Fourth Grade Earth/Space Science

FLOODS! Erosion by Water

Background Information:

Water was the most important environmental factor in early human settlement and rivers were useful sources of water. They were important sources for fresh drinking water, washing, food, and transportation. Floods are a natural part of river ecosystems and flood control by humans has been practiced since ancient times with methods such as reforestation, and the construction of levees, dams, reservoirs and channels diverting floodwater. Farmers often settled near rivers for steady access to water. The river's natural flooding could help irrigate their farms and in dry seasons the farmers could dig canals or trenches to direct river water to their crops.

Flooding is a coast-to-coast threat to the United States and its territories in all months of the year. The most common cause of flooding is rain and/or snowmelt that accumulates faster than soils can absorb it or rivers can carry it away. The National Weather Service (NWS) issues Flood Warnings for designated River Forecast Points where a flood stage has been established. River flooding is classified as "Minor, Moderate, or Major" based on water height and impacts along the river.

The Great Flood of 1993 was one of the most significant and damaging natural disasters ever to hit the United States. Damages totaled $15 billion, 50 people died, hundreds of levees failed, and thousands of people were evacuated. It was certainly the largest and most significant flood event ever to occur in the United States. Conditions for the flood started with saturated soils and streams filled to capacity across the Upper Midwest in June. Runoff from persistent heavy rains of June, July, and August had no place to go other than into the streams and river channels. The record summer rainfalls equaled or exceeded flood recurrence intervals of 100 years along major portions of the upper Mississippi and lower Missouri Rivers.

In July 1996, record rainfall produced flash flooding over Northeast Illinois. A new state 24-hour rainfall record was set when Aurora, Illinois, received 16.94 inches of rain. Major flooding along portions of the Fox, Illinois, and DuPage Rivers. The flooding caused hundreds of millions of dollars of damage to flooded houses and washed out bridges and resulted in 2 deaths.

Erosion is the process of wearing away the surface of the Earth by water, waves, wind, glacier and chemical or temperature changes. Weathering by water, waves and wind are fairly easy for students to see and understand. Weathering due to chemical or temperature change is common but the process is not always evident.

One of the most common ways that soil erodes is by water. Soil erosion occurs naturally, but is also the result of land changes caused by people. As water travels over the land, it takes some soil with it and leaves or deposits some along the path it takes; this is called deposition. Water moves

soil through the process of erosion and any buildings or structures on top or nearby that river and its surrounding soil can be affected. Erosion also changes the edges of riverbanks because the movement, or flow, of water in rivers is not always the same and the speed of water changes depending on the location in the river. For example, when water goes around a turn in a river, the water on the inside of the turn moves faster than the water on the outside of the river. The path of a river and how many turns it has can change how the water moves through it, which causes erosion.

To prevent property destruction and injury to people, engineers study the dynamics of moving water and floodplains to the design ways to control flood waters. The changing cycles of natural disasters and hurricanes call for engineers to come up with new, innovative ideas to reduce the disaster risks.

Performance Expectations

4-ESS2-1 Earth's Systems: Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. https://www.nextgenscience.org/pe/4-ess2-1- earths-systems

4-ESS3-2 Earth and Human Activity: Generate and compare multiple solutions to reduce the impacts of natural processes on humans.

https://www.nextgenscience.org/pe/4-ess3-2-earth-and-human-activity

Disciplinary Core Ideas

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.

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.

ETS1.B: Designing Solutions to Engineering Problems: Testing a solution involves investigating how well it performs under a range of likely conditions.

Science and Engineering Practices

Developing and using Models: Develop and/or use models to describe and/or predict phenomena. Develop a diagram or simple physical prototype to convey a proposed object, tool, or process. Use a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

Designing solutions for an engineering problem: Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.

Crosscutting Concepts

Cause and effect: Cause and effect relationships are routinely identified, tested, and used to explain change.

Systems and system models: A system can be described in terms of its components and their interactions.

Materials:

- Plastic storage containers
- Burlap ribbon
- Graduated cups
- Vinegar
- Plastic cups

- Wooden wedges or blocks
- Mesh bags
- Small fabric scraps
- Clay
- Gravel
- Hand Lenses
- Small blocks, Meeples, or Legos
- Craft sticks
- Pipettes, eye droppers, spray bottles
- Small sea shells
- Fine sand or soil
- Computer with Internet Access

Advance Preparation:

- The activity works best with a fine-grained substance like sand so that small details can be seen.
- You can use local materials or purchase fine grain sand at a local hardware or garden center. Alternate materials include clay and heavy soil (not one with lots of lightweight filler). This should be spread on the bottom of a square waterproof container to a depth of at least 1 inch.
- It is best to have the students start with damp sand/soil/clay so dampen it with a spray of water and let it sit overnight for any top water to evaporate.
- Determine where and how materials will be distributed or accessed in the classroom
- Determine if you will have students investigate weathering with shells and vinegar

Resources:

https://www.weather.gov/safety/flood-states-il
https://www.weather.gov/media/owlie/NWS_FloodsHappen2018.pdf
https://www.teachengineering.org/activities/view/nyu_erosion_activity1

Suggested Implementation:

Ask students to list ways that show that the earth is changing. These might include major events like earthquakes and volcanoes, but encourage them to also consider smaller changes closer to home, such as erosion. A video by Bill Nye is a good intro to the processes of erosion. https://www.youtube.com/watch?v=J-ULcVdeqgE

If students are investigating weathering you may have them put a shell in vinegar and a similar one in water leaving both overnight.

Show students several video clips of flooding rivers. Ask them to list effects of the floods that they noticed from the videos or from their experience. Ask them to brainstorm ways that the floods might have been prevented or caused less destruction. The following videos may enhance discussion:

- https://www.youtube.com/watch?v=JME8XU8rZNI
- http://www.newstrib.com/multimedia/illinois-river-flooding-video/youtube_29e945b4-1904-11e8-ae6c-ab973b6aca1f.html

- https://www.washingtonpost.com/video/local/weather/total-devastation-major-flooding-strikes-from-nebraska-to-wisconsin/2019/03/16/d68e4ef0-0e4a-435e-ab8d-6860e3cc17c5_video.html?noredirect=on&utm_term=.38a5d7e1dd7b
- https://wgntv.com/2019/02/01/7-mile-ice-jam-on-kankakee-river-causing-flooding-concerns-in-wilmington/

Share with students that they will explore the impact of changing river volumes and different river shapes in experimental trials with small riverbed models. Each group will select the two river shapes they wish to model and test. Distribute and discuss the handout of river photographs. Read through the procedure answering any questions students have.

Each group will be given a small container with sediment in the bottom to test different river shapes and to design a flood prevention system for a little town along the river. The town will consist of small blocks that can be placed near the river.

In small groups, have the students look at the river cards and choose 2 river shapes that they would like to simulate. They should develop a testing procedure to use with their chosen 2 river shapes. Allow the groups to discuss how they will simulate light and heavy rain and how they will collect evidence about the speed of the water.

They will form their selected river shape in the sediment with a wood craft stick so that the river is about 1" wide. Small blocks placed near the river mark the town. The rivers can be tilted slightly (no more than 1") with building blocks or other spacers so that there is a slope for the water to run down. Rain will be simulated at the upper end of the container with small droppers or with a spray bottle. Sediments will move along the river and the students should carefully watch the movement and record their observations.

Once the students have had a chance to work with their river models under different conditions, they will design a system to prevent flooding of their town under heavy rain situations. Point out the variety of materials available to them. Suggestions include gravel, sea shells, mesh and fabric, burlap, craft sticks, clay, small sticks, and plastic vegetation. Allow them to explore how well these work (or don't) and then to design a system to protect the town. Ask them to collect evidence that helps to make the case that their design will work. Have the groups present their designs to the class, sharing the evidence that they used to choose the parts of their design.

The final activity asks students to find out about a stream in their own area that might have a water level gauge. If students have internet access, visit the National Weather Service at http://water.weather.gov/ahps/ and zoom into the map by clicking the + button.

Find a stream gauge that is in a stream or river year your classroom and click on the dot. The different colors indicate what the water level is at that point of the stream. If you do not have many computers, this can be done as a whole class with a projector. An alternate site: https://waterdata.usgs.gov/il/nwis/current/?type=flow

Debrief Discussion Questions:

- Ask the students to compare the stream shapes for speed of water, impact on town buildings and erosions.
- Ask the students to compare their final designs. Are there some common components? Are there methods that are not as good for the town?
- Discuss the impact of their final designs on the wildlife habitat near the river. If anyone tried vegetation or sticks, that would model marshes or wetlands that can serve as effective ways to slow river water and act as natural sponges by slowly capturing water over a longer period of time.
- Point out that streams with a lot of curves (meanders) are often found in flatter parts of the watershed. Streams that end in another body of water frequently have a branched shape as the water slows down and forms little rivulets. How would this influence your plans?

Accommodation:

- If students are having a hard time seeing the flow of the water in their little models, suggest a pinch of glitter at the top before the "rain" is started.

Extensions:

- Ask the students to design a poster or multimedia campaign for their school about the dangers of floods.
- Ask students to examine the pros and cons of living near a river in Peru. Although the rivers are important for farming, fishing, crafts, and transportation but they are also very prone to flooding. Images and more information about Peru river uses at http://gotravelzing.com/life-on-the-amazon-river/ Peru has been plagued with many floods. After a period of severe drought, floods caused by the coastal El Niño phenomenon in 2017 affected 1.9 million people in Peru, nearly a third of them children. In 2008, intense rains began to pound much of South America and rivers along the northwest coast of Peru flooded. The NASA Terra satellite captured images of the flooded river systems on April 1, 2008. Streams and pools of dark blue water dominate what was a tan-pink desert in early February, immediately before the rains began. Ask students to compare the 2 images before and during the flooding. https://earthobservatory.nasa.gov/images/19670/heavy-rain-floods-south-america
- Ask students to experiment with several elevations with their river shape to simulate different geographic areas of the country with steeper or shallower river beds.
- Students may investigate how other towns have solved flooding problems. They will find a variety of responses from moving the town out of the floodplain to building extensive levees and dams.
- There are pros and cons of changing a river's shape. There are many dams and levees that have changed the flooding scenarios for many towns. However, there are downsides for cutting off the river or sending the flood waters downstream to others less prepared. Straight rivers are also faster rivers.

- Beavers are well known dam builders, living near rivers, streams, ponds, small lakes, and marshes. When beavers build dams, they create new wetland environments for other species. These wetlands can help slow erosion, raise the water table, and help purify the water. (Source: https://nhpbs.org/natureworks/beaver.htm) Beavers and muskrats are found in every county in Illinois. Ask students to investigate the life history of beavers or muskrats and report about the ecological advantages and downsides of their construction work.
  https://www.dnr.illinois.gov/conservation/wildlife/Pages/Muskrat.aspx and
  https://www.dnr.illinois.gov/conservation/wildlife/Pages/Beaver.aspx
- Reading about floods, understanding what causes floods, and talking about natural disasters in general will help children who have experienced a flood to communicate their feelings and fears. Here is as link to a list of books that can be ordered through interlibrary loan from your local library: Books for Grades 4 - 6
- Also consider these books:
  - *Flood*, by Alvaro F. Villa, a picture book appropriate for every member of the family. The story highlights a family preparing for a storm, boarding up their home and evacuating. The waters rush into and fill their home, destroying it. When the family returns, it's barely standing, but they rebuild and make it a home once again.
  - *Once I Was Very Scared*, by Chandra Ghosh Ippen, uses animals to convey the fact that feeling frightened is common and, more importantly, that people respond to that stress and anxiety in different ways — and that's okay. A Spanish version, *Una Vez Tuve Mucho Mucho Miedo*
  - *Flood* by B. Knapp, Describes some of the world's greatest flood disasters, why floods occur, and how people have learned to live with floods.
- Have your students in small groups investigate the history of dam construction through-out history. There are many different types of dams and for different purposes (flood control, water storage, hydroelectric generation). Ask them to build a model of one of the more interesting dams that they find out about. Excellent online resources:
  - Human-built dams across history: http://origins.osu.edu/connecting-history/top-ten-origins-dams
  - Taming Rivers in South Africa: https://blog.nationalgeographic.org/2016/10/06/taming-rivers-a-fulbright-national-geographic-journey/
  - History of dams: https://watershed.ucdavis.edu/shed/lund/dams/Dam_History_Page/History.htm