Iowa - The Rivers of Her Valleys 4.0

REAP Resource Enhancement and Protection

UNI University of Northern Iowa
Earth and Environmental Sciences

Title - Stream Erosion
Audience - Grades 4 and 5, Formal to Informal Education, Teachers to Naturalists, students and their families, Iowa citizens
Lesson Description - Use local stream or stream table to observe, characterize and interpret sediment erosion. ***Big Ideas / Big Questions*** **- Iowa Core, NGSS and Earth Science Literacy** http://www.earthscienceliteracy.org/document.html **1. Earth scientists use repeatable observations and testable ideas to understand and explain our planet.** **2. The Earth changes over space and time / Why does the Earth Change, Why is it important to track these changes?** **3. How are changes in Earth systems classified?** **4. Human actions are capable of changing the Earth's surface at different scales (small to large) / How do human activities change the Earth's natural systems?**
Time Needed to Complete - 50 minutes, likely one to two class sessions
Iowa Science Standards - 4ESS_2-1, Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. 4-ESS_2-2, Analyze and interpret data from maps to describe patterns of Earth Features 4-ESS_3-2, Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	Sustainability Implications & Practices
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (4-ESS2-1) **Analyzing and Interpreting Data** Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning. (4-ESS2-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Identify the evidence that supports particular points in an explanation. (4-ESS1-1) Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-ESS3-2)	**ESS1.C: The History of Planet** Earth Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1) **ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1) **ESS3.B: Natural Hazards** A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.) **ETS1.B: Designing Solutions to Engineering Problems** Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)	**Patterns** Patterns can be used as evidence to support an explanation. (4-ESS1-1),(4-ESS2-2) **Cause and Effect** Identify the changes they observe Cause and effect relationships are routinely identified, tested, and used to explain change. (4-ESS2-1),(4-ESS3-2) **Connections to Engineering, Technology, and Applications of Science** Influence of Engineering, Technology, and Science on Society and the Natural World Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands. (4-ESS3-2) **Connections to Nature of Science** Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science assumes consistent patterns in natural systems. (4-ESS1-1)	**Construction/Engineering and Natural System** Sustainable engineering practices must include comprehensive characterization, understanding and appreciation of the Earth's earth materials and natural systems. **Cause and Effect** Observe and characterize the cause and effect relationships between construction practices and landscape stability.

Students will… **Design and conduct a stream erosion experiment. Analyze and interpret stream data. Then use these data to suggest the potential factors in stream erosion and erosion mitigation.**	**Students will** **Gain knowledge of local geologic history through an investigation of earth materials and processes. Experiment with cause and effect relationships between earth materials, energy variability and natural hazards. Use qualitative and quantitative data to design and text hazard solutions.**	Students will **Identify patterns within river systems that may lead to erosion through cause and effect relationships. Visualize connections between the earth sciences, natural systems and engineering.**	**Students will** **Interpret sustainable construction practices through river processes experimentation**

Student Objectives

I-can statements

1. I can define…. create or lessen erosion
2. I can tell the difference between a stable/good stream bank from an unstable/bad stream bank
3. I understand the causes and consequences of erosion and deposition
4. I can make recommendations on how to improve stream bank conditions

Resources

1. local stream, stream table/visit to museum or interpretive center, final option virtual stream table
2. silt/clay, sand, gravel, cobble
3. Watch with second hand/Stopwatch
4. Tape measure/meter stick
5. Notebook,pencil

Evidence of Learning

Students will produce:

A. Field journal entries, observations and interpretations
B. An understanding of energy, erosion and deposition through discussion and stream OR stream table engagement,
C. Designs for stream bank sustainability/reciprocity constructive human-environmental interactions

5-E Format

Engagement/ Excitement	Class/day before set up: A. Open discussion using a Geo-Role Playing Game B. You could also open with one of the following videos to support the role playing game, OR just use the videos and a class discussion Option 1 = https://www.youtube.com/watch?v=q45yqIw5844&t=9s , Iowa Land and Sky Comparison of Two Watersheds Option 2 = https://www.iowapbs.org/iowalandandsky/map , you will need to click on the binoculars along a river to find videos C. Introduce characters through 'show and tell' while discussing … a. Energy - moving water i. Velocity - Speed of water ii. Discharge - Speed of water * channel area b. Sediment - i. types, small to large (clay, silt, sand, gravel, cobble) - It would be a great idea to collect and dry some sediment from local stream to share with the students during discussion, maybe even have a sediment sorting activity… They may sort by size, color, shape… The key is to get them understanding there are different kinds of sediment and those different kinds of sediment will behave differently in our streams in rivers when they are placed under variable energy ii. volume/yield, how much sediment is in the water? c. Erosion - sediment transport influenced by increased energy d. Deposition - sediment accumulation, influenced by decrease e. Importance of landscape change with subsequent impacts to ecosystems/earth systems D. Iowa stream banks - Examples of unstable and stable stream banks handout a. Space/time - working with students to understand stream segments, changes from one stream segment to the next (space) and that energy drives processes that lead to changes in the stream over short to long term time scales. b. Stability/instability - working with students to understand factors stable vs unstable streams as well as humans can have positive or negative impacts in stream stability. Online - visualization/assistance A. Best link to landslide videos/landscape instability, https://blogs.agu.org/landslideblog/ B. United States Geological Survey Landslide Hazards, https://www.usgs.gov/natural-hazards/landslide-hazards C. Bank Stability Online - https://streamhandbook.org/evaluating-your-property/bank-stability/ D. Nature Education, Knowledge project = https://www.nature.com/scitable/knowledge/library/rivers-and-streams-water-and-26405398/ E. Iowa DNR River Restoration ToolBox https://www.iowadnr.gov/Portals/idnr/uploads/RiverRestoration/toolbox/lineart/View_13_Bed_vs_Bank.pdf

Exploration	1. Career Role Playing Game a. Characters - Geologist, Farmer, Naturalist, City Engineer, Conservation officer. Character description handout… b. Have students choose a character until there are approximately the same number of students in each group (4 or 5 students group). This may be completed well with large groups, but it becomes more challenging. Suggestions for larger groups are: 1. Develop more career choices e.g. Environmental Scientist, City Facilities Manager, Mayor to State legislator… 2. Do some of the prepwork e.g. formation of groups in the previous class and provide the career background characterization as a homework assignment allowing time for student led career research and increase the amount of time available for debate and discussion. c. Based on and ideally after activity set up (teacher lead presentations, videos, Career Role Playing Game etc) lead the students in the following direct observation of their local landscape/stream still emphasizing each career group's perspectives. *It is import for students to begin learning that different groups of people/careers view our natural resources differently and their actions may lead to constructive or destructive landscape changes. *Outdoor activity* 2. Stream hike a. Ideally you have access to an accessible stream with examples of stable and unstable banks. If the stream is to large to easily and safely access the banks, it would be a good idea to bring print outs of bank images and/or a whiteboard and markers to help the students visualize stream bank processes. Stream component vocabulary development: channel, bank, levee, floodplain, sediment, vegetation b. Working in their groups, help the students to observe and characterize two to three banks. Each group should work together to characterize each stream bank setting, Potential characterization details include: bank height (top of bank to water's surface), bank slope, sediment type in bank? in channel? vegetation (type and concentration) on the bank? Is there a tree canopy above the stream? , Landscape use (agriculture, natural, urban, pasture etc.) Here is an excel sheet and a PDF of a general recording sheet. c. Led a discussion how the different character group may 'see' / characterize the landscape and stream components. d. Video and image support : Video of stable, well-vegetated stream banks 1 , stable well-vegetated banks #2 3. Erosion a. Construct a chute using larger stones approximately 1 meter in length and 30 to 40cm wide, (to save time you could construct one before the students arrive) *Ask questions 1. How does this chute change the movement of water? 2. Will this chute change how sediments move*? 3. Will this chute increase or decrease the erosion potential? Draw pictures of the chute and compare/contrast with the first drawing, discuss… b. Stream hike, point out examples of both erosion and deposition highlighting energy's role. c. Video and image support : Videos showing unstable stream banks - Video #1 , Video #2

	Indoor activity option 4. Stream table Set up stream table with varying sediment size pebble, sand, clay (0.25 to 6.3mm dia.), ideally run stream table for a few hours to develop stream landforms: chanel, banks, bars * Don't have a stream table or cannot visit a local Museum/Interpretive Center stream table, it may be possible to check out a stream table from UNI Earth and Environmental Sciences Dept. (contact = chad.heinzel@uni.edu) a. Use popsicle sticks or other flat pieces of wood/metal/plastic to create a 'human-made' levee. Observe how the sediment behaves under 'normal' flow. Then increase the flow of water, observe, characterize and interpret… Video 1 - Shows and human made levee, this video shows the levee working well. It is keeping the the water and sediments from negatively impacting the house. Video 2 - As the water increases in velocity and height, during low to moderate flow the levee works well. As the flow increases a critical threshold is passed and water begins to break around the levee, eventually the levee would fail. Video 3 - Another video showing increased velocity and height, but this time undercutting and failure is present. b. Ideally a stream table would be set up and run over the course of one to two days so students could make observations and prediction slope stability and channel stability. 5. Erosion - *Variability in energy + differential geologic properties (function of minerals, rocks, structure) = landscape change* a. Arrange stream table to exhibit variability between sediment (pebbles to sand) and stream flow b. Vary water flow/velocity over time to observe both slow and rapid change, have students observe and document how different discharges (velocity within a channel area) affects particle movement. c. Have the students record their observations by mapping where the stream has changed, where it appears unstable vs stable.
	A. Stream bank instability is a major cause of sediment erosion in Iowa, loss of land, development of poor stream habitats/turbid/cloudy sediment filled water. Helping students become familiar with the different components to a stream initiates vocabulary development and communication. B. Stream bank erosion can also lead to negative impacts on infrastructure (e.g. bridge foundations), agriculture (e.g. land loss) and degraded recreation. C. Increased stream discharge (the water's velocity/speed multiplied by average channel area width and depth) leads to increased stream energy and power creating the potential for more erosion. Natural meanders or curves in a stream help to slow down the energy/power. Some agricultural practices straighten streams/waterways (this is a poor practice as straightened stream lead to increased water velocity and erosion potential. Proper stream restorations practices commonly add meanders or curves back to the stream system (decreasing velocity and the potential for erosion) https://www.iowadnr.gov/environmental-protection/water-quality/river-restoration D. Natural stable stream banks often have gradual/gentle slopes AND are well vegetated (short-grass, then tall-grass and finally a shrub to tree canopy). Natural and reconstructed streams that have all three properties 1. Meanders, 2. Gradual slopes and 3. Well-vegetated slopes have the best chance to become stable due to their energy-lessening potential. E. Artificial stream changes lead to the opposite conditions and increase potential for stream erosion: 1. Straight channels, 2. Steep, perhaps, vertical slopes and 3. Little to no vegetation all properties that commonly lead to increased velocity to discharge and erosion.

	Activity extension ideas.. Hungry water concept F. Dams, Your local stream or river may have a dam. You could also try to construct a dam in your stream table. Dam's tend to trap sediment and release water. Downstream from the dam, the released water commonly has less sediment. Water with less sediment has the capability of moving faster. Faster moving water leads to the potential for increased erosion (hungary water). https://www.iowadnr.gov/portals/idnr/uploads/riverprograms/dam_chap1.pdf G. Urbanization: From natural/permeable to artificial/impermeable, Here is a short video of hard rain onto impermeable concrete (UNI campus street), notice how the water moves in waves, it cannot move into the concrete so it races across its surface. Permeability defined - A sediment, rock or landscapes ability to have water pass through it… If you cut the bottom off a coffee container, filled it with gravel, then poured a gallon of water into the container how long would it take for the water to spill all over the table? If you had another bottomless coffee can filled with dry concrete and you dumped a gallon of water into the container, what would happen? This concept carries over on a much larger scale to Iowa's towns and cities. Think of how your grocery store's parking lot or favorite park would handle a lot of rainfall (2 inches in less than an hour)… This is important as we reconsider energy's role in erosion; many of the 'experiments or observations in this activity state that increased energy leads to increased erosion. A landscape that has poor to no permeability will lead to water rushing across its surface, moving downslope, looking for the path of least resistance and the nearest stream. Once that fast moving water hits the stream channel, look out power will be exerted and erosion will likely occur.
Evaluation	Outdoor and Indoor options At the end of the observations have the students redraw/map what they remember. A. River shapes - How does one segment move into another? B. Associated sediments - Are all sediments the same size or different? If there are different sediment sizes, where do the larger and small sediments group together? Are there any patterns? C. Locations of slow vs fast water? What are the sediment characteristics in the fast water vs slow water?
Enrichment/ Elaboration/ Extension	1. Would steams behave the same in desert vs Iowa, how could you test? 2. How might climate change impact stream bank erosion, basic options to much water flooding to not enough water drought. 3. Design a system to reduce the impacts of flooding and/or reduce stream bank erosion.