



Sea Level Rise: Risks and Mitigation

High School/Undergraduate

Lesson Driving Question:

What challenge(s) does changing sea-level rise pose?

How can we mitigate the effects of sea-level rise?

What You Will Be Doing:

Lesson Outline

Part 1: Sea Level Rise Case Study

- Sea-level rise case studies
 - Global average sea-level vs regional sea change

Part 2: Flood Maps

- How can we plan?

Lesson Outline

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Warm-up:



What do you **think** are the challenges a changing sea level poses to communities?



Credit: Hawaii Sea Grant King Tides Project, retrieved from climate.nasa.gov

Read:

With a partner:

You'll each read about **one** place in Alaska being affected by sea-level change.



As you read, **highlight** when the following are affected by sea-level change:

- **People** (residents, housing)
- The **economy** (jobs, businesses)
- **Infrastructure** (roads, transportation, power supply, resources)

You will share your highlights with your partner, and the class



Share Out:

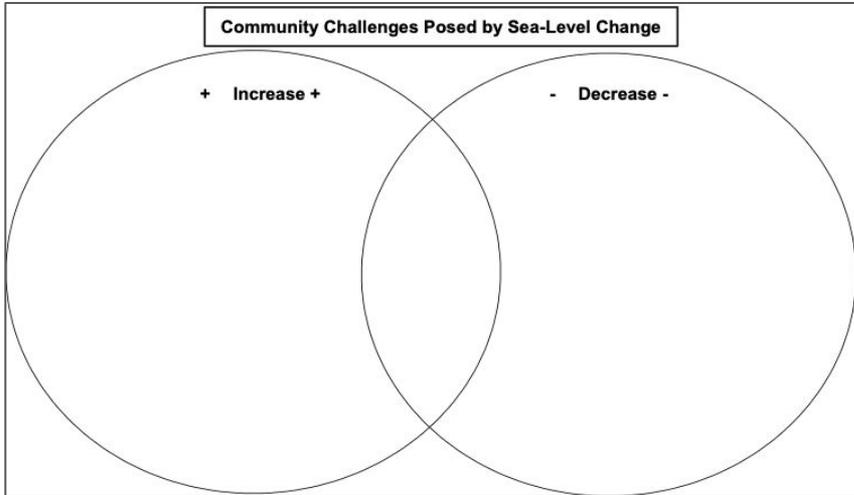
Share with your partner:

- **Name** of the community
- Recent and expected **sea-level change**
- Biggest **challenge** to the community posed by the sea-level change



Concept Diagram:

With your partner:



- Add the community challenges you highlighted to the venn diagram.
- Use a different color for
 - **People**
 - **Economy**
 - **Infrastructure**



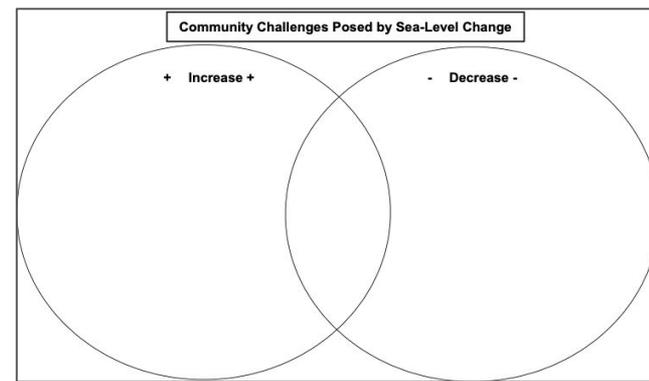
Class Share Out:

What issues does a locally rising sea cause?

- Low areas are inundated, or filled, with water,
- Beaches and wetlands erode
- Increases flooding from storm surges and rainstorms
- Saltwater advances upstream, into fresh water sources

From the article?

Whole class Venn Diagram



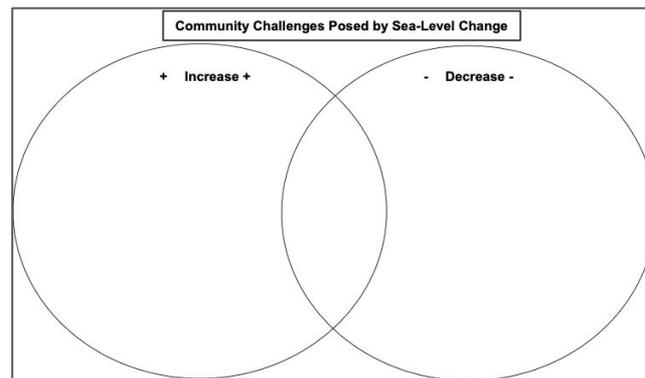


Class Share Out:

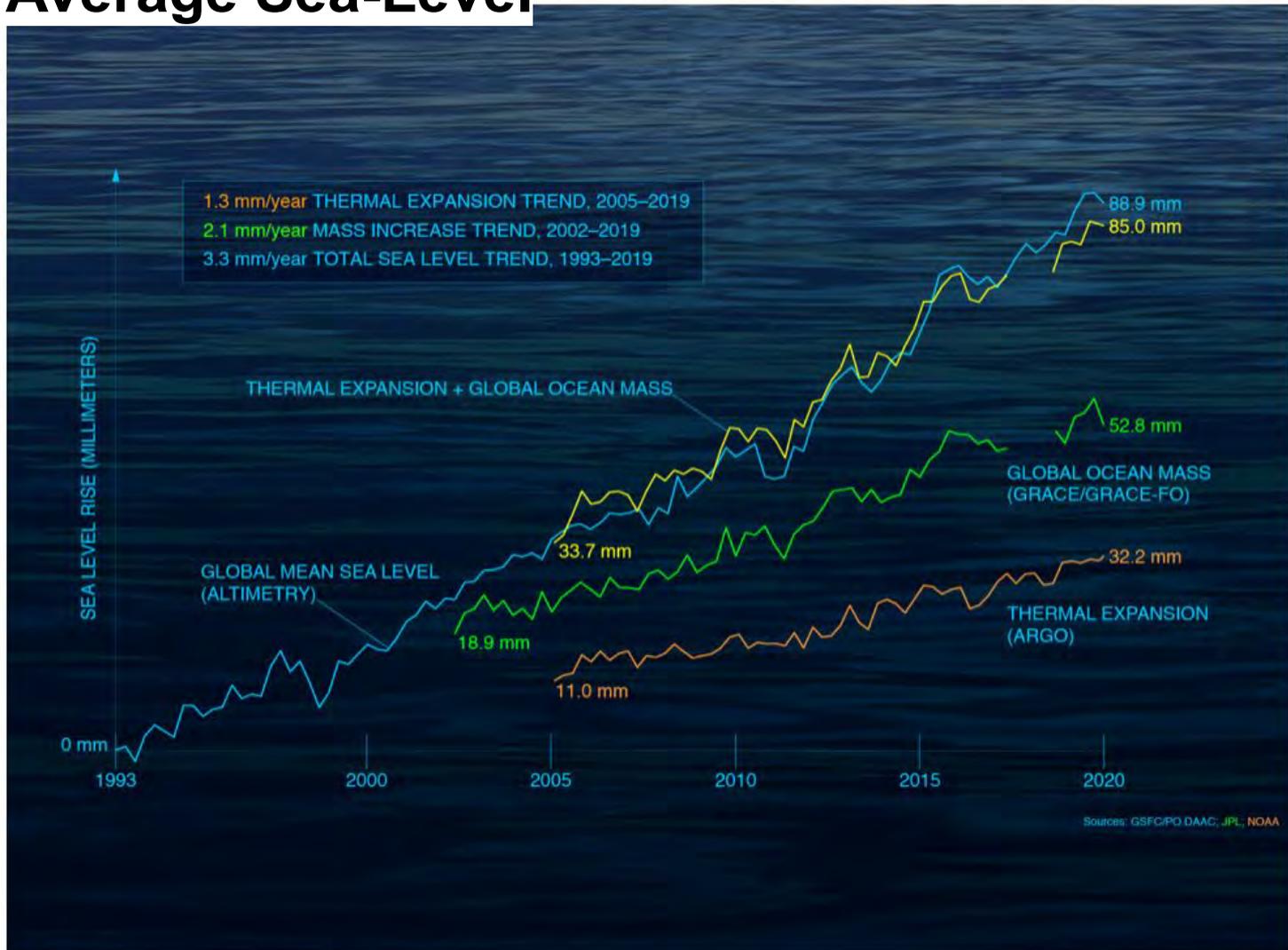
What issues does a locally **decreasing** sea cause?

- Vegetation and ecosystem change in low areas, example mudflat to grasslands or forest
- Shallower water near wetlands, in rivers, and in harbors

From the article?



Global Average Sea-Level

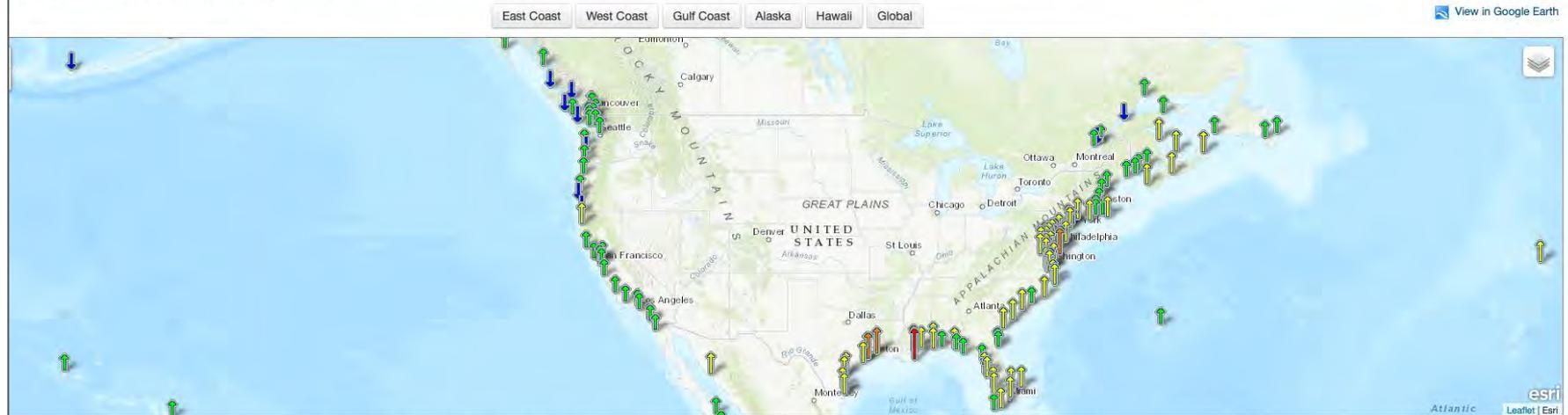


Analysis of the global sea level "budget". Comparison of the combined GMSL time series from GRACE/GRACE-FO and Argo to the GMSL time series from satellite altimeters. The comparison is limited to the overlapping time period of the three observing systems. Over the time period from 1993 to 2019, there is general agreement between the estimates, and we can "close the GMSL budget" Credit: NASA.

Local Sea-level:

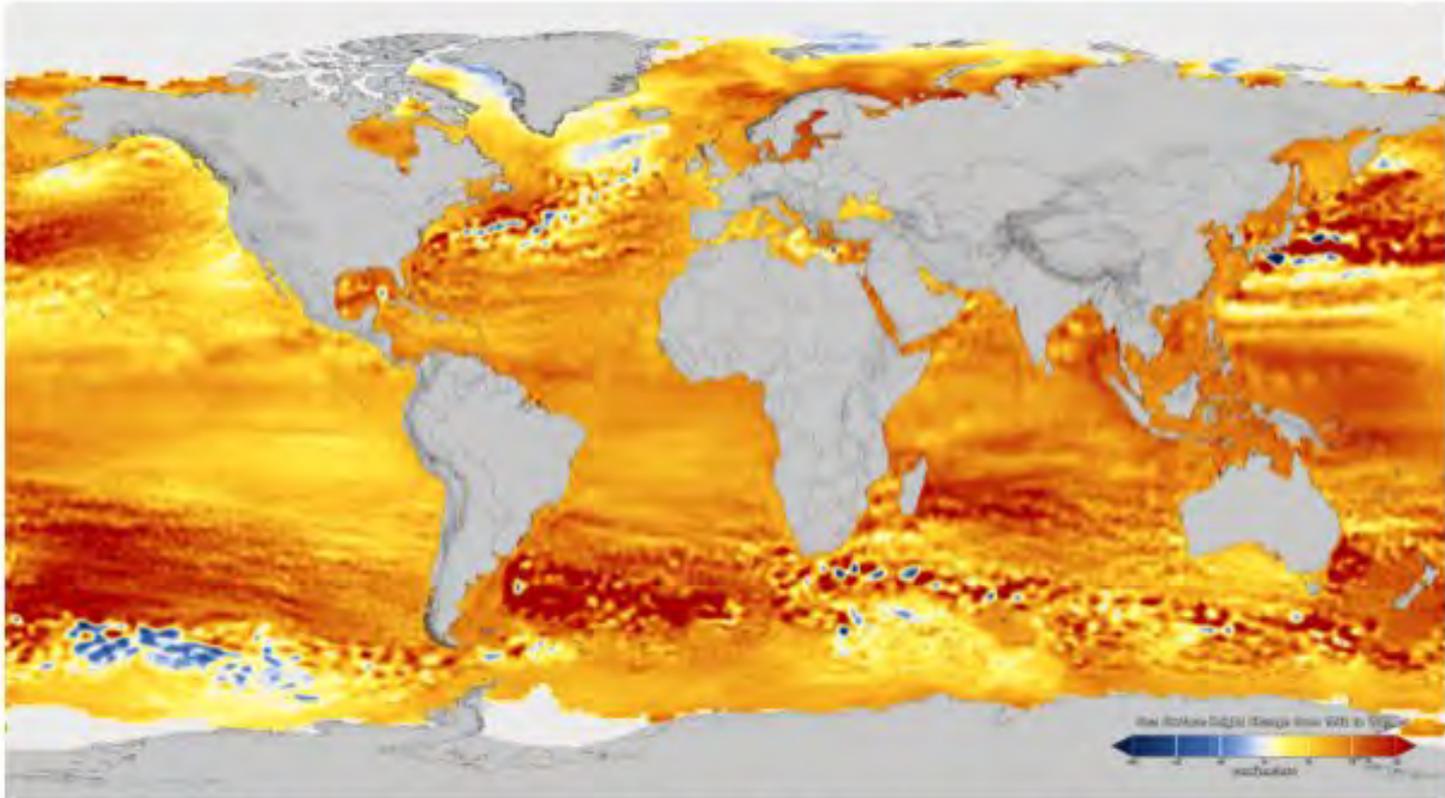
Sea Level Trends

Sea level trends measured by tide gauges that are presented here are local relative sea level (RSL) trends as opposed to the global sea level trend. Tide gauge measurements are made with respect to a local fixed reference on land. RSL is a combination of the sea level rise and the local vertical land motion. The sea level trend has been recorded by satellite altimeters since 1992 and the latest global trend can be obtained from NOAA's Laboratory for Satellite Altimetry, with maps of the regional variation in the trend. The University of Colorado's Sea Level Research Group compares global sea level rates calculated by different research organizations and discusses some of the issues involved.



The map above illustrates relative sea level trends, with arrows representing the direction and magnitude of change. Click on an arrow to access additional information about that station.

The National Oceanic and Atmospheric Administration's Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the National Water Level Observation Network operating on all U.S. coasts. Changes in RSL, either a rise or fall, have been computed at 142 long-term water level stations using a minimum span of 30 years of observations at each location. These measurements have been averaged by month which removes the effect of higher frequency phenomena in order to compute an accurate linear sea level trend. The trend analysis has also been extended to 240 global tide stations using data from the Global Sea Level Observing System (GLOSS).



Regional sea-level change between 1992 and 2019, based on data collected from the TOPEX/Poseidon, Jason-1, Jason-2, and Jason-3 satellite altimeters. Blue regions are where sea level has gone down, and orange/red regions are where sea level has gone up. Since 1993, seas around the world have risen an average rate of 3.3 millimeters per year. Credit: NASA

Why?

Many factors can cause regional differences in sea-level rise:

- Land subsidence (sinking) (New York City)
- Glacial rebound (Juneau)
- Gravitational changes (Greenland)
- Thermal Expansion of water

Lesson Outline

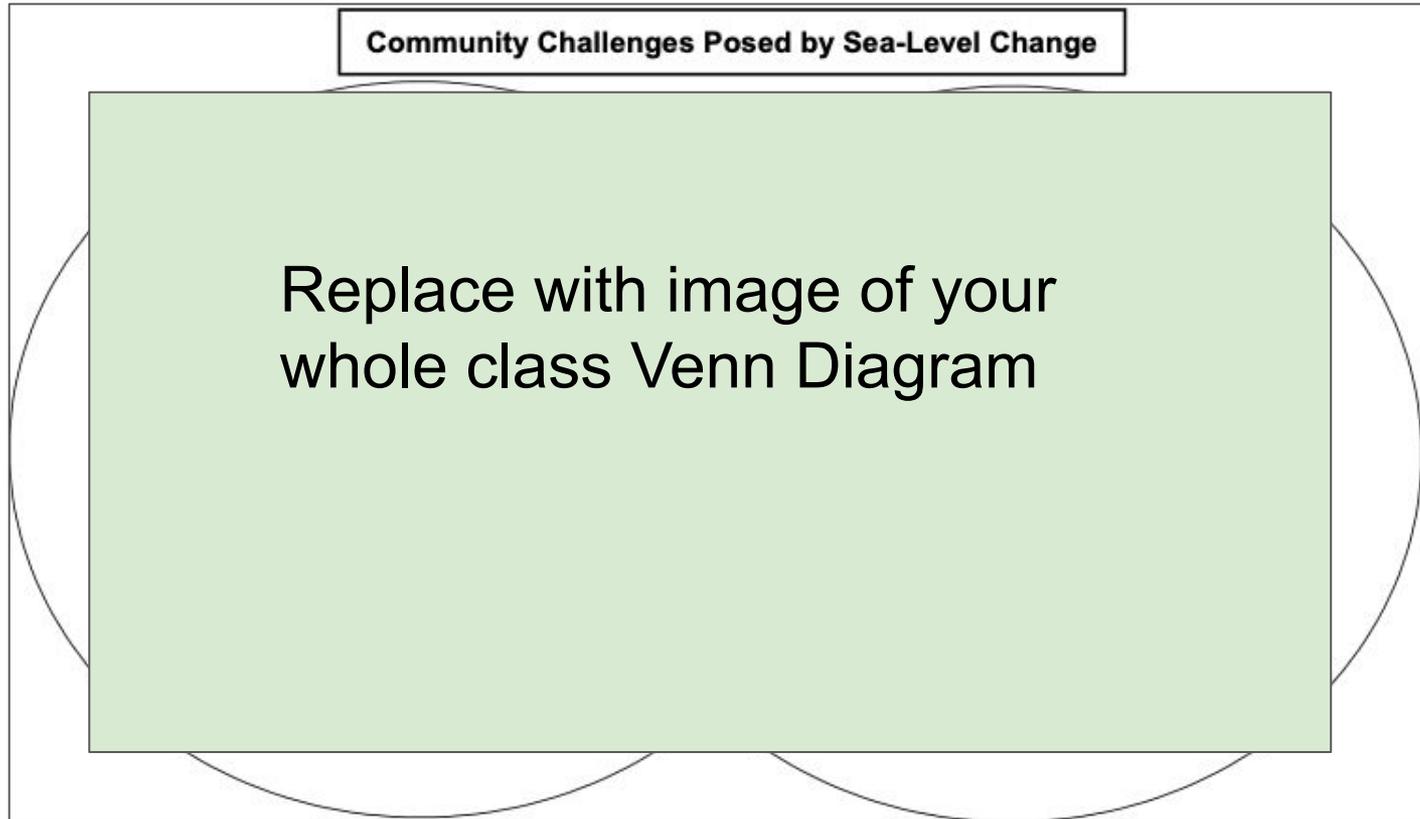
Part 1: Sea Level Rise Case Study

- Sea-level rise case studies
- Mean sea level vs Global

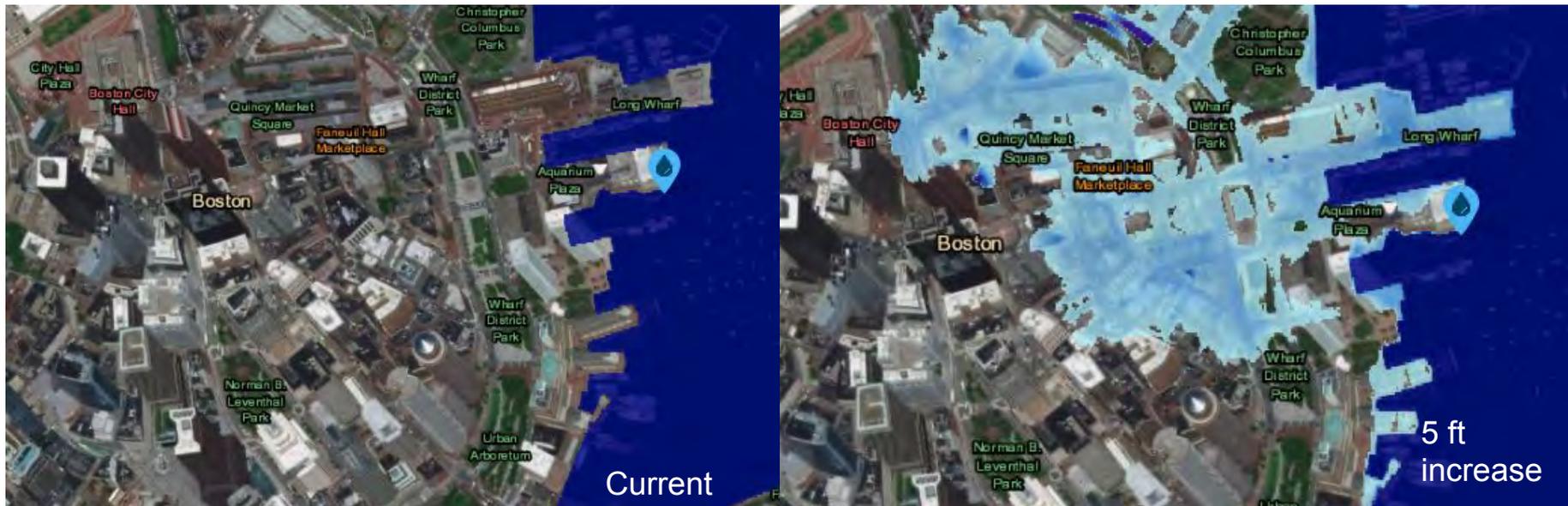
Part 2: Flood Mapping

- How can we plan?

How can communities prepare & plan for sea-level change?



Visualizing Problems:



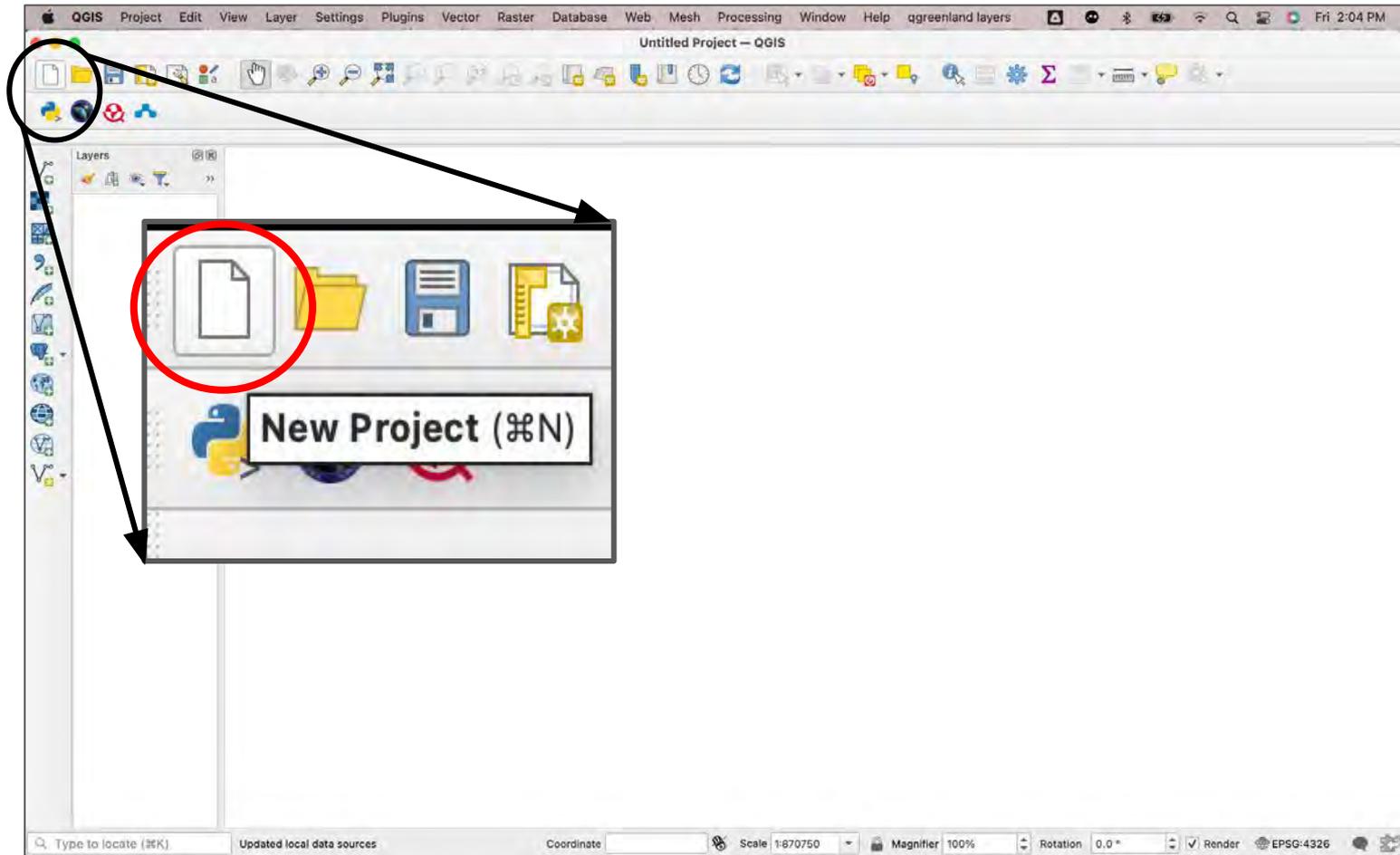
Visualization of sea-level rise in Boston, Massachusetts. Credit: NOAA Sea Level Rise Viewer

Assess the impact of sea-level change:

- With a partner or small group, you will be creating a compelling **map** that shows the effects of sea-level rise on a coastal community.
- You may choose a local coastal community or any coastal community worldwide that interests you.

Download Base Map

1. Start with a new blank project



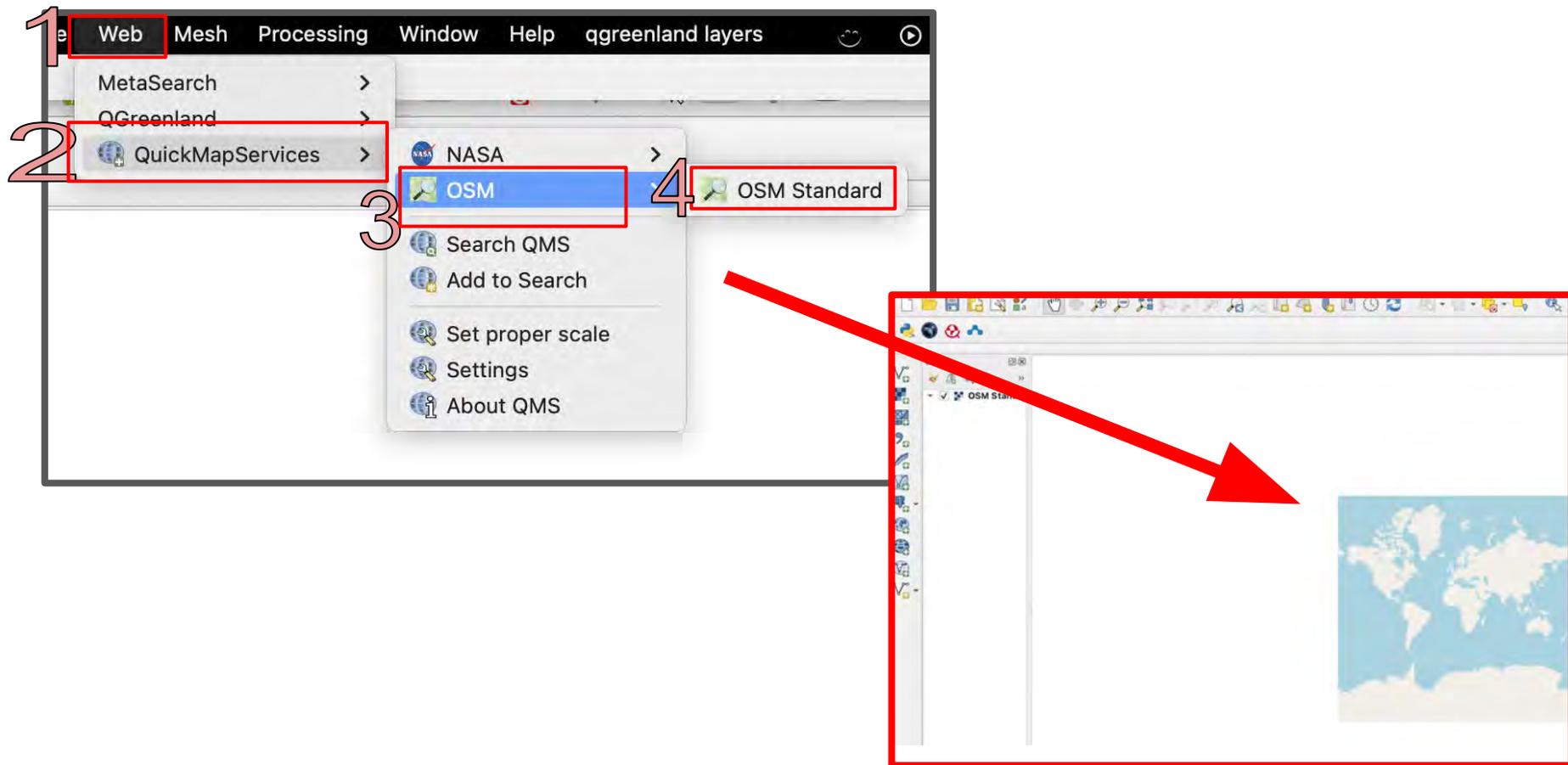
Download Base Map

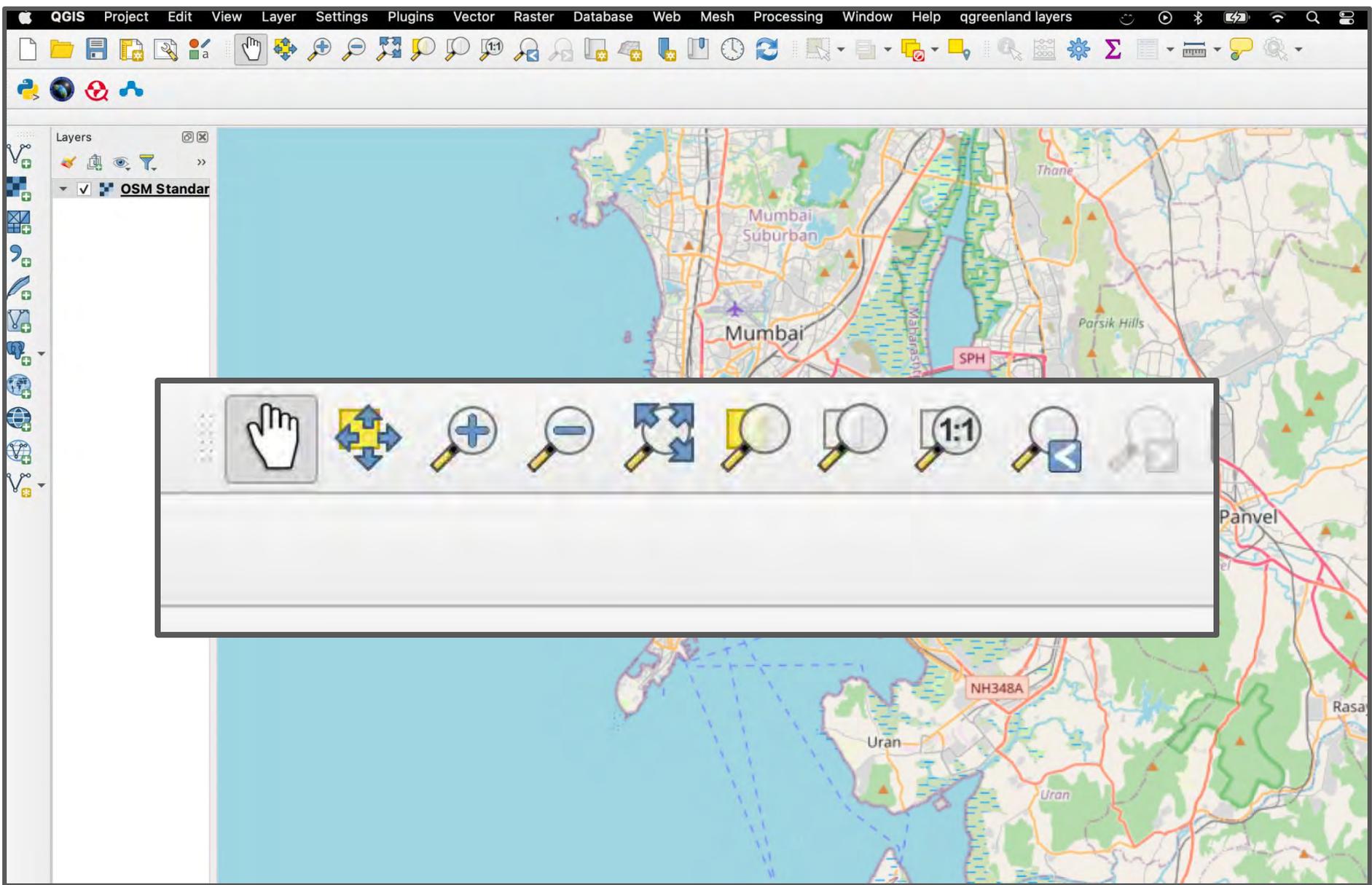
2. From the plug-in menu, search for “quick map services”, then install the ‘QuickMapServices’ plug-in.

The image shows a screenshot of the QGIS Plugins | All (902) window. On the left, a menu is open with 'Manage and Install Plugins...' highlighted. An arrow points from this menu to the main window. In the main window, the search bar contains 'Quickmap', and 'QuickMapServices' is selected in the list. The details for 'QuickMapServices' are displayed on the right, including its description, tags, and version information. The 'Reinstall Plugin' button is highlighted with a red box. Large red numbers 1, 2, and 3 are overlaid on the image to indicate the steps: 1 points to the menu, 2 points to the search bar, and 3 points to the 'Reinstall Plugin' button.

Download Base Map

3. From the Web menu, select 'QuickMapServices', then select 'OSM', and click 'OSM Standard'.





Download Community DEM

DEM stands for Digital Elevation Model. It contains land elevations.

1. From the plug-in menu, search for “SRTM-Downloader”, then install the plug-in.

The screenshot shows the QGIS Plugins window with the 'SRTM-Downloader' plugin selected. A red box highlights the 'Manage and Install Plugins...' option in the top menu. A large red number '1' is placed next to the menu. Another red box highlights the 'SRTM-Downloader' plugin entry in the search results, with a large red number '2' next to it. A third red box highlights the 'Reinstall Plugin' button at the bottom right, with a large red number '3' next to it. The plugin details for 'SRTM-Downloader' are visible, including its description, rating, and version information.

Plugins | All (902)

Search: srtm

SRTM-Downloader

SRTM-Downloader

Downloads SRTM Tiles from NASA Server

Plugin for download of SRTM Tiles from NASA

★ ★ ★ ★ ☆ 127 rating vote(s), 183361 downloads

Category Plugins

Tags python

More info [homepage](#) [bug tracker](#) [code repository](#)

Author Dr. Horst Duester

Installed version 3.1.17

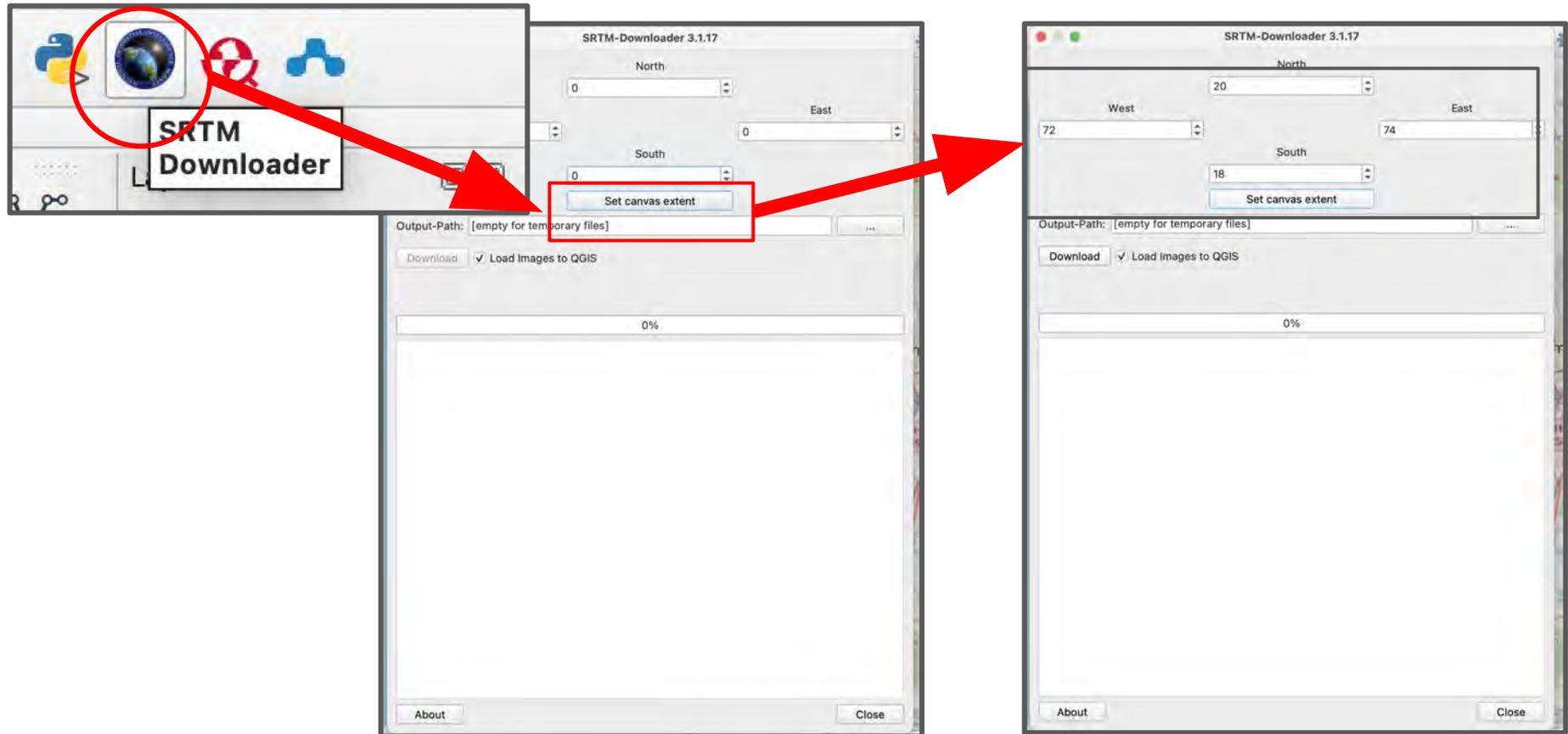
Available version (stable) 3.1.17 updated at Tue Mar 1 04:15:16 2022

Changelog

- 3.1.17 - Bugfixing
- 3.1.16

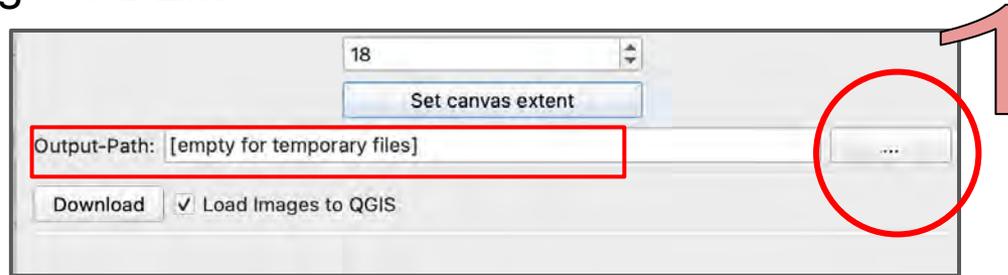
Download Community DEM

2. Click on the the SRTM Downloader icon to open the menu. Then, click the 'set canvas extent' to define your community.



Download Community DEM

3. Use the ellipse button to set the download folder. You will have to create a log-in before downloading the DEM

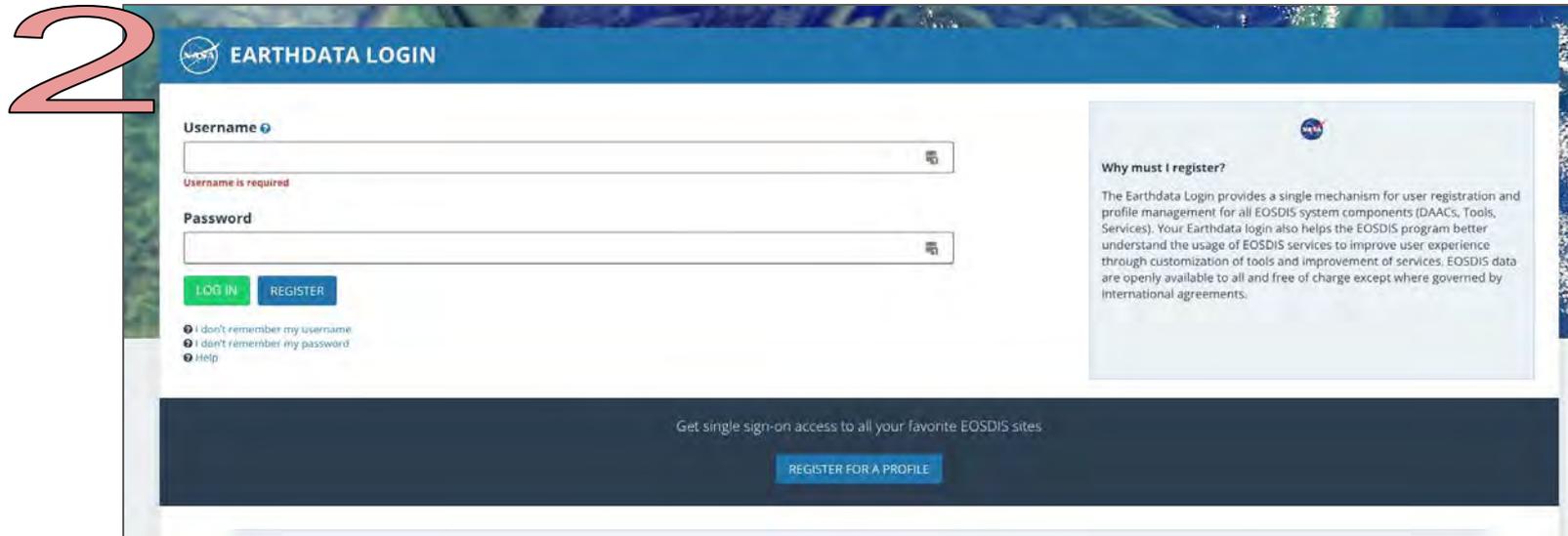


18

Set canvas extent

Output-Path: [empty for temporary files]

Download Load Images to QGIS



2

EARTHDATA LOGIN

Username

Username is required

Password

LOG IN REGISTER

I don't remember my username
 I don't remember my password
 Help

Why must I register?

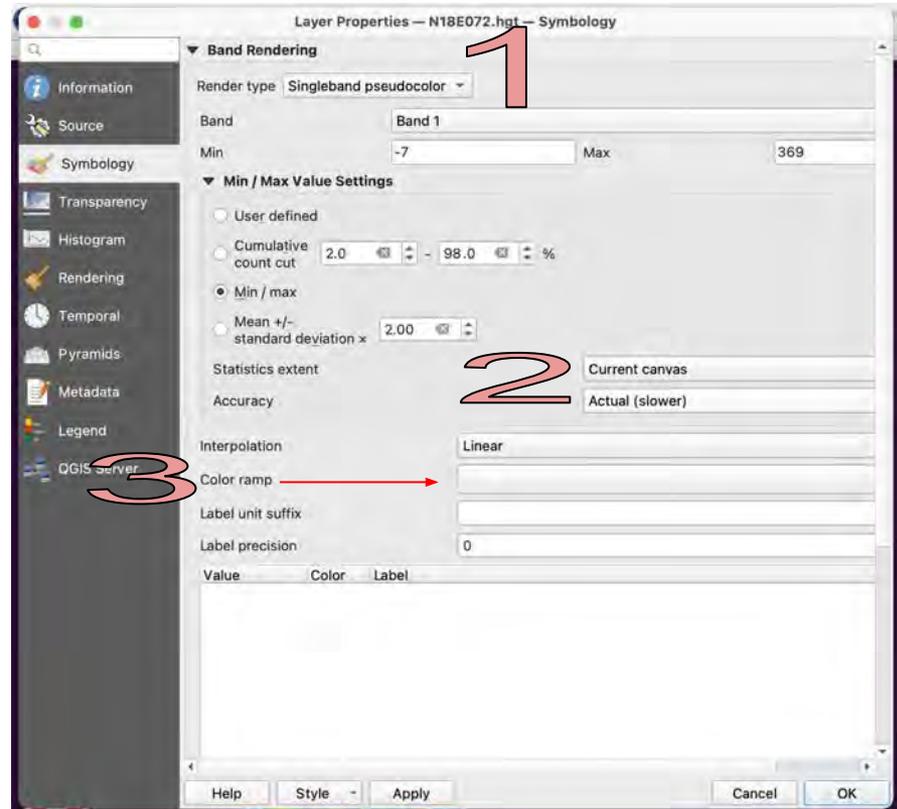
The Earthdata Login provides a single mechanism for user registration and profile management for all EOSDIS system components (DAACS, Tools, Services). Your Earthdata login also helps the EOSDIS program better understand the usage of EOSDIS services to improve user experience through customization of tools and improvement of services. EOSDIS data are openly available to all and free of charge except where governed by international agreements.

Get single sign-on access to all your favorite EOSDIS sites

REGISTER FOR A PROFILE

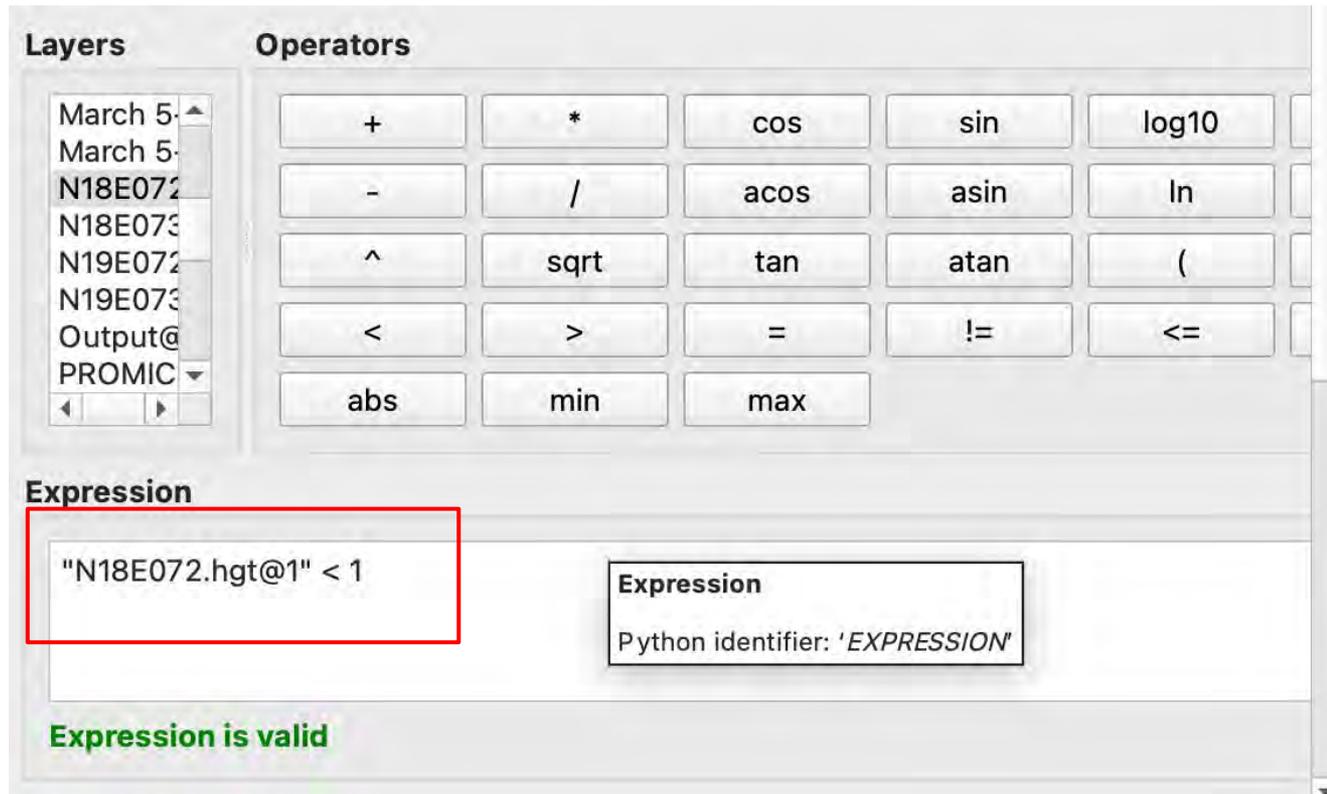
Change Symbology of the DEM

The DEM will show up in black and white. Open the symbology for your DEM, (1) set the render type as singleband pseudocolor, (2) set the min/max to actual and current canvas, then (3) choose a different color ramp.



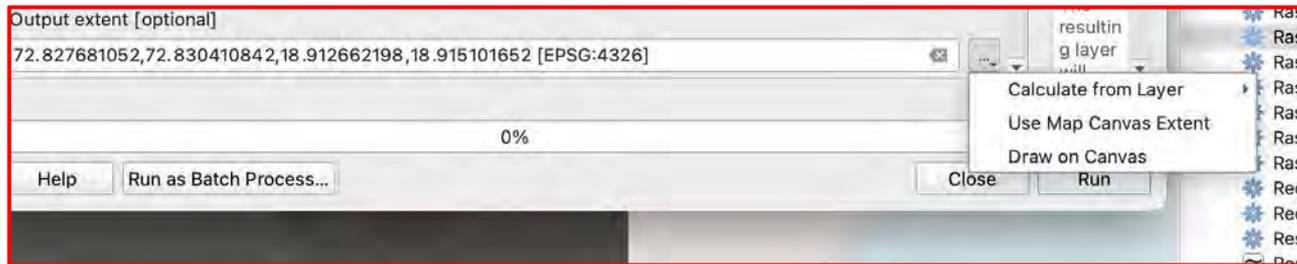
Create a Flood Map using the DEM

- (1) Open the **raster calculator** in the geoprocessing tools.
- (2) In the Layers menu, choose the DEM you previously downloaded.
- (3) Finish the expression with <1 . This will make anything in the DEM that is less than 1m in height 1, and everything else 0.



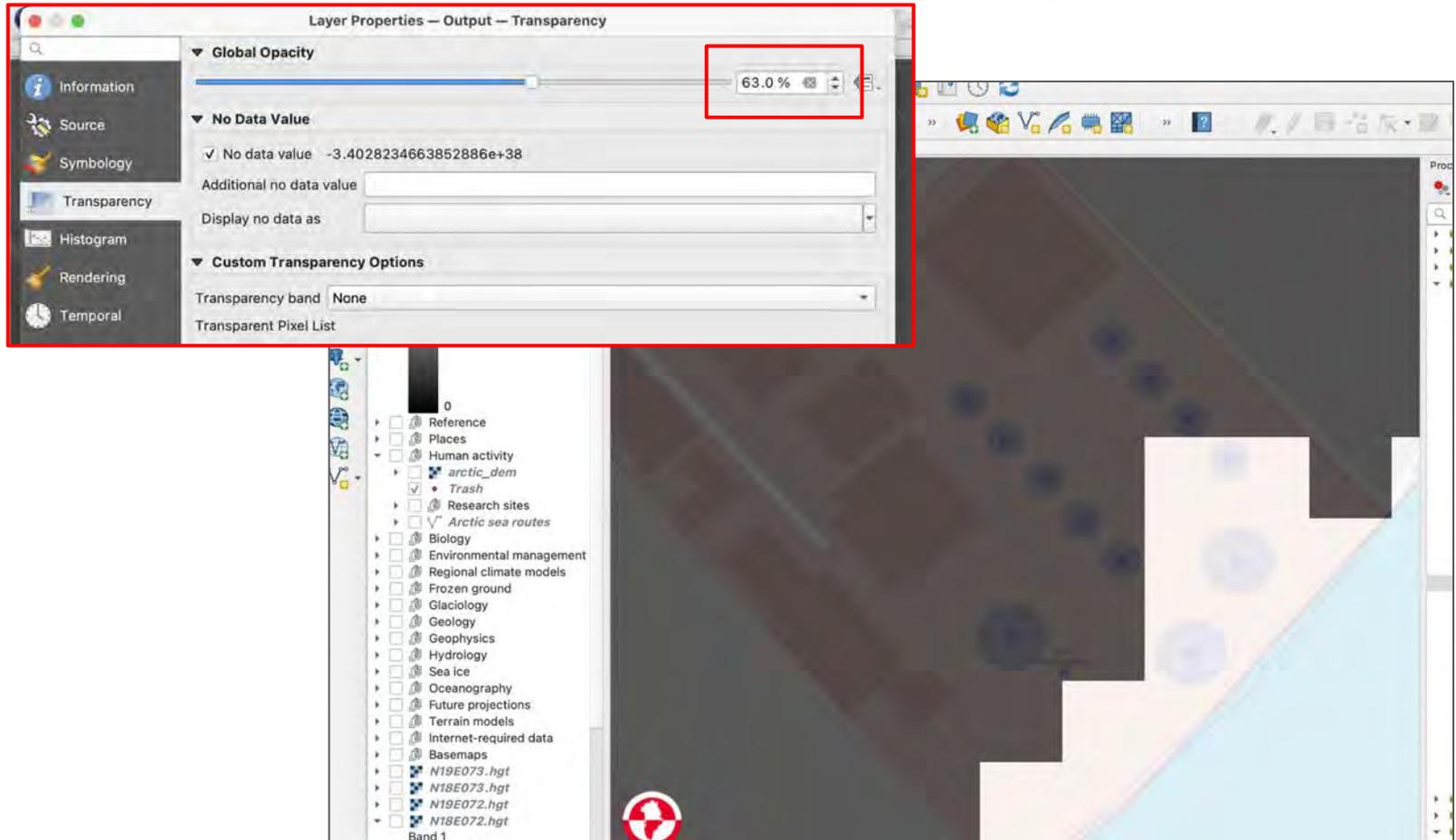
Create a Flood Map using the DEM

- (4) Set the reference layer as the original DEM
- (5) Set the output extent as the canvas extent
- (6) Choose 'Run'



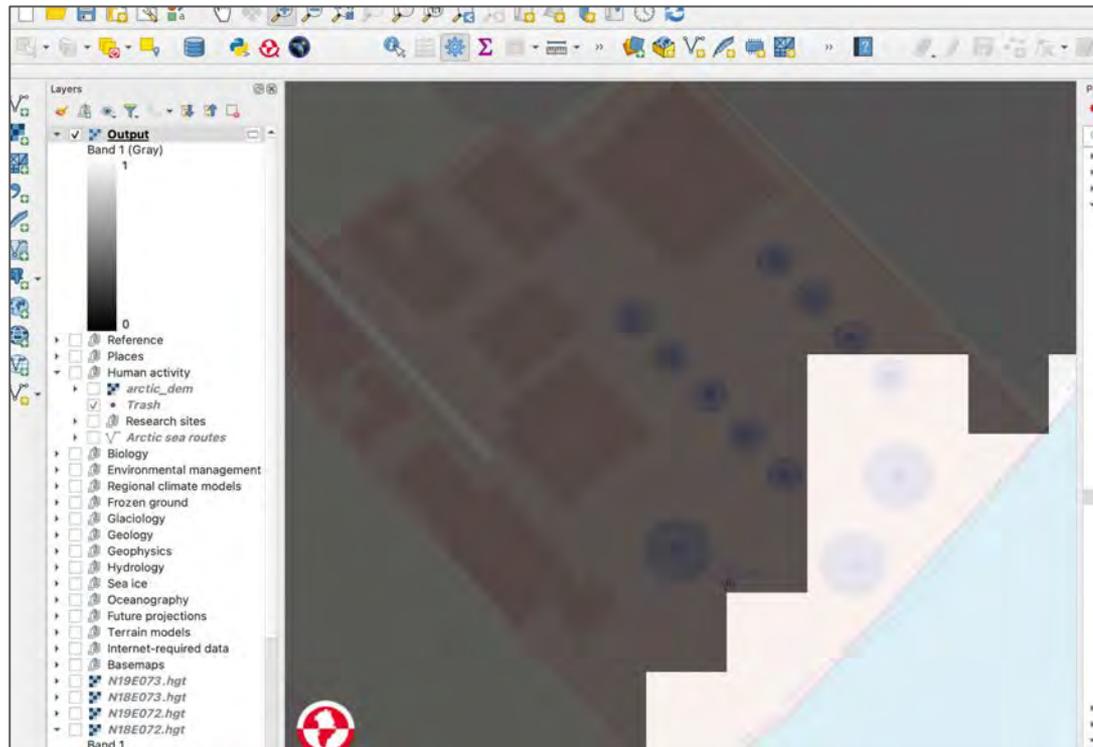
Create a Flood Map using the DEM

- (7) On your output layer, open layer properties
- (8) Change the transparency so you can see the basemap through the layer



Create a Flood Map using the DEM

- On this map, elevations above 1m are shaded and below 1m are not shaded.
- Average global sea-level rise by the year 2100 is predicted to be between 0.6 and 1.1m.
- Anything not shaded would be ocean by 2100.
- Scroll around. What is now in the water?



Assess the impact of sea level change:

Use your flood map and a combination of the base map and satellite images available on google Earth to assess the local impacts of sea level change.

You must create a **map** that highlights risks to each of the following 6 areas:

1. Infrastructure: Are there cell towers, power plants and power lines, landfills, major roadways, or railways in the flood zone?
2. Community: Are gathering places such as public buildings, schools, and places of worship impacted?
3. Economics: Are there businesses in the area?
4. Health: Are there hospitals, doctors offices, and nursing homes in the flood zone?
5. Water: Is there a freshwater source impacted? Water towers or storage?
6. Housing: How many homes or apartment buildings are impacted?

How to create a map for export:

