Earth 107: Module 4 Lab

Important! We advise you to either print or download/save this document as it contains the steps you need to take to complete the Lab in Google Earth. In addition, it contains prompts for questions that you should take note of (by writing down or typing in) as you work through the Lab.

Once you have worked through all the steps and answered the questions, you will go to the ***Module 4 Lab in Canvas*** *to complete the Lab by answering multiple-choice questions available in quiz format. The answers to questions on this Lab worksheet will match choices in the multiple-choice questions in Canvas. Submit the quiz in Canvas for credit.*

Module 4 Lab Overview

The objectives of this lab are for you to:

1. Use the PSMSL web site and Google Earth to explore historical records from tide gauges around the U.S. that provide reliable long-term data sets, to gain an understanding of different rates of sea level change on the Pacific, Atlantic, and Gulf coasts.
2. Use NOAA's Sea Level Rise Viewer to make observations and compare sea level change predictions in locations around the U.S.

There are two parts to this Lab.

- Part I is Analyzing Sea Level Change Using Tide Gauge Data. You will download the tide gauge Google Earth kmz data file from the PSMSL site. Use the tide gauge data to answer questions 1-14.
- Part II is the NOAA Sea Level Rise Viewer. After spending time exploring and figuring out how to manipulate the viewer to give you the information for projected sea levels at the location of interest for different years, use the viewer to answer questions 9-15.

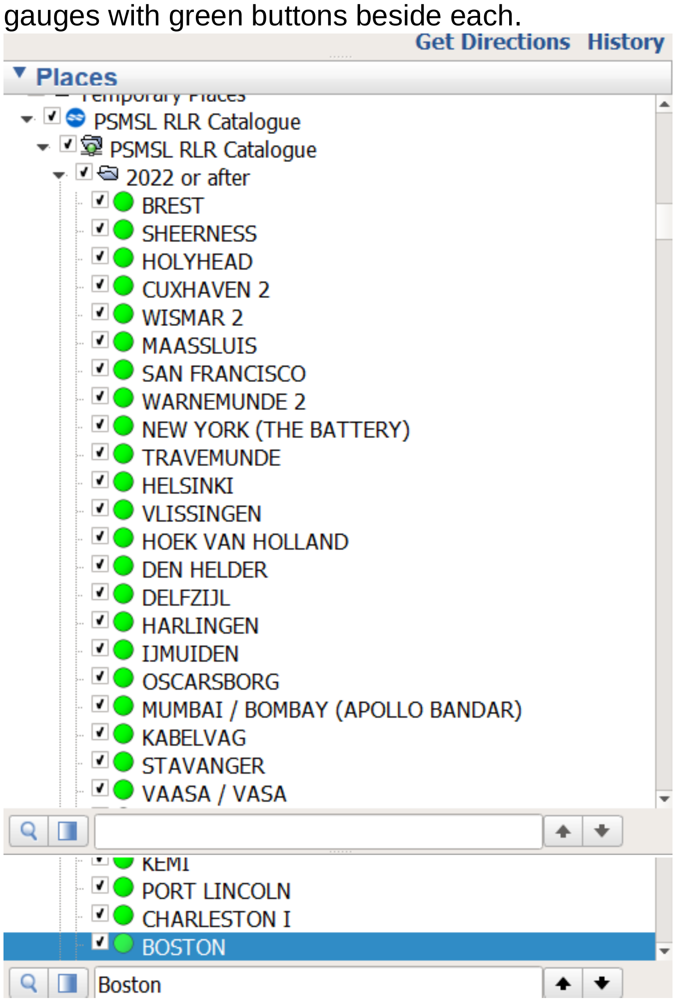
__Part I: Analyzing Sea Level Change Using Tide Gauge Data__

Procedure

(Note: you were prompted to download the tide gauge data using the PSMSL site on the course web site: Module 4 Lab page.)

__Boston (Example directions)__

1. After downloading the tide gauge kmz data file on the PSMSL site and opening in Google Earth, go to your Google Earth Temporary Places, find the PSMSL RLR Catalogue and click on "2022 or after" folder (or most recent). This will open a list of tide gauges with green buttons beside each.



2. Enter Boston into the search below the tide gauge list. Check the box and click on the green button next to "Boston" to zoom in to Boston.
3. Click on the green dot that indicates the tide gauge in Boston. A box will open for navigating to the PSMSL data for this gauge (# 235). Click on the number and this will

take you to the data for Boston on the PSMSL site. This site may open in your default browser.

4. Note the details of the Boston Data given on this page. The data cover the time period from 1921 to the most recent year of data availability. They are 99% complete. Therefore, these are valuable data for seeing trends in sea level change.
5. Scroll down and click on the link to open a “larger image of **annual** data plot” version of the data plot for annual data (bottom of two plots). You will answer questions about this plot in the lab on Canvas (see questions below).
6. Now go back to the site and click on “download **annual** mean sea level data” This will give you a string of values in 4 columns. **The left-hand column is the year. The next column to the right is the sea level in millimeters. The other two columns are not relevant to our task.**
7. Calculate the change in sea level from 1921 to 2023. Find the rate per year using this value.
8. Using the data, answer questions 1 -2.

Boston

1. The best description of the Boston data plot is:

    a) A positive sea level trend of close to 30 cm (200 mm) in 95 years with short-term variability.
    b) A positive sea level trend of more than one meter (100 mm) over 95 years with short-term variability.
    c) The variability in the data makes it impossible to detect a clear trend.
    d) A smooth increase in sea level of less than 1 meter over 95 years, with no variation.

2. Use the difference in sea level between 1921 and 2023 to calculate the rate per year in mm/yr. What is the closest value?

    a) 1.5 mm/yr
    b) 3.5 mm/year
    c) 5.5 mm/yr
    d) 10 mm/yr

San Francisco

Repeat steps 2 -5 for the San Francisco tide gauge and answer questions 3-4.

3. The best description of the San Francisco data plot is:

    a) Positive sea level trend of more than 20 cm (200 mm) more than 160 years with a great deal of short-term variability.
    b) Positive sea level trend of more than 20 cm (200 mm) more than 160 years, with a small amount of short-term variability.
    c) The variability in the data makes it impossible to detect a clear trend.

d) A negative trend of less than 20 cm over >160 years with little variability.

4. Use the difference in sea level between 1855 and 2023 to calculate the rate per year in mm/yr. What is the closest value?

a)1.5 mm/yr
b)4.5 mm/yr
c)7.5 mm/yr
d)9.5 mm/yr

Grand Isle, LA

Repeat steps 2 -5 for the Grand Isle, LA tide gauge and answer questions 5-6.

5. The best description of the Grand Isle, LA data plot is:

a) Positive sea level trend of more than 100 cm (1,000 mm) over >65 years, with a less short-term variability than in San Francisco or Boston.
b) Positive sea level trend of more than 60 cm (600 mm) over >65 years, with less short-term variability than in San Francisco or Boston.
c) Very unreliable due to a short-term record and missing data.
d) Positive sea level trend of more than 60 cm (600 mm) over >65 years, with greater short-term variability than in San Francisco or Boston.

6. Use the difference in sea level between 1947 and 2023 to calculate the rate per year in mm/yr. What is the closest value?
   a) 1.5 mm/yr
   b) 3.5 mm/yr
   c) 5.5 mm/yr
   d) 8.5 mm/ yr

7. Which of the following is the correct order, from greatest to least, for sea level rise rates for the 3 cities you have made calculations for?

a) San Francisco, Grand Isle, Boston
b) Boston, Grand Isle, San Francisco
c) Grand Isle, San Francisco, Boston
d) Grand Isle, Boston, San Francisco

8. Which of the following would best explain the differences in observed rates of sea level rise?

   a) The Gulf of Mexico is rising faster than any other part of the ocean and the Pacific Ocean is rising more slowly than the rest of the ocean.

b) The land on the Louisiana Gulf coast is experiencing subsidence in addition to sea level rise and the west coast of the U.S. is a tectonically active coast experiencing uplift.
c) Boston has greater rates of sea level rise than San Francisco due to their coastal classification of trailing edge vs. continental collision.
d) Both b. and c. are plausible explanations for the differences observed in the data.

Part II: NOAA Sea Level Rise Viewer

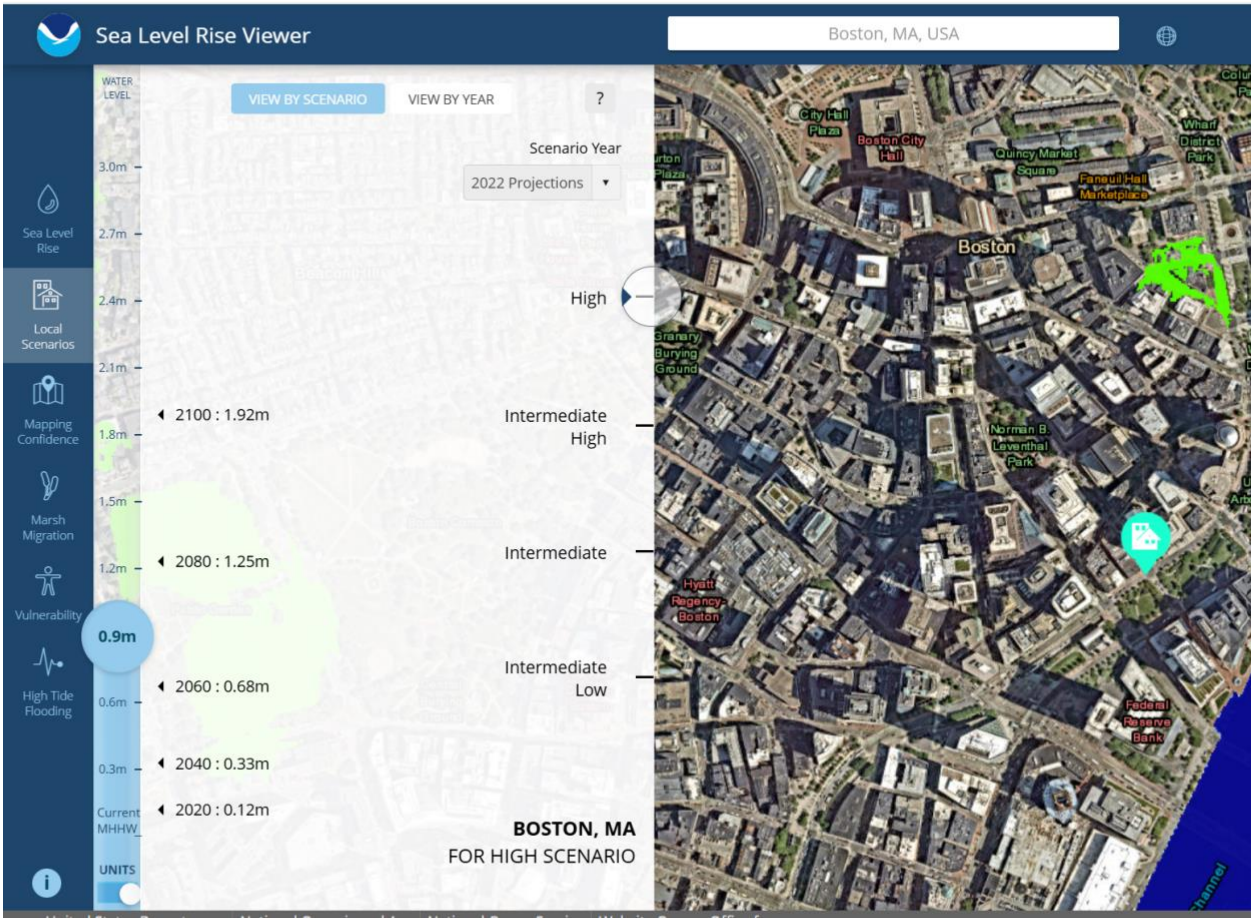
In Part II of this Lab, you will use the NOAA Sea Level Rise Viewer to help you visualize what these levels would look like in particular locations around the U.S. You will keep your calculated rates in mind for each place from Part I as you work with the viewer and consider the factors that influence the future projections of increased sea level rise.

Procedure

Note: The NOAA Sea Level Rise Viewer may work better in Chrome than in other browsers. You may want to try it in your favorite browser and compare to Chrome to decide which to use. After exploring each location, we recommend you close the viewer and re-open in a new window before going to a new location.

1. Go to the NOAA Sea Level Rise Viewer. *(Note: link above and on the Module 4 Lab page on the course web site).* The viewer allows you to perform a variety of actions to visualize what sea level rise means to a particular location at a particular time in the future, using the five sea level rise scenarios of Intermediate-Low, Intermediate, Intermediate-High, High and Extreme. It allows you to manipulate the sea level in 0.3 m (~1 ft.) increments.
2. Let’s start in Boston to explore the viewer. To quickly arrive there, type in the name of the city in the search bar at the top of the page. Set the units to meters before you begin. On the left side of the screen are themes by which we can explore sea level rise in our places of interest.
3. Settings: We will use the View by Scenario, and the Local Scenarios buttons for this exercise. Also, be sure to set the scenario for 2022 projections.
4. Begin by clicking on the Sea Level Rise Button and explore how increasing the sea level with the slider causes low lying areas to show as inundated.
5. Next, click on the yellow Local Scenarios icon, go to the Information (i) button below the left-hand list to read important information and directions for using the local scenarios data. Also click the (?) button to the top right of the left hand-pane. This provides simple directions for choosing a scenario location and gives a tutorial for using the Local Scenarios.
6. After spending time exploring and figuring out how to manipulate the viewer to give you the information for projected sea levels at the location of interest for different years, use the viewer to answer questions 9-15.

When you have the correct settings, your screen should look similar to the screen shot below. Don’t forget to click on the Scenario icon  on the map.



Boston

9. Starting with the "view by Scenario" turned on and at the "HIGH" sea level rise scenario for BOSTON, what is the projected sea level rise for 2040 and 2100 respectively?

   a) 0.51 m and 2.73 m (1.64 ft; 8.95 ft)
   b) 0.33 m and 1.92 m (0.08 ft.; 6.3 ft)
   c) 0.2 m and 2.5 m (0.65 ft; 8.2 ft.)
   d) 0.29 and 1.55 m 0.95 ft.; 5.08 ft)

10. With the sea level rise viewer set on View by Scenario and the HIGH sea level rise scenario selected, observe the areas in Boston that would be inundated at 1.5 m sea level rise, and answer the following question:

    Around which year would Quincy Market Square first be flooded in this scenario?

    a) 2090
    b) 2100
    c) 2050

d) 2030

San Francisco

After completing your exploration of Boston, close the viewer and re-open before navigating to your next location: San Francisco

11. Starting with the “view by Scenario” turned on; what are the sea level rise projections at the “HIGH” level for San Francisco (near Golden Gate Bridge) for 2040 and 2100 respectively?

    a. 0.23 meters; 1.99 meters (0.75 ft.; 6.53 ft.)
    b. 0.16 meters; 2.53 meters (0.52 ft.; 8.3 ft.)
    c. 0.5 meters; 2.5 meters (1.6 ft.; 8.2 ft.)
    d. 0.07 meters; 0.48 meters (0.22 ft; 1.57 ft.)

12. Starting with the “view by Scenario” turned on and the HIGH sea level rise scenario selected, observe the areas in San Francisco that would be inundated at 1.5 m sea level rise, and answer the following question:

    Around what year would Highway 101 (Presidio Highway) first be flooded between Palace of Fine Arts and Crissy Field? (This is the large highway traversing this part of San Francisco)

    a) 2100
    b) 2090
    c) 2030
    d) 2050

Grand Isle, LA

13. Starting with the “View by Scenario” turned on; what are the sea level rise projections at the “HIGH” level for Grand Isle for 2040 and 2100 respectively?

    a) 0.67 meters; 2.46 meters (2.19 ft.; 8.07 ft).
    b) 0.55 meters; 2.7 meters (1.8 ft; 8.8 ft.)
    c) 0.34 meters; 3.17 meters (1.1 ft.; 4.8 ft.)
    d) 0.48 meters; 1.26 meters (1.57 ft.; 4.1 ft.)

14. Starting with the “View by Scenario” turned on and the HIGH sea level rise scenario selected, observe the areas in Grand Isle that would be inundated at 1.5 m sea level rise, and complete the following statement:

    At a 1.5 m sea level rise, Grand Isle, LA will be more than _____ inundated. This will take place around ______

    a) 25%, 2020

b) 50%, 2040
c) 75%, 2060
d) 90%, 2070

15. Based on the sea level trends seen in the tide gauge data and your observations using the Sea Level Rise Viewer, write a brief take-away statement describing a 50-year sea level rise projection for each of the three locations we have analyzed in this lab. Describe what you predict each location will look like by 2075**. (3 points)**