

WATERSHED DYNAMICS LESSON - Water Erosion Processes & Patterns



TOPIC: Varying volumes and velocities of water erode, transport, and deposit Earth materials and shape Earth's surface at different spatial scales.

AUTHOR: Beaver Water District

CLASS TIME NEEDED: A minimum of two 60-minute class periods or three 45-minute class periods would be required.

Two 60-Minute Periods Scenario:

Period 1 - Students participate in an initial erosion discussion/visualization and do the review of online Erosion resources as described in the BACKGROUND/BEFORE ACTIVITY

Period 2 - Erosion bin activity, BACKGROUND/AFTER ACTIVITY online resources review with discussion, and (optional) school grounds erosion features survey.

Three 45-Minute Periods Scenario:

Period 1 - Students participate in an initial erosion discussion/visualization and do the review of online Erosion resources as described in the BACKGROUND/BEFORE ACTIVITY

Period 2 - Erosion bin activity

Period 3 - BACKGROUND/AFTER ACTIVITY online resources review with discussion, and (optional) school grounds erosion features survey.

SUBJECT/GRADE LEVEL: Physical Science; Biology; Earth Science; ETS; Environmental Science - K-12th

The "new" vision for Science Learning shifts the implementation of instruction from presentation of facts and information by a teacher and "cookbook science lab" exercises to initial student inquiry and application of **The 3-Dimensions of Science Learning: 1-Science and Engineering Practices** that lead to deeper experiential understanding of **2-Disciplinary Core Ideas** and revelation of **3-Cross-Cutting Concepts** (Source: "A Vision and Plan for Science Teaching and Learning" by Brett Moulding, Dr. Roger Bybee, and Nicole Paulson is available for purchase at www.etlpd.com/a-vision-and-plan-for-science-teaching-and-learning).



SMALL-SCALE effects of water on fine-to-medium grained sand (in desktop "erosion" bins) **MODEL**

PLANET-SCALE PROCESSES AND PATTERNS in this "Classroom Example" of

Phenomena-Based 3-Dimensional Science Learning that may be adapted for age

appropriateness and made suitable for all grade levels (K-12). The inquiry-driven

approach is designed to pique curiosity as students first ponder and discuss, pose

and note questions about ways varying volumes and velocities of water impact and

interact with earth materials, then observe, describe, note and/or draw the effect of

water dripped by pipette drop-by-drop from different heights, applied in diffuse mist

or focused stream from a spray bottle, and poured from a cup in volumes that vary

from trickle to ample stream. Pages 5-8 include links to maps, images, and videos of terrestrial water erosion

features for a compare/contrast summary discussion of **SMALL-TO-LARGE SCALE** water erosion **PROCESSES AND**

PATTERNS, as well as links to student educational resources for further inquiry and investigation into "Factors and

Forces That Shape Earth's Surface."



ARKANSAS SCIENCE STANDARDS:

Grades K-2

- Physical Science – K-PS2-1, K-PS2-2, K-PS3-1, 2-PS1-1, 2-PS1-2, 2-PS1-3, 2-PS1-4, 3-PS2-1
- Biology – 2-LS4-1
- Earth Science – K-ESS2-1, K-ESS2-2, K-ESS3-2, K-ESS3-3, 2-ESS1-1, 2-ESS2-1, 2-ESS2-2, 2-ESS2-3
- Engineering, Technology, & Application of Science –K-ETS1-1, K-ETS1-2, K-ETS1-3, 2-ETS1-1, 2-ETS1-2, 2-ETS1-3

Grades 3-4

- Physical Science – 3-PS2-1, 3-PS2-2, 4-PS3-1, 4-PS3-3, 4-PS4-1
- Biology – 3-LS3-2, 3-LS4-3, 3-LS4-1, 3-LS4-3, 3-LS4-4
- Earth Science – 3-ESS2-1, 3-ESS2-2, 3-ESS3-1, 4-ESS1-1, 4-ESS2-1, 4-ESS2-2, 4-ESS3-1, 4-ESS3-2
- Engineering, Technology, & Application of Science – 3-ETS1-1, 3-ETS1-2, 3-ETS1-3, 4-ETS1-1, 4-ETS1-2, 4-ETS1-3

Grades 5-8

- Physical Science – 5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4, 5-PS2-1, 6-PS3-5, 7-PS1-2, 7-PS1-5, 8-PS2-1, 8-PS2-2, 8-PS3-1, 8-PS3-2, 8-PS4-1
- Biology – 7-LS2-1, 7-LS2-2, 7-LS2-4, 7-LS2-5
- Earth Science –5-ESS2-1, 5-ESS2-2, 5-ESS3-1, 6-ESS2-4, 6-ESS2-5, 6-ESS2-6, 6-ESS3-3, 6-ESS3-4, 6-ESS3-5, 7-ESS2-1, 7-ESS2-2, 7-ESS3-1, 7-ESS3-2
- Engineering, Technology, & Application of Science – 5-ETS1-1, 5-ETS1-2, 5-ETS1-3, 6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4, 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4, 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4

Grades 9-12

- Physical Science – PSI-LS2-7, PSI-LS4-5, PSI-ESS3-1, PSI6-ETS1-2, PSI6-ETS1-4
- Biology – BI-LS2-6, BI-LS2-7, BI-LS4-5, BI-LS4-6, BI-ESS2-2, BI-ESS2-5, BI-ESS3-1, BI-ESS3-3, BI-ESS3-4, BI-ESS3-6, BI3-ETS1-3, BI6-ETS1-2, BI6-ETS1-3, BI7-ETS1-1, BI7-ETS1-4
- Earth Science - ES-ESS2-1, ES-ESS2-2, ES-ESS2-4, ES-ESS2-5, ES-ESS2-6, ES-ESS3-1, ES-ESS3-3, ES-ESS3-4, ES1-ETS1-1, ES2-ETS1-1, ES2-ETS1-3, ES3-ETS1-1, ES3-ETS1-2, ES3-ETS1-4, ES-ESS3-5, ES-ESS3-6
- Environmental Science - EVS-ESS2-2, EVS-ESS2-5, EVS-ESS3-1, EVS-ESS3-3, EVS-ESS3-4, EVS-ESS3-5, EVS-ESS3-6, EVS3-ETS1-3, EVS4-ETS1-3, EVS-LS2-6, EVS-LS2-7, EVS-LS4-6, EVS-PS3-2

LEARNING PERFORMANCE TARGET(S): (learning expectations for this lesson combine a science practice, crosscutting concept and core idea embedded in the lesson)

Students who demonstrate understanding can:

- Ask questions; make, use, and share observations; gather and use information from several sources; identify evidence from patterns
- Plan and conduct an investigation
- Develop a simple sketch, drawing, physical, and/or a computer simulation model
- Analyze data
- Construct an argument supported by evidence or an evidence-based account
- Define, communicate, compare, evaluate, and make a claim about the merit of solutions
- Use a computational representation and/or represent data in tables and graphical displays

SCIENCE AND ENGINEERING PRACTICES:

- Asking questions & defining problems (K-12)
- Developing & using models (K-12)
- Planning & carrying out investigations (K-12)
- Analyzing & interpreting data (MS, HS)
- Using mathematics & computational thinking (MS, HS)
- Constructing explanations & designing solutions (K-12)
- Engaging in argument from evidence (K-12)
- Obtaining, evaluating, & communicating information (K-12)

DISCIPLINARY CORE IDEAS

- Life Science – Ecosystems: Interactions, energy, and dynamics
- Earth & Space Science – Earth’s systems, Earth and human activity
- Physical Science – Matter and its interactions, Motion and stability: Forces and interactions, Energy
- Engineering, Technology, and the Application of Science

CROSSCUTTING CONCEPTS:

- Patterns
- Cause and effect
- Scale, proportion, and quantity
- Systems and system models
- Energy and matter
- Structure and Function
- Stability and Change

CCSS CONNECTIONS: (include mathematical concepts and reading, writing, speaking and listening opportunities in the lesson) • All exist throughout the lesson. • ELA/Literacy • Mathematics

MATERIALS:

- Cups, pipettes/eyedroppers, spray bottles, water
- Desktop: Waxed paper & dissecting/flat pans, flour or cocoa powder (See Links #1, p. 4)
- Desktop: Plastic Bins (approximate dimensions 16-inch x 24-inch), playground sand
- A SUPPLY container with surplus DRY sand and a “SLOP” bucket for collecting saturated sand

TEACHER PREPARATION:

- Review online **RESOURCES & YOUTUBE VIDEOS** on **EROSION BY WATER** (See pages 6-8)
 - Grades K-4: **Soil Erosion** - soilerosion.net/index.html; **Water Erosion** - soilerosion.net/water_erosion.html
 - Grades 5-12: **Erosion** - nationalgeographic.org/encyclopedia/erosion
 - K-12 **Erosion By Water Experiment**: www.youtube.com/watch?v=xzVBFkpD94E
 - Grades 6-12 “**Water Erosion**” video: www.youtube.com/watch?time_continue=12&v=ofhQvAu_L1l

BACKGROUND INFORMATION:

Problem Question:

How do the properties and movements of water shape Earth’s surface and affect its systems?

Teachers:

- Research local watershed(s), land use, and erosion problems associated with these watersheds (See NW Arkansas Watershed Resources, page 5).

Students:

- **BEFORE ACTIVITY** – Have the class comment on what they know about erosion by water, then do online research to read about, note, and discuss Weathering, Erosion, Types of Erosion, and Water Erosion terms, features, and/or processes on websites listed below:
 - **Grades K-4: Weathering** - kidsgeo.com/geology-for-kids/weathering; **Erosion** - kidsgeo.com/geology-for-kids/erosion; **Types of Erosion** - kidsgeo.com/geology-for-kids/types-of-erosion; **Water Erosion** - kidsgeo.com/geology-for-kids/water-erosion
 - **Grades 5-12: The Water Cycle and Runoff** - water.usgs.gov/edu/watercyclerrunoff.html; **Runoff** - water.usgs.gov/edu/runoff.html; **Erosion**- nationalgeographic.org/encyclopedia/erosion
- **AFTER ACTIVITY** – View the following, then discuss, and note insights gained about water erosion features and processes, and compare/contrast erosion processes and features of varying spatial scales:
 - “**Water Erosion**” video - https://www.youtube.com/watch?time_continue=12&v=ofhQvAu_L1l
 - **GRADE LEVEL EROSION BY WATER RESOURCES & YOUTUBE VIDEOS** on pages 6-8.

Keywords (According to Grade/Reading Skill Level)

Alluvium: Earth material that has been deposited after movement by flowing water.

Creek/Stream/River: narrow to wide terms of scale for a natural elongated course along which water flows.

Erosion: detachment (breaking loose) and transport (moving) of earth materials by wind, water, or the activity of living organisms.

Flash Flood: a sudden, but relatively brief inundation of high volume and velocity in a localized or limited area.

Gully: long narrow steep-sided channel created by the erosion of soil or rock by water

Raindrop Impact Crater: A circular depression formed when a raindrop strikes a surface covered by small, loose particles.

Rill: small grooves that form as water flows over and erodes soil.

Runoff: flow of precipitation or irrigation water across the ground surface or pavement until it enters a surface water body

Sediment: small particles of rocks or minerals deposited after being moved by wind, flowing water or ice, or other natural processes.

Streambank Erosion: removal of soil and vegetation from land boundaries of stream channels by flowing water.

Swale: a natural or man-made low-lying elongated land surface area between ridges along or through which water moves

Watershed: an area of land that catches precipitation and moves **runoff** across the ground surface and along drainages (e.g. rill, gully, ditch, etc.) to the lowest elevation within it, usually a water body such as river, lake, or ocean.

Watershed Boundary: A topographical divide consisting of an elevated linear land surface off which water flows to one side or the other.

ACTIVITY: 7 E's WATER EROSION PROCESSES & PATTERNS

Elicit

Review and talk about Weathering, Erosion, Types of Erosion, Water Erosion, small-to-large impacts of water erosion processes, and shapes and sizes of erosion features described in BACKGROUND INFORMATION links on page 3. Ask students to describe erosional **phenomena** they have observed firsthand.

Engage

Assign teams of 2 to 4 students per water erosion station with activity materials and have them suggest how the materials could be used to model water erosion processes and features.

Explore

Water erosion teams set up trays/bins and conduct 3 Erosion Surface Trials (1. On a LEVEL "soil" surface; 2. On a slope of 10-15 degrees; 3. On a 25-30-degree slope) in which they observe/draw the erosion features that develop as water is applied to the "soil" drop-by-drop from different heights with the eyedropper/pipette, sprayed to imitate a light-to-heavy rainfall, then steadily poured from a cup starting with a trickle and gradually increasing in amount to an ample stream.

Explain

Ask teams to describe the impacts of different volumes and velocities of water dropping, falling on, or flowing across level surfaces and slopes of varying degrees.

Elaborate

Compare and contrast the scale of desktop erosion model processes and phenomena with those that are found or occur in nature, including examples from the watershed in which the school is located, students reside, or another local watershed. Identify phenomena related to erosion during a walk on school grounds or surrounding areas. Research recent local-to-global flooding events, causes, erosion impacts, and solutions (or have brainstorming session on solutions to flooding and erosion issues).

Evaluate

Assess student functional knowledge by evaluating model(s), results, presentation(s), and/or unit test.

Extensions

Use this lesson along with other weathering and erosion resources to create a plan for mitigating flooding, runoff, and erosion or for repairing damage in an erosion prone area. Create a community project to identify and assess erosion problem areas and involve the community in implementing Stormwater Best Management Practices (uaex.edu/environment-nature/water/stormwater) to prevent degradation of water quality due to potential increased eroded sediment load in surface water bodies.

LINKS TO NW ARKANSAS WATERSHED RESOURCES:

1. **Arkansas Environmental Education Association (AEEA)** – arkansasee.org
 - Seeing Watersheds Stormwater Extension - arkansasee.org/wp-content/uploads/2018/06/SeeingWatershedsStormwaterExtension.pdf
2. **Arkansas Water Resources Center (AWRC)** - arkansas-water-center.uark.edu
3. **Center for Advanced Spatial Technologies (CAST)** – <https://cast.uark.edu/>
 - Arkansas Watershed Information System –
 - Arkansas Watersheds - watersheds.cast.uark.edu
 - Find your watershed - watersheds.cast.uark.edu/find_your_watershed.html
4. **Beaver Water District (BWD)** – bwdh2o.org
 - WATERSHED MAPS & INFORMATION - bwdh2o.org/beaver-lake/watershed-maps
5. **Beaver Watershed Alliance (BWA)** – beaverwatershedalliance.org
 - ABOUT THE WATERSHED - PRIORITY ISSUES - beaverwatershedalliance.org/about/our-watershed.aspx
6. **Illinois River Watershed Partnership (IRWP)**- irwp.org
 - CONSERVATION & RESTORATION - irwp.org/conservation-and-restoration
7. **Northwest Arkansas Land Trust (NWALT)** - nwalandtrust.org
 - EXPLORE - 4 NWALT Priority Areas
 - Illinois River Headwaters Corridor - nwalandtrust.org/illinois-river-headwaters-corridor
 - Greater Kessler Mountain Wildlife Region – <https://www.nwalandtrust.org/greater-kessler-mountain-wildlife-region>
 - West Fork of the White River – nwalandtrust.org/west-fork-of-the-white-river
 - Beaver Lake Source Water Protection Zone - nwalandtrust.org/beaver-lake-source-water-protection-zone
8. **Northwest Arkansas Regional Planning Commission (NWARPC)** - nwarpc.org
 - OUR WORK: ENVIRONMENT - nwarpc.org/environment
9. **Ozarks Water Watch at Beaver Lake (OWW-BL)** - owwbeaverlake.org
 - HOME OWNERS EDUCATION PROGRAM - owwbeaverlake.org/education/home-owners-education-program
10. **University of Arkansas Cooperative Extension Service (UAEX)** – uaex.edu
 - Arkansas Stormwater Education Program - <https://www.uaex.edu/environment-nature/water/stormwater/default.aspx>
 - Water Sustainability in Arkansas - <https://www.uaex.edu/environment-nature/water/sustainability.aspx>
11. **U.S. Army Corps of Engineers (USACE)/Beaver Lake** – www.swl.usace.army.mil/Missions/Recreation/Lakes/Beaver-Lake
 - Shoreline Management Webpage - www.swl.usace.army.mil/Missions/Recreation/Lakes/Beaver-Lake/Shoreline-Management/
 - Beaver Lake Shoreline Management Plan – Section VIII: 8-06 Erosion Control (page 23) <http://cdm16021.contentdm.oclc.org/utis/getfile/collection/p16021coll7/id/3972>
 - SWLR 1130-2-48 Appendix J: Shoreline Erosion Control – www.swl.usace.army.mil/Portals/50/docs/beaverlake/SWLR1130-2-48.pdf
12. **Watershed Conservation Resource Center (WCRC)** - watershedconservation.org

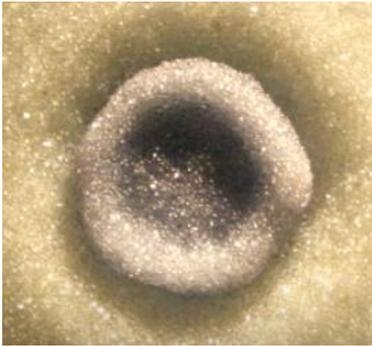
ASSORTED ONLINE EROSION BY WATER RESOURCES & YOUTUBE VIDEOS

Grades K-4: Earth Processes - www.onegeology.org/extra/kids/earthprocesses/home.html; Weathering - www.onegeology.org/extra/kids/earthprocesses/weathering.html; kidsgeo.com/geology-for-kids/weathering/; Weathering & Erosion - www.education.com/worksheet/article/weathering-and-erosion/

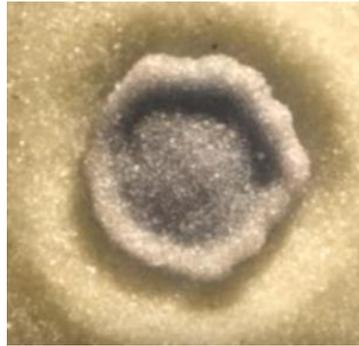
Grades 5-12: Erosion - www.nationalgeographic.org/encyclopedia/erosion/; www.nps.gov/tica/learn/education/upload/Erosion.pptx; Weathering & Erosion - www.nationalgeographic.com/science/earth/the-dynamic-earth/weathering-erosion/; aetn.pbslearningmedia.org/resource/nat08.earth.geol.eros.lpbreakit/breaking-it-down-weathering-and-erosion/; Water Cycle and Runoff - water.usgs.gov/edu/watercyclerrunoff.html; Runoff - water.usgs.gov/edu/runoff.html

DROP IMPACT VIDEO: www.youtube.com/watch?v=6swY05e2iT4

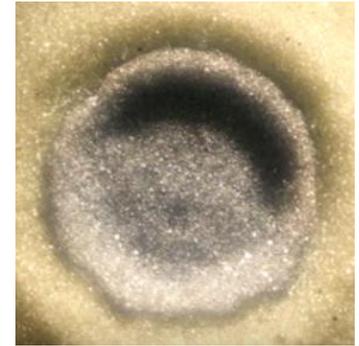
Low Velocity



Medium Velocity



High Velocity



WEATHERING AND EROSION

K-4 Weathering and Erosion

www.youtube.com/watch?v=exS9gFXgib0



K-4 What is Weathering?

www.youtube.com/watch?v=BxmAJMjJ5Nk



G5-12 Mechanical & Chemical Weathering

www.youtube.com/watch?v=AD7sqlOIgI4



K-12 Erosion and Soil

www.youtube.com/watch?v=im4HVXMG168



G5-12 EmRiver Introduction: erosion and deposition in a self-forming model river channel

www.youtube.com/watch?v=g65_MgWaBoM

ASSORTED EROSION BY WATER YOUTUBE VIDEOS

K-4 Water Erosion Model

www.youtube.com/watch?v=FEppX7ahU3s



G5-12 HowStuffWorks Show: Episode 4: Power Of Water Erosion

www.youtube.com/watch?v=MFpCJsc_k64



K-12 Erosion By Water

www.youtube.com/watch?v=xzVBFkpD94E



K-12 The Power of Water: How Erosion by Water Shapes Landforms

www.youtube.com/watch?v=qqsTS67BKmA



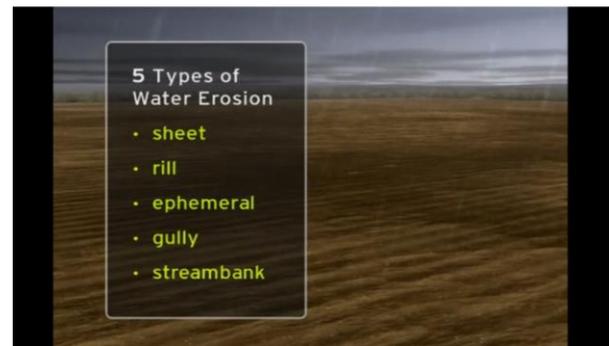
G2-4 PBL & STEM Project: Designing Erosion Solutions

<https://www.youtube.com/watch?v=2QvZTokDc1s>



G5-12 Water Erosion

www.youtube.com/watch?v=ofhQvAu_L1l



K-12 Erosion Lab: Wave, Wind, Flowing Water, Slope Runoff

<https://www.youtube.com/watch?v=ZNJe6hrdL3M>



G6-12 Erosion by Running Water – Video Notes

www.youtube.com/watch?v=6VzpzQO1Nsw

Running Water
Streams and Rivers

- Running water is the **most common** agent of erosion.

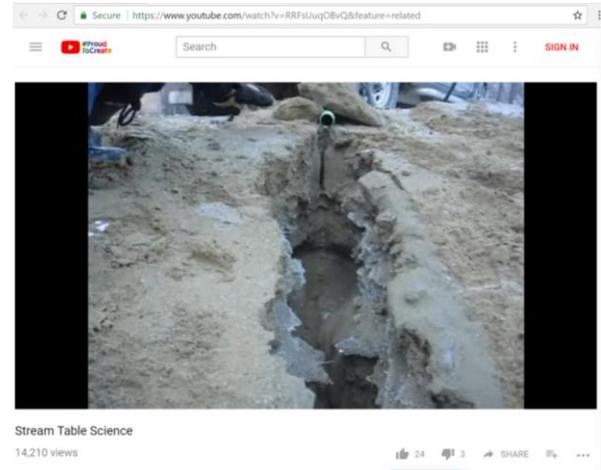


ASSORTED EROSION BY WATER YOUTUBE VIDEOS

G6-12 A Stream Story by Devin and Pete – Science project on meandering rivers, sedimentary deposits and water erosion.

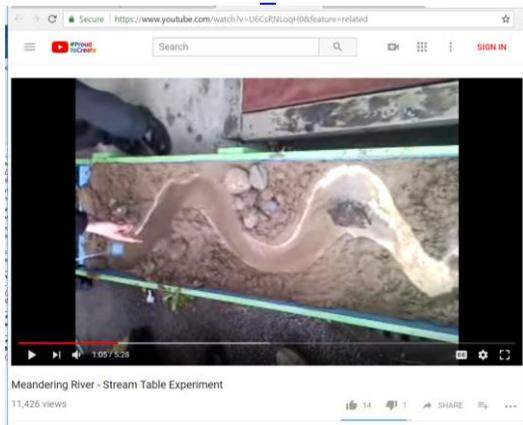
www.youtube.com/watch?v=RRF4UuqOBvQ&feature=related

- 1) **Canyons** – Flow over flatland picks up/erodes rocks and sediment, banks collapse, form v-shaped channel
- 2) **Waterfalls** – Plunge pools, undercutting, overhang collapse, headward erosion
- 3) **Meanders and Oxbows** – Rapid flow side of channel erodes forming cutbank, slow flow side of channel forms depositional point bars, erosion progresses on upstream side of point bar, new channel forms, deposition occurs at entrance and exit of former meander



G6-12 Meandering River – Stream Table Experiment (SJS 2008-2009. Geography 12. Byron's River Design.

www.youtube.com/watch?v=U6CsRNlQhH0&feature=related



G6-12 Emriver river gravel mining demonstration (www.emriver.com) 12/02/2007

www.youtube.com/watch?v=0tb5may-Ghw



G6-12 Stream Channel Demo – Meander Cutoff During Flood 09/25/2011

www.youtube.com/watch?v=qszdUx6zNag



G6-12 Winona State University (MN) Em4 Delta Building and Analysis (www.emriver.com) 09/01/2011

www.youtube.com/watch?v=zbdM5Kjoxaw&feature=related

