Surface Processes on Earth

This unit includes using maps and data to predict and map flooding, as well as landslides and other features as a result of the flooding

Student Science Performance

Grade or course Earth Science HS	**Title:**
Topic: Predicting and Mapping Flooding	Predicting and Mapping Flooding

Performance Expectation for GSE:

SES3. Obtain, evaluate, and communicate information to explore the actions of water, wind, ice, and gravity as they relate to landscape change.

a. Plan and carry out an investigation that demonstrates how surface water and groundwater act as the major agents of physical and chemical weathering.
b. Develop a model of the processes and geologic hazards that result from both sudden and gradual mass wasting.
c. Construct an explanation that relates the past and present actions of ice, wind, and water to landform distribution and landscape change.
d. Construct an argument based on evidence that relates the characteristics of the sedimentary materials to the energy by which they were transported and deposited.

SES1. Obtain, evaluate, and communicate information to investigate the composition and formation of Earth systems, including the Earth's place in the solar system.

b. Ask questions to evaluate evidence for the development and composition of Earth's early systems, including the geosphere (crust, mantle and core), hydrosphere and atmosphere. (*Clarification statement:* The differentiation by density of Earth into crust, mantle and core should be included in this element.)

Performance Expectations for Instruction:

Students will

- Research how wind, water, and ice can cause weathering and erosion.
- Use sandbox or stream table to demonstrate how water affects landforms and landscapes.
- Investigate the effects of water in causing mass wasting.
- Relate how weather events cause flooding and damage.
- Research hurricanes and the resulting damage caused by wind and rain to the economy and land.
- Construct models of landforms demonstrating the actions of water, wind, ice, or gravity on the land.
- Write a public service announcement about areas prone to flooding.
- Research floodplains and their impact on homes, businesses and insurance.

Additional notes on student supports

Materials:

Computers/Tablets
Internet access
Homemade or commercial sandbox/stream table with flowing water, sand or other particulates.
Students or Teacher will need to research this background information to share; possible examples:

- Video on Predicting Flooding: ScienceCasts: Predicting Floods
- Information Handout: Global Flood Monitoring System (GFMS) University of Maryland
- Video: Aerial Footage of flooding in New Orleans after Hurricane Katrina
- Video: Virginia flooding from Irene
- Video: South Carolina flooding from Florence

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- Information Handout: Vahdettin Demir and Ozgur Kisi, “Flood Hazard Mapping by Using Geographic Information System and Hydraulic Model: Mert River, Samsun, Turkey,” (full text can be found online)
- Landslides: Teachers Notes and Student Activities Click on the Landslides activity. This 50 page booklet explains the nature of landslides and gives examples of various historical landslides that have occurred in Australia. Student activities with answers included.

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<tr><td colspan="2">Students will continuously obtain, evaluate, and communicate information. This is not a linear process. Students will communicate through writing and discussions to allow for formative assessment. This benefits the teacher, student, and whole group to guide instruction to clarify misconceptions or extend content.</td></tr>
<tr><td rowspan="4">Engaging Learners</td><td>Phenomenon
Flash Flooding: research a video on: Severe Flash Flood Caused by a Heavy Rainstorms, an example is video footage of flooding in Yulin, China.

Teacher note: If there is a current event of flooding and damage available as a phenomenon, use it. An example could include pending landfall of a hurricane. A perfect example is Hurricane Harvey approaching Texas with anticipated 24+ inches of rainfall expected. A great resource for images and information will be your local emergency management agency, local meteorologists, local media on social media. Just watch and make sure the images are from the current storm and not recycled from a prior storm.</td></tr>
<tr><td>Obtaining
Students obtain information about flooding on the Earth’s surface. Students can achieve this via direct observation, online resources, or historical data.</td></tr>
<tr><td>Evaluating
Students evaluate their understandings of the impact of rainfall (current and recent) and surface features on flooding.</td></tr>
<tr><td>Communicating
Students communicate their understandings via a graphic organizer or some other medium (e.g. interactive science notebook, “K” portion of a KWL chart, etc.) using the evidence that relates the characteristics of the sedimentary materials to the energy by which they were transported and deposited.</td></tr>
<tr><td>Exploring</td><td>Obtaining
Students obtain information about flooding and landforms by exploring the impacts of moving water.
Teacher resources and lessons:
Run for your lives lesson on flooding. And Lab: Exploring Flooding. Other lessons</td></tr>
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	Resource: Research - A video on the surface process lab called Delta in Sandbox is a time-lapse video of a geomorphology lab in University of Connecticut. The topic in this lab is modeling the development of a Gilbert-type delta. A river delta which consists of a wedge-shaped body of sediment, comprising relatively thin, flat-lying, topset sediments, long, steeply dipping forests which prograde (see progradation) from the river mouth, and thinner, flat-lying, bottomset or toeset deposits. Gilbert-type deltas are often developed in lakes, where river water and lake water are of the same density. It was first described by the American geologist Grove Karl Gilbert (1843–1918). (Oxford Index) Erosion is an important natural process that links mountain building and soil formation. Erosion is definitely an effect caused by flooding. This video discusses erosion in Wyoming: Erosion, A Natural Phenomenon. Students will develop labs to show how water moves soil and sand using a sandbox. *Teacher Hint: The box can be a commercial box or handmade with a cake pan, sand and cup to pour water.* *Make a sand and water table.* STEM Challenge: Have students design and build miniature structures that can withstand flooding. Research: Weather Survival; be sure to give constraints at the beginning of the project. 1. Students have a discussion about how heavy rain can cause flooding. 2. Students will brainstorm ideas to keep their structure safe from flooding. 3. Students use 3D printable or other methods to make their 3D a structure. 4. Students then take their printed structures and place them into a plastic tub filled with sand and some small pebbles. 5. The teacher places the tub on a small incline and pours water into the tub. 6. The student observes how their structure stands up to the flooding water. 7. The student reflects on the changes they would make to their structure next time. 8. Students should collect data and analyze what their stream table is "telling" them as far as ground cover, etc. Students would be assessed on their design – if they followed the constraints – if their structure had doors and windows that will be included in the constraints. They would also be assessed on their reflection and their understanding of what changes they would make and why. The students would not be assessed on whether or not their structure withstood the flood because it is a STEM challenge and failures need to be allowed. If time, allow for adjustments in design.

	Communicating Have students use the stream table or sandbox to investigate various landforms that occur during flooding, heavy rains, and drainage of the flood waters. Have them sketch their findings at each step and write explanations of what occurred. Students should research in small groups to find real life examples of those landforms that occur from flooding and the resulting erosion. Remind students to document how the soil or sand characteristics changed as these materials were transported and deposited. They can use magnification to look at particles of soil before, during and after this process to see if there is any changes of particle size or form. *Teacher Note: There might not be any noticeable change in the sand or soil particle since these particles do not spend a long time in the stream table - but having students be observant and denote a before, after, and why would be a good exercise.* Have them use this evidence to write an argument of how soil and sand are changed by large volumes of rapidly moving water. Have them use this information to explain resulting landforms. ● Research a video that shows pictures of three kettles formed by different means while explaining how they are formed. A "kettle" is a shallow, sediment-filled body of water formed by retreating glaciers or draining floodwaters. ● Also, research to share information about Erosion and Deposition by Streams ● Understanding the type of soil and how prone it is to erosion can help avoid problems in agriculture and on waterways and infrastructure. Impacts of land and soil erosion
	Evaluating **Phenomenon** Caves and other physical formation Show students pictures of specific landforms or area and have them construct an explanation about current and potential past events that formed a specific landform or area of the world using the terms physical and chemical weathering. Possible landforms include: Badlands of Utah Kaolin Belt Fall Line River deltas Dunes (ancient and modern) Mars surface

	The students' explanations can come from research or from hands-on modeling of landforms. They should be able to explain how each of these landforms were formed by physical and chemical weathering. The students can construct various landforms on a small scale and explore how water and wind impact the landforms. From there, they can construct an idea of how various landforms are impacted by water, ice and wind. The wind can be simulated with a fan, but make sure students wear safety glasses. Students communicate their understandings with suggestions for how to strengthen the model, as well as, evaluate what would need to be done differently in order to extend the model to include other landforms. Challenge students to replicate the demonstrations in the video that teacher can research called The Effect of Water on Soil Strength to help gain a better understanding of the connections between water and soil type. *Explain:* Major disasters can take place if geotechnical engineers don't take into account water pressure in soil so it is important to understand how water affects soil movement. (A geotechnical engineer uses the disciplines of rock and soil mechanics to investigate subsurface conditions. These engineers use their investigations to design, and build foundations, earth structures, and pavement.) Resources to be researched either by teacher or student. ● Australian Landforms and their History ● Sea cliff erosion ● Model of a demonstration of aeolian transport using a hair dryer and sand. ● Pictures of Aeolian environments Wind-driven sediment motion, wind ripples, grain flows
	Formative Assessment of Student Learning
Explaining Finalizing Model	*Obtaining* Students obtain elevation maps of coastal Georgia or any other coastal area.
	Evaluating Students will evaluate the locations and heights produced by various hurricanes. *A visit from a meteorologist or emergency management agency person may be appropriate at this time. These people can help the students analyze the maps and make them real world. They may also bring images that are not public domain.* *Flood insurance and decisions to evacuate are often based on elevation and location to bodies of water.*
	Communicating Students will write a public address announcement about the locations that will flood if a hurricane is on its way.

Elaborating Applying Model to Solve a Problems	**Phenomenon** **Landslides:** have teacher or student research landslide videos. ● Example: Landslide on 23 July 2017**:** View this video without sound since it is a landslide in Manali Chandigarh. The actual landslide occurs at :53 on. The beginning is of people sitting in the car waiting for it to occur. Soil and rocks will travel down a slope due to mass wasting. The movement is gradual or sudden resulting in a geologic hazard. Ask: Why is this important for people to know? What can happen if there is a landslide, rockslide or avalanche? Have groups of students research these geologic hazards and their cause. Resources for background information: Mass Wasting Classification of Mass Wasting
	Obtaining - Students will obtain rainfall forecast at a location using various resources such as NOAA, USGS, and local weather stations.
	Evaluating Using topographical maps, students will predict flooding and other issues that will arise from the rain. Students should be able to complete this if they have completed the unit on Mapping in 2D and 3D. Students should evaluate different locations and be able to predict/explain why certain areas are considered higher risk by insurance companies for flood insurance. Topographic map source: USGS; searchable feature, PDFs are free: found here. FEMA also offers map source: found here. *Rock types have not been presented yet, but the following question can be posed and then followed up during the rock segments. (Should have precious knowledge from middle school)* *Which type of rock would weather and erode the faster during flooding?* *A common misconception/or incorrect use of language is "sediment" will be the answer to this question. If you hear sediment, then review the differences between rocks and sediment.*
Evaluation	***Assessment of Student Learning***
	Have students compare flooding data around cities and in rural areas. Then have students explain discrepancies in flooding when manmade structures are involved.
SEP, CCC, DCI	**Science Essentials**
Science and Engineering Practices	● Asking questions and defining problems. ● Developing and using models ● Planning and carrying out investigations ● Analyzing and interpreting data ● Using mathematics and computational thinking ● Constructing explanations (for science) and designing solutions (for engineering) ● Engaging in argument from evidence

	• Obtaining, evaluating, and communicating information
Crosscutting Concepts	• Patterns • Cause and Effect • Systems and System Models • Stability and Change
Disciplinary Core Ideas	**ESS2.C: THE ROLES OF WATER IN EARTH'S SURFACE PROCESSES** • The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks.

Additional Supports for struggling learners:

The following supports are suggestions for this lesson and are not the only options to support students in the classroom. These supports target students that struggle with science material, this lesson or a previous lesson. These are generalized supports and do not take the place of IEP accommodations as required by each student's Individualized Education Program.

General supports for the following categories:

Reading:	Writing:	Math:
1. Provide reading support by reading aloud or doing partner reads 2. Have the teacher model what they are thinking when reading the text 3. Annotate the text with students so that they may refer to it as they work through the lab	1. The teacher can provide a sentence starter for the students. 2. The teacher can give students an audience to write to (i.e. Write a letter to your sibling explaining this topic). 3. The teacher can provide constructive feedback during the writing process to help students understand the expectations.	1. Provide calculators as needed. 2. Provide graph paper as needed.

Supports for this specific lesson if needed:

Performance expectations for instruction:

1. The teacher should provide information to students in various formats to reach as many students as possible.
2. The students should be given adequate time to complete each part of the lesson.
3. The students should be allowed to express their knowledge in various formats.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material.

Engage:

1. The teacher should help students connect flooding to their area. Have they experienced flooding in their area?
2. The teacher should use a video, text to speech program or read aloud to help struggling readers.
3. The teacher should have students generate questions about flooding.

4. The students can then use their questions to guide their research.
5. The teacher should consider giving students sources to find information on flooding.
6. The teacher should provide students with a graphic organizer to record their research, observations and questions they have.
7. The teacher may need to explicitly teach students to use any graphic organizer they provide to the students.

Exploring:

1. The teacher should consider showing a video of flooding or a flooded area to get students engaged.
2. The teacher may need to teach students to plan an investigation. The teacher should consider doing a demo on how to plan an investigation. The teacher can make a PB&J (The teacher should only use peanut butter if no student in the class is allergic) using student instructions to reinforce how important plans are to the investigation process. The teacher should only do what is instructed by the students which may lead to the teacher doing things like trying to get jelly out of a closed jar.
3. The teacher should have clearly defined guidelines for discussion. The intention is to make students feel safe and comfortable participating in the discussion.
4. The teacher should use intentional and flexible grouping. Best practice is to use data to drive grouping.
5. Students may need additional time to complete their design.
6. The teacher should provide the students with an organizer to record observations and sketches of their investigations.
7. The teacher should consider giving sentence stems for writing explanations and arguments.
8. The teacher should remind students of the definition of a scientific argument.
9. The teacher should consider providing an organizer for students to plan, make observations, collect data and begin the scientific argument.
10. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
11. The teacher should consider giving students a rubric to evaluate their own work. This increases student ownership and makes the students more invested in their learning.
12. Students may need additional time to complete their explanation.

Explaining:

1. The teacher should consider giving students resources that they can use to find elevation maps.
2. The teacher should prepare students for visitors. Change leads to anxiety in many students and students would do much better if warned of any large changes.
3. The teacher should provide students with a rubric to evaluate their own work.
4. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
5. Students may need additional time to complete their public address.

Elaborating:

1. The teacher should use intentional and flexible grouping. Best practice is to use data to group students.
2. The teacher should consider giving resources to find information on landslides to students.

3. The teacher should consider providing ab organizer to students to record research.

Evaluating:

1. The teacher should be sure to provide multiple ways for the students to communicate their knowledge of the material. These formats could include writing, drawing or verbally explaining.
2. Students may need additional time to construct their explanations.