity was presented at Explora Science Museum as a table-top demonstration with live facilitation. Attendees at a "Meet a Scientist" event ranged from young children to adults (*age not inquired*) while "Adult Night" attendees were 18+. After the demonstration, facilitators asked participants: "Which box had the clearest water runoff?" Participants placed a token in a covered box corresponding to their answer. At the end of the museum event, tokens were counted and tallied.

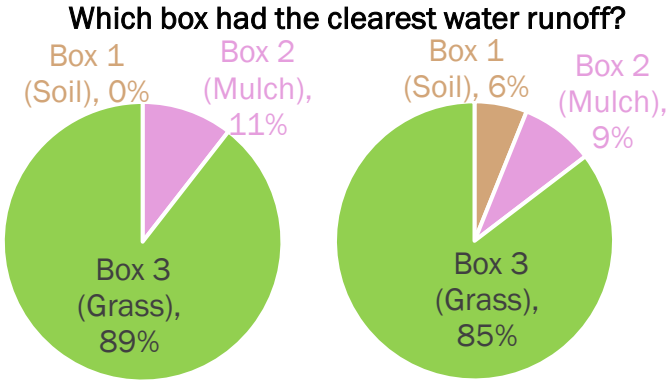

Figure 2: Respondent answers to question posed after activity. *n=19 Meet a Scientist (left), n=82 at Adult Night (right)*

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