Washington King Tides Curriculum

The objective of this curriculum is to engage students in king tides and coastal flooding using Washington tools and resources. Students will use tools from WA's King Tides program to select and analyze appropriate data, model potential impacts on their community, and propose actions to prevent or minimize those impacts.

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Washington King Tides Curriculum Overview

	DAY 1: King Tides in Context	DAY 2: Projecting SLR	DAY 3: Visualizing SLR Impacts
Learning Objectives	• Define and explain the causes of a king tide. • Compare and contrast regular tides, king tides, and storm surge. • Interpret likelihood graphs. • Apply likelihood graphs to evaluate different levels of subjective risk.	• Choose and justify which greenhouse gas scenario (High/Low) is more appropriate for SLR projections. • Interpret graphs of SLR projections for communities in WA State. • Predict the impact of SLR in combination with King Tides and storm surge.	• Communicate the cause and impacts of SLR on local Washington communities. • Interpret maps depicting different information. • Synthesize different types of data to quantify SLR and understand impacts.
Essential Question(s)	• What causes king tides, and how are they different from regular tides and storm surge? • What is likelihood and how is it related to risk?	• What causes sea level rise and how does it interact with other coastal hazards? • How likely will sea level rise impact your community within your lifetime?	• How will sea level rise and other coastal hazards impact infrastructure in your community?
Lesson Overview	***5E Mini-Lesson: High Water Levels*** 1. ENGAGE by watching a video of flooding. 2. EXPLORE by sorting examples of tides. 3. EXPLAIN tides vs. king tides. 4. EXTEND by considering storm surge. 5. EVALUATE by explaining the flooding video. ***5 Step Mini-Lesson: Risk and Likelihood*** 1. Open with everyday meaning of "likely." 2. Model how to interpret/use likelihood graph. 3. Small groups interpret/use likelihood graphs. 4. Written explanation of likelihood choice. 5. Close with likelihood of flooding and photos.	***5E Lesson*** 1. ENGAGE by watching video of flooding. 2. EXPLORE the WA Coastal Network SLR Projection website. 3. EXPLAIN sea level rise and its relationship to climate change. 4. EXTEND by interpreting SLR projection graphs for your community. 5. EVALUATE by considering the potential impacts of SLR plus storm surge and king tides.	***5E Lesson*** 1. ENGAGE by observing photos from the MyCoast app. 2. EXPLORE the NOAA SLR Viewer website. 3. EXPLAIN infrastructure and view impacts on Google Maps. 4. EXTEND by incorporating storm surge. 5. EVALUATE by creating a presentation describing SLR impacts to your community.
Next Generation Science Standards	• ***HS-ESS3-1.*** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.	• ***HS-ESS3-5.*** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	• ***HS-ESS3-5.*** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
Math/ELA Standards	• Reason abstractly and quantitatively. • Interpret the scale and origin in graphs. • Write informative/explanatory texts.	• Reason abstractly and quantitatively. • Interpret the scale and origin in graphs. • Write informative/explanatory texts.	• Reason abstractly and quantitatively. • Interpret the scale and origin in graphs. • Write informative/explanatory texts.
Ocean Literacy Principles	• ***OLP-1C.*** Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation	• ***OLP-1D.*** Sea level is the average height of the ocean relative to land, taking into account the differences caused by tides. Sea level changes…as	• ***OLP-3G.*** Changes in the ocean-atmosphere system can result in changes to the climate that in turn cause further changes to the ocean

	(Coriolis effect), the Sun, and water density differences. This 'global ocean conveyor belt' moves water throughout all of the ocean's basins, transporting energy (heat), matter, and organisms around the ocean.	ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools. • ***OLP-3G.*** Changes in the ocean-atmosphere system can result in changes to the climate that in turn cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences. • ***OLP-6F.*** Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).	and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences. • ***OLP-6F.*** Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).
Climate Literacy Principles		• ***CLP-5.5.*** Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change. • ***CLP-6.2.*** Emissions from the widespread burning of fossil fuels since the start of the Industrial Revolution have increased the concentration of greenhouse gasses in the atmosphere, and their warming influence is projected to persist into the next century. • ***CLP-7.1.*** Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Seawater is beginning to move onto low-lying land, contaminating coastal fresh water sources and gradually submerging coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes. • ***CLP-7.3.*** Incidents of extreme weather are projected to increase as a result of climate change. Precipitation events are expected to become less frequent but more intense in many areas.	• ***CLP-5.5.*** Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change. • ***CLP-7.1.*** Seawater is beginning to move onto low-lying land, contaminating coastal fresh water sources and gradually submerging coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes. • ***CLP-7.3.*** Incidents of extreme weather are projected to increase as a result of climate change. Precipitation events are expected to become less frequent but more intense in many areas.

DAY 1: BACKGROUND MINI-LESSONS

5E: KING TIDES IN CONTEXT - HIGH WATER LEVELS (25 min.)

Content Objective(s):

- SWBAT define and explain the causes of a king tide.
- SWBAT compare/contrast regular tides, king tides, and storm surge.

Learning Standard(s):

- ***HS-ESS3-1.*** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
  - ***SEP-7-Constructing explanations.*** SWBAT apply scientific ideas and evidence to provide an explanation of phenomena, taking into account possible unanticipated effects.
  - ***DCI-ESS3.B-Natural hazards.*** Natural hazards have shaped [and continue to shape] human activities at local, regional, and global scales.
  - ***CCC-2-Cause and effect.*** SWBAT recognize changes in systems may have various causes that may not have equal effects.
  - ***CCC-7-Stability and change.*** SWBAT understand much of science deals with constructing explanations of how things change and how they remain stable. They see positive feedback can destabilize a system.
  - ***WHST.9-12.2.*** Write informative/explanatory texts.
- ***OLP-1C.*** Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis effect), the Sun, and water density differences. This 'global ocean conveyor belt' moves water throughout all of the ocean's basins, transporting energy (heat), matter, and organisms around the ocean.

Modifications:

- Word wall/vocabulary list
  - Tier 1: storm, snow, rain, coast, hazard
  - Tier 2: observation, inference, coastline, tides
  - Tier 3: king tides, syzygy, perigee, perihelion, storm surge
- Guided notes w/ graphic organizers
- Cooperative learning/grouping modifications
- Think-pair-share
- Discovery learning (5E)

Engagement (3 min):

- Westport king tide plus storm surge video: https://www.youtube.com/watch?v=KrV0TSKSURU
- Students record observations and inferences

Exploration (7 min.):

- Students are provided photos of regular tides and king tides from a community within WA state.
- In small groups, students sort the photos into two groups, explaining their reasoning.
- Guiding question: How does the coastline change in the photo?

DAY 1: BACKGROUND MINI-LESSONS

Explanation (5 min.):

- [OPTIONAL: If your students have not yet learned about tides, consider showing one of the brief introductory videos explaining tides provided in the Powerpoint slides 10-11.]
- *King Tides* are exceptionally high tides.
- *King Tides* can be caused by *syzygy*, *perigee*, or *perihelion*, or any combination of these events. (https://www.youtube.com/watch?v=eop7Tsrk2tI&ab_channel=Exploratorium; start at 00:40 and end at 07:07)
- [OPTIONAL: To review the video and reinforce how different causes of high water levels interact and combine, consider going through slides 15-17.]
- In Washington State, *King Tides* happen each year between November and January.

Extension (5 min.):

- *Storm surge* is the extra rise in seawater level that occurs during a storm, measured as the height of the water above the normal predicted tide.
- Two factors associated with storms that contribute to a storm surge are onshore wind and a low pressure system.
- Think-pair-share: What do you think would happen if a king tide happened on the same day as a winter storm?

Evaluation (5 min.):

- Rewatch Westport king tide plus storm surge video: https://www.youtube.com/watch?v=KrV0TSKSURU
- Exit Slip/Write a Tweet: Explain which phenomena are driving these high water levels and how.

Materials:

- NOTE: This lesson assumes students already have a basic understanding of tides in general. An OPTIONAL mini-unit focused on tides is provided in the Teacher Notes.
- Photo sort [see Teacher Notes, Day 1]
- Powerpoint
- Optional Guided Notes

DAY 1: BACKGROUND MINI-LESSONS

5-STEP: KING TIDES IN CONTEXT - RISK & LIKELIHOOD (20 min.)
Content Objective(s): ● SWBAT interpret likelihood graphs. ● SWBAT apply likelihood graphs to evaluate different levels of subjective risk.
Learning Standard(s): ● ***SEP-6-Using mathematics and computational thinking.*** SWBAT use mathematical, computational, and/or algorithmic representations of phenomena to describe and/or support claims and/or explanations. ● ***MP.2.*** Reason abstractly and quantitatively. ● ***HSN.Q.A.1.*** Interpret the scale and origin in graphs and data displays. ● ***WHST.9-12.2.*** Write informative/explanatory texts.
Modifications: ● Word wall/vocabulary list ○ Tier 1: risk, graph, outcome ○ Tier 2: x-axis, y-axis, legend, scenario, exceedance ○ Tier 3: likelihood, probability ● Guided notes w/ graphic organizers ● Cooperative learning/grouping modifications
Opening (1 min.): ● Hook (could become embedded in PPT) ○ Some easy likelihood question (i.e. How likely is it going to rain today? OR What is the likelihood that there will be fries for lunch?)
INM (8 min.): ● *Likelihood* is the chance that something will happen. ● *Risk* is the possibility of something bad happening. ● Teacher Think-Aloud: Buying car insurance ○ X-axis = time spent driving ○ Y-axis = number of accidents ○ Likelihoods graphed = 1% (low likelihood/risk); 50% (equal likelihood/risk); 100% (high likelihood/risk) ○ Questions to consider: ■ What are the costs/benefits? ■ What are my constraints? ■ How comfortable am I with risk?
GP (8 min.): ● Students work in small groups to consider two scenarios based on a different example: buying phone insurance ● SCENARIO 1: Bridget's parents just bought her a brand new phone to replace the one that she dropped from a hotel balcony. But it was very expensive, and they explained that they will not buy her another phone until their plan renews in 2 years. Bridget's parents give her a $20 allowance each month; she could save up for a new phone, choose to spend about a quarter of her allowance each month on phone insurance, or just wait and see what happens. Which likelihood (1%, 50%, or

DAY 1: BACKGROUND MINI-LESSONS

100%) do you think Bridget will choose when making decisions about her new phone? ● SCENARIO 2: Nico's birthday is in 1 month and they asked their parents for a new phone. They are very studious and responsible, and never bring their phone to school. They only use it at home for watching movies, TikTok, and gaming. Nicolas is torn between spending the money on phone insurance versus paying for a monthly gaming subscription. Which likelihood (1%, 50%, or 99%) do you think Nicolás will choose when making decisions about their new phone and why?
IP (2 min/HW): ● Exit slip/Write a Tweet: Think about your current cell phone situation. Which likelihood scenario makes the most sense for you and why?
Closing (1 min.): ● Photo series of King Tides ● What do you think is the likelihood of events like these happening in your community? (rhetorical question)
Materials: ● Powerpoint ● Optional Guided Notes

King Tides in Context

Student Guided Notes

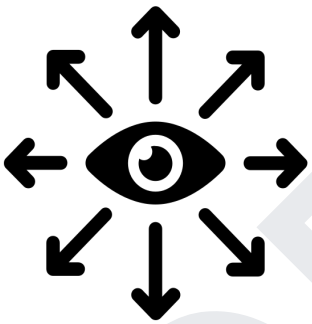
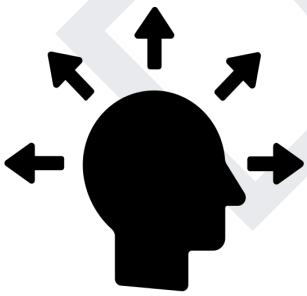
Today's essential questions are:

1.
2.

PART A. Coastal Flooding

VOCABULARY: Observation and Inference

Instructions: Fill in the table below.

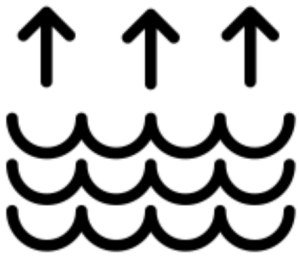
	***OBSERVATION***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***INFERENCE***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

VIDEO: Historic King Tide in Westport, WA

Instructions: As you watch the video, write down your observations and inferences in the table below.

Observations	***Inferences***

Instructions: Fill in the table below.



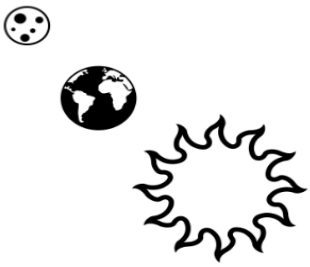
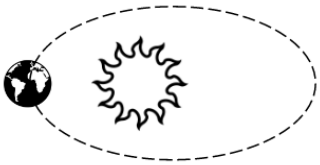
KING TIDE
*Write the **definition**:*
*Think of a **synonym**:*
*Use in a **sentence**:*

VIDEO NOTES: King Tides

Instructions: Read through these questions before you watch the video, and then answer them after you watch the video.

***Question 1:** How does the moon's gravitational pull affect the earth's water level?*

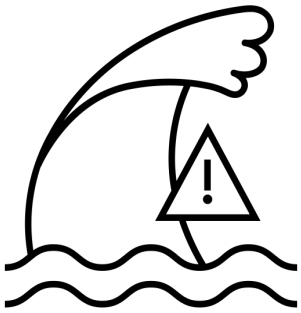
Question 2: *Complete the table below for each of the three events that can cause King Tides. WHERE are the sun, moon, and/or earth in relation to each other? WHEN (how often) does the event occur? HOW does it affect the tides, and WHY?*

WHAT?	 **Syzygy**	 **Perigee**	 **Perihelion**
WHERE?			
WHEN?			
HOW?			
WHY?			

Question 3: *What is the name of tides that occur during the new moon and full moon?*

Question 4: *When do the highest tides of the year occur and why?*

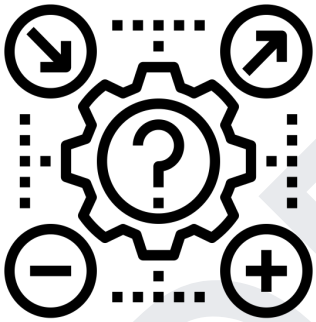
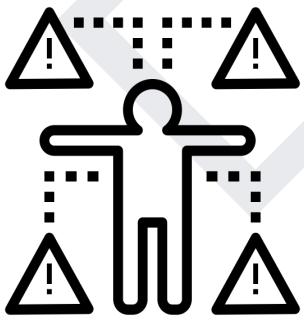
Instructions: Fill in the table below.

	***STORM SURGE***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

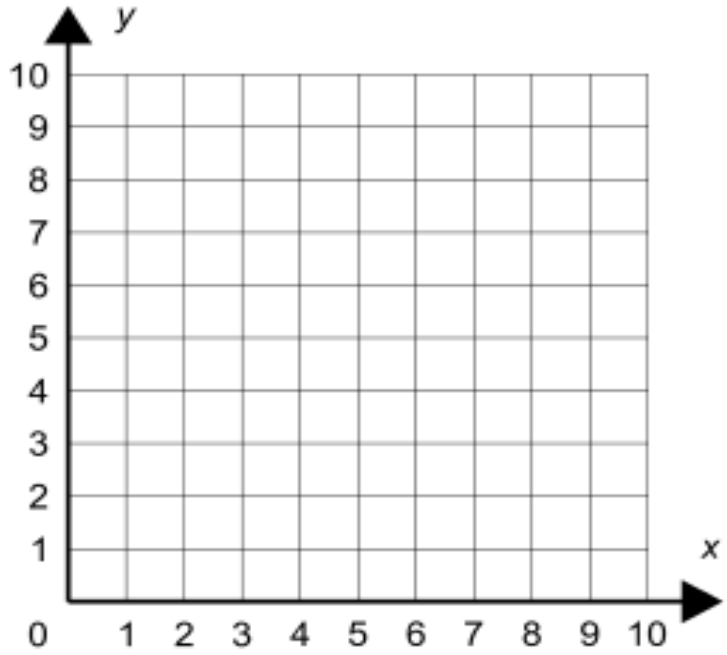
PART B. Risk and Likelihood

VOCABULARY: Risk and Likelihood

Instructions: Fill in the table below.

	***LIKELIHOOD***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***RISK***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

Instructions: Complete the graph and table below as your teacher explains likelihood using the car insurance example.



Parts of a graph checklist:

- ☐ ***Title?***
- ☐ ***X-axis label?***
- ☐ ***Y-axis label?***
- ☐ ***Legend?***

Likelihood	***What does this mean?***
1%	
50%	
99%	

DAY 2: PROJECTING SEA LEVEL RISE

5E LESSON PLAN

PLANNING/PREPARATION

CONTENT OBJECTIVE(S). What will your students know & be able to do?	**NEXT GENERATION SCIENCE STANDARD(S).** Which NGSSs do these context objectives align with?

• SWBAT choose and justify which greenhouse gas scenario (High/Low) is more appropriate for SLR projections.
• SWBAT interpret graphs of SLR projections for communities in WA State.
• SWBAT predict the impact of SLR in combination with King Tides and storm surge.
	• ***HS-ESS3-5.*** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
	  ○ ***SEP-5-Analyzing and interpreting data.*** SWBAT analyze data using computational models in order to make valid and reliable scientific claims.
	  ○ ***NOS.A-2.*** Scientific knowledge is based on empirical evidence.
	  ○ ***DCI-ESS3.D-Global climate change.*** Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.
	  ○ ***CCC-7-Stability and change.*** SWBAT understand change and rates of change can be quantified and modeled over different periods of time; SWBAT see positive feedback can destabilize a system.

ELA STANDARD(S). How will language development be supported?	**MATH STANDARD(S).** How will mathematical reasoning be supported?
• ***WHST.9-12.2.*** Write informative/explanatory texts.	• ***MP.2.*** Reason abstractly and quantitatively. • ***HSN.Q.A.1.*** Interpret the scale and origin in graphs and data displays.
OCEAN LITERACY PRINCIPLE(S) How will ocean literacy be supported?	**CLIMATE LITERACY PRINCIPLE(S).** How will climate literacy be supported?
• ***OLP-1D.*** Sea level is the average height of the ocean relative to the land, taking into account the differences caused by tides. Sea level changes as plate tectonics cause the volume of ocean basins and the height of the land to change. It changes as ice caps on land melt or grow. It also changes as sea water expands and contracts when ocean water warms and cools. • ***OLP-3G.*** Changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences. • ***OLP-6F.*** Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).	• ***CLP-5.5.*** Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change. • ***CLP-6.2.*** Emissions from the widespread burning of fossil fuels since the start of the Industrial Revolution have increased the concentration of greenhouse gasses in the atmosphere, and their warming influence is projected to persist into the next century. • ***CLP-7.1.*** Melting of ice sheets and glaciers, combined with the thermal expansion of seawater as the oceans warm, is causing sea level to rise. Seawater is beginning to move onto low-lying land, contaminating coastal fresh water sources and gradually submerging coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes. • ***CLP-7.3.*** Incidents of extreme weather are projected to increase as a result of climate change. Precipitation events are expected to become less frequent but more intense in many areas.

DAY 2: PROJECTING SEA LEVEL RISE

RELEVANCE/PREVIOUS LEARNING.
How does this relate to what students have already learned, or will need to learn?

- In the previous mini-lessons, students reviewed basic information about tides, learned about king tides, and considered the impacts of coinciding king tides and storm surges. They also learned how to think about likelihood and interpret likelihood graphs.
- In the next lesson, students will combine information from SLR projection models with NOAA SLR viewer to visualize and describe the impacts of SLR in combination with king tides and storm surges.

ASSESSMENT.
How will you know whether your students have made progress toward the objective?
How and when will you assess mastery?

Students will complete a worksheet where they record SLR projections for different years and likelihoods, describe the relationship between likelihood scenarios and coastal hazard preparedness, and consider the additive flooding impacts of SLR, king tides and storm surge.

KEY POINTS.
What three to five key points will you emphasize?

1. Local sea level is the average sea level in one particular place, while global sea level is the average sea level of the entire planet.
2. Global sea level has been rising over the last century due to global climate change, which leads to higher temperatures and warmer oceans.
3. The main sources of sea level rise are melting ice caps and glaciers, thermal expansion, and melting ice sheets.
4. Global climate change is caused by greenhouse gas emissions.

VOCABULARY DEVELOPMENT
How will you help students connect to content and academic vocabulary (graphic organizers, word wall, concept maps, personal dictionaries, lingo bingo, etc.)?

- Word wall
  1. Tier 1: impact, flood, storm, snow, rain, risk, coast, global, local, graph
  2. Tier 2: emission, projection, exceedance
  3. Tier 3: sea level rise, greenhouse gas
- Guided notes with graphic organizers

MODIFICATIONS.*
How will you make the material accessible to English language learners?
How will you make the material accessible to students with learning differences (e.g., G/T, special education?)

English Language Learners	Learning Difference
● cooperative learning ● note-taking with graphic organizers ● think-pair-share ● cognates ● word wall	● diagrams/maps/graphs ● discovery learning (5E) ● grouping modifications ● (reduced) note-taking with graphic organizers ● vocabulary lists

E N G A G E

OPENING.
How will you communicate *what* is about to happen?
How will you communicate *how* it will happen?

- Essential questions
  - What causes sea level rise and how does it interact with other coastal hazards?
  - How likely will sea level rise impact your community within your lifetime?
- Agenda
  - See an example of coastal flooding: Bellingham, WA
  - Explore the WA Coastal Network's Sea Level Rise Projection online tool
  - Learn about sea level rise
  - Analyze sea level rise projections for your community

MATERIALS.

- Powerpoint slides
- Guided Notes (optional)

CONNECT TO PAST EXPERIENCES, PAST LEARNING, & THE REAL-WORLD.

MATERIALS.

Sea Grant Washington

DAY 2: PROJECTING SEA LEVEL RISE

	How will you communicate its *importance*? How will you communicate *connections* to previous lessons? How will you engage students and capture their interest?	

	• Hook: City of Bellingham dramatic flooding video
	• Have you observed flooding in your area?
	  ○ Where?
	  ○ What body of water flooded? River? Ocean?
	  ○ What caused the flooding? Rain event? Snow melt? Storm surge? King tide?
		• Powerpoint slides
		• Guided Notes (optional)

E X P L O R E	**ACTIVITY.** What are students thinking about, planning, investigating, or organizing?	**MATERIALS.**

	• What does SLR look like in Seattle, WA?
	• Students work in small groups to explore the WA Coastal Network Sea Level Rise Projection website.
	  ○ Go to: https://wacoastalnetwork.com/research-and-tools/slr-visualization/
	  ○ Under "VISUALIZATION #1 Projected sea level change by year," go to County and select King County, and go to WRIA and select "9, Duwamish-Green." Click on northern most area (West Seattle) until it is highlighted in blue.
	  ○ Look at the "Likelihood" boxes and make sure that 1%, 50%, and 99% are selected. Click on the green question mark to review what these likelihood scenarios mean. This should sound familiar!. What does 50% likelihood RSLR projection mean?
	  ○ Under "Select greenhouse gas scenario," uncheck "Low (RCP 4.5)." Click on the green question mark to review what the High and Low RCP scenarios mean. The High (RCP 8.5) represents no change in current carbon emissions. The Low (RCP 4.5) represents a scenario when we slow down our carbon emissions. When do the High and Low scenarios begin to diverge? [~2050]
	  ○ Look at the graph to the right. What does the x-axis represent? What does the y-axis represent? What does the legend represent?
	  ○ Use the graph to determine how many feet of sea level rise are projected under the 1% likelihood scenario in the year 2050? [1.5 feet]
	  ○ Use the graph to determine how many feet of sea level rise are projected under the 50% likelihood scenario in the year 2100? [2.3 feet]
		• Powerpoint slides
		• Day 2 Worksheet
		• Guided Notes (optional)

E X P L A I N	**REFLECTION.** How are students analyzing what they explored? How is their understanding clarified? How will students reflect on the significance of what they learned?	**MATERIALS.**
	• How old will you be in the year 2050, when the High and Low scenarios begin to diverge? • How old will you be in the year 2100? • 1-2-4-All: Should the class use the Low (RCP 4.5) scenario or the High (RCP 8.5) scenario for today's sea level rise activity? Why? Some things to consider: Which scenario do you think is more likely in your lifetime? How comfortable are you with the risk of SLR?	• Powerpoint slides • Day 2 Worksheet • Guided Notes (optional)
	INTRODUCTION TO NEW MATERIAL. What key points/vocabulary will you emphasize and reiterate? How will you ensure that students actively take-in information? Which potential misunderstandings will you anticipate? Why will students be engaged/interested?	**MATERIALS.**
	• Video: What causes sea level rise? https://www.youtube.com/watch?v=QH-KYmRAzOA	• Powerpoint slides • Guided Notes (optional)
	CHECK FOR UNDERSTANDING. How will you check for understanding of content & vocabulary before moving on? How will you monitor and correct student performance?	**MATERIALS.**

Sea Grant Washington

DAY 2: PROJECTING SEA LEVEL RISE

	• Class Consensus: Which greenhouse gas scenario do you want the class to use? Thumbs down for High (RCP 8.5) and thumbs down for Low (RCP 4.5). • [If the content about SLR is sinking in, the class will more likely opt to plan for the worst-case scenario, i.e., High]	• Powerpoint slides
E X T E N D	**APPLICATION.** How are students expanding their knowledge? What new situations are students applying their knowledge to?	**MATERIALS.**
	• As a group, find your community by clicking on the map. When the graph is ready, select the greenhouse gas likelihood scenario that the class voted on. • On your own, answer the following questions on the table in your worksheet. 1. How many feet of SLR will there be in the years 2050, 2080, and 2100 with a 1% likelihood? 2. How many feet of SLR will there be in the years 2050, 2080, and 2100 with a 50% likelihood? 3. How many feet of SLR will there be in the years 2050, 2080, and 2100 with a 99% likelihood? 4. If a homeowner wants to be prepared for the worst case scenario, which likelihood scenario would they choose? (1%, 50%, 99%)	• Powerpoint slides • Day 2 Worksheet • Teacher Notes: Day 2
	CHECK FOR UNDERSTANDING. How will you check for understanding of content & vocabulary before moving on? How will you monitor and correct student performance?	**MATERIALS.**
	• Walk around and check on worksheet answers	• Day 2 Worksheet
E V A L U A T E	**FINAL PRODUCT.** How will students synthesize what they learned? What will students create or do? How will you provide all students with opportunities to demonstrate mastery? Why will students be engaged/interested?	**MATERIALS.**
	• On your worksheet, answer the following questions to think about how storms and king tides amplify the impact of SLR. ○ Fill in the storm surge + SLR table on your worksheet by adding 3 feet to the SLR projection numbers if your community is along Puget Sound. Add 6 feet to the SLR projection numbers if your community is along the Outer Coast. ○ Now also consider the effect of King Tides. How do you think King Tides would affect the overall water level?	• Day 2 Worksheet
A S S E S S M E N T	**FORMAL ASSESSMENT.** How will you formally assess mastery of the content and vocabulary objectives? When will you formally assess mastery of the content and vocabulary objectives?	**MATERIALS.**
	• See (optional) Performance Assessment ideas in the Teacher Notes and at the end of the Day 3 lesson plan.	

*Sheltered Instruction strategies for ELL students: analysis pizza, anticipation guide, capsule vocabulary, characterization chart, chunking, cloze passages, cognates, concept of definition map, cooperative learning, Cornell notes, flow chart, foldables, KWL, note-taking, outlining, RAFT, retelling, self-monitoring, semantic mapping, sketch to stretch, story map, summarizing, think-pair-share, Venn diagram, verbal/visual word association, window paning, word wall.

†Strategies to help students with Learning Differences: assignment notebooks, diagrams/maps/graphs, discovery learning, extended time, grouping modifications, highlighting, marking copies of texts, note-taking, peer reading, peer tutoring, shortened assignments, skeleton outlines, special seating, recorded texts, vocabulary lists, writing models, reduced note-copying, graphic organizers, assignment contract, task analysis (steps), alternate projects, repetition of directions, study guide, simply exam format, objective exams, extended exam time, minimize options, oral exams.

Projecting Sea Level Rise

What does sea level rise look like in Washington?

Student Instructions

Today you will work with your small group to explore an important tool that helps scientists, community planners, and policymakers visualize what Sea Level Rise might look like in the future. Using this tool will then help you observe what sea level rise is projected for your community.

You will need:

- Access to a computer or tablet that can be shared with your small group
- A reliable WiFi connection
- At least 1 copy of this worksheet to fill out per group

PART A: Get to know the Sea Level Rise Projection Tool

Step 1: Please go to **https://wacoastalnetwork.com/research-and-tools/slr-visualization/**

Step 2: Under "VISUALIZATION #1 Projected sea level change by year," go to County and select King County, and go to WRIA and select "9, Duwamish-Green." Click on northern most area (West Seattle) until it is highlighted in blue.

Step 3: Look at the "Likelihood" boxes and make sure that 1%, 50%, and 99% are selected. Click on the green question mark to review what these likelihood scenarios mean. This should sound familiar!

***Question 1:** What does 50% likelihood RSLR projection mean?*

Step 4: Next, under "Select greenhouse gas scenario," uncheck "Low (RCP 4.5)." Click on the green question mark to review what the High and Low RCP scenarios mean.

***Question 2:** When do the High and Low scenarios begin to diverge?*

Step 5: Look at the graph displayed on the right side of the screen.

Question 3:

A) What does the x-axis represent?

B) What does the y-axis represent?

C) What does the legend represent?

D) Use the graph to determine how many feet of sea level rise are projected under the 1% likelihood projection in the year 2050?

E) Use the graph to determine how many feet of sea level rise are projected under the 50% likelihood projection in the year 2100?

Question 4:

A) How old will you be in 2050, when the High and Low scenarios begin to diverge?

B) How old will you be in the year 2100?

Step 6: Stop here and wait for your teacher to give additional instructions and more information about sea level rise.

PART B: Apply this to your own community.

Step 1: Please return to **https://wacoastalnetwork.com/research-and-tools/slr-visualization/**

Step 2: As a group, find your community by clicking on the map. When the graph is ready, select the greenhouse gas likelihood scenario that the class voted on.

Step 3: On your own, answer the following questions in the table below.

Question 5:

A) For each year in the table (white columns only), use the graph to determine how many feet of Sea Level Rise there will be for each percent likelihood.

Likelihood	2050	+ storm surge	2080	+ storm surge	2100	+ storm surge
1%						
50%						
99%						

B) If a homeowner wants to be prepared for the worst case scenario, which likelihood scenario would they choose, and why?

PART C: Storms and King Tides

Step 1: These projections only show projected water levels due to Sea Level Rise. To also consider the effect of storm surge on overall water level, complete the gray columns in the table above by following the instructions below.

Question 6:

A) In the "+ storm surge" column of the data table, add 3 feet to the Sea Level Rise projection numbers if your community is along Puget Sound. Add 6 feet to the Sea Level Rise projection numbers if your community is along the Outer Coast.

B) Now let's also consider the effect of King Tides. How do you think King Tides would affect the overall water level?

Projecting Sea Level Rise

What does sea level rise look like in Washington?

Student Instructions

Today you will work with your small group to explore an important tool that helps scientists, community planners, and policymakers visualize what Sea Level Rise might look like in the future. Using this tool will then help you observe what sea level rise is projected for your community.

You will need:

- Access to a computer or tablet that can be shared with your small group
- A reliable WiFi connection
- At least 1 copy of this worksheet to fill out per group

PART A: Get to know the Sea Level Rise Projection Tool

Step 1: Please go to **https://wacoastalnetwork.com/research-and-tools/slr-visualization/**

Step 2: Under "VISUALIZATION #1 Projected sea level change by year," go to County and select King County, and go to WRIA and select "9, Duwamish-Green." Click on northern most area (West Seattle) until it is highlighted in blue.

Step 3: Look at the "Likelihood" boxes and make sure that 1%, 50%, and 99% are selected. Click on the green question mark to review what these likelihood scenarios mean. This should sound familiar!

***Question 1:** What does 50% likelihood RSLR projection mean?*

Step 4: Next, under "Select greenhouse gas scenario," uncheck "Low (RCP 4.5)." Click on the green question mark to review what the High and Low RCP scenarios mean.

***Question 2:** When do the High and Low scenarios begin to diverge?* **[~2050]**

Question 3:

A) *What does the x-axis represent?*

B) *What does the y-axis represent?*

C) *What does the legend represent?*

D) *Use the graph to determine how many feet of sea level rise are projected under the 1% likelihood projection in the year 2050?* ***[1.5 feet]***

E) *Use the graph to determine how many feet of sea level rise are projected under the 50% likelihood projection in the year 2100?* ***[2.3 feet]***

Question 4:

A) How old will you be in 2050, when the High and Low scenarios begin to diverge?

B) How old will you be in the year 2100?

Step 6: Stop here and wait for your teacher to give additional instructions and more information about sea level rise.

PART B: Apply this to your own community.

Step 1: Please return to **https://wacoastalnetwork.com/research-and-tools/slr-visualization/**

Step 2: As a group, find your community by clicking on the map. When the graph is ready, select the greenhouse gas likelihood scenario that the class voted on.

Step 3: On your own, answer the following questions in the table below.

Question 5:

A) For each year in the table (white columns only), use the graph to determine how many feet of Sea Level Rise there will be for each percent likelihood.

Likelihood	2050	+ storm surge	2080	+ storm surge	2100	+ storm surge
1%						
50%						
99%						

B) If a homeowner wants to be prepared for the worst case scenario, which likelihood scenario would they choose, and why?

PART C: Storms and King Tides

Step 1: These projections only show projected water levels due to Sea Level Rise. To also consider the effect of storm surge on overall water level, complete the gray columns in the table above by following the instructions below.

Question 6:

A) In the "+ storm surge" column of the data table, add 3 feet to the Sea Level Rise projection numbers if your community is along Puget Sound. Add 6 feet to the Sea Level Rise projection numbers if your community is along the Outer Coast.

B) Now let's also consider the effect of King Tides. How do you think King Tides would affect the overall water level?

Projecting Sea Level Rise

Guided Notes

Today's essential questions are:

1.
2.

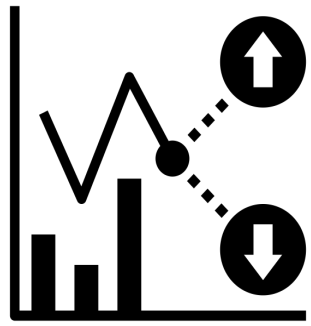
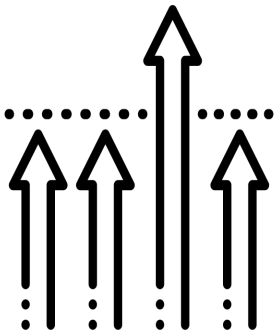
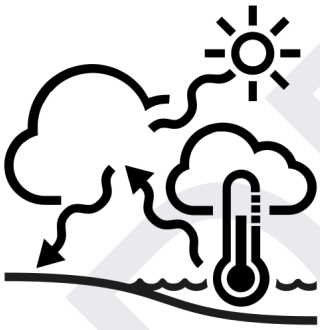
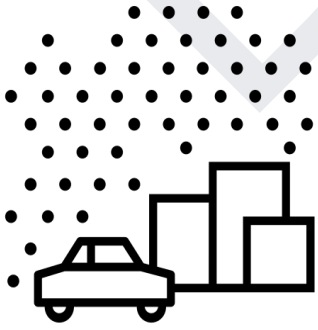
VIDEO NOTES: Flooding in Bellingham, WA

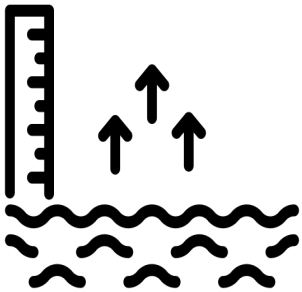
Instructions: As you watch the video, write down your observations, your inferences, and connections to other things you have seen or experienced.

Observations	*Inferences*	*Connections to Self*

VOCABULARY

Instructions: Fill in the table below.

	***PROJECTION***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***EXCEEDANCE***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***GREENHOUSE GAS***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***EMISSION***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

	***SEA LEVEL RISE***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

VIDEO NOTES: What causes sea level rise?

Instructions: Read through these questions before you watch the video, and then answer them after you watch the video.

***Question 1:** Why do scientists use the average water level instead of just one measurement?*

***Question 2:** What is the difference between local sea level and global sea level?*

***Question 3:** What has happened to the global sea level over the past century?*

***Question 4:** Describe two ways that warmer oceans lead to sea level rise.*

DAY 3: VISUALIZING SEA LEVEL RISE IMPACTS

5E LESSON PLAN

PLANNING/PREPARATION

CONTENT OBJECTIVE(S). What will your students know & be able to do?	**NGSS OBJECTIVE(S).** Which NGSSs do these context objectives align with?

• SWBAT communicate the cause and impacts of SLR on local Washington communities.
• SWBAT interpret maps depicting different information.
• SWBAT synthesize different types of data to quantify SLR and understand impacts.
	• ***HS-ESS3-5.*** Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.
	  ○ ***SEP-3-Developing and using models.*** SWBAT use multiple types of models to provide mechanistic accounts and/or predict phenomena, and move flexibly between model types based on merits and limitations.
	  ○ ***SEP-5-Analyzing and interpreting data.*** SWBAT analyze data using computational models in order to make valid and reliable scientific claims.
	  ○ ***NOS-SEP-1.*** Scientific investigations use a variety of methods, tools, and techniques to verify, revise and produce new knowledge.
	  ○ ***NOS-SEP-2.*** Scientific knowledge is based on empirical evidence.
	  ○ ***DCI-ESS3.D-Global climate change.*** Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.
	  ○ ***CCC-7-Stability and change.*** SWBAT recognize that systems can be designed for greater or lesser stability.

ELA STANDARD(S). How will language development be supported?	**MATH STANDARD(S).** How will mathematical reasoning be supported?
• ***WHST.9-12.2.*** Write informative/explanatory texts.	• ***MP.2.*** Reason abstractly and quantitatively. • ***HSN.Q.A.1.*** Interpret the scale and origin in graphs and data displays.
OCEAN LITERACY STANDARD(S) How will ocean literacy be supported?	**CLIMATE LITERACY STANDARD(S).** How will climate literacy be supported?
• ***OLP-3G.*** Changes in the ocean-atmosphere system can result in changes to the climate that in turn, cause further changes to the ocean and atmosphere. These interactions have dramatic physical, chemical, biological, economic, and social consequences. • ***OLP-6F.*** Much of the world's population lives in coastal areas. Coastal regions are susceptible to natural hazards (tsunamis, hurricanes, cyclones, sea level change, and storm surges).	• ***CLP-5.5.*** Scientists have conducted extensive research on the fundamental characteristics of the climate system and their understanding will continue to improve. Current climate change projections are reliable enough to help humans evaluate potential decisions and actions in response to climate change. • ***CLP-7.1.*** Seawater is beginning to move onto low-lying land, contaminating coastal fresh water sources and gradually submerging coastal facilities and barrier islands. Sea-level rise increases the risk of damage to homes and buildings from storm surges such as those that accompany hurricanes. • ***CLP-7.3.*** Incidents of extreme weather are projected to increase as a result of climate change. Precipitation events are expected to become less frequent but more intense in many areas.

Sea Grant Washington

DAY 3: VISUALIZING SEA LEVEL RISE IMPACTS

RELEVANCE/PREVIOUS LEARNING.
How does this relate to what students have already learned, or will need to learn?

- In the previous lesson, students learned about the causes and some of the consequences of sea level rise, considered the additive effects of king tides and storm surge, and learned how to use and interpret SLR projection models.
- After combining different sources of evidence and visualization tools, students will be better positioned to communicate with their families, communities, and decision-makers about the potential impacts of SLR in combination with other coastal hazards, including king tides and storm surge.

ASSESSMENT.
How will you know whether your students have made progress toward the objective?
How and when will you assess mastery?

Students will add to the previous lesson's worksheet by listing infrastructure that will be impacted by SLR and storm surge in their community, and then work in small groups to create and present a slide about impacts to specific forms of infrastructure.

KEY POINTS.
What three to five key points will you emphasize?

1. Infrastructure is the basic facilities and systems that provide goods and services to an area, such as a town, city, state or country.
2. Examples of infrastructure include transportation systems, communication networks, educational facilities, water and sewage services, recreational facilities, health systems, public safety services, power networks, arts and cultural facilities, and hospitality services.
3. Many types of infrastructure that you and your community depend on will be impacted by high water levels causes by king tides, storms, and sea level rise.

VOCABULARY DEVELOPMENT.
How will you help students connect to content and academic vocabulary (graphic organizers, word wall, concept maps, personal dictionaries, lingo bingo, etc.)?

- Word wall
  1. Tier 1: map
  2. Tier 2: water level, department, landmark
  3. Tier 3: MHHW, infrastructure, inundation
- Guided notes with graphic organizers

MODIFICATIONS.*
How will you make the material accessible to English language learners?
How will you make the material accessible to students with learning differences (e.g., G/T, special education?

English Language Learners	Learning Difference
● cooperative learning ● note-taking with graphic organizers ● cognates ● word wall	● diagrams/maps/graphs ● discovery learning (5E) ● grouping modifications ● (reduced) note-taking with graphic organizers ● vocabulary lists

E N G A G E

OPENING.
How will you communicate *what* is about to happen?
How will you communicate *how* it will happen?

- Essential question:
  - How will sea level rise and other coastal hazards impact infrastructure in your community?
- Agenda

MATERIALS.

- Powerpoint slides
- Guided Notes (optional)

Sea Grant Washington

DAY 3: VISUALIZING SEA LEVEL RISE IMPACTS

	CONNECT TO PAST EXPERIENCES, PAST LEARNING, & THE REAL-WORLD. How will you communicate its *importance*? How will you communicate *connections* to previous lessons? How will you engage students and capture their interest?	**MATERIALS.**
	• Hook: Select a King Tide photos from your community (see Teacher Notes) and have students locate where they are on Google Maps.	• Powerpoint slides • Teacher Notes
EXPLORE	**ACTIVITY.** What are students thinking about, planning, investigating, or organizing?	**MATERIALS.**

	• What are the impacts of SLR on communities in WA State?
	• Students work in small groups to explore the NOAA Sea Level Rise viewer website.
	  ○ Go to https://coast.noaa.gov/digitalcoast/tools/slr.html and click "Launch"
	  ○ Zoom into Washington State until you see raindrop icons.
	  ○ Click on a few of the raindrops and explore what happens when you adjust the water level (blue circle that starts at MHHW). [define MHHW - what the acronym stands for, what it means; green vs. blue shading; Blue - flooded, green - low-lying areas.
	  ○ At the top, type in your local community (i.e., the community you picked for the SLR Projection website during the last activity). [NOTE: It may be helpful to have students type in a specific address along the shore. See Teacher Notes for suggested addresses.]
	  ○ Look at the table of SLR Projection numbers from the last activity, and find the 50% likelihood scenario column.
	  ○ Adjust the water level so that it reflects that amount of sea level rise projected for 2050.
		• Powerpoint slides
		• Guided Notes (optional)
		• Day 2 worksheet
		• Teacher Notes

EXPLAIN	**REFLECTION.** How are students analyzing what they explored? How is their understanding clarified? How will students reflect on the significance of what they learned?	**MATERIALS.**
	• Open a new tab, go to Google Maps (maps.google.com) and type in the address you entered in the SLR viewer. • Cross-reference with Google Maps so that you can zoom in more. Identify important places/landmarks that will be impacted by SLR.	• Powerpoint slides • Day 3 worksheet
	INTRODUCTION TO NEW MATERIAL. What key points/vocabulary will you emphasize and reiterate? How will you ensure that students actively take-in information? Which potential misunderstandings will you anticipate? Why will students be engaged/interested?	**MATERIALS.**
	• Provide examples of infrastructure (roads, parks, wastewater treatment, etc.) • Go through 4-5 'raindrop' examples on the NOAA SLR viewer and talk through which kinds of infrastructure are shown and how they are impacted. • Most types of infrastructure are managed by your local (city, county) government (e.g., sewage treatment plants, schools, fire departments, parks, etc.)	• Powerpoint slides • Guided Notes (optional)
	CHECK FOR UNDERSTANDING. How will you check for understanding of content & vocabulary before moving on? How will you monitor and correct student performance?	**MATERIALS.**
	• Given these four examples, which isn't infrastructure?	• Powerpoint slides
EXTEND	**APPLICATION.** How are students expanding their knowledge? What new situations are students applying their knowledge to?	**MATERIALS.**
	• Now add storm surge (3 feet within Puget Sound, 6 feet on the Coast) to the SLR projection number for 2050 and adjust the water level accordingly. • Cross-reference with Google Maps again, and describe what infrastructure is impacted by SLR plus storm surge.	• Powerpoint slides • Day 3 worksheet

Sea Grant Washington

DAY 3: VISUALIZING SEA LEVEL RISE IMPACTS

	CHECK FOR UNDERSTANDING. How will you check for understanding of content & vocabulary before moving on? How will you monitor and correct student performance?	**MATERIALS.**
	● Walk around and check worksheet progress	● Day 3 worksheet
EVALUATE	**FINAL PRODUCT.** How will students synthesize what they learned? What will students create or do? How will you provide all students with opportunities to demonstrate mastery? Why will students be engaged/interested?	**MATERIALS.**
	● Class presentation ○ Groups split into types of infrastructure (houses, restaurants, roads, parks, etc.) and explain what is impacted in your community scenario ○ Spend ~20 minutes on building your presentation and investigating ○ Create a slide with notes for a 2 min share out ● Tie it back to King Tide photos and MyCoast app, engage students in community science ○ Look for photos on MyCoast that show your flooded infrastructure and include it in your presentation ○ Optional Extension: Prior to the lesson, give students an extra credit opportunity to take their own photos of King Tides. Incorporate these photos into the presentation and add to MyCoast app. **NOTE:** Remember to be safe! Be extra careful when walking on slippery surfaces and be aware of your surroundings. Be aware of weather conditions and big waves. Always stay a safe distance away from waves. Remember to obey safety signage, guard rails, and weather advisories. Never turn your back on the ocean.	● Powerpoint slides
ASSESSMENT	**FORMAL ASSESSMENT.** How will you formally assess mastery of the content and vocabulary objectives? When will you formally assess mastery of the content and vocabulary objectives?	**MATERIALS.**
	● (Optional) Performance Assessments: ○ Imagine you are a city planner. Create and give a presentation about the causes and projected impacts of flooding due to sea level rise, king tides, and storm surge. ○ Write a letter to your city/community government (mayor, etc.) about the causes and projected impacts of flooding due to sea level rise, king tides, and storm surge. ○ Create a GIS Story Map about the causes and projected impacts of flooding in your community due to sea level rise, king tides, and storm surge.	● Teacher Notes

*Sheltered Instruction strategies for ELL students: analysis pizza, anticipation guide, capsule vocabulary, characterization chart, chunking, cloze passages, cognates, concept of definition map, cooperative learning, Cornell notes, flow chart, foldables, KWL, note-taking, outlining, RAFT, retelling, self-monitoring, semantic mapping, sketch to stretch, story map, summarizing, think-pair-share, Venn diagram, verbal/visual word association, window paning, word wall.
†Strategies to help students with Learning Differences: assignment notebooks, diagrams/maps/graphs, discovery learning, extended time, grouping modifications, highlighting, marking copies of texts, note-taking, peer reading, peer tutoring, shortened assignments, skeleton outlines, special seating, recorded texts, vocabulary lists, writing models, reduced note-copying, graphic organizers, assignment contract, task analysis (steps), alternate projects, repetition of directions, study guide, simply exam format, objective exams, extended exam time, minimize options, oral exams.

Visualizing Sea Level Rise Impacts

How will sea level rise and other coastal hazards impact infrastructure in your community?

Student Instructions

Today you will work with your small group to explore a tool that visualizes the impact of Sea Level Rise. By using data collected from yesterday's activity, we will observe the impact of sea level rise in your community.

You will need:

- Access to a computer or tablet that can be shared with your small group
- A reliable WiFi connection
- At least 1 copy of this worksheet to fill out per group

PART A: Navigating the MyCoast App

Step 1: Please go to https://mycoast.org/wa and scroll down to the bottom of the page. Click on the "King Tides" crown button.

Step 2: After the new page opens, zoom in on the map at the top to find your community or another area that interests you within Washington State. As you zoom in, crown icons will appear. Click on an icon to see an image of a King Tide at that location.

PART B: Get to know the NOAA Sea Level Rise Viewer Tool

Step 1: Please go to https://coast.noaa.gov/digitalcoast/tools/slr.html and click 'Launch.' After the new tab opens, click the 'Get Started.'

Step 2: Zoom into Washington State until you see raindrop icons.

Step 3: Click on three of the raindrops and explore what happens to the landmark photos and the map when you increase the water level from MHHW. MHHW is an abbreviation for "mean higher high water," or the average daily water height of the higher high tide over a 19-year period. Green shading on the map indicates low-lying areas, and light blue shading on the map indicates inundation.

Question 1: ***Describe what happens to the landmark photo as you increase the water level one foot at a time from MHHW.***

Question 2: ***Describe what happens to the map as you increase the water level one foot at a time from MHHW.***

Step 4: At the top, type in your local community (i.e., the community you picked during the last activity).

Step 5: Look at the table of SLR Projection numbers from the last activity, and find the 50% likelihood scenario column. Adjust the water level so that it reflects the amount of sea level rise projected for 2050.

Question 3: ***What is the sea level rise projected to be in your community in 2050? (50% likelihood)***

PART C: Cross-Reference with Google Maps.

Step 1: Open a new tab, go to Google Maps (maps.google.com) and type in the address you entered in the SLR viewer.

Step 2: Cross-reference with Google Maps so that you can zoom in more. Identify 2-3 important places or landmarks that will be impacted by sea level rise.

Question 4: ***Name 3 important landmarks that will be impacted by sea level rise in your community.***

1.

2.

3.

Stop here and wait for the teacher

PART D: Adding Storm Surge

Step 1: Now add storm surge (3 feet within Puget Sound, 6 feet on the Coast) to the sea level rise projection number for 2050 and adjust the water level accordingly. Write your number below.

Question 5: ***What is the sea level rise projected to be in your community in 2050 with storm surge? (50% likelihood)***

Step 2: Go back to Google Maps (maps.google.com) and identify 2-3 important places/landmarks that will be impacted by sea level rise and storm surge.

Question 6: ***List 3 examples of infrastructure that will be impacted by sea level rise and storm surge in your community.***

1.

2.

3.

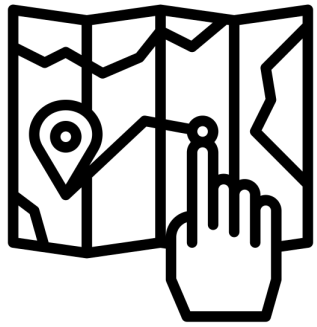
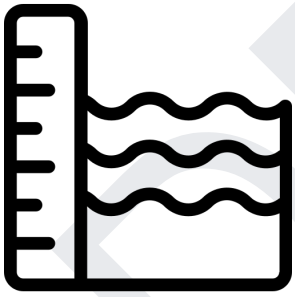
Visualizing Sea Level Rise Impacts

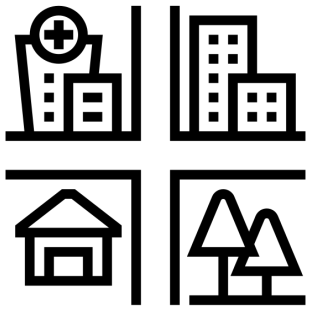
Guided Notes

Today's essential question is:

VOCABULARY

Instructions: Fill in the table below.

	***LANDMARK***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***MEAN HIGHER HIGH WATER (MHHW)***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*
	***INUNDATION***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

	***INFRASTRUCTURE***
	*Write the **definition**:*
	*Think of a **synonym**:*
	*Use in a **sentence**:*

Washington King Tides Curriculum

TEACHER NOTES

DAY 1

- Optional lesson add-ons if your students have not yet learned about tides, generally:
  - Introductory videos:
    - What causes tides? (4-minute video)
    - Dance of the tides (2-minute video)
  - Ups and downs: What causes tides and tidal currents? (3-5, 45-minute class periods)
- Photos of regular and king tides in Washington communities

Community	Normal Tide	King Tide
Westport	Westport Beach Summer Tide	Westport King Tide
Cape Disappointment	Cape Disappointment Summer Tide	Cape Disappointment King Tide
Alki Beach	Alki Summer Tide 1 Alki Summer Tide 2	Alki King Tide
Birch Bay	Birch Bay Summer Tide	Birch Bay King Tide 1 Birch Bay King Tide 2

- King Tides Calendar - Slide 13 currently includes information for Seattle. Replace the dates, times, and predicted high tides with information from the city closest to your community.

DAY 2

- NOTE: Negative numbers are possible!
  - We live in a geologically active area with moving tectonic plates. Off of the Washington coast is a subduction zone which is causing some areas along the coast to buckle.
  - Neah Bay is one example where pressure between tectonic plates is causing uplift that outpaces sea level rise.
- Optional add-ons to further explore sea level rise: NOAA-NOS Sea Level Rise Learning Module
  - Educator Guide
  - Sea Level Rise video and graphing activity (1, 45-minute class period)

- Data in the Classroom: Investigating Sea Level Using Real Data (5, 45-minute class periods)
  - Educator guide
  - Online materials and resources
- Calculating Your Carbon Footprint (1-2, 45-minute class periods)
  - Activity
  - Climate wheel

DAY 3

- Suggested photos to pull from the MyCoast App for Day 3

County	Link to Photo(s)
Clallam	https://mycoast.org/reports/45424
Grays Harbor	https://mycoast.org/reports/64058
Island	https://mycoast.org/reports/43948
Jefferson	https://mycoast.org/reports/55476
King	https://mycoast.org/reports/63630
Kitsap	https://mycoast.org/reports/44507
Mason	https://mycoast.org/reports/46740
Pacific	https://mycoast.org/reports/46690
Pierce	https://mycoast.org/reports/80733
San Juan	https://mycoast.org/reports/45791
Skagit	https://mycoast.org/reports/44831
Snohomish	https://mycoast.org/reports/64081
Thurston	https://mycoast.org/reports/55295, https://mycoast.org/reports/44144
Wahkiakum	No photos submitted yet!
Whatcom	https://mycoast.org/reports/45932

- Suggested addresses to plug into NOAA Sea Level Rise Viewer

County	City	Landmark	Address
Clallam	Sequim	Dungeness Spit	554 Voice of America Rd W, Sequim, WA 98382
Grays Harbor	Westport	Port Viewing Tower/Downtown	421 Neddie Rose Dr, Westport, WA 98595
Island	Camano Island	Warm Beach	20800 Marine Dr, Stanwood, WA 98292
Jefferson	Port Townsend	Maritime Center	431 Water St, Port Townsend, WA 98368
King	West Seattle	Alki Beach	2665 Alki Ave SW, Seattle, WA 98116
Kitsap	Poulsbo	SEA Discovery Center	18743 Front St NE, Poulsbo, WA 98370
Mason	Union	Twanoh State Park	12190 WA-106, Union, WA 98592
Pacific	Long Beach	Adrift Hotel	409 Sid Snyder Dr, Long Beach, WA 98631
Pierce	Tacoma	Port of Tacoma	One Sitcum Plaza, Tacoma, WA 98421
San Juan	Lopez Island	Lopez Island Resort and Marina	2864 Fisherman Bay Rd, Lopez Island, WA 98261
Skagit	La Conner	La Conner USPS	125 1st St, La Conner, WA 98257
Snohomish	Everett	Port of Everett	1638 W Marine View Dr, Everett, WA 98201
Thurston	Olympia	Percival Landing Park	217 Thurston Ave NW, Olympia, WA 98501
Wahkiakum	Rosburg	Deep River Boat Launch	600-, 618 Oneida Rd, Rosburg, WA 98643

Whatcom	Bellingham	Port of Bellingham	1801 Roeder Ave, Bellingham, WA 98225

OPTIONAL UNIT EXTENSION IDEAS

- Performance assessments
  - Imagine you are a city planner. Create and give a presentation about the causes and projected impacts of flooding due to sea level rise, king tides, and storm surge.
  - Write a letter to your city/community government (mayor, etc.) about the causes and projected impacts of flooding due to sea level rise, king tides, and storm surge.
  - Create a GIS Story Map about the causes and projected impacts of flooding in your community due to sea level rise, king tides, and storm surge.
- English/Language Arts connections
  - Selected chapter(s) from *Rising: Dispatches from the New American Shore*, by Elizabeth Rush. This is a Pulitzer Prize winning non-fiction about sea level rise in the U.S.
- Career-connected learning
  - Explore careers related to city planning, climate modeling, etc.
- Data collection and analysis
  - Using the King Tide Calendar, plan field-based collection of sea level data and/or photographs to contribute to ongoing citizen science efforts (i.e., the MyCoast App). **NOTE:** Remember to be safe! Be extra careful when walking on slippery surfaces and be aware of your surroundings. Be aware of weather conditions and big waves. Always stay a safe distance away from waves. Remember to obey safety signage, guard rails, and weather advisories. Never turn your back on the ocean.
  - Mathematical modeling of past sea level rise projections for comparison to ground-truthing data.