Developing Possible Solutions: Slippery Soil

Lesson Duration:
Session 1: One hour
Session 2: Forty-five minutes

Lesson Overview:
In session one, students are introduced to the main reasons humans remove large areas of trees from the natural environment. The term deforestation is introduced and the class generates a working definition. In groups, students discuss deforestation and how it impacts the land, water, air, and other living things. The focus is narrowed and the concept of how deforestation impacts the land/soil is explored. In response to a scenario, students predict how the presence of trees on a hill will impact the movement of the soil. At stations, students will use models to test their predictions. A 12 inch square of half inch bubble wrap is used to represent the hill while forested and a 12-inch square of plastic wrap is used to represent the hill after deforestation. Students use 32-ounce spray bottles to simulate rain showers so they can compare the movement of soil on the hill before and after deforestation. Students use their observations to draw conclusions about the important role of trees in soil stabilization.

In session two, students manipulate a model to portray the most environmentally friendly way to install six homes on a forested plot. Students generate design solutions based on assigned criteria and use evidence to justify their choices. To challenge students, the scenario is modified and students are asked to re-evaluate their solutions to determine if there is a need to re-design. To assess individual student understanding, students evaluate two community designs to determine which is the most environmentally friendly.

Academic Standards:

Disciplinary Core Ideas:
ESS2.A Earth Materials and Systems
• Wind and water can change the shape of the land.

ESS3.C Human Impacts on Earth’s Systems
• Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air and other living things.

ETS1.B Developing Possible Solutions
• Designs can be conveyed through sketches, drawings or physical models. These representations are useful in communicating ideas for a problem’s solutions to other people.

ETS1.C Optimizing the Design Solution
• Because there is always more than one possible solution to a problem, it is useful to compare and test designs.
Science and Engineering Practices:

Analyzing and Interpreting Data
- Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording and sharing observations.
- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.

Constructing Explanations and Designing Solutions
- Constructing explanations and designing solutions in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
- Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.
- Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem.

Developing and Using Models
- Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e. diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions.
- Use a model to represent relationships in the natural world.

Engaging in Argument from Evidence
- Engaging in argument from evidence in K-2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
- Construct an argument with evidence to support a claim.

Obtaining, Evaluating and Communicating Information
- Obtaining, evaluating and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information.
- Read grade-appropriate texts and/or use media to obtain scientific information to describe patterns in the natural world.
- Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.

Planning and Carrying Out Investigations
- Planning and carrying out investigations to answer questions or test solutions to problems in K-2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations and design solutions.
- Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question.
- Make observations (firsthand or from media) to collect data that can be used to make comparisons.

Crosscutting Concepts: Cause and Effect
- Events have causes that generate observable patterns.
Common Core State Standards Connections:

ELA/Literacy
- R.1.K.1 With prompting and support, ask and answer questions about key details in a text.
- W.2.8 Recall information from experiences or gather information from provided sources to answer a question.

Mathematics
- K.MD.A.2 Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute and describe the difference.
- MP.5 Use appropriate tools strategically.

Background for the Teacher:
For the purpose of this lesson, deforestation is when humans clear large areas of trees for non-forest use. Non-forest uses include urban development, agricultural use (e.g. planting crops, grazing livestock) and natural resource extraction. Deforestation can also result from natural causes such as forest fires ignited by lightning (common in the American Southwest) and floods.

Trees provide shade, help stabilize the land, return water back to the atmosphere, absorb greenhouse gases and provide habitats for living organisms. Without the shade of trees soil is exposed to the Sun’s heat, which decreases the nutrients, cultures of helpful bacteria, and moisture levels in the soil. Soil with lower moisture levels is more likely to erode and negatively impact the watershed. Fewer trees returning water vapor to the atmosphere can lead to drought. If there are not enough trees to absorb greenhouse gases, carbon dioxide can reach high/dangerous levels. High levels of carbon dioxide in Earth’s atmosphere causes too much of the Sun’s heat to be trapped, upsetting the delicate balance of Earth’s ecosystems. Many living organisms rely on trees for habitats. Cutting down large numbers of trees results in the endangerment/extinction of species. As a result of rainforest destruction, it is estimated that 137 species become extinct every day, or 50,000 per year. Global rates of deforestation are staggering. For example, South America has lost 70 percent of its rainforests, Madagascar has lost 95 percent, and the Philippines 90 percent. Due to the destruction caused by deforestation, governmental organizations have established laws, rules, and regulations in an effort to protect our trees.

Materials:
For the class:
- *The Lorax* by Dr. Seuss
- Round Robin resource copied onto chart paper or projected onto interactive whiteboard
- 1 jar of soil
- 1 image of tree that illustrates root system in the ground
- 1 Undeveloped Land Plot Model
  1. Use 4 inch squares of green paper to create a 40 inch square
  2. Replace one green 4 inch square towards the middle with a blue 4 inch
Cut out ten 2 inch brown squares and leave to the side.

For each group:
- 1 Round Robin strategy student resource
- 12 inch square of ½ inch bubble wrap
- 12 inch square of plastic sheeting
- 1 32ounce spray bottle per group
- Two 12 inch square pieces of thick cardboard
- 2 bricks (may substitute plastic tanks)
- 1 cup of soil
- Two 12 inch long strips of laminated blue construction paper labeled stream (aluminum foil may be substituted)
- 1 yardstick

Teacher Prep for Stations: Gather materials. Mount the bubble wrap and plastic wrap squares on cardboard squares. Fill each spray bottle with water and set nozzle to mist. Pre-measure the soil. Obtain same-size bricks/plastic tanks to prop hills on an incline.

Station Set Up:
- 1 bubble wrap square mounted and propped on an incline, sprinkled with one-half cup of soil, with a stream at the bottom of the hill
- 1 plastic wrap square mounted and propped on incline (equal to the bubble wrap square), sprinkled with one-half cup of soil, with a stream at the bottom of the hill
- 1 spray bottle filled with water, be sure to test and adjust nozzle spray level to produce optimal soil movement results prior to the student investigation
- 1 yardstick, pre-determine optimal height for spraying while testing nozzle spray level

For each student:
- 1 “What if...?” student resource
- 1 “Slippery Soil Investigation Observations” two-sided student resource
- Optional: Access to free Web 2.0 flipbook maker such as Bennettonplay! http://www.benettonplay.com/toys/flipbookdeluxe//player.php?id=429209
- 1 pair safety goggles
- 1 copy of “Home Connection Resource”
- 1 copy of “The Best Way to Build” student resource

Note: To implement the K-1 pathway you will need chart paper and will not need the Round Robin Strategy student resource or the “What if...?” student resource.

Classroom Activities:
Session 1:
1. Read and discuss the The Lorax by Dr. Seuss. Prompt students to ask and answer questions about the key details of the text. Explain and discuss the reasons (urban development, agricultural use and natural resource extraction) humans remove trees from the natural environment.
2. Introduce the term deforestation. Explain that deforestation is when humans clear large areas of trees for non-forest use. Optional: Have students create a flipbook to illustrate or develop a skit act out the meaning of deforestation.

3. Grade 2: Create student groups of four.
K-1: Conduct a Think-Pair-Share to discuss the question, “How did removing the trees impact the environment?” Prompt students to think about the air, water, land and plants/animals. Let students know that they will be expected to share their ideas with the class.

4. Grade 2: In groups, have students circulate the Round Robin Strategy resource sheet and use pictures or words to document their ideas about how removing trees/forests impacts the land, water, air and other living things. Encourage groups to list at least one idea per square. Require every individual to contribute an idea. To help you monitor individual student progress have the students record initials next to their contributions. Suggested Scaffold: Copy and cut up Round Robin Strategy resource sheet to make land, air, water and animal group cards. Distribute one card to each group of students then generate and discuss ideas about how removing trees/forests impacts the land, water and other living things as a class.

K-1: Lead a class discussion on how removing trees/forests impacts the environment. Use Round Robin Strategy to allow student pairs to share their ideas. Record student ideas on a chart. After students share, ask questions and provide summary statements to help students make connections between their ideas.

Round Robin Strategy: Circulate through student groups or pairs repeating the same order (e.g. Table 1, 2, 3...Table 1, 2, 3...Table 1, 2, 3). Have them share as many ideas as they can in a specific amount of time or until they run out of ideas. The rule is students cannot repeat an idea that has already been shared.

5. Grade 2: Randomly call on student groups to share their ideas. Post and discuss their contributions. Focus in on their ideas about the land. Hold up a jar of soil. Explain that trees play an important role in helping to keep soil in place. Ask students. "What holds a tree in the ground?” Explain that the roots of trees have many important roles including holding the soil in place. Use image of tree with root system to reinforce this concept. Ask students, “Why it is important for the soil to stay in place?” Accept all answers with justification. Then clarify that if the soil washes away it can pollute local waterways. Explain that too much soil in the water can kill plants, fish and other living organisms.

K-1: Hold up a jar of soil. Explain that trees play an important role in helping to keep soil in place. Ask students. “What holds a tree in the ground?” Explain that the roots of trees have many important roles including holding the soil in place. Use image of tree with root system to reinforce this concept. Ask students, “Why it is important for the soil to stay in place?” Accept all answers with justification. Then clarify that if the soil washes away it can pollute local waterways. Explain that too much soil in the water can kill plants, fish and other living organisms.
6. Grade 2: Direct student attention to a station and explain the set-up. Describe how the models represent land plots with trees (bubbles) and without trees (no bubbles). Explain that the spray bottle with water will be used to simulate rain.

K-1: Direct student attention to the demonstration table with materials for the investigation. Describe how the models represent land plots with trees (bubbles) and without trees (no bubbles). Explain that the spray bottle with water will be used to simulate rain.

7. Grade 2: Present the “What if...?” scenario. Ask individual students to make and record predictions about what will happen when it rains on the hill when it has trees as compared to what will happen on the hill after all of the trees have been removed.

K-1: Make groups of four. Have student groups generate predictions about what will happen on the hills with and without trees when it rains. Record their predictions on a class chart.

8. Grade 2: Have students share their predictions with the other members of their group. Ask a couple of groups to share their predictions with the class.

9. Grade 2: Facilitate the Slippery Soil Investigation at stations. Have student groups record their observations on the Slippery Soil Observations resource.

K-1: Conduct Slippery Soil Investigation as a class. Have individual students come up to produce rain showers in thirty-second intervals. Allow all students to record observations after each rain shower. Discuss student data as a class.

Teacher Directions:
Explain to students that it is important for them to not adjust the spray nozzle or inclines during the investigation in order to get accurate results. Direct students to put on their safety goggles. Tell students that they will be testing how rain impacts soil on a forested hill first. Do a quick check by asking students to point to the hill covered with trees/bubble wrap. Instruct students to use the yardstick to make sure they are holding their spray bottles at the same pre-determined height for each trial. Direct students to use the spray bottle to create rain for thirty seconds. Stop students after thirty seconds and have them record and share observations. Repeat 4-6 times. Move on to the deforested hill and repeat the process. Ask students questions to prompt them to recognize, analyze and compare the amount/rate of soil movement such as, “Did the rain cause soil/sediment to wash into the stream?” or “Are the trees helping the soil stay in place? How do you know?” “Did more soil move on the hill with or without trees? Explain.” and/or “Is the soil moving faster or slower on the hill now that the tree have been removed?”
1. Grade 2: Have students generate a quick summary statement or conclusion based on their observations. Allow students time to reflect on their predictions.

K-1: Use class data to generate a summary statement/conclusion.

2. Enrich: Show images of sediment control fencing being used to reduce erosion/prevent sediment from entering waterways/storm drains. Ask students explain the rationale for the placement of the fencing/how the fencing will reduce soil/sediment run-off.

Session 2:
1. Use green and blue construction squares to construct model of undeveloped land plot on floor.
   **Undeveloped Land Plot Model Set-Up**
   - Use 4 inch squares of green paper to create a 40 inch square
   - Replace one green 4 inch square towards the middle with a blue 4 inch square
   - Cut out ten 2 inch squares of brown paper and leave to the side

2. Gather students to sit in a circle around the undeveloped land plot. Display and explain the key below:
   - Green Square = Forest
   - Blue Square = Lake
   - Brown Square = A House with Yard

3. Emphasize that tree removal always impacts the environment, but that the impact can be reduced by making environmentally friendly choices. Tell students that a builder wants to install six homes in a forested area and is seeking their expertise/advice. Prompt students to recall information from *The Lorax* and the Slippery Soil investigation to help them answer the question, “What is the best/most environmentally friendly way to construct six homes in a forested area?” Hold up brown squares and remind students that they represent areas where trees have been removed and a house with a yard has been installed. As a class, have students manipulate the model to design and re-design until they agree on the environmentally friendly solution they feel is best to submit to the builder. Pose questions while students are working, “Does anyone have a different design idea/solution?” “Why did you decide to keep trees around the lake area?” or “Is there a way to modify the house and yard design to make it more environmentally friendly?”

4. Challenge students to re-think their solution by modifying the scenario. For example:
   - Move water/lake and ask students if the design is still the most environmentally friendly.
   - Tell students that the homeowners do not want to see their neighbors and ask if their design still works.
   - Tell students the homeowners want to be near their neighbors and ask if
Tell students at least two homeowners that love to fish want to live near the lake. Ask students if they would make any modifications or recommendations to homeowners building near the lake (e.g. smaller yard, forested yard). If so, allow students to rip/cut the brown paper to illustrate their design ideas.

Use extra 2 inch brown squares to expand two of the homeowners yards and require students to explain how these home owners can make their yards more environmentally friendly (e.g. keep some of the existing trees, if applicable expand yard in a different direction to keep more trees around the lake). Ask students what they would say to convince the homeowners to modify their yard design. Suggested Scaffold: Ask students guiding questions such as "We learned that too much soil/sediment run-off can be harmful to the fish and other living organisms in water. Is it the best idea to cut down the trees right around the lake to install the houses? Why or why not?"

Home Connections:
Send home a copy of the “Home Connection Resource” with each child to inform parents about what the children have been learning.

Assessment:
K-2: To assess individual student understanding, have each student complete The Best Way to Build exit card. Students should select Design 2 as the most environmentally friendly. Acceptable explanations for selecting Design 2 include the presence of trees around the lake to reduce soil/sediment run-off and the presence of more trees in the community. Suggested Scaffold: Allow students to orally share justification for their design choice.
Dear Parent or Guardian,

Your child has been learning about the impacts of deforestation. For the purpose of our lesson, deforestation was defined as when humans clear large numbers of trees for non-forest use. Non-forest uses include urban development, growing crops, grazing livestock and obtaining natural resources such as wood. This week, your child participated in an investigation to explore how removing trees impacts the land. In groups the students used models to compare how well soil stayed in place in areas with and without trees.

Complete the following tasks together with your child to help reinforce and apply his/her understanding of the science concepts addressed in this lesson:

- Ask your child to describe why he/she selected the community design on the attached exit card as the most environmentally friendly.
- Discuss ways your family can help reduce deforestation from the list below.

What can I do?

- Share information about deforestation and its effects with others
- Plant trees
- Go paperless
- Recycle and buy recycled products
- Look for Forest Stewardship Council (FSC) certification on wood and wood products
**Group Name:**

How does removing trees change...

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<th>Land?</th>
<th>Water?</th>
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<th>Air?</th>
<th>Plant and Animal Habitats?</th>
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Brainstorm Activator: Round Robin Strategy
“What if...?”

Make a prediction about what will happen, to the soil, on the hill when there are trees.

Make a prediction about what will happen, to the soil, on the hill after the trees are cut down.

Reflect: Would removing all of the trees from a hill cause changes to the local stream or wildlife? Why or why not?
Slippery Soil Investigation

Observations

Hill with Trees...

Before Rain

30 seconds

1 minute

90 seconds

120 seconds

150 seconds
Slippery Soil Investigation Observations
Hill without Trees...

Before Rain

30 seconds

Stream

1 minute

90 seconds

Stream

120 seconds

150 seconds

Stream

Stream
The Best Way to Build
Exit Card

Circle the community design you think is the most environmentally friendly. Use pictures or words to explain your choice on the back of this sheet.

Key:

= Tree

= House

**Design #1**

**Design #2**

Lake