“Solutions-Oriented Learning” Storyline

4- Natural Hazards: Erosion

Storyline introduction and overview:

What we see on Earth’s surface is a complex and dynamic set of interconnected systems that include the geosphere, hydrosphere, atmosphere, cryosphere and biosphere. Earth’s processes are the result of energy flow and matter cycling within and among these systems. Understanding Earth’s systems is important for many decisions made in communities today such as where to build a road, where a salmon can successfully build a redd to lay eggs, and how to ensure air quality. Erosion involves all five spheres giving students an excellent example of the interconnectedness of these large systems.

Students may begin the storyline by hearing a story about the relationship between the land and plants from an Indigenous perspective, a local tribe elder or expert if possible. This perspective can be woven throughout the storyline while students explore different types of erosion: wind, water and ice in sand and soil. For real life experiences, students visit their schoolyard or nearby area to find examples of erosion. They may find examples from very small to larger examples of places where soil has eroded. They may find places where human foot traffic has made pathways through a previously planted area.

Teachers may also bring local experts who have knowledge about land restoration into the classroom. This could be a tribal biologist, someone who works with a state or federal agency, or someone from a local land trust or conservancy program. This connection could also provide opportunities for students to create and implement action plans for land restoration.

NGSS Learning Progression for this Storyline: The 4th grade storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Take a look at how the 4th grade performance expectations fit in a continuum of learning for your students.

Placemaking: For real life experiences, students visit their schoolyard or nearby area to find examples of erosion. They may find examples from very small to larger examples of places where soil has eroded. They may find places where human foot traffic has made pathways through a previously planted area.	**Anchoring phenomena:** Students notice erosion on their schoolyard.	**Drawdown:** Indigenous People's Forest Tenure
Indigenous and other relevant cultural connections:	**NGSS PEs:** 4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water,	

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There is a wonderful connection to Indigenous perspectives in one of the solutions in Drawdown (#39 Land Use Indigenous Peoples' Land Management). This can be nicely woven with an invitation for a tribal elder or tribal expert to visit your class and share their locally relevant perspective on land use.	ice, wind, or vegetation.

Vocabulary:

When water, wind, ice, and chemicals cause rocks and earth to wear away, it is called **weathering**. When these weathered bits of rock and soil are moved to new places, it is called **erosion**, and can be caused by water, wind, ice, and humans, or some combination of any of them. Weathering and erosion are forces that change the shape of the land.

Estimated time required to implement this storyline: 2 to 3 weeks

NGSS PEs:

4-ESS2-1 Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Science & Engineering Practice (SEP)	Disciplinary Core Idea (DCI)	Cross Cutting Concept (CCC)
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. Students make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**For 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. **For ESS2.E Biogeology** Living things affect the physical characteristics of their regions.	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change. **Systems and system models** **Stability and change**

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Learning Sessions

Materials List

Learning session	Materials
1.	Connect to regional tribal resources
2.	N/A
3.	Erosion picture, pre-assessment and rubric
4.	9 cafeteria trays (dish tubs can be used as well, particularly for the water stations), Enough straws for each student to have one, 4 spray bottles, 1 plastic (so it can be squeezed) water bottle with squirt cap, Methods for creating slope: two foot-long pieces of 2x4 wood; 1” high objects to raise one end of the tray up 1” (Legos or other wood blocks work well), One ice cube per team of 4-5 students; optional: use a different color of food coloring for each team’s ice cube, 60 lb. bag of washed play sand; most hardware stores or garden supply stores carry this; it works best if it is dry, Bucket of soil to compare erosion differences between sand and soil, 4”x6” section of grass for ‘plants prevent erosion’ station, Student Data Sheets
5.	Erosion card set
6.	Clipboards, paper, pencils, drawing materials
7.	Erosion card set
8.	N/A
9.	N/A
10.	Erosion picture, post assessment, rubric

1. Grounding Native Ways of Knowing: Estimated time: 45 minutes

Students hear a story about the relationship between the land and plants from an Indigenous perspective, a local tribe if possible. This perspective can be woven throughout the storyline.

	Plan ahead to invite in a tribal member who can share a story with the students. Here is a link from OSPI on how to partner with your local tribes: OSPI: Partnering with local tribes Summary of native ways of knowing for erosion: 1. One of the gifts of plants is that they 'hold the world together.' They literally shield the land from forces of water and wind and hold in soil with their roots. 2. Example Plant Teaching: The alder (or cottonwood) tree is a community builder. It is one of the first to take root and sprout in recently disturbed areas. It is a "nitrogen fixer" that prepares the soil for other plant communities to take root. It has a special relationship with a bacteria, Frankia, that takes nitrogen from the roots and puts it back into the soil in exchange for some sugars from the tree. Nitrogen is a key nutrient for plants. Alder (Cottonwood) heal and prepare the land for the next community of plants, such as Douglas fir or cedar. This gift is also an important teaching for humans. *How can we heal the land? How can we prepare the way for others? How can we put our community needs before our own?* 3. Indigenous communities are vulnerable to changes in the land and have had to be adaptable to these changes. Today, our communities are especially vulnerable to climate change, pollution, etc. Often marginalized populations feel the deepest impacts of unhealthy lands and unhealthy communities. Native worldview recognizes that the health of the land is intrinsically tied to our own health. 4. Since Time Immemorial, local Native American communities have stewarded these lands in ways that enriched biodiversity and secured the gifts of the landscape. Through treaties, our ancestors secured access to usual and accustomed places for hunting, fishing and gathering. Since treaty times, local Indigenous worldview and scientific knowledge has been ignored and devalued and our local landscapes have deeply suffered as a result. Incorporating ancient management knowledge will benefit all local communities.

2.	**Examine phenomena: Erosion happens in our schoolyard and community.**	Estimated time: 30 minutes
	Teachers can find various forms of erosion on their schoolyard or near the school grounds. Some examples include: ● roadway erosion ● creek erosion ● playground erosion ● erosion from a drain spout ● local rivers and streams Teachers should take the students to the erosion site and ask, "What do you think caused this? What could be a solution to this problem?"	

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3.	**Pre Assessment:**	Estimated time: 30 minutes
	Erosion Picture (This photo is in the assessment. The teacher may want to display on a larger screen.) **4-Natural Hazards: Erosion Pre- Assessment** **4-Natural Hazards: Erosion Assessment Rubric**	

4.	**Guiding questions: Do the Earth's landforms look the same today as they did a million years ago? How are they the same or different?**	Estimated time: Several 30 minute sessions (dependent on how teacher structures the stations)
	Supplies needed: - 9 cafeteria trays (dish tubs can be used as well, particularly for the water stations) - Enough straws for each student to have one - 4 spray bottles - 1 plastic (so it can be squeezed) water bottle with squirt cap - Methods for creating slope: two foot-long pieces of 2x4 wood; 1" high objects to raise one end of the tray up 1" (Legos or other wood blocks work well) - One ice cube per team of 4-5 students; optional: use a different color of food coloring for each team's ice cube - 60 lb. bag of washed play sand; most hardware stores or garden supply stores carry this; it works best if it is dry - Bucket of soil to compare erosion differences between sand and soil - 4"x6" section of grass for 'plants prevent erosion' station - Student Data Sheets Students engage and explore with erosion stations, working in groups of 4 or 5. There are six stations in all. Students observe results and record them on data sheets. Design class management techniques so students aren't having spray bottle battles. If conducting stations indoors, cover tables and be careful to keep water stations away from electronics. If possible, conduct stations outdoors. The wind station will need to be on a table so the tray can be at their eye level. Decide how well you want to control the variables, if that is a goal for this activity, other than just observation of erosion. Provide instructions for each station so students are clear on	

the procedures. Allow ample time for student experimentation, observation, and data collection. After conducting the investigations, have students discuss their observations and ideas with each other. Create a word wall with vocabulary that students use to describe their observations and conclusions. You may want to provide them with these definitions after they have had time to observe the changes at each station:

When water, wind, ice, and chemicals cause rocks and earth to wear away, it is called **weathering**.

When these weathered bits of rock and soil are moved to new places, it is called **erosion**, and can be caused by water, wind, ice, humans, or some combination of any of them. These forces change the shape of the land.

(Optional) You may want to use Total Physical Responses (TPR's) to differentiate learning of the new vocabulary words:
Use a total physical response (TPR) strategy using a hand movement and a brief verbal definition to represent each new vocabulary word. For example:

Weathering – Wiggle fingers from top to the sides and say, "Weathering the breaking apart of Materials."

Erosion – With hands at hand level make a downward wave motion and say, "Erosion…the movement of soil and materials."

(Optional) You may find this 7:35 minute video helpful in showing how plants hold onto soil: Erosion and Soil

1. **Wind erosion** - 1 tray; enough straws for each student to have one
   - put about ½" of dry play sand in the tray. Students will put their faces at the same level of the tray and blow gently through the straw across the top of the sand. Groups can 'reset' the sand by gently patting it flat again.
2. **Water erosion** (3 stations: with slope, low rainfall/high rainfall, different substrates)

- **Slope station:** 2 trays; sand; 1 spray bottle; 2" high and 1" high object to create slopes
  -cover ¾ of each tray with sand to fill the tray, leaving space at the bottom for the water to run off and collect. Put a 1" high object under one tray to provide a slight slope. Put a 2" high object under the other tray to provide a steeper slope (a piece of 2x4 wood works great).
  -if the sand is wet, you can mound the sand to make a small 'mountain' that is steeper than the other water stations.

-students use a spray bottle to make it 'rain'. They should keep the amount of water and the distance of the spray the same for both trays.

- **Low and high rainfall station:** 2 trays; sand; one spray bottle; one water bottle with squirt top; 1" high object to create slope
  - put the same amount of sand in each tray with a 1" object under the tray to provide a slight slope. Leave some space free of sand at the bottom of the tray for water to collect. One tray gets heavy 'rainfall' from a squirt bottle. Students compare that to the other tray that gets low rainfall from a spray bottle.
- **Different substrate station:** 2 trays; sand in one tray and dirt in the other; 1 spray bottle; 1" high object to create slope
  - put sand in one tray and dirt in another with similar amounts in each tray. Students use the same spray bottle to apply the same amount of 'rain' to each substrate and note differences

3. **Ice erosion** - 1 tray; ice cubes (one per pair of students); sand; foot-long piece of 2x4 wood
   - fill the tray with sand, leaving some space at the bottom for water to collect
   - arrange the tray so the long side has the 2x4 under it, providing more space for ice cubes to fit
   - each pair of students puts one ice cube (simulating a glacier) at the top of the tray and observes the results; they may visit other stations while their ice cube is traveling down the slope.
   - you may want to use a different color of food coloring for each team's ice cube to see the difference in ways each ice erodes the sand or soil

4. **Plants prevent erosion** - 1 tray; one 1" high object to create a slight slope; sand; 4"x6" section of grass; one spray bottle
   - fill the tray with sand, leaving some space at the bottom for water to collect
   - put the grass on top of the sand on one side of the tray, leaving bare sand on the other
   - put a 1" high object under one tray to provide a slight slope; arrange the tray so the long side has the 1" object underneath it
   - students spray the same amount of water on each side of the tray (grass vs. no grass)

5.	**Guiding question: What causes erosion?**	Estimated time: 45 minutes
	Supplies needed:	

- One set of 16 Erosion card set for each group of students; set includes the two groups of card sort categories

Students sort 16 cards depicting different types of erosion into three groups: erosion caused by nature / erosion caused by humans / don't know. Then they create a second sort where they determine if wind, water, snow/ice, humans, or a combination of more than one caused the types of erosion. The teacher will be able to assess whether the students are able to draw accurate conclusions about the examples in the card sort based on their experiences in the stations.

1. Hand out one set of 16 erosion cards to each team of 3-5 students. They will sort them into 3 categories:
   • caused by nature • caused by humans • don't know
2. In their notebooks, have students list the card numbers under each category and their brief reasoning for choosing that category. You may choose to have them pick three cards to describe their reasoning and evidence in detail
3. Hold a class discussion and summarize their results.
4. Hand out the next set of categories and have students resort their cards accordingly:
   • wind • water • ice/snow • humans • don't know
5. Have students list the card numbers under each category and their brief reasoning for choosing that category. Students may decide to put some cards in two categories such as 'humans' and 'water' as in the case of card #3. Allow students to create as many categories as they need.
6. Create new groups to tour the card sorts. Ensure that one 'expert' from each table is present to explain their reasoning for choosing the way they sorted their cards. During the tour, each group will have a chance to guess the reasoning used to sort cards into groups before hearing the actual reasoning from their 'expert'. Encourage students to take notes on what they thought of the different card sorts.
7. Hold a class discussion and summarize their results.

6.	**Guiding question: Can you find erosion in your environment?**	Estimated time: 45 minutes

Supplies needed:
-Clipboards or journals where students can record their findings out of the classroom
-Writing and drawing materials for notes and sketches

Take the class outside in the schoolyard or a nearby area to find examples of erosion. Gather them in a central place and describe the boundaries of where they can investigate safely.

1. Have students work in teams to find examples where wind, water, snow/ice, or humans have caused erosion.
2. Students should describe what they see, explain why they think it is an example of erosion, list the causes, and the evidence for their reasoning. Students can use sketches and words to help describe what they see.
3. Take the class on a tour of each example of erosion found by the teams. At each location, students can describe their observations and reasoning for their example of erosion. Encourage respectful questioning about the claims, evidence, and reasoning used for their decisions.
4. Debrief back in the classroom. Have students share their discoveries of types of erosion and where they were found. Students may find problems with erosion in the schoolyard or nearby location.
5. (Optional) You may choose to have your students make plans for solving the erosion problem they found at the end of the storyline. Have them write their ideas in their notebooks at this time to be expanded upon and implemented later. This could be used as a STEM performance task or assessment.
6. (Optional) Students may benefit from watching this 28-minute Bill Nye video on erosion to better understand the processes that caused the erosion at the stations and in their school area. Have students make connections between what they observed in the classroom and in the school area to the images in the video: Bill Nye: Erosion

7. Guiding question: What causes erosion?

Estimated time: 30 minutes

Supplies needed:
One set of 16 erosion cards for each group of students; set includes the two groups of card sort categories

Card sort, part 2
After having real life opportunities to see erosion, the second card sort will allow students to reflect more deeply on their observations and conclusions for categorizing the cards.

1. Hand out one set of 16 erosion cards to each team. They will sort them again into 3 categories:
   • caused by nature • caused by humans • don't know
2. Have students list the card numbers under each category and their brief reasoning for choosing that category. You may choose to have them pick three cards to describe their reasoning and evidence in detail. Have students note which cards they changed from their previous sort and explain their reasoning.
3. Hold a class discussion and summarize their results.
4. Hand out the next set of categories:
   • wind • water • ice/snow • humans • don't know

	(allow students to put some cards in two categories such as 'humans' and 'water' as in the case of card #3) 5. Have students list the card numbers under each category and their brief reasoning for choosing that category. They can correlate the example of erosion they saw outside to one or more of the cards. 6. Have students 'tour' the card sorts. Use the same groups as before with one student from each table in the new group. Students can take notes of their impressions of the different sorts. 7. Hold a class discussion and summarize their results. 8. Compare their results of this card sort to the first one. Students should be showing signs of increased understanding of erosion and its causes. 9. Have students resort their cards in order of how fast the landform in the picture changed from what it might have been before. Students can record the card numbers and their reasoning in their notebooks. 10. Debrief this new sort with the class. What evidence can they provide to support their choice of placement of the cards? Can they draw any conclusions about the types of landforms that change fast? … that change slowly? What types of erosional forces (wind, water, ice/snow, humans, or a combination) might make landforms change the quickest? … the slowest? 11. Revisit the question, "Do the Earth's landforms look the same today as they did a million years ago? How are they the same or different?" Have students write their answers in their notebooks. When they have finished, they can share their answers with their teams. Ask for a few tables to share an answer they thought was helpful in understanding the question.

8.	**Guiding Question: Who in our community has knowledge about erosion?**	Time will be dependent on presenter
	Bring local restoration experts into your classroom Invite local experts who have knowledge about land restoration into your classroom. This could be a tribal planner or historian, someone who works with a city, or county planning office. Local tribal members can share Traditional Ecological Knowledge with students. They can reflect on what they have learned about erosion and how TEK informs them of different ways of thinking about how they can make a difference.	

If you cannot find a restoration specialist for your classroom or if you want to add reading components to your career connections, you could use career cards:

- Land Steward
- Restoration Biologist and Project Manager
- Salmon Habitat Restoration Manager
- Water Quality Specialist

Bringing Native Ways of Knowing into your classroom

1. Students reflect on the story of Alder/Cottonwood, any traditional stories shared and how traditional stories relate to what they've learned about erosion.
   Online resources for getting started (please utilize your local tribal resources first):
   Roger Fernandes Storytelling
   Ancestral Stories of the Klallam People (Grandfather and Grandson is especially relevant and speaks about changing the course of a river.)

2. If possible, invite a local elder to speak about their tribal values and knowledge regarding erosion and land changes. Perhaps find tribal members involved in a restoration project. You may want to arrange a partnership with the tribe to help them with their restoration projects. As opposed to the story to begin this unit, this opportunity can provide a much bigger picture of how plants and trees hold the soil to prevent erosion.

9.	**Guiding question: How can I mitigate erosion?**	Estimated time: Hour + Teacher dependent

Tying it all together

1. Students review their notes on places where they saw erosion in their schoolyard or nearby location.
2. Have them plan where they might plant grass, other plants, or trees to mitigate or prevent erosion. They may want to divert foot traffic from an area being eroded by humans.
3. If you are going to partner with a local tribe or conservation agency, students can work with them to create plans for restoration of a local area.
4. If you are having students plant trees at your school or nearby area, they can register the trees they plant with Plant for the Planet. This is an international organization

	started by a 9-year-old in Germany in 2008 and run by students. They have been tasked by the United Nations to track all the trees planted by students worldwide.

10.	**Post Assessment**	Estimated time: 30 minutes
	Erosion Picture **4-Natural Hazards: Erosion Post-Assessment** **4-Natural Hazards: Erosion Assessment Rubric**	

OER Tracker - Erosion - 4-Natural Hazards: Erosion-OER Tracker

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