Unit 3:
Natural and Agricultural Erosion Rates

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This activity is part of the On the Cutting Edge Exemplary Teaching Activities collection and has been reviewed by 1 other review process

Summary

Students will identify their perceptions of erosion by examining images of mountain and agricultural landscapes and discussing which environment is more erosive. They will use geospatial figures to compare erosion rates associated with both natural and agricultural landscapes in the United States. Students will then consider how the presence of agriculture has reduced the areas of soil production, replacing them with regions of soil loss. They will reflect on the negative impact of agricultural erosion on soil sustainability.

Used this activity? Share your experiences and modifications

Learning Goals

Unit 3 supports the following overarching goals of the Growing Concern Module:

North Appalachian Experimental watersheds in Coshocton, Ohio

1. Use geological data to develop a plan for sustainable soil management in one or more agricultural settings.
2. Predict, using systems thinking, agricultural challenges that might result from climate change.

By the end of the unit, students will be able to:

- Interpret data from geospatial figures and analyze erosion rates.
- Discuss the influence of agricultural erosion on soil sustainability.
- Confront preconceived ideas, reframe these ideas given new data, and reflect on that process.

This unit directly supports multiple InTeGrate guiding principles. Students use authentic geospatial data to investigate human and natural rates of erosion. They also consider implications for the interdisciplinary problem of soil sustainability.

Context for Use

This unit is designed for a 50-minute period in an introductory (undergraduate) geology, environmental science, critical zone, agricultural, soil, or sustainability course. Activities were written for in-class use; they fit many class sizes and notes are provided on how to adapt materials to fit various classroom settings. In a think-pair-share activity, students consider their perceptions of erosion. Students then examine two geospatial figures showing natural and human-derived erosion. Follow-up questions ask them to consider how agricultural erosion impairs soil sustainability and how their perceptions have changed after working with both geospatial figures. Students are also prompted to reflect on what questions they still have about erosion. This activity can be completed individually and could also be used to prepare for a quantitative activity exploring the influence of Humans as Geomorphic Agents.

Description and Teaching Materials

The activities are meant to be completed consecutively, with students first exploring their perceptions, and then challenging their perceptions through the examination of geospatial erosion figures. The activities can be completed in class, except for the follow-up questions that should be assigned at the end of class.

Examine images of erosion Think-Pair-Share (5 minutes)

In a think-pair-share activity, students will examine photos of erosion in mountain environments (without agriculture) and non-mountainous agricultural environments. These photos ask the question "Which environment is more erosive?" If erosion is a new concept for your class, have students provide a working definition for erosion before they compare the photos. Students should identify that erosion is the

movement of earth material, including soil and rock, away from a location. The instructor should ask the class to examine the images together and to discuss the evidence for erosion in each. After discussing the images with a partner, the class can be polled to determine whether most of the class considers agricultural settings or mountainous ones to be more erosive. This will set up the next activity, in which they will look at erosion data and confront their perceptions.

Geospatial examination of authentic data (25 minutes)

(Slide 1) To begin, the instructor should project the first slide of the Geospatial Erosion PowerPoint, pass out notecards or instruct students to write answers on a piece of paper, and overview the instructions for the activity.

(Slides 2 and 3) Student teams will work with two figures showing erosion in natural/geologic and human-modified settings (from Wilkison and McElroy, 2007). If students have completed Unit 1 of this module, you might remind them of physiographic regions; if not, consider projecting Slide 4 from the Landscapes Powerpoint (PowerPoint 2007 (.pptx) 18.4MB Feb2 15) as part of this activity. Students will then describe how erosion rates associated with human activity compare to natural erosion rates (much higher). They should then predict that agricultural activity is a potential source of that erosion. If other sources are incorrectly identified, the instructor will follow up with the correct answer in Slide 4.

Visualize erosion (5 minutes)

(Slides 5-9) After working with the geospatial figures, students will work to visualize what the amount of erosion associated with agriculture looks like. First they are asked to visualize cropland erosion over a century (600 mm/century). The instructor might pause on this slide and ask students if they are able to indicate this thickness of 600 mm/century with their hands. Then the instructor will follow up by presenting analogies to help visualize the volumes associated with soil erosion and soil production. For example, one year of erosion, 0.6 mm, is approximately as thick as a business card. If the class period is longer, a campus example of erosion could be examined and discussed (e.g. how much erosion occurred in this footpath and how long did it take to form? Then calculate the rate of erosion).

Final reflection & homework: soil imbalance (10 minutes)

(Slides 10 and 11) Students will reexamine both erosion figures and estimate how much area is potentially producing soil. Using the figure of natural erosion rates, the instructor should remind students that the average soil production rate (0.36 mm/yr or 36 m/my) is lower than the rate of erosion for all but the green and white areas. Students should look at both natural and cropland erosion figures and determine that very little of the United States is still producing soil. Instructors might also remind students that soil production does vary from the average considered, but that the variation in production rates is far less than cropland erosion rates.

(Slide 12) Before leaving, students are assigned homework questions asking them to reflect on how agriculture threatens soil sustainability. They will also return to the initial examination of images showing mountain and agricultural erosion and reflect on how their perception of erosion changed after looking at the two geospatial figures. Finally, students are asked to think about the figures they examined and to come up with additional questions.

Materials

- Think-Pair-Share Erosion Activity (PowerPoint 2007 (.pptx) 8.5MB Sep22 14)
- Geospatial Erosion Examination: Instruction & Follow-up Slides (PowerPoint 2007 (.pptx) 5.3MB Sep22 14)

Teaching Notes and Tips

During the think-pair-share activity, the instructor might walk around and ask students if they have seen examples of erosion and can discuss them. When projecting the geospatial erosion figures, walking through an example conversion on the board is useful. Some students may require additional help, or time to learn conversions. If so, encourage them to work together in class.

Let them know that unit conversion and rate practice problem sets are available on the Math You Need website. You might also post notecard answers to the questions that they answered during class online. Practice problems could also be assigned as prework, or as a follow-up to this activity. The instructor might also want to walk around as students are viewing the natural and human erosion figures to see if all students are participating and discussing responses. One way to encourage participation is to charge each student with being able to report for the group.

After reviewing the homework assignment, the instructor should summarize student responses to the homework and point out that our preconceptions frame our opinions about the way the world works. Looking at data and analyzing trends is how scientists validate or invalidate preconceptions. The truth is not always what we perceive. In addition to reiterating this point in class, it is helpful to go over answers to the questions most frequently asked by students, especially any that clarify concepts covered in class.

Assessment

- Notecard Answer Key for Geospatial Erosion Activity (MS Word Version) -- private instructor-only file
  Notecard Answer Key for Geospatial Erosion Activity (PDF Version) -- private instructor-only file

  This activity is formative and won't be graded.
- Erosion Reflection Assignment Answer Key (MS Word Version) -- private instructor-only file
  Erosion Reflection Assignment Answer Key (PDF Version) -- private instructor-only file

  The first question in the reflection activity could be in an exam. As written, it is a low-stakes homework to determine if students understand the relation between agricultural erosion and soil sustainability. This question appears at the end of the Geospatial Erosion Examination powerpoint.

References and Resources

- Montgomery, D.R., 2007. Soil erosion and agricultural sustainability, Proceedings of the National Academy of Sciences, vol.104, no 22, p. 13268
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- Wilkinson, B.H., and McElroy, B.J., 2007. The impact of humans on continental erosion and sedimentation, Geological Society of America Bulletin, January/February, v. 119, no 1-2, p. 140-156.