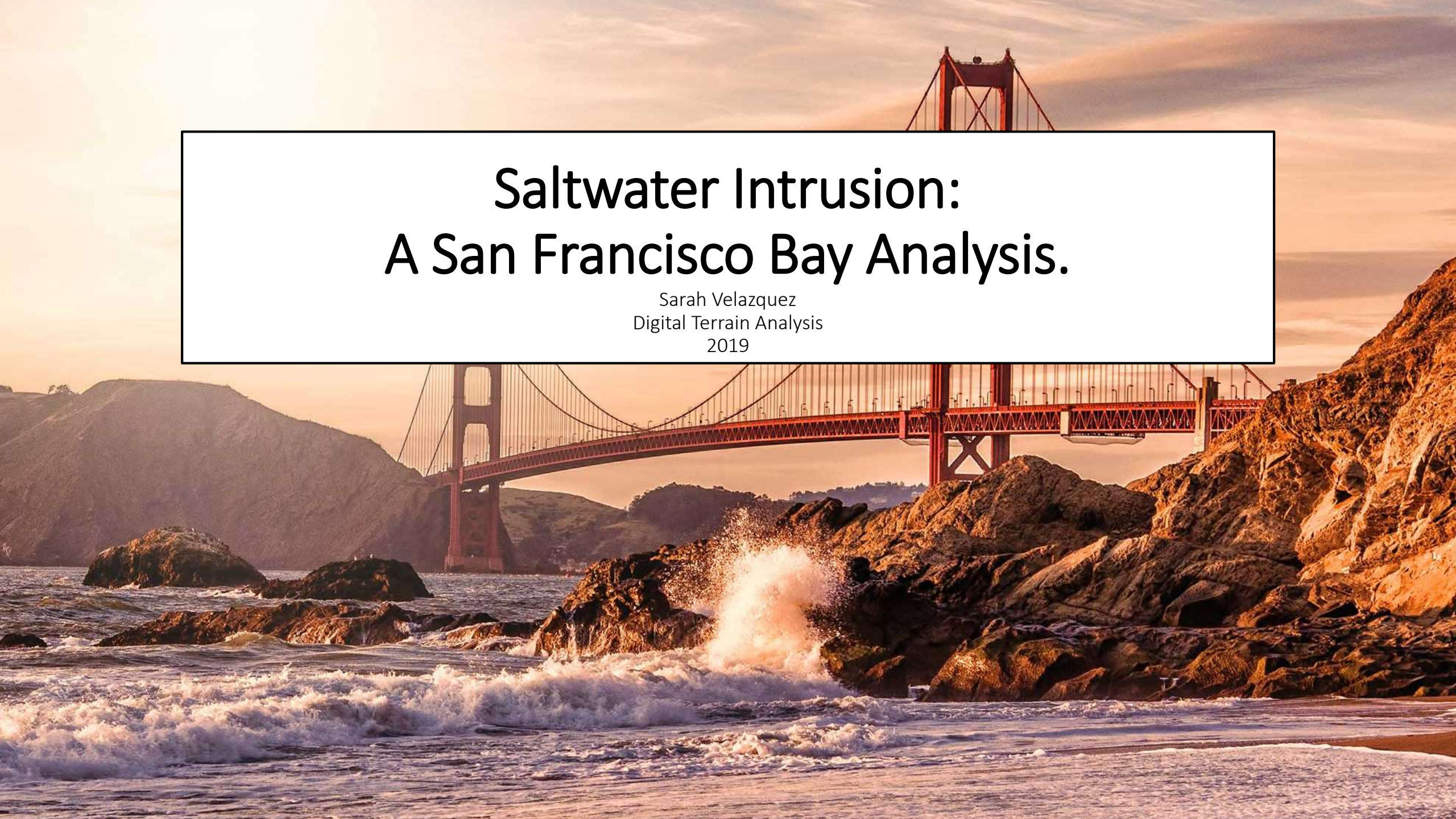


Saltwater Intrusion:
A San Francisco Bay Analysis.

Sarah Velazquez
Digital Terrain Analysis
2019

Project Question

- **What percentage of wetland habitats are at risk of saltwater intrusion along the San Francisco Bay?**

<u>Supplementary Question</u>

- What additional factors could affect the surrounding wetlands?

Predictions/Expected Results

I expect to find a greater than 40% saltwater intrusion risk to freshwater wetlands along the San Francisco Bay.

https://www.courthousenews.com/farmers-environmentalists-join-battle-planned-delta-tunnels-project/

Wetlands

The San Francisco Bay wetlands are interconnected ecosystems

Importance

- Flood Protection
- Water Quality Improvement (Filtration of storm water runoff, pesticides)
- Refills ground water
- Nutrient Cycling
- Carbon sequestration
- Native Habitat/ brooding site

Species That Rely on Them?

- Migrating birds (ex: Bald Eagles) (resting/nesting)
- Many birds would go extinct without freshwater wetland sites
- Spawning fish (ex. Herring)
- Pupping Grounds (Seals)
- Amphibians (reproduction, food)
- Insects (pollination, food source for other animals)

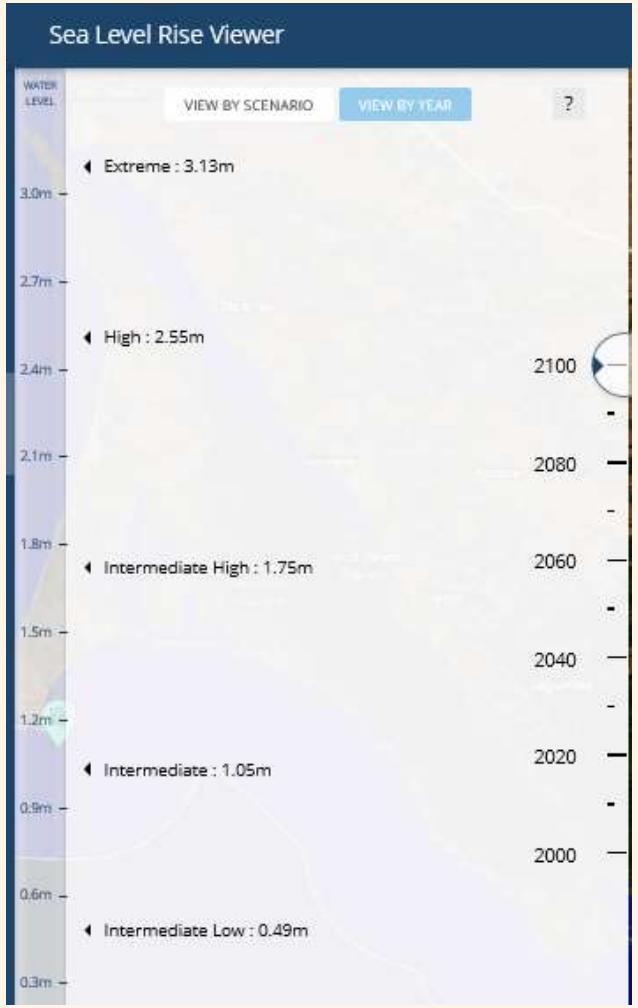
Saltwater Intrusion in Freshwater wetlands.

- Affects drinking water
- Salinization of agricultural lands (4)
- Plants adapted to freshwater environments will die off
- Opportunity for Invasive species to flourish
- Extinction of native fauna –Amphibians
- Loss of habitat for many animal species

1800-2013 = About 200,000 acres of bay wetlands have been filled. (1)

Sea Level Rise

Based on 2019 Research



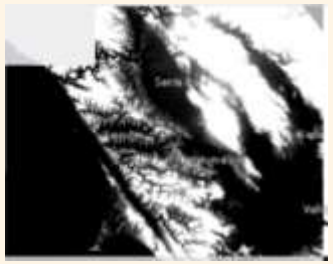
NOAA Interactive Sea Level Rise Predictions. (2)

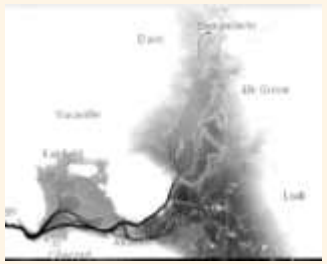
According to the National Ocean and Atmospheric Administration (NOAA) sea level rise rates have increased to about 1/8 of an inch a year. (6)

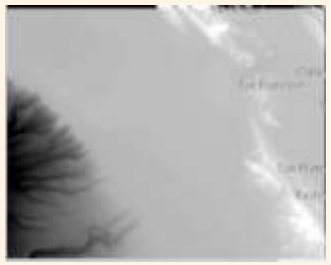
- I chose to look at the year 2100 in order to capture the low and high extremes in this region.
- Using predictions from NOAA for the year 2100, I chose to look at sea level rise at 1-meter and 3-meters.

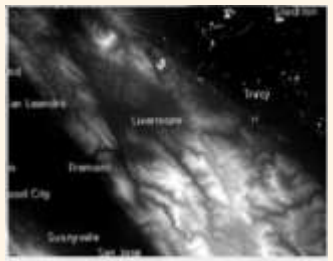
Putting Together My Digital Elevation Model

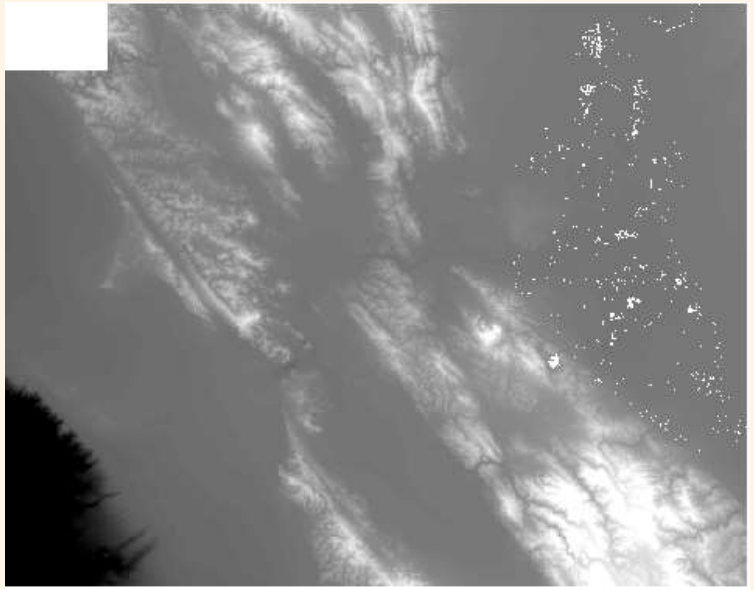
The struggle was real…



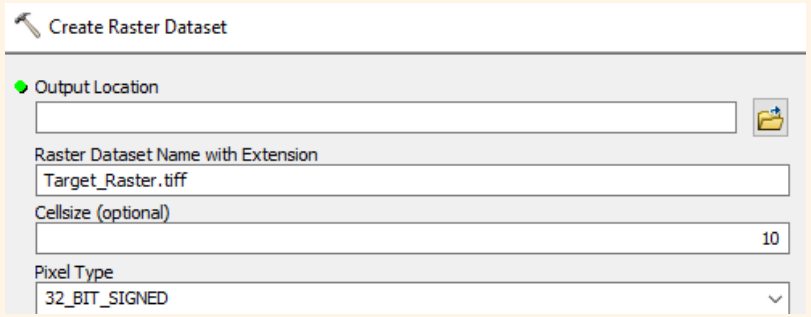




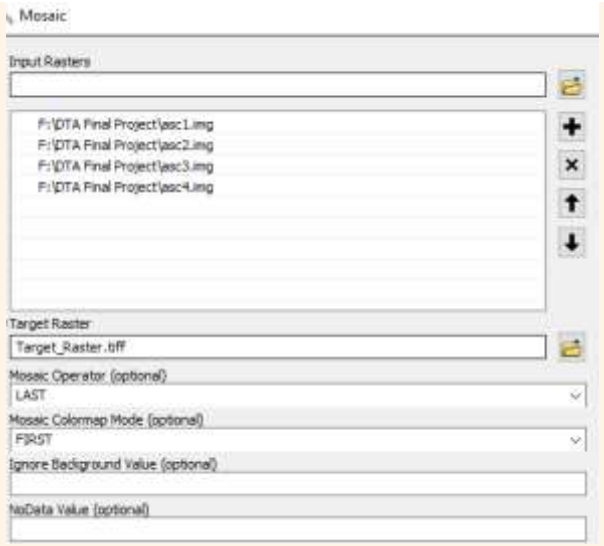


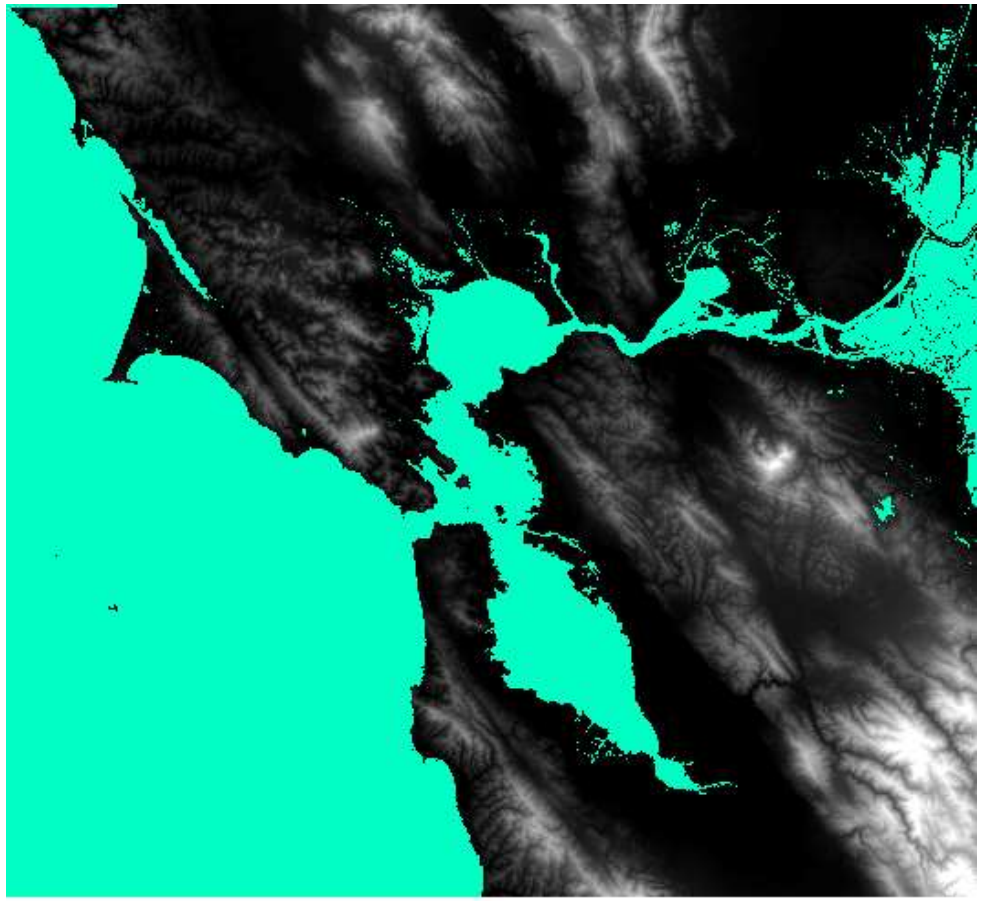


1) Create Raster Dataset tool – Used to created a blank raster.

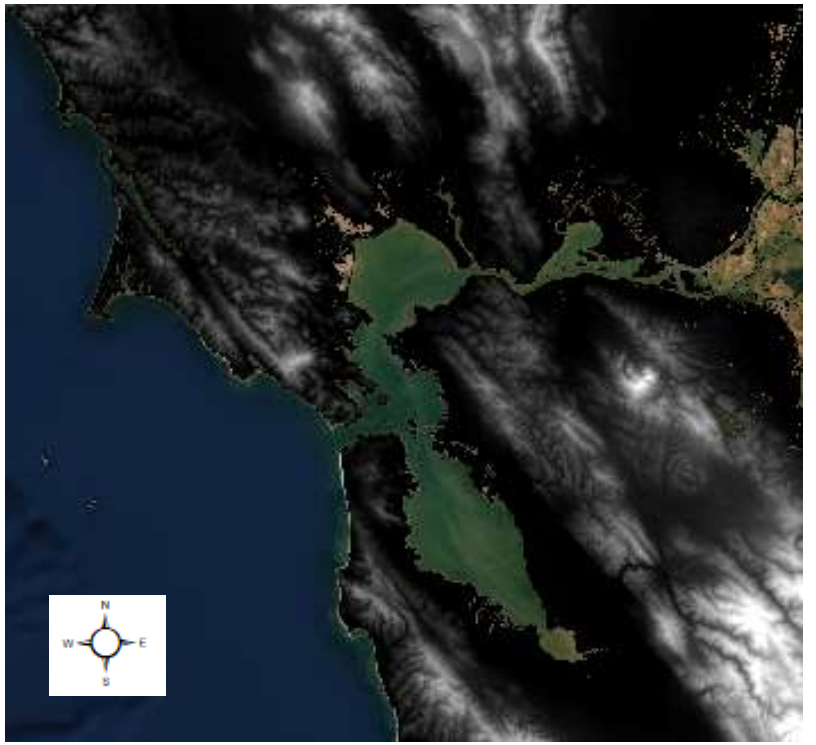


2) Mosaic tool – Combined my three seamless DEMs into one using the blank raster.





Areas at or Below Sea Level



The land surrounding the San Francisco bay is mostly above sea level. Though, you can see a few regions where land is indicated to be below sea level.

Con

Input conditional raster

Target_Raster.tif

Expression (optional)

"Value" <=0

Input true raster or constant value

0

Input false raster or constant value (optional)

Target_Raster.tif

Study Area

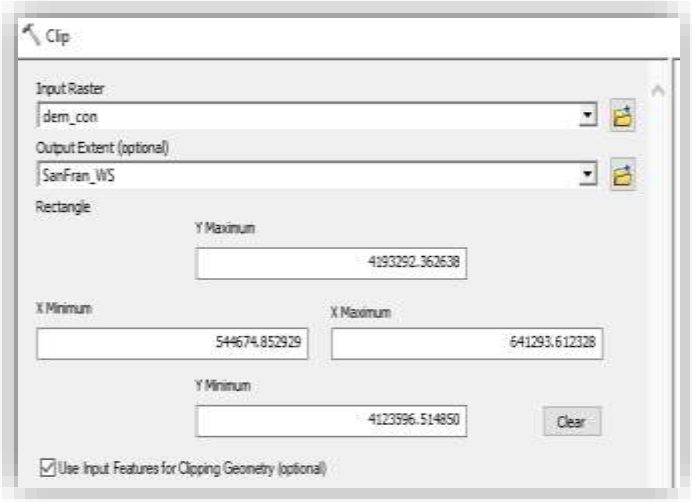
Watersheds

San Francisco Bay

10m DEM from the California Department of Water Resources. (3)

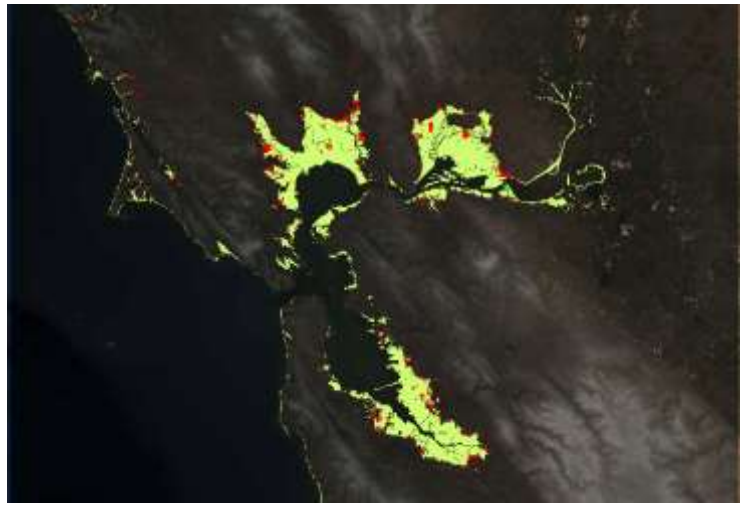
Raster Clip

Tool Used:



In order to restrict the study area I chose to use the three watersheds that make up the San Francisco Bay.

Study Area Wetland Analysis

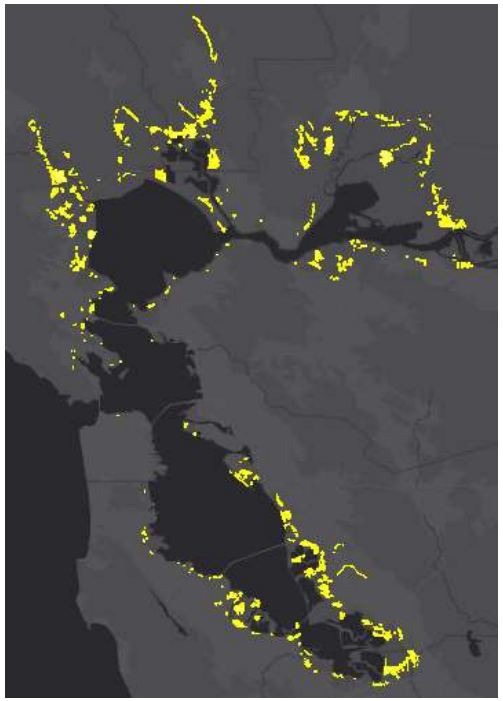


Wetland Data from NOAA's website (2)

Freshwater Only

Used "Select by Attribute" to isolate freshwater wetlands from salt/brackish water wetlands.

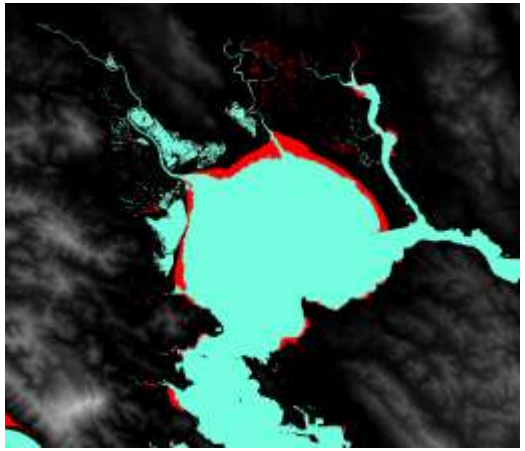
Watershed Only

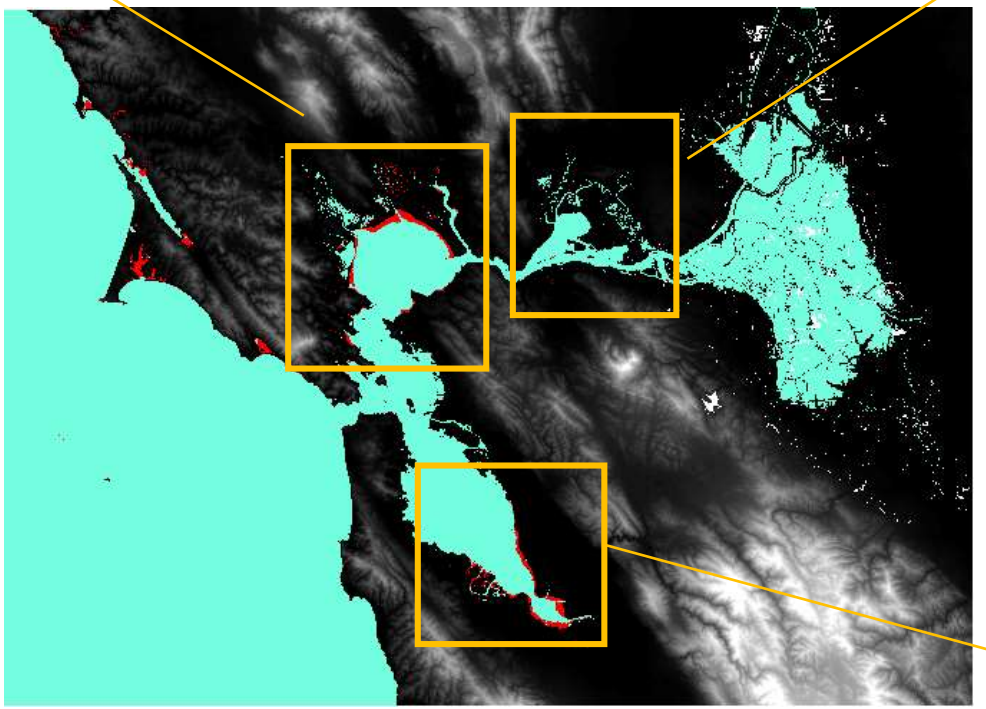


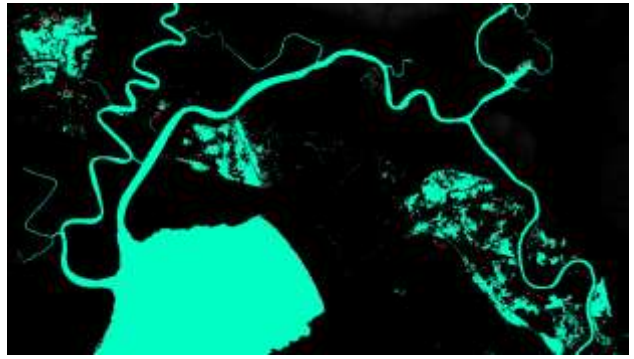
Used Clip tool to isolate freshwater wetlands to my study area.

Low Estimate

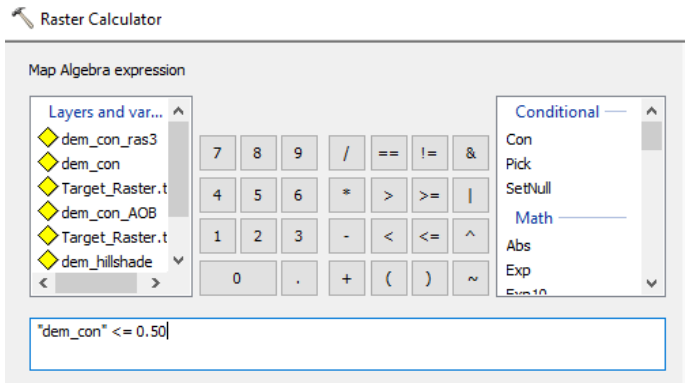
Sea Level Rise of 1-Meters



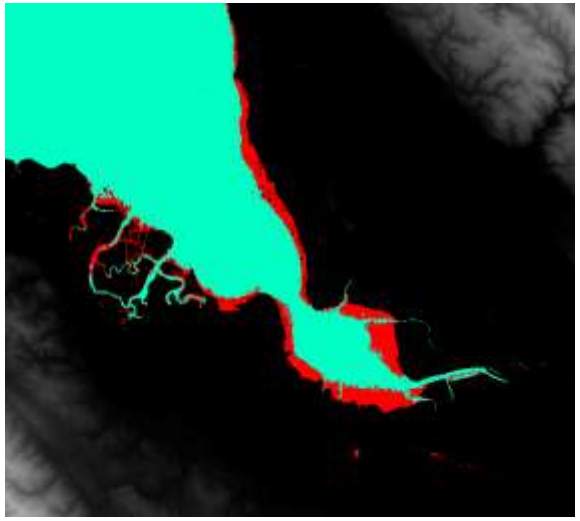




Tool Used:

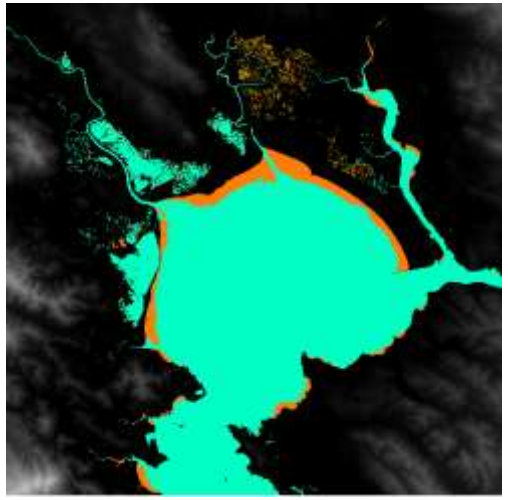


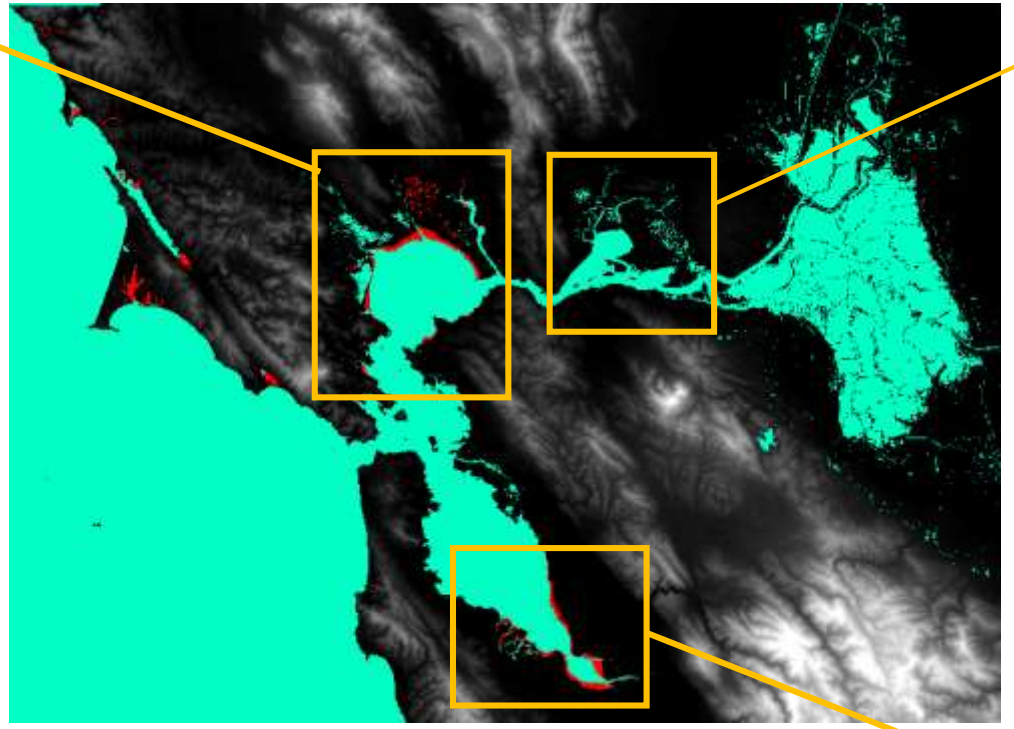
I've highlighted three regions where a 1-meter sea level rise has the largest impact within the San Francisco Bay.

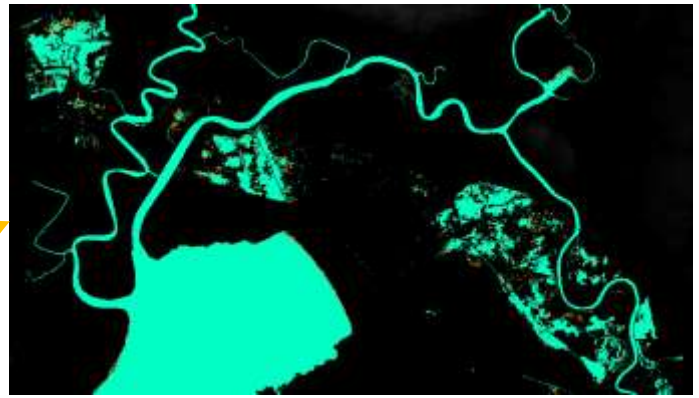


High Estimate

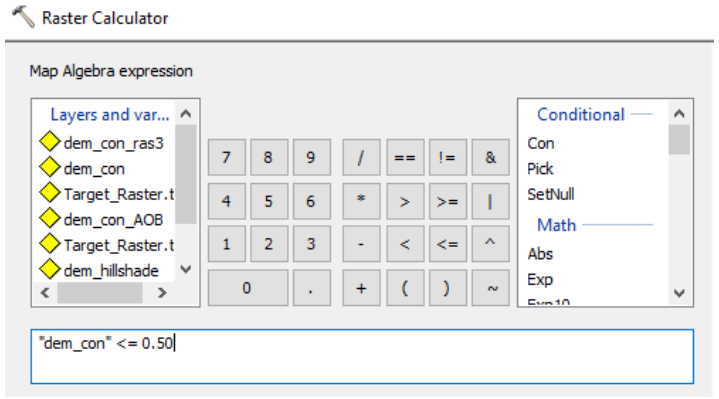
Sea Level Rise of 3-Meters

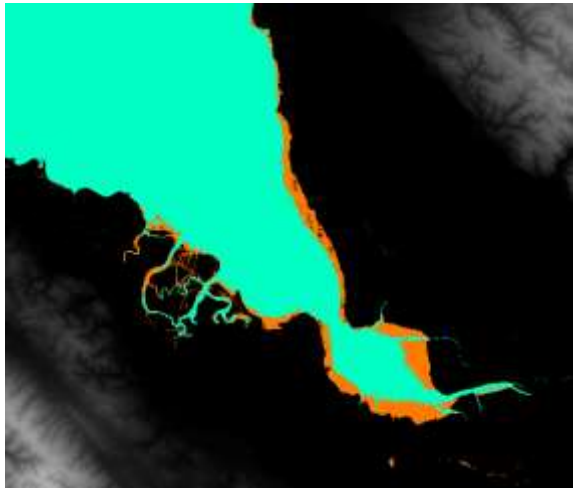






Tool Used:



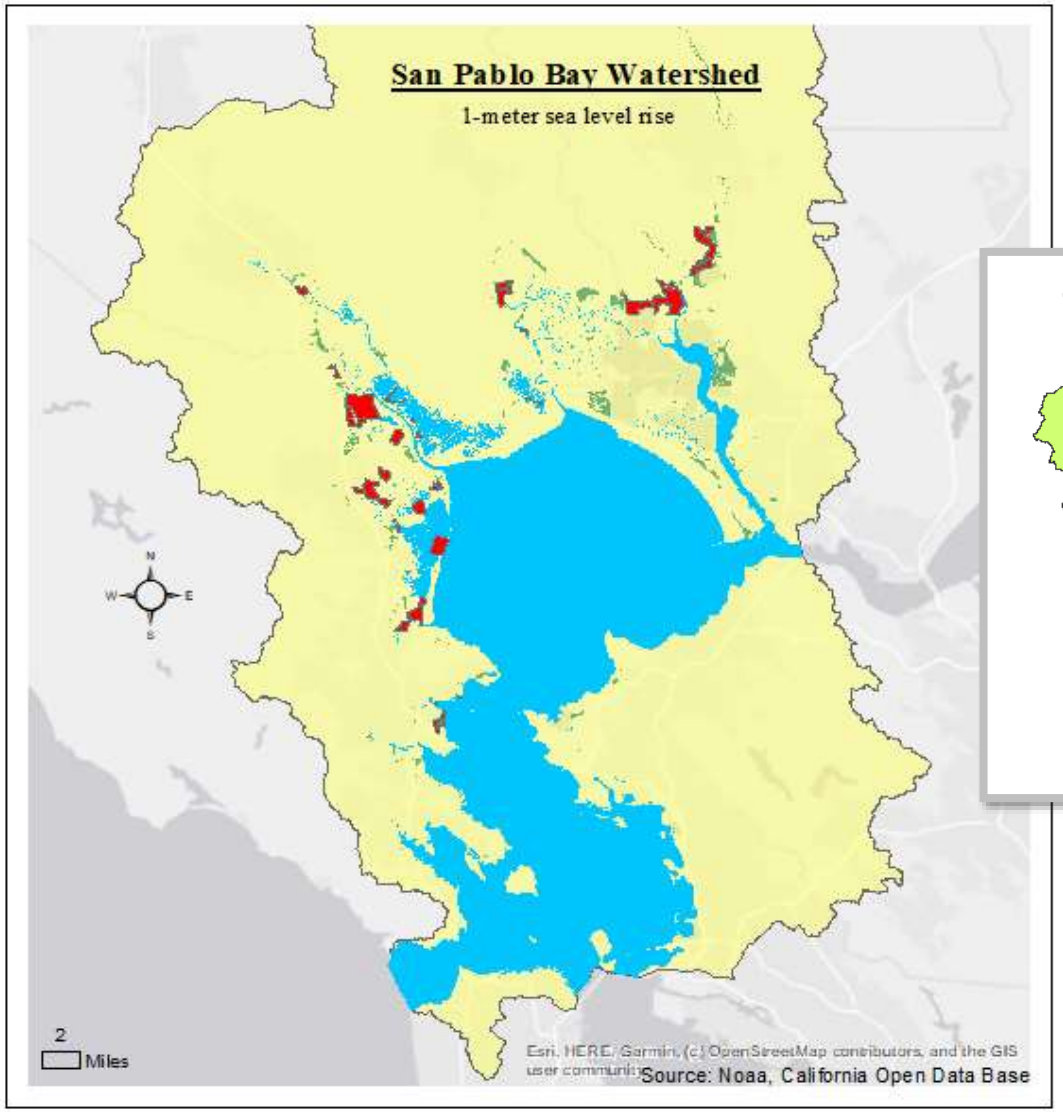


The red areas on the center map represent areas affected by a 3-meter rise.

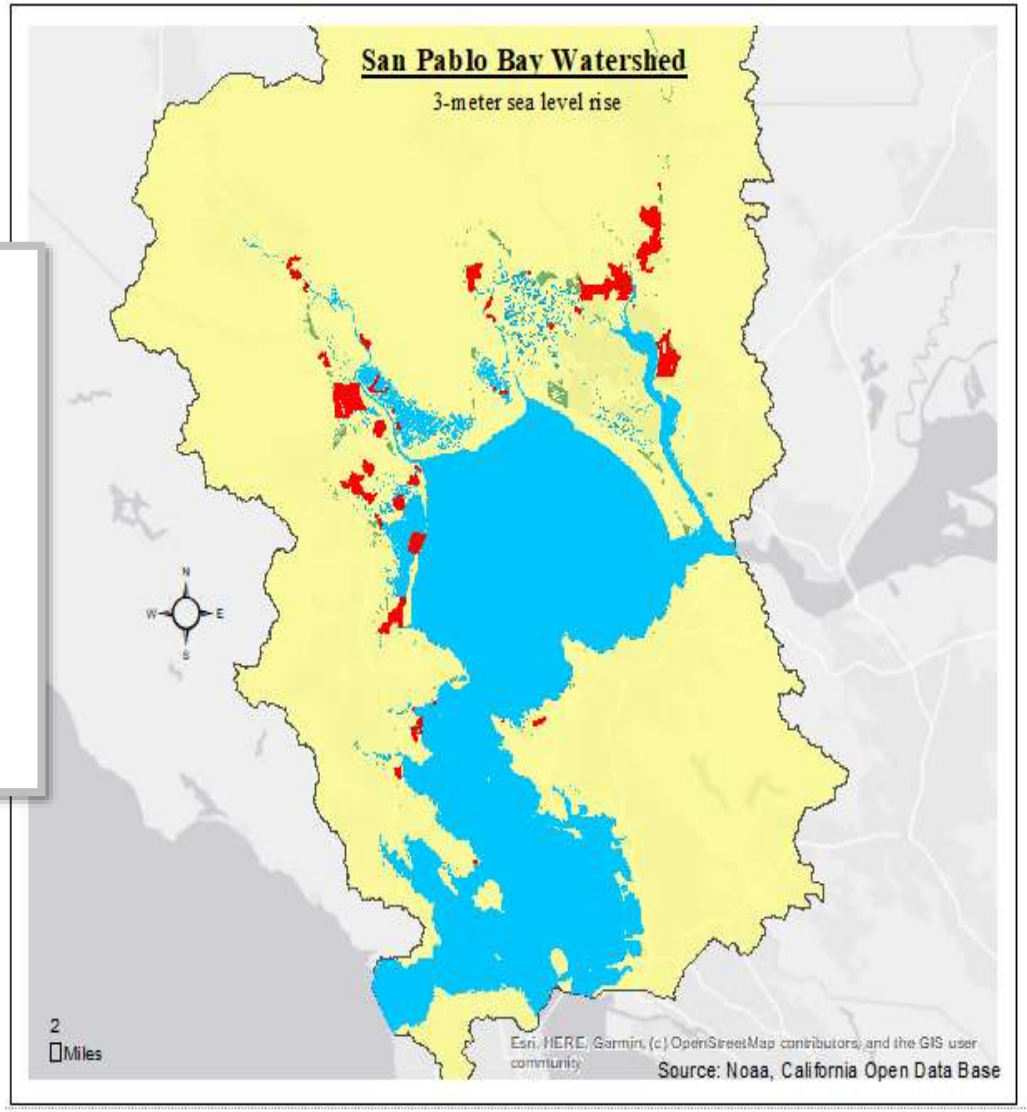
The orange in the side maps represent an overlap of low estimate rise.

San Pablo Bay Watershed

At a 1-meter sea level rise 10% of the freshwater wetlands are at risk of saltwater Intrusion.

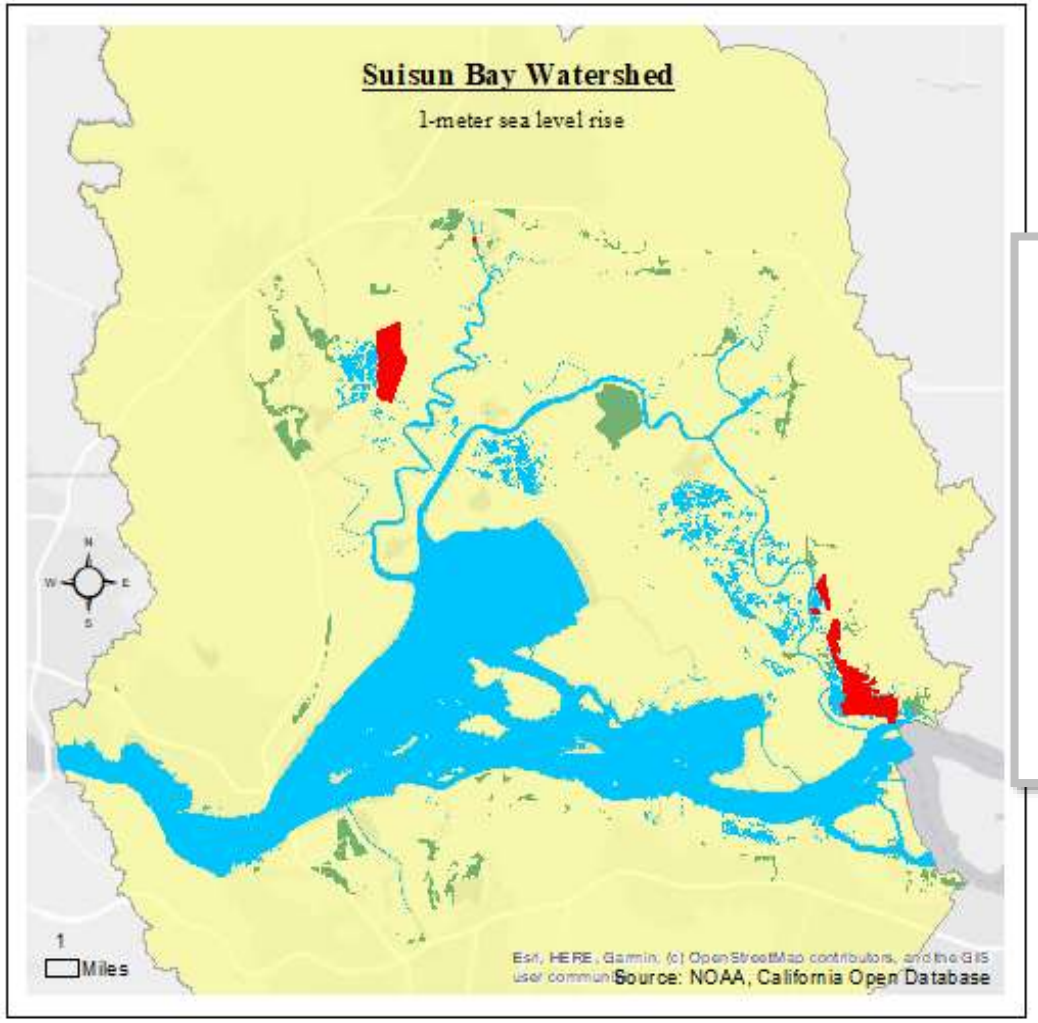


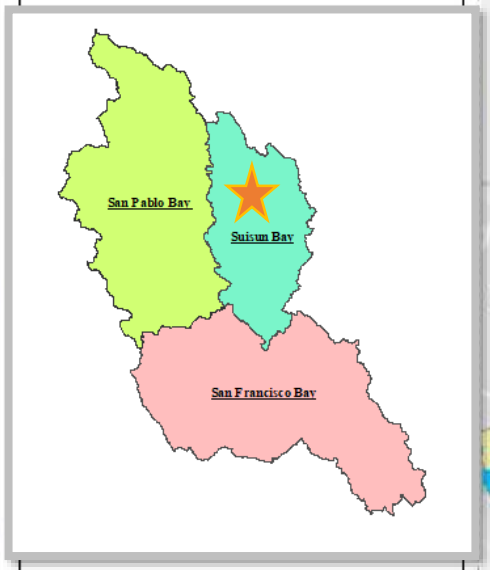
At a 3-meter sea level rise 17% of the freshwater wetlands are at risk of saltwater Intrusion.



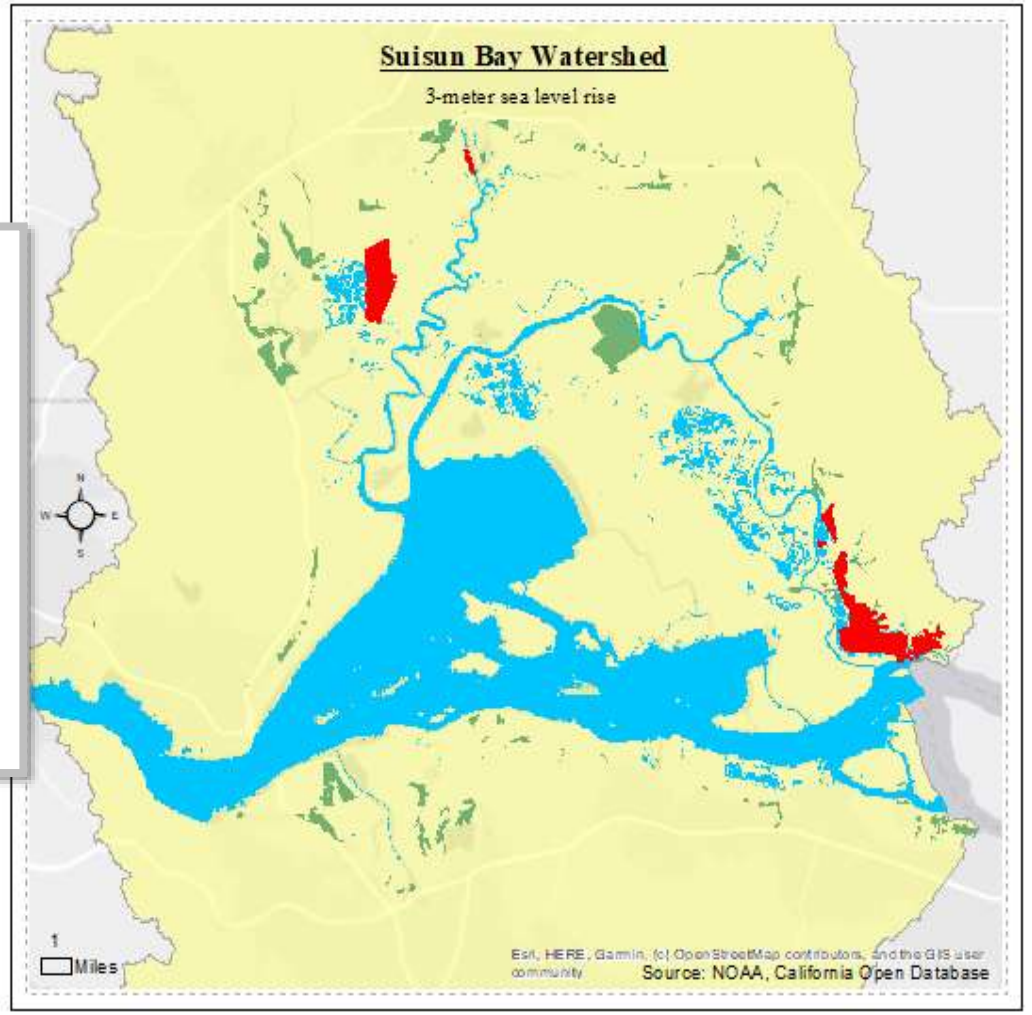
Suisun Bay Watershed

At a 1-meter sea level rise 4% of the freshwater wetlands are at risk of saltwater Intrusion.



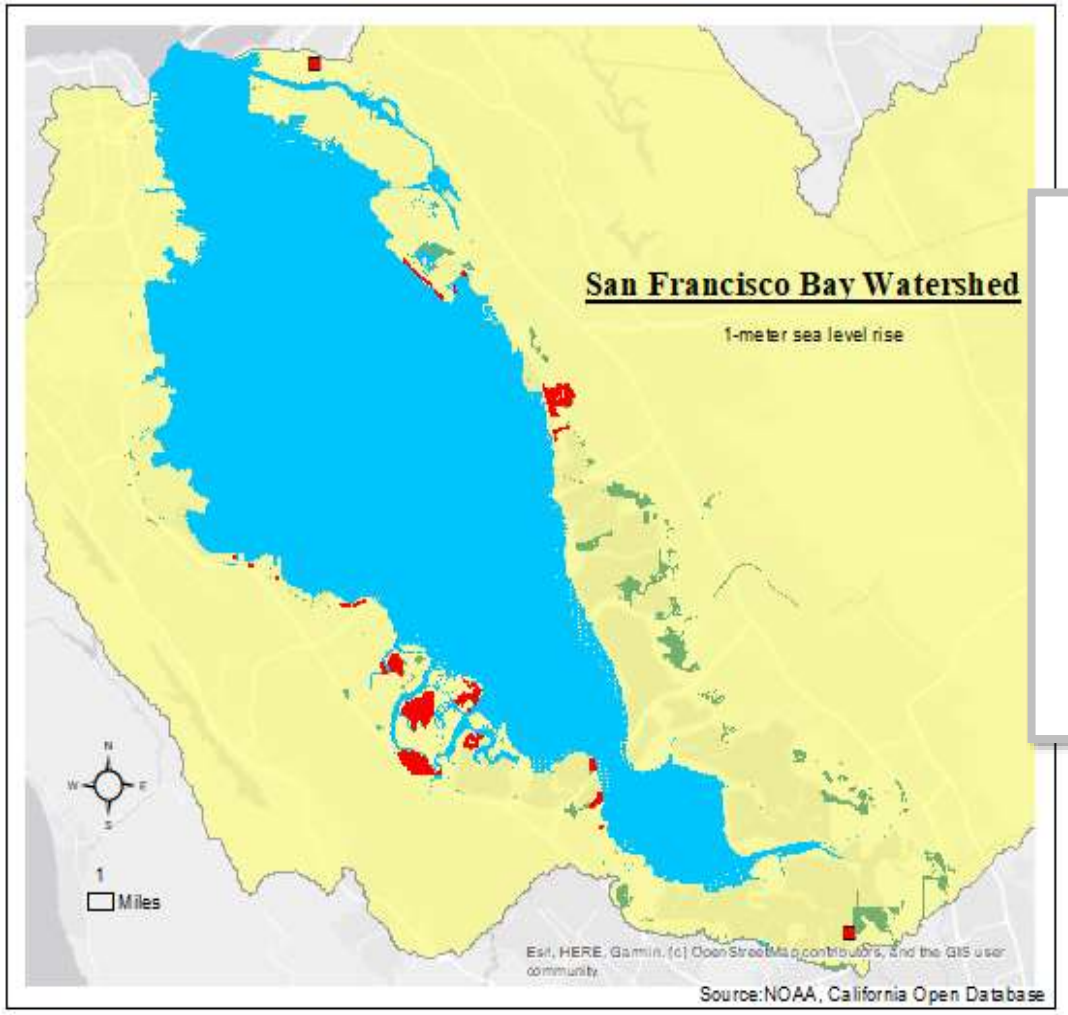


At a 3-meter sea level rise 7% of the freshwater wetlands are at risk of saltwater Intrusion.

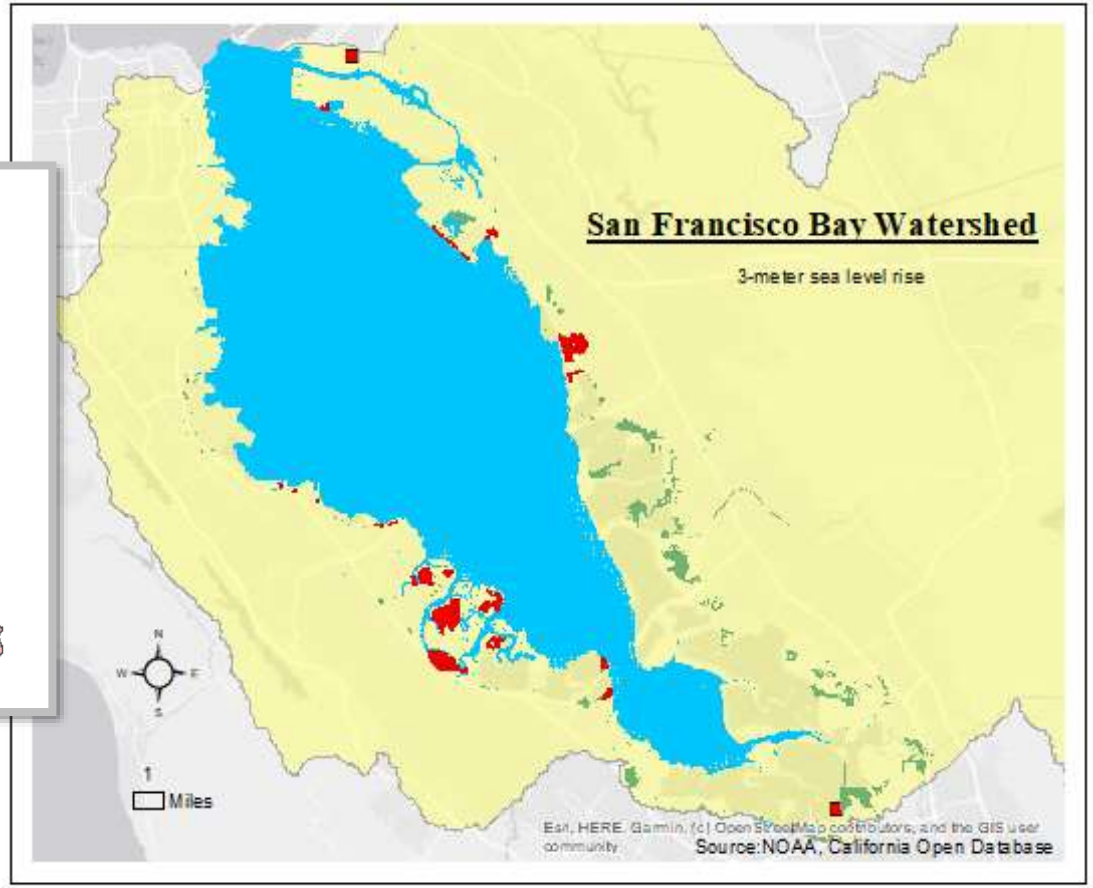


San Francisco Bay Watershed

At a 1-meter sea level rise 11% of the freshwater wetlands are at risk of saltwater Intrusion.



At a 3-meter sea level rise 12% of the freshwater wetlands are at risk of saltwater Intrusion.

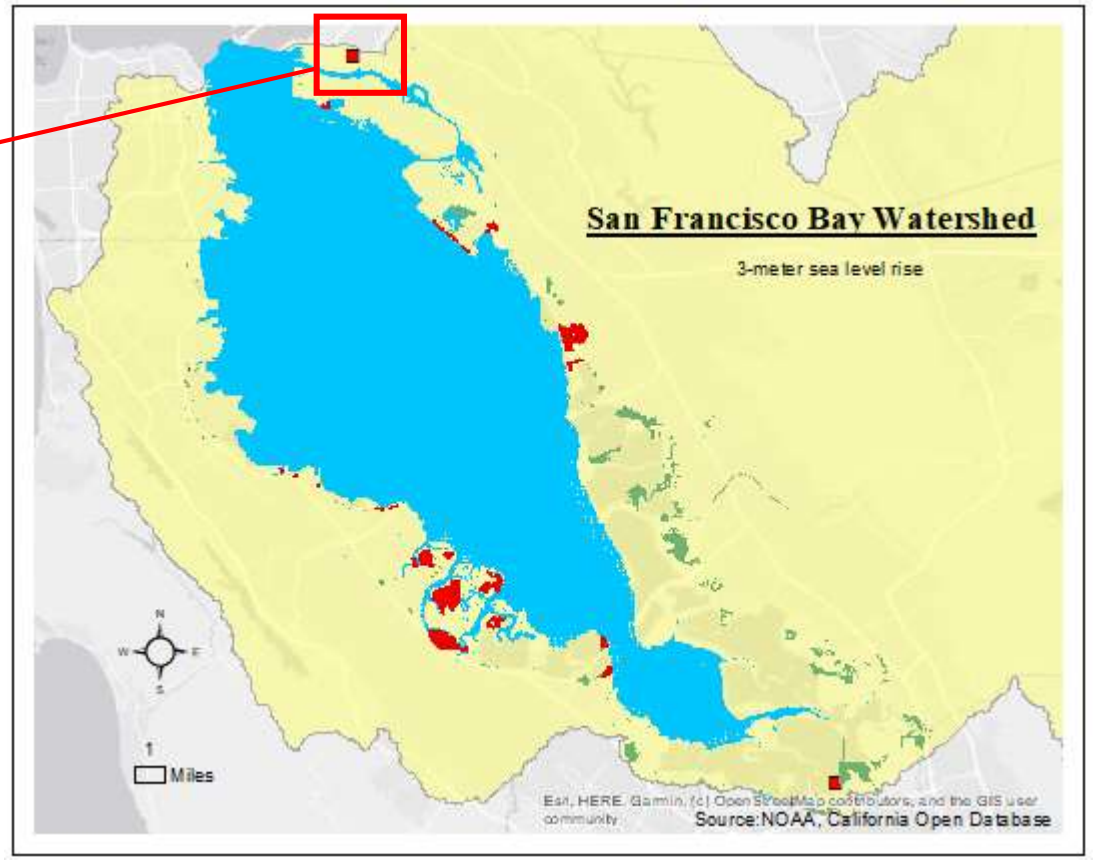


What additional factors could affect the surrounding wetlands and watersheds?

Superfund sites

At 1-meter sea level rise the Heckathorn co. superfund site is at risk of flooding.

At 3-meter sea level rise the AMCO chemical superfund site is at risk of flooding.



Both sites have had issues with ground contamination and are currently undergoing ongoing clean-up. (8)

Final Thoughts…

- My study being solely focused on elevation concluded…

1. San Pablo Bay freshwater wetlands -> Highest risk at 10-17%
2. San Francisco Bay Freshwater wetlands -> Closer to high risk at 11-12%
3. Suisun Bay freshwater wetlands -> lower risk at 4-7%

- Though, many factors such as; high tide, storm surges, or subsidence can have an impact on costal flooding.

- Due to such factors the extent of freshwater wetland loss in this region will be more extensive then predicted by this study.

- Rising sea levels is now beyond our efforts to stop. We should now utilize technology to predict the affects of sea level rise and use this knowledge to prepare.

NOAA (2)

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NOAA (2)

Higher sea levels mean that deadly and destructive storm surges push farther inland than they once did, which also means more frequent nuisance flooding. Disruptive and expensive, nuisance flooding is estimated to be from 300 percent to 900 percent more frequent within U.S. coastal

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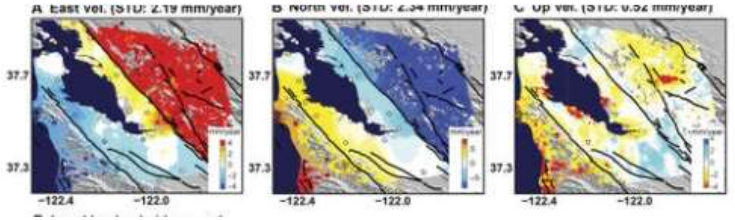
Using satellites to measure the rate at which the land is sinking, the researchers found that it was about 2 millimeters a year for much of the city's coast and about 10 a year for some sections.



Business Insider(9)

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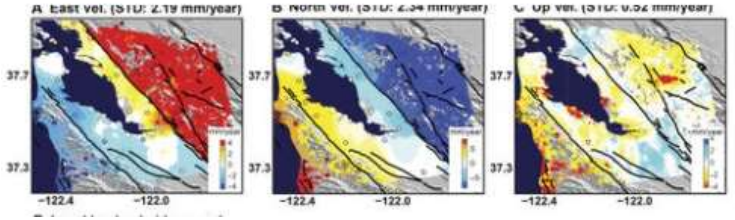

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Evaluating regional resiliency of coastal wetlands to sea level rise through hypsometry-based modeling

Cheryl L. Doughty, Kyle C. Cavanaugh, Richard F. Ambrose, Eric D. Stein

First published: 30 October 2018 | https://doi-org.proxy.lib.pdx.edu/10.1111/gcb.14429 | Citations: 3

Sea level rise (SLR) threatens coastal wetlands worldwide, yet the fate of individual wetlands will vary based on local topography, wetland morphology, sediment dynamics, hydrologic processes, and plant-mediated feedbacks. Local variability in these factors makes it difficult to predict SLR effects across wetlands or to develop a holistic regional perspective on SLR response for a diversity of wetland types. To improve regional

Primary Research Article (5)

Future response of global coastal wetlands to sea-level rise

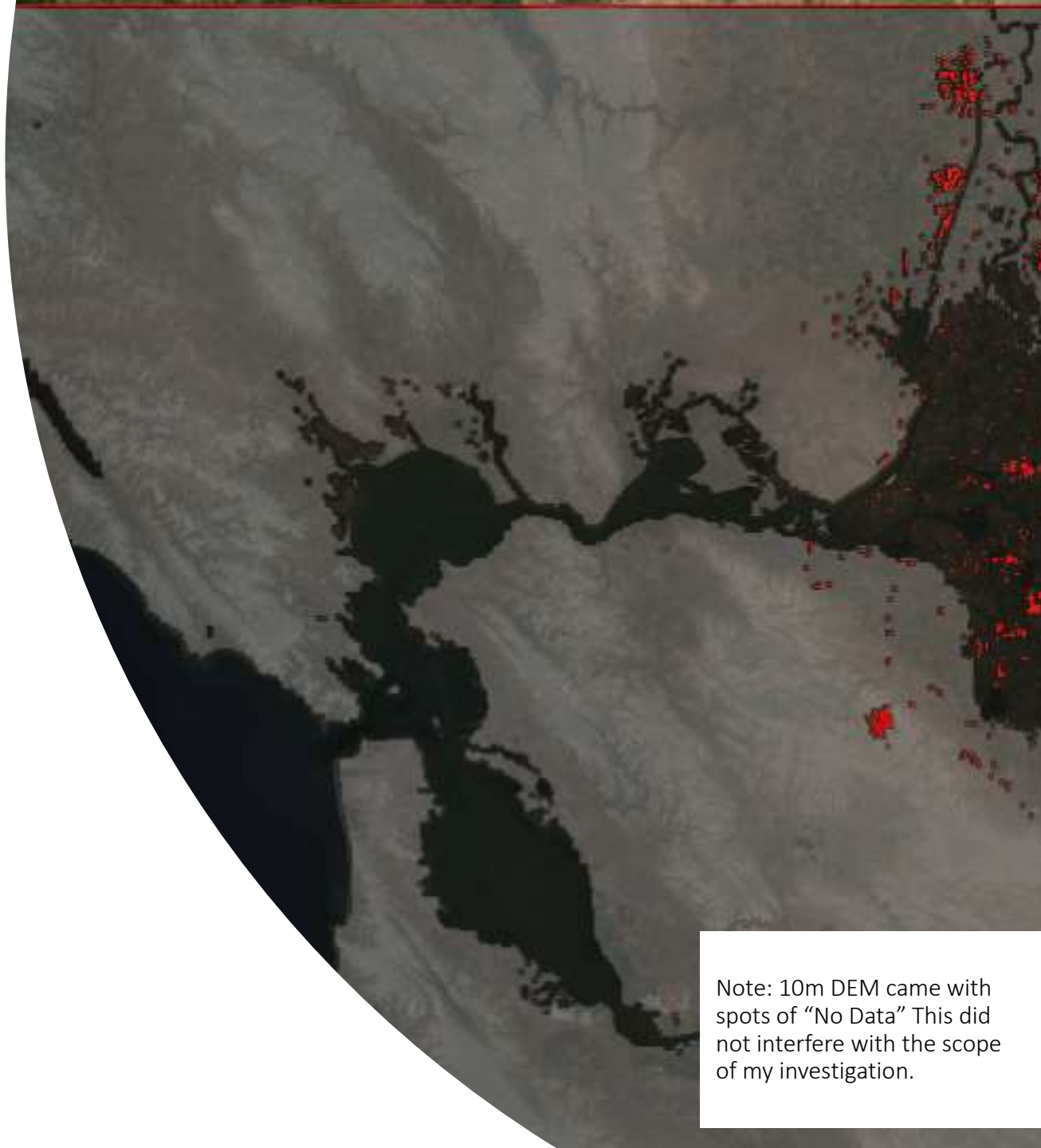
Mark Schuerch, Tom Spencer, Stijn Temmerman, Matthew L. Kirwan, Claudia Wolff, Daniel Lincke, Chris J. McOwen, Mark D. Pickering, Ruth Reef, Athanasios T. Vafeidis, Jochen Hinkel, Robert J. Nicholls & Sally Brown

supply remains at present levels. In contrast to previous studies[1,2,3], we project that until 2100, the loss of global coastal wetland area will range between 0 and 30 per cent, assuming no further accommodation space in

Nature Article (7)

Things I Would Change:

- Smaller Study Area
- Include other important factors such as high tide
- DEM without missing data
- Terrestrial DEM only – No bathymetric
- Listen to my professor and give myself more time



Note: 10m DEM came with spots of “No Data” This did not interfere with the scope of my investigation.

Thank you for listening

References:

1. https://blog.savesfbay.org/2013/04/wonky-wednesday-san-francisco-bay-a-wetland-of-international-importance/
2. https://coast.noaa.gov/slr/#/layer/mar/0/-13644577.643899833/4599347.228493327/13/satellite/45/0.8/2100/interLow/lowAccretion
3. Wang, R. & Ateljevich, E. (2012). A Continuous Surface Elevation Map for Modeling (Chapter 6). In *Methodology for Flow and Salinity Estimates in the Sacramento-San Joaquin Delta and Suisun Mars, 23rd Annual Progress Report to the State Water Resources Control Board.* California Department of Water Resources, Bay-Delta Office, Delta Modeling Section.
4. https://www.salineagricultureworldwide.com/salinization
5. Doughty, CL, Cavanaugh, KC, Ambrose, RF, Stein, ED. Evaluating regional resiliency of coastal wetlands to sea level rise through hypsometry-based modeling. *Glob Change Biol*. 2019; 25: 78– 92. https://doi-org.proxy.lib.pdx.edu/10.1111/gcb.14429
6. https://oceanservice.noaa.gov/facts/sealevel.html
7. Schuerch, M., Spencer, T., Temmerman, S. *et al.* Future response of global coastal wetlands to sea-level rise. *Nature* **561,** 231–234 (2018) doi:10.1038/s41586-018-0476-5
8. https://www.epa.gov/superfund-redevelopment-initiative/superfund-sites-reuse-california#amco
9. https://www.businessinsider.com/san-francisco-bay-area-is-sinking-into-the-ocean-2018-3