

Step-by-Step Instructions for Lesson and Materials List

Materials:

- Modeling clay (beige, terra cotta, dark brown, green)¹
 - Roll the beige, dark brown, and green modeling clay into flat layers using a rolling pin. Provide a limited amount of terra cotta rolled into a ball (approx. 5-7cm) for building structures such as levees, dams, hills, etc.
- Clay-working tools²
- Plastic office tray (approx. 12in. x 7in. x 2in.)³ with 10mm hole drilled
- 100mL graduated cylinders (one per group)
- 10 ml graduated cylinders (one per group)
- Plastic houses (Monopoly® hotels work well)
- Sand
- Flour
- Plastic cup with ~30 holes punched in bottom
- Rinse basin
- Large, shallow tray

Lesson Timing: This lesson requires 45 minutes to one hour of time for the main activity and an additional 30 minutes for the elaborate portion.

¹ Claytoon ® and VanAken ® brand clays work best. They are non-hardening and can be reused.

² Tree House Studios brand tools are widely available at craft stores for less than \$10/set.

³ Rubbermaid ® office trays work well for this and are widely available.

Step-by-Step Instructions:

- 1) Before beginning, prepare each tray with the orange (general soil) clay. This is easiest to do if you rollout the clay to approximately 2cm and lay it in the tray. Cut out a small river that aligns with the drilled hole (Figure 1).

Although we used relatively straight rivers in our implementations, rivers with more bends could be incorporated to increase the engineering challenges.



Figure 1: An example of a properly drilled hole aligned with the river in the landscape model.

Ensure that rivers included in the model are deep enough to hold a minimal amount of water (30mL-50mL approximately.) For this portion of the activity, the hole in the tray should be plugged with a small piece of clay.

2) A common misconception about scientific modeling is that models require a tremendous amount of detail to be useful. We explained that clay colors represent different land use areas and everything contained within them, so features like individual trees are unnecessary. Projecting a PowerPoint slide (Figure 2) allows students to reference the land use types as they build. When constructing their models, students must include: a river, transportation, agriculture, human habitation, and natural areas. Explain that they will choose one of the human needs (transportation, agriculture, or habitation sites) to try to protect with their model design. In addition, students should construct their model from bird's eye view or airplane perspective. We drew a picture of what the model could look like on the board with the appropriate amount of detail (Figure 3) and had the students construct their models as if they were looking at the landscape from an

airplane.

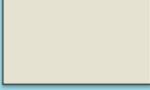
	Terra cotta: general soil, you can make mountains, valleys, and rivers from this color clay.
	Beige: roads or other transportation types (train tracks, bridges, etc.)
	Dark brown: agriculture
	Dark green: forests or other wildlife habitats.
	Plastic houses: these represent areas where humans can build homes

Figure 2: Example of PowerPoint slide showing land use types.

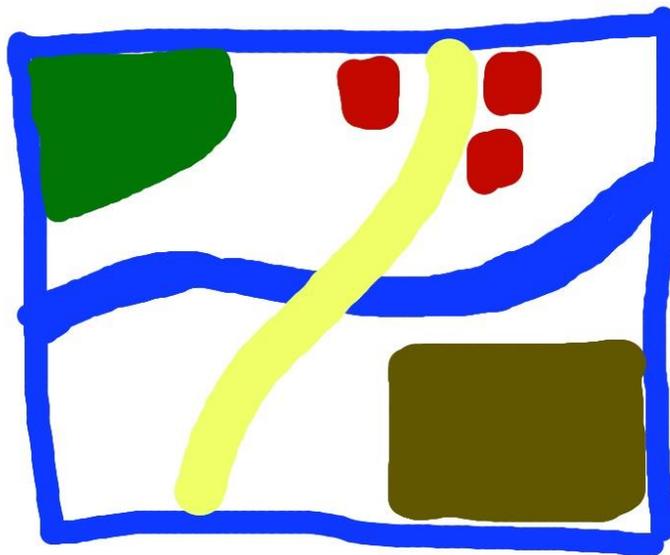


Figure 3: Example of bird's eye view diagram.

- 3) Place students in groups of three to five, depending on the amount of materials available. Have students discuss which need they will try to protect with their model and circle it under Question 1 on the Data Collection Worksheet (see Worksheet and Probes in Supplementary Materials). Be sure students choose one need and stick to it.
- 4) Explain to students there are rules for working with clay. On the board, write the following rules:
 - a. **Use only the clay you need.** This avoids students making complex features that do not affect the model and spending too much time on model construction.
 - b. **Avoid mixing colors.** Although some mixing is unavoidable, keeping the clay colors separate reinforces the land use concepts and allows the clay to be reused.
 - c. **Clay tools are not toys.** Some tools used for working with clay have sharp points that could potentially be dangerous to students if misused. Reinforce the appropriate use of these tools to ensure safety.
- 5) Give the students a tray, clay in four colors, and tools for working with clay and allow students to begin model construction. Provide guidance to ensure that all parts of the required model are included. *Reinforce the concept that models are approximations of reality and should not include lots of detail. The amount of time dedicated to construction should be less than 15 minutes.*
- 6) Explain that the students are now going to add water to the system. First, fill a 100 ml graduated cylinder with water. Using the 100mL-graduated

cylinder, pour water into the 10mL-graduated cylinder. Instruct students pour in enough water to fill their river system, ten milliliters at a time. Students should keep track of the amount of water they added using a tally system. Record the amount of water they added in Question 2 on the Data Collection Worksheet. Circle the needs that were protected (i.e. no water flooded these areas) in Question 3 on the Data Collection Worksheet.

- 7) Second, add the amount of water from Question 2 on the Data Collection Worksheet to the 100mL-graduated cylinder. Pour the water into the already filled river and watch the landscape flood. On the Data Collection Worksheet, have students record the amount of water added (Question 4) and circle the needs were protected (i.e. not touched by water)(Question 5) and the needs that were destroyed (i.e. partially covered) by the floodwaters (Question 6). Encourage students to write about the strategies they used to protect their human needs in the model, what worked, and what did not under Question 7 in the few minutes following the modeling activity.
- 8) Prior to handing out the post-activity assessment probe, we found it helpful to have a group discussion of their results. The following questions help focus their thinking and provide a natural bridge to the activity in the Elaborate section:
 - a. What strategies were more or less effective in protecting human needs?
 - b. Are there strategies that are used in the real world that we could not model during this activity (e.g., spillways, putting homes on stilts)?

- c. If you had the chance to modify your model, what would you do differently? What are some possible long-term effects of continued human changes to the environment?
- d. What would you expect to happen if rainfall and flooding continued to happen on your landscape for a very long time (over 100 years)?
Would your strategies still work or would you need to change them?
- e. What other processes, besides flooding, can cause changes to a landscape?

Elaborate

- 1) Using the same river system built previously, you will now demonstrate the effects of erosion and deposition on a landscape.
- 2) Mix flour and sand in a 2:1 ratio (e.g. 100mL of flour and 50ml of sand).
Depending on the size of your class, you may not use the entire mixture.
Adjust the amounts to fit your individual needs.
- 3) Have students spread the sand and flour mixture evenly over the landscape ensuring that not too much of the mixture is in the river before the activity begins. At this point, students may also add additional features to their landscapes to further reinforce the effects of various components of the landscape on erosion. Some possible suggestions include using small sponges to mimic the effects of vegetation in preventing erosion of riverbanks or adding rocks to the landscape to demonstrate how geological features affect the flow of water and resulting erosion.
- 4) Remove the plug from the hole in the tray.

- 5) Using the plastic cup with the holes in the bottom, begin the rain simulation event. Pour ~100ml of water slowly into the cup while moving the cup over the portion of the landscape on the opposite end of the river (see photo).



- 6) Students will observe that the larger components of sand move less, that much of the sand and flour mixture runs-off into the river and out of the system. Ask students to describe what happened when they added a rain and erosion event to their models.
- 7) Immerse the entire model in the rinse basin to remove the sand and flour mixture. Pat dry with paper towels if necessary,
- 8) Explain to students that they are going to artificially erode their landscape using the knowledge they just acquired during the simulated erosion event. Explain that they should imagine changes to their model over many years. Some ways for students to artificially erode their landscapes include:
- Eroding the riverbanks by decreasing the angle of the riverbank.

- b. Reduce the elevation of any areas for which they used elevation as a strategy in the original flooding event.
 - c. Carve gullies or small ravines in their landscape similar to those that formed during the erosion activity.
- 9) Plug the hole in the tray and repeat Steps 6 and 7 from the first activity using the same amounts of water previously added (i.e., if in the original activity the rivers system was stable/full after adding 35mL of water, add 35mL to the newly eroded system. Have students record their results on the Data Collection Worksheet in the same way they did in the first activity.