What Can King Tides Photos Tell Us About Sea Level Rise?

Grade Levels:	6th-12th grades
Time:	1-2 class periods (45 min – 1 hr 30 min)
Supports NGSS:	MS-ESS3-3, MS-ETS1-1, HS-LS2-7, HS-ETS1, HS-ESS3-4, HS-ESS3-6

Summary

Students work individually and in groups on computers with internet access. If student computers are not available or practical, or if instructor prefers to standardize the investigative process, hand-outs can be used instead. Download those from www.coastal.ca.gov/kingtides/educators.html

Objectives

Students will be able to:

- Use photo data and predictive models to analyze sea level rise vulnerabilities
- Use photo data to ground-truth a climate change model
- Identify solutions to help communities prepare for and reduce the cause of sea level rise.

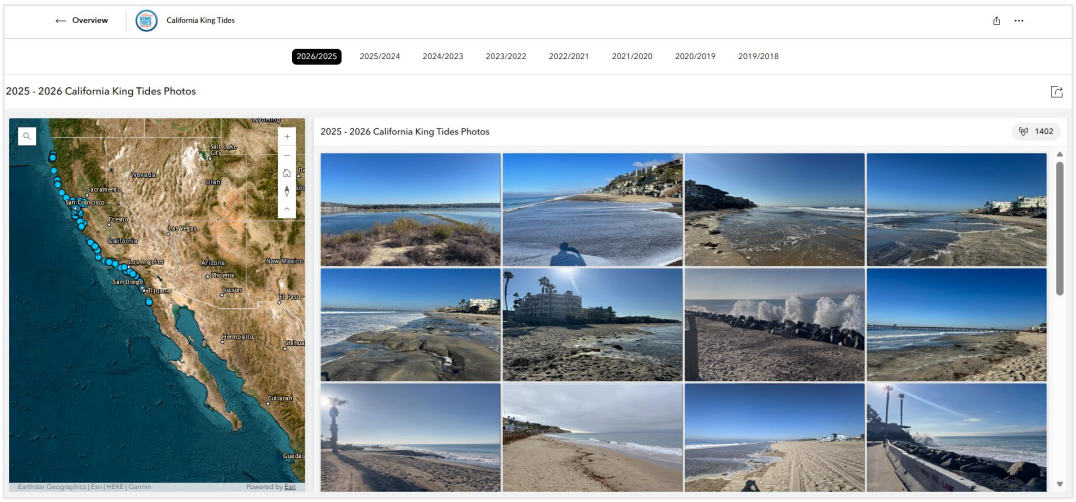
Materials

- Worksheet - *What Can King Tides Photos Tell Us About Sea Level Rise* (1 per group)
- Computers with access to:
  - www.coastal.ca.gov/kingtides
  - tidesandcurrents.noaa.gov
  - ourcoastourfuture.org/hazard-map
- *Computer alternative:* Use hand-outs downloaded from www.coastal.ca.gov/kingtides/educators.html

Activity Procedure

1. Invite students to individually explore a map of photos from the 2025/2026 king tides season (or share your screen to explore as a class). Explain that these photos were submitted by volunteers who visited the shoreline when the tide was predicted to be among the highest of the year. (To access the map, use a computer rather than a tablet or phone to visit www.coastal.ca.gov/kingtides and click "Explore a Map of King Tide Photos.")
   - The photo gallery on the right side of the screen adjusts to display the photos that are included in the viewable area of the map on the left.
   - Zoom in or out on the map to change the gallery selection.
   - Click on a photo to enlarge it. On the bottom right of the photo are icons allowing you to see the photo full screen or to download the photo. On the map, the location name of the photo is displayed, and clicking on the arrow/carrot to the right of the location name expands the box to show the description, if any, that was submitted by the photographer.

Tip: When viewing the California King Tides Project Photo Map, students should see the map on the left and a photo gallery on the right as pictured below. If they see a different orientation, they should reduce the zoom level of their browser until the map appears on the left side. (If on a PC, reduce zoom level by holding the **Ctrl** key while pressing on the **– (Minus)** key. On a Mac, it's **Command + Minus (⌘ + -)**. Or reduce zoom level using the tools menu of the browser window.)



2. Instruct students to choose a location on the map they're familiar with, or a place they're interested in visiting or learning more about.
   - What do students notice about the photos of that location? What do they wonder?
   - Do they find evidence of flooding and flooding impacts? Is there evidence in the photos or photo descriptions of the weather on the day the photo was taken? How might they learn more?

3. Divide the class into groups of 2 or 3 students and give each group a worksheet to work on throughout the lesson. Have each group select one location with good photo coverage on the map, *or* have them use the hand-outs showing City of Alameda data. (Some location suggestions for the 2025/2026 season include City of Alameda, Marin County, Morro Bay, King Salmon in Humboldt Bay, Long Beach, and San Diego.)

4. What were the predicted tide heights for the days the photos in the chosen location were taken? Have groups visit tidesandcurrents.noaa.gov/tide_predictions.html, navigate to California, and then to the tide station closest to their chosen location. Students can select a date range and *Plot Calendar* to see the tide predictions for that location and date. What do students notice? What questions do they have?

5. Share with students that King Tides are 1 to 2 feet higher than the average high tide throughout the year. That's about equal to the amount of sea level rise scientists expect within the next few decades due to human-caused global heating. That means that students can use the king tides photos to validate, or "ground-truth," a sea level rise model.

> ***What is causing Sea Level Rise?*** When people burn fossil fuels like oil, gas, and coal, excess carbon dioxide is released into the atmosphere, heating the earth, air, and ocean. Global sea level is rising because land-based glaciers and ice sheets are melting into the ocean and because water expands in volume when it warms.

6. Have groups open a new browser window or tab and go to ourcoastourfuture.org/hazard-map/. Students should click "Agree" on the pop-up disclaimer to access the map and zoom into their chosen location. Using the tools on the left, they can set an amount of sea level rise and a storm frequency and observe how the model responds.
   - What levels best replicate the conditions on the day of their king tides photos?
   - Do the photos validate the model? If not, can students speculate on reasons that might be the case?

7. NOAA posts verified water level data for some tide stations. Have students find the station list at tidesandcurrents.noaa.gov/stations.html?type=Water+Levels. Then have student groups select the station closest to their chosen location and plot the data for the dates of their king tides photos. (If the NOAA website is unable to retrieve data for their chosen location, they should select another tide station on the Water Level list that will retrieve data.) Compare the *Predictions* to the *Verified* water level. Why might they be different? How could you find out more information?

8. Have groups share out to the class their arguments for or against the effectiveness of king tides photos in ground-truthing the sea level rise model.

Wrap-Up

Within the next few decades, the water level every day is likely to be at least as high as today's king tide. Based on the vulnerabilities students identified in their chosen location, what would they recommend the community do to *prepare for* rising sea level? What is one solution students would recommend to reduce the *cause* of sea level rise? Who would need to be involved in implementing the solution?

Optional Extensions

- For students near the coast, they can contribute to the California King Tides Project by safely photographing the highest predicted tides of the year. Learn how at https://www.coastal.ca.gov/kingtides
- Grow students' climate communication skills and reflect on emotional responses to climate change. They can enter the Climate Storytelling Contest by creating a podcast, photo essay, or narrative essay. www.coastal.ca.gov/climatechallenge/

Educator Background

While "King Tide" isn't a scientific term, it is used to describe especially high tides that occur when the gravitational pull between the sun, moon, and Earth align and the moon is closest to Earth in its orbit. The Earth is also closest to the sun around the New Year, further increasing the gravitational pull on the ocean during California's winter season. When king tides occur during floods or storms, water levels can rise even higher and have the potential to cause great damage to the coastline.

King tides:

- occur naturally and regularly,
- are predictable and expected, and
- are not an everyday occurrence.

King tides are 1 to 2 feet higher than the average high tide throughout the year. The National Oceanic and Atmospheric Administration (NOAA) makes their tide predictions based on astronomical conditions (Earth, moon, and sun), *not* based on weather or El Niño forecasts. A storm surge or strong El Niño that coincides with king tides can cause the water level to be higher than the NOAA tide predictions.

The California King Tides Project, organized by the California Coastal Commission, asks the public to safely photograph the king tides to:

- document current flood risk in coastal areas,
- visualize the impacts of future sea level rise in a community,
- ground-truth climate change models by comparing model predictions with the high-tide reality,
- serve as a living record of change for future generations, and
- help start climate conversations.

Learn about the California King Tides Project and how to participate at www.coastal.ca.gov/kingtides. View mapped King Tides photos from 2018 to today by clicking on “Explore a map of King Tide photos.”

More King Tides Resources

- Watch a video from the Exploratorium explaining King Tides: www.exploratorium.edu/video/full-spectrum-science-shorts-king-tides
- Get into the science of tides and learn what a “perigean spring tide” is: oceanservice.noaa.gov/facts/perigean-spring-tide.html.
- Watch an explanation from the National Weather Service about how El Niño impacts and storm events can increase water level, produced for the 2026 El Niño season: Video about El Niño, storms, and king tides.

WORKSHEET – What Can King Tides Photos Tell Us About Sea Level Rise?

Visit www.coastal.ca.gov/kingtides, and "Explore a Map of King Tide Photos," or follow teacher instructions. Use another sheet if you need more space to answer the following questions.

1. Location Name:

2. What are some things you notice about the photos?

3. What are some questions you have about the photos?

4. What visual evidence, if any, is there of flooding?

5. From the photos, what do you think is vulnerable to flooding and future sea level rise? For example, animal or plant habitat, homes, farmland, businesses, roads, parks or other community-gathering areas?

6. Using the King Tides map, or another map of the area, do you find evidence that there are other vulnerabilities not shown in the photos?

7. How would you describe the weather conditions, based on evidence in the photos or in the written descriptions?

8. Choosing one of the photos, what was the predicted highest tide height on that day? (Use tidesandcurrents.noaa.gov/tide_predictions.html to find the closest tide station, enter your photo's date, and select "Plot Calendar." Or follow teacher instructions.)

9. What else do you notice, or what questions do you have, from examining the tide table?

10. Visit ourcoastourfuture.org/hazard-map/ or follow teacher instructions. King tides are 1-2 feet higher than the average high tide throughout the year. How can you best replicate the conditions of your photo on the model? Does the photo validate, or "ground-truth," the sea level rise model?

11. Are there any limitations or weaknesses with using king tides photos to validate the sea level rise model?

12. Using NOAA's Water Level data (tidesandcurrents.noaa.gov/stations.html?type=Water+Levels), was the *Verified* water level on the date of your photos different from the *Predicted* tide height? (Use the tide station with available water level data that is closest to your photo location.) If different, by how much?

13. If the verified water level was different from the tide prediction, why do you think that was? How or where could you find evidence for your claim?

14. Within the next few decades, the everyday water level is expected to be at least as high as today's king tide. Based on the vulnerabilities you identified in your photo location, what is one specific thing you would recommend this community do to prepare for rising sea level?

15. When people burn fossil fuels like oil, gas, and coal, heat-trapping gases like carbon dioxide are released into the atmosphere. Global sea level rise is caused by global heating from these heat-trapping gases. What is one solution you would recommend to reduce the cause of sea level rise?

16. Who would implement your solution? Circle all that apply:

Individual	Community Group	Local Government
State Government	Federal Government	International Alliance

17. If you only circled Individual, is there something that one of the other levels could do to support the individual or increase the impact?