

Climate Change from Both Ends: Projected Sea Level Rise and Inflow Changes in San Francisco Bay

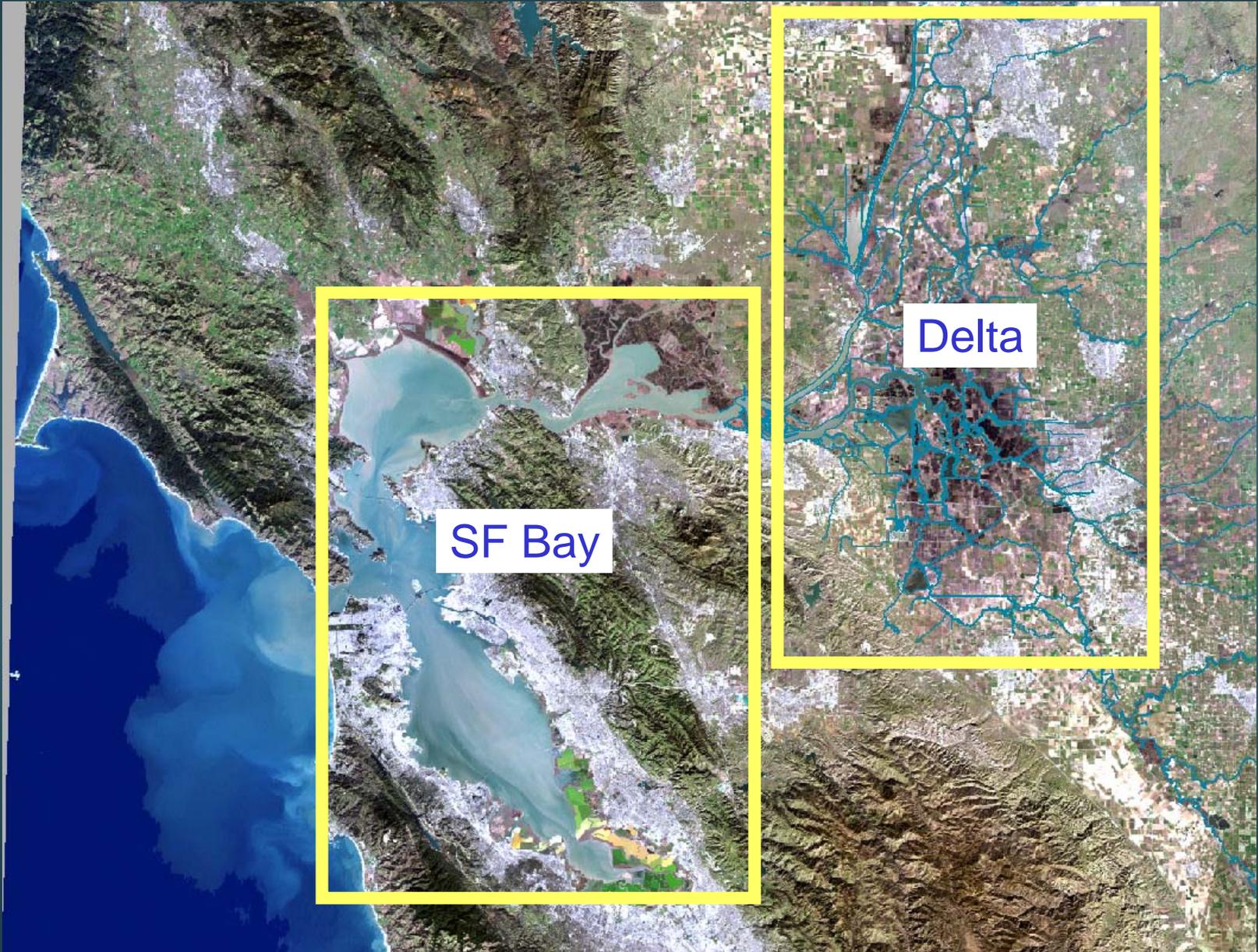
Noah Knowles, USGS, Menlo Park

1. Inflow changes and effects on SF Bay water quality
2. Sea level rise and SF Bay area inundation risks
3. Potential Delta flooding and Bay impacts

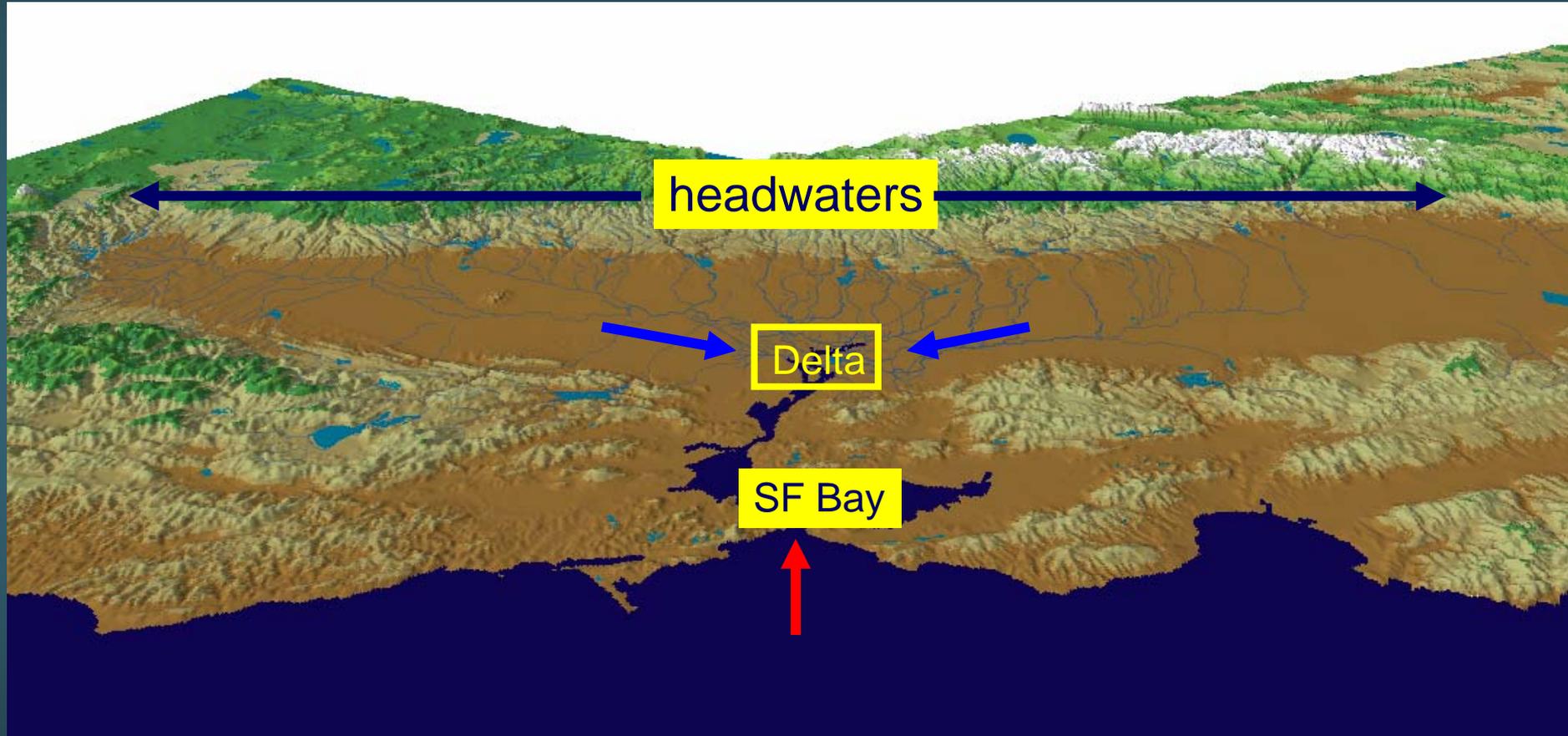


Funded by the California Energy Commission's Public Interest Energy Research Program (PIER) through the California Climate Change Center at Scripps Institution of Oceanography, and by the CALFED Science Program through the USGS CASCaDE Project.

San Francisco Bay-Delta Estuary



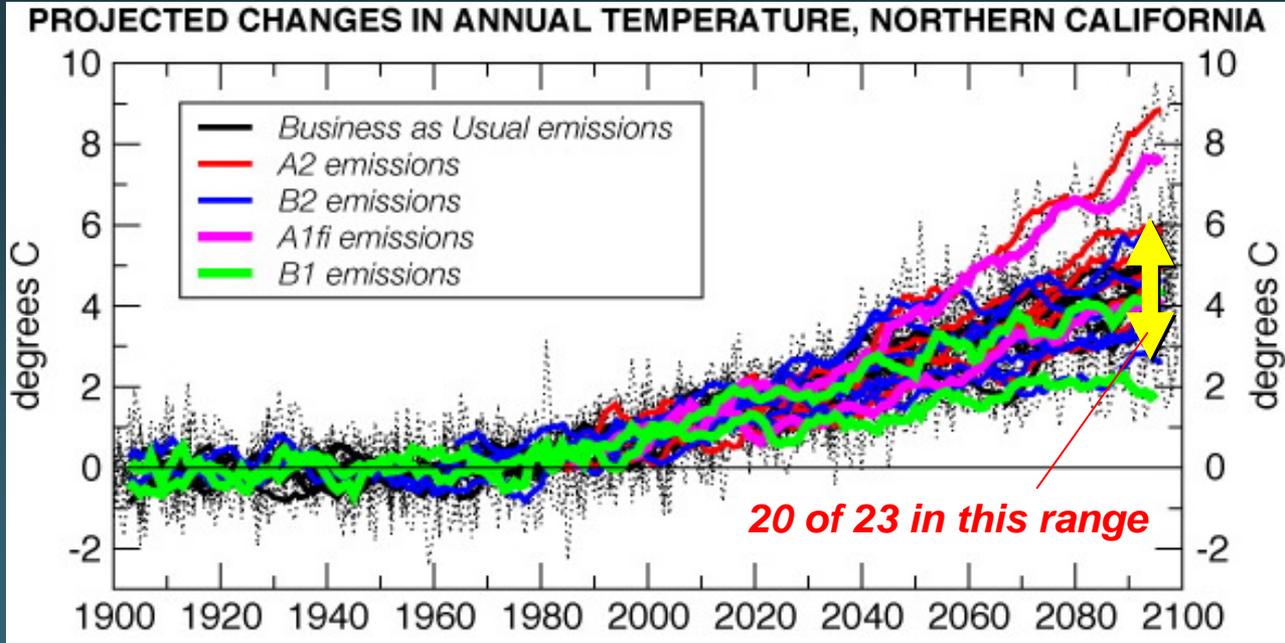
Bay-Delta Watershed



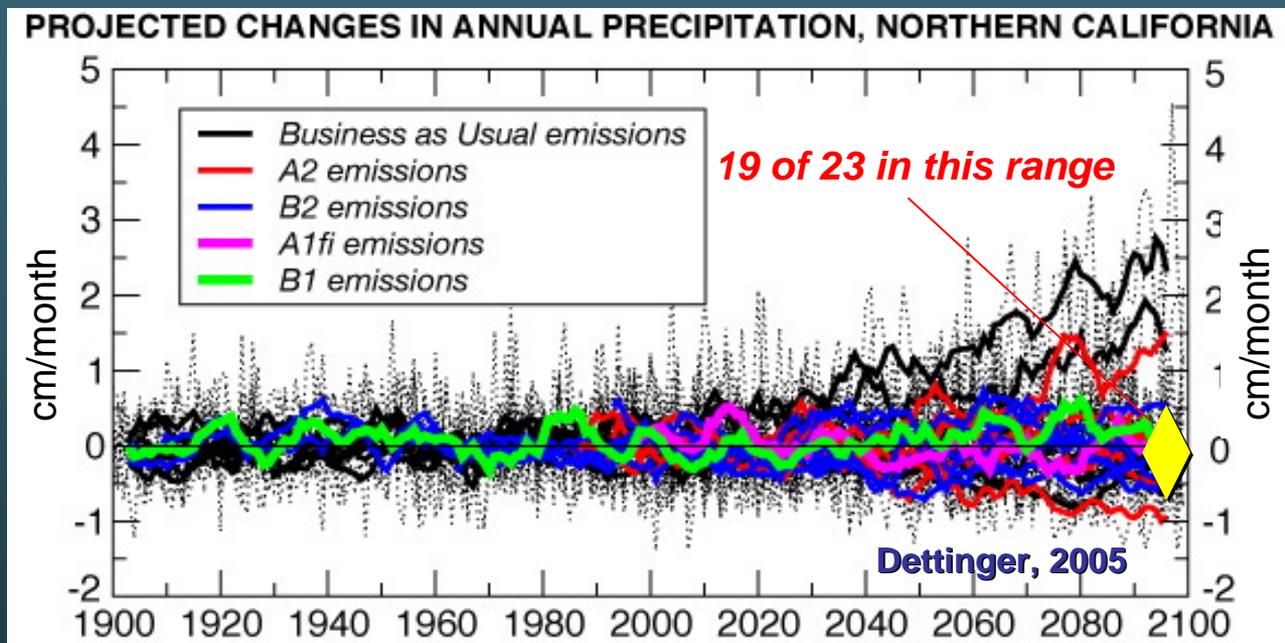
40% of California's area drains to the Delta and San Francisco Bay

1. Inflow changes and effects on SF Bay water quality

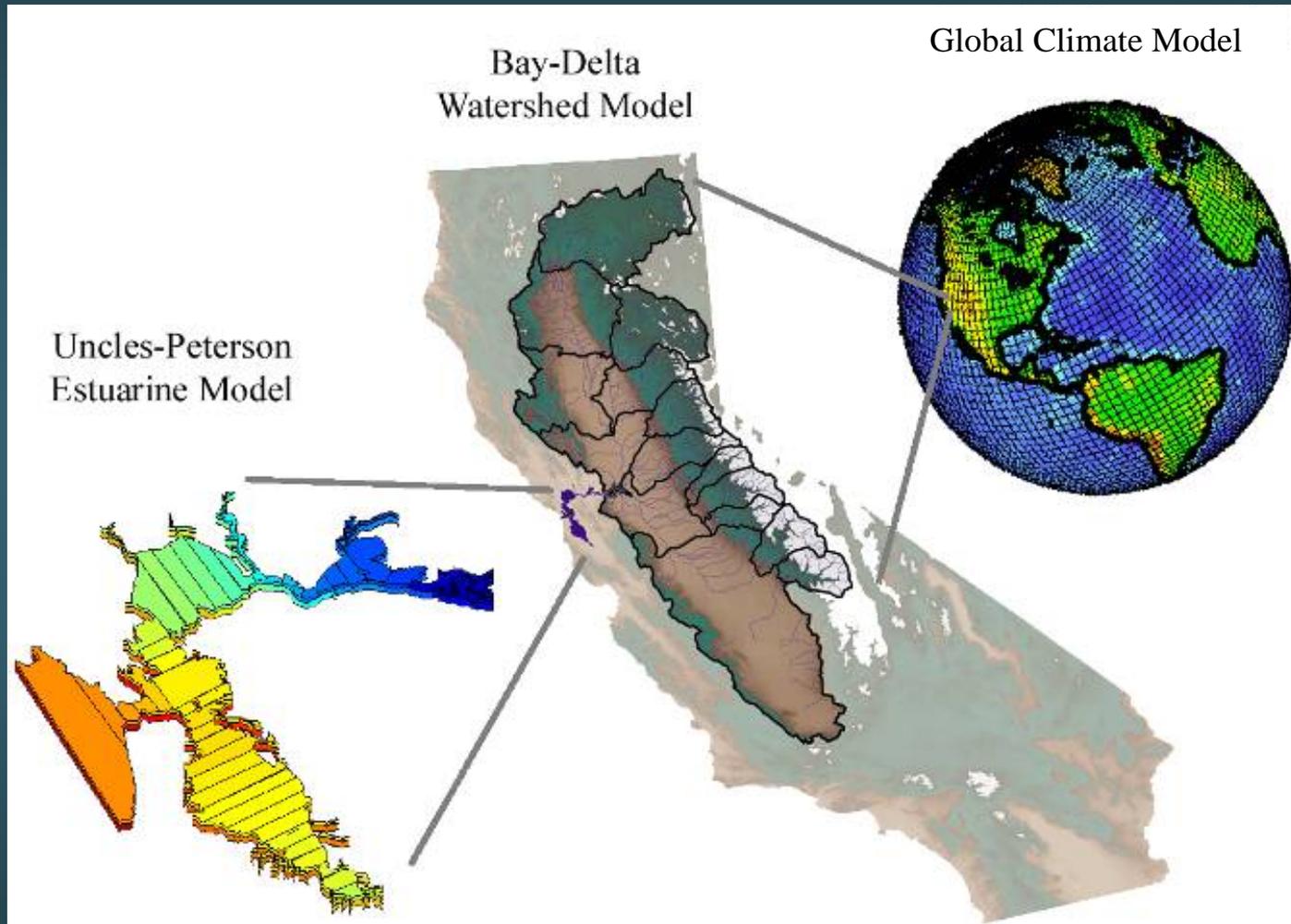
Under projected greenhouse forcings, all climate models yield warmer futures for California...



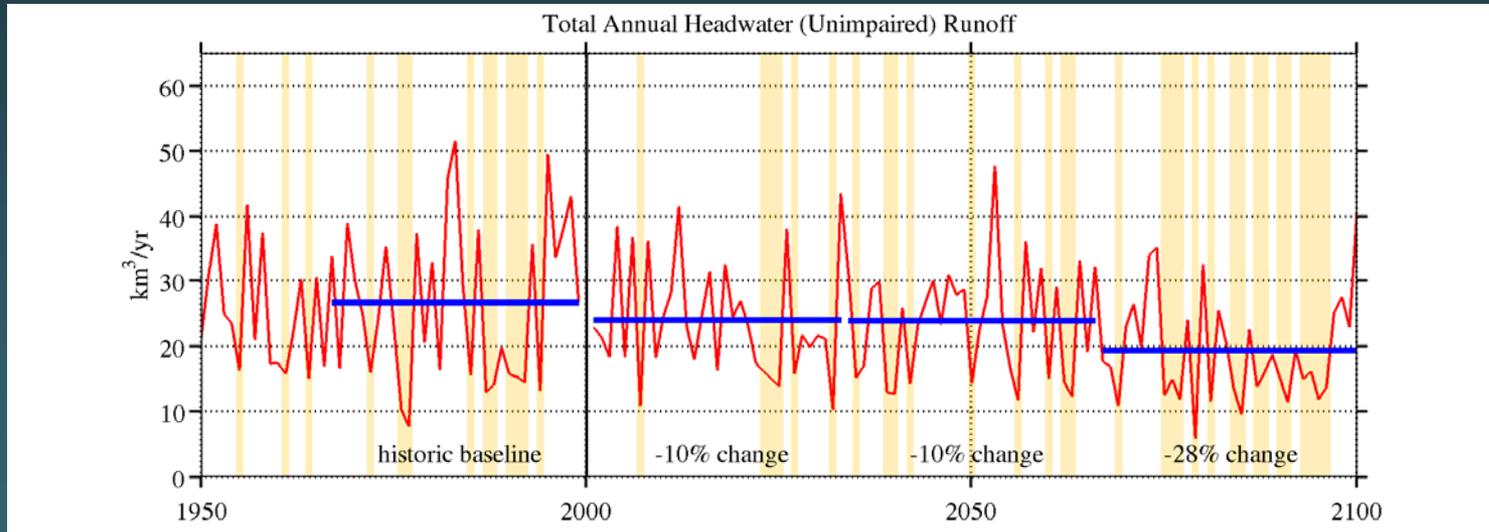
...and most climate models yield a fairly narrow range of precipitation changes in California.



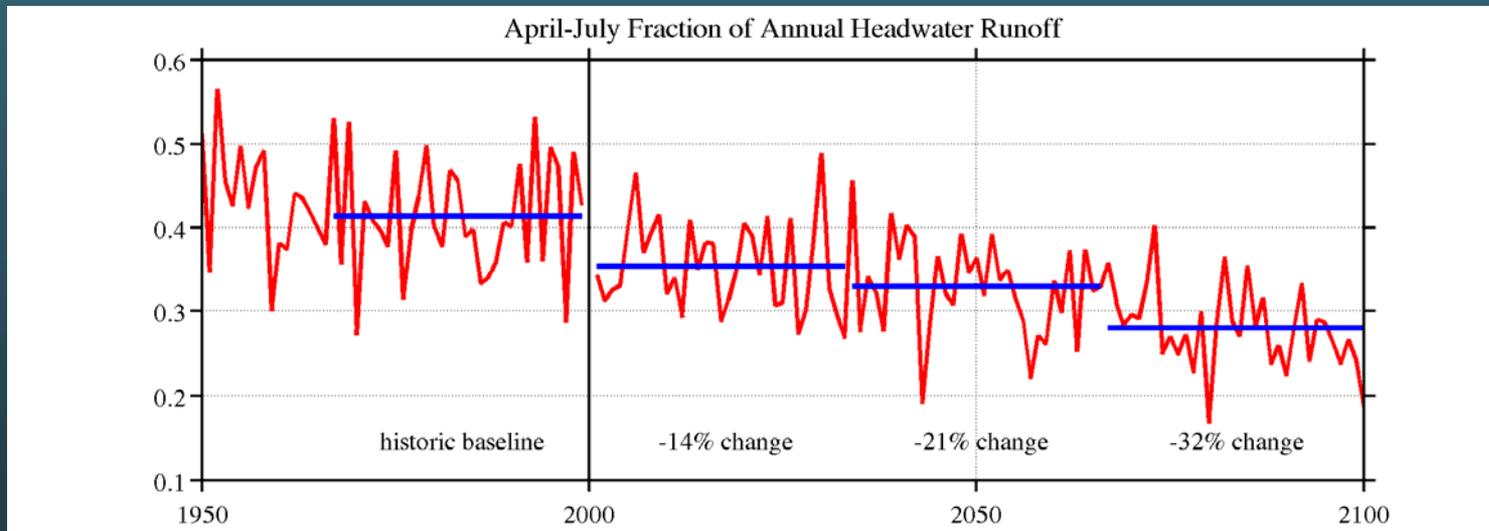
GCM outputs drive a hydrology model, which in turn drives a water quality model of SF Bay.



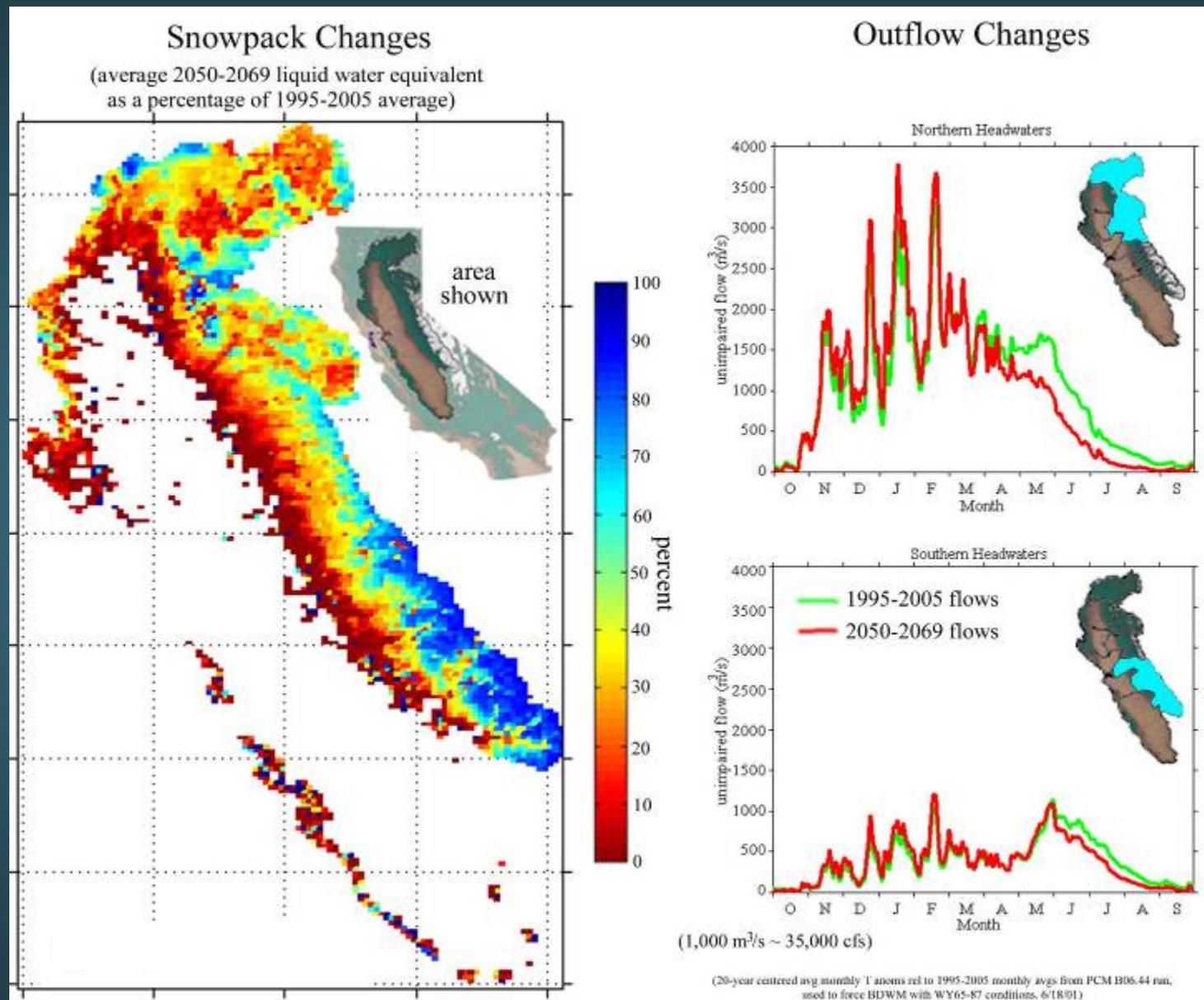
Most climate projections range from significant drying to little change for CA.



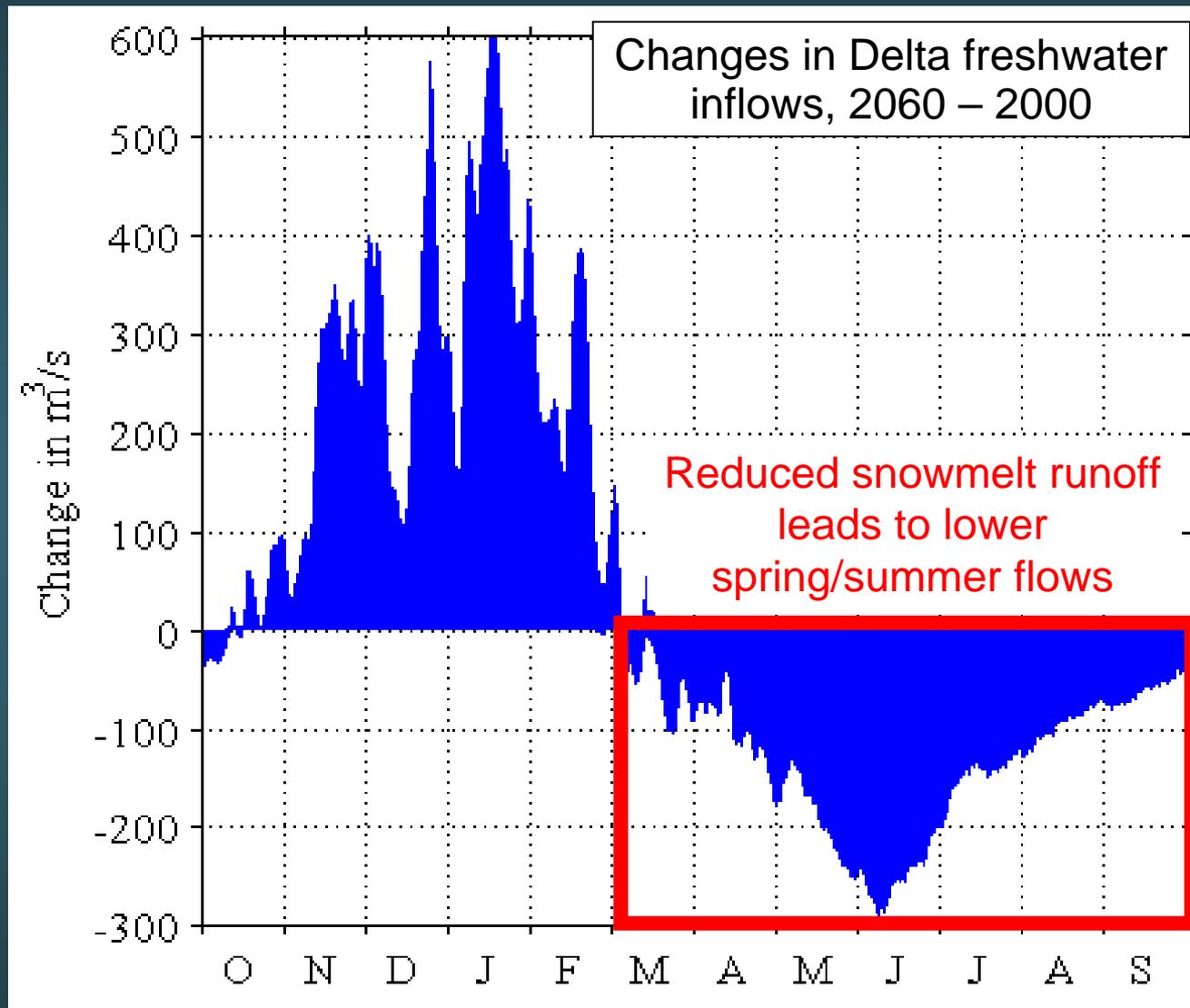
Snowmelt fraction of annual runoff declines in all projections.



Smaller snowpacks result in earlier runoff.

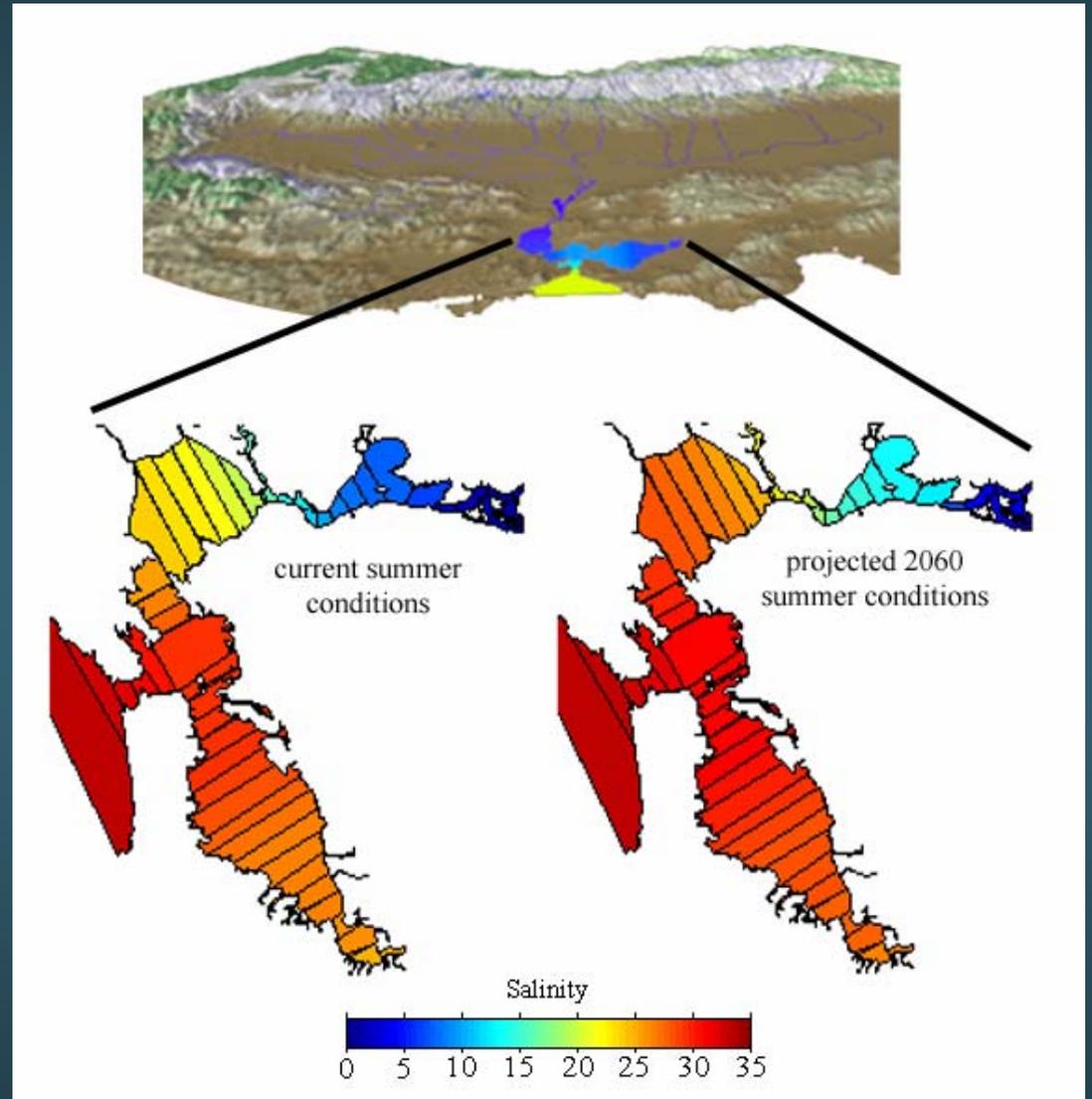


Upstream timing shifts may lead to changes in Delta freshwater inflows.



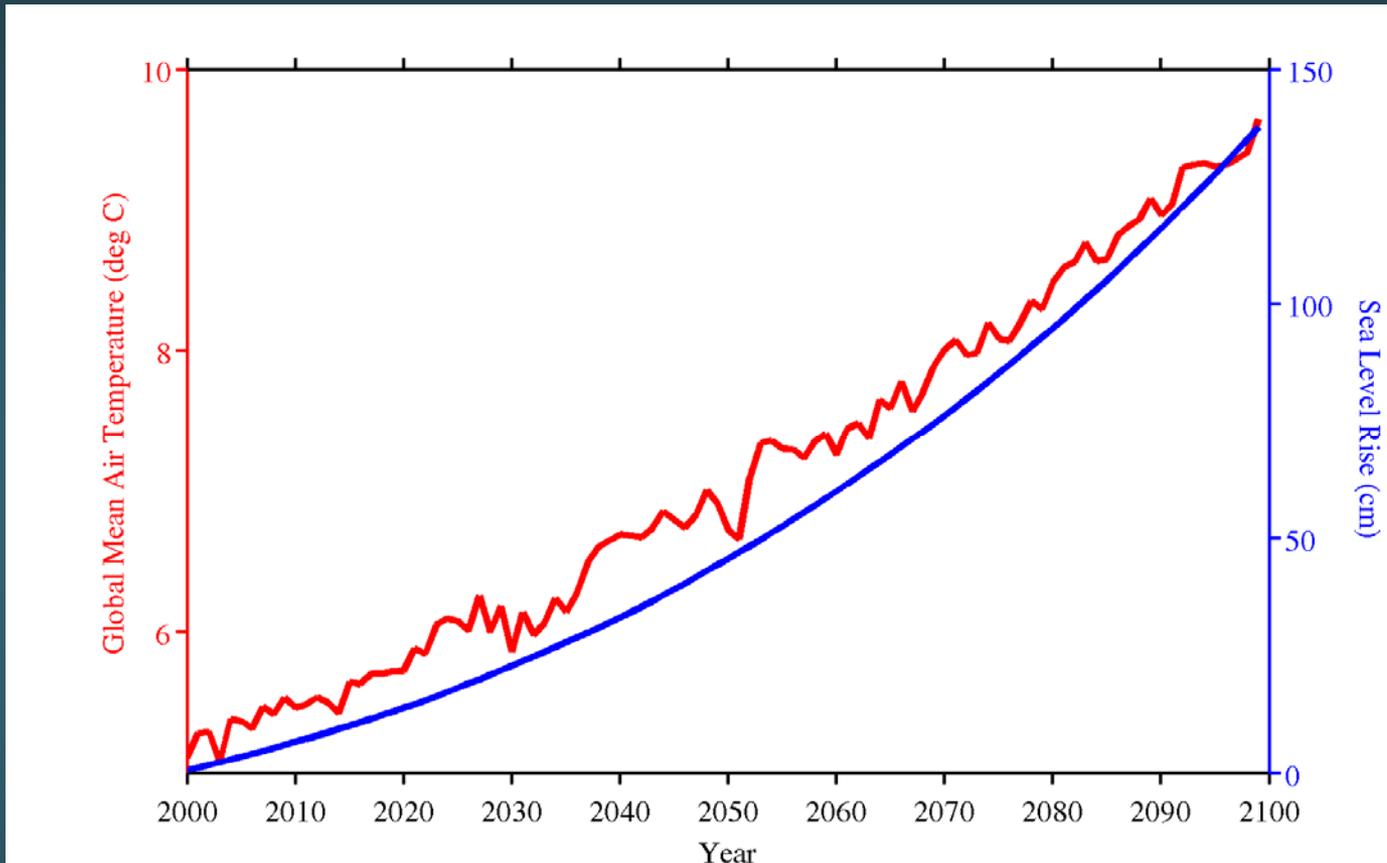
The salinity field shifts upstream in response to:

1. reduced spring and summer snowmelt runoff,
2. a general drying trend (in most projections), and
3. sea level rise.



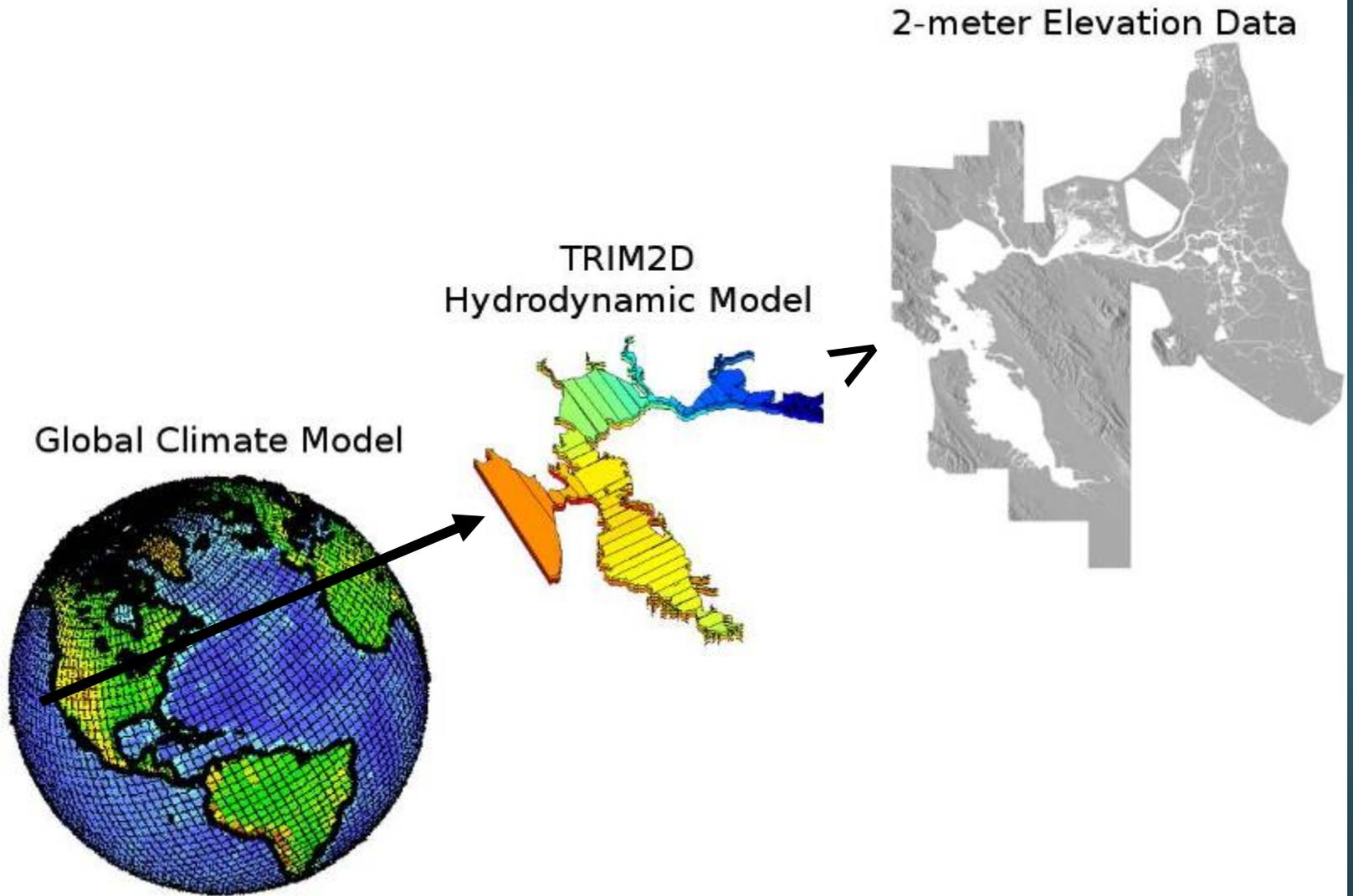
2. Sea level rise and SF Bay area inundation risks

Sea Level Rise Projection based on CCSM3-A2 GCM Run



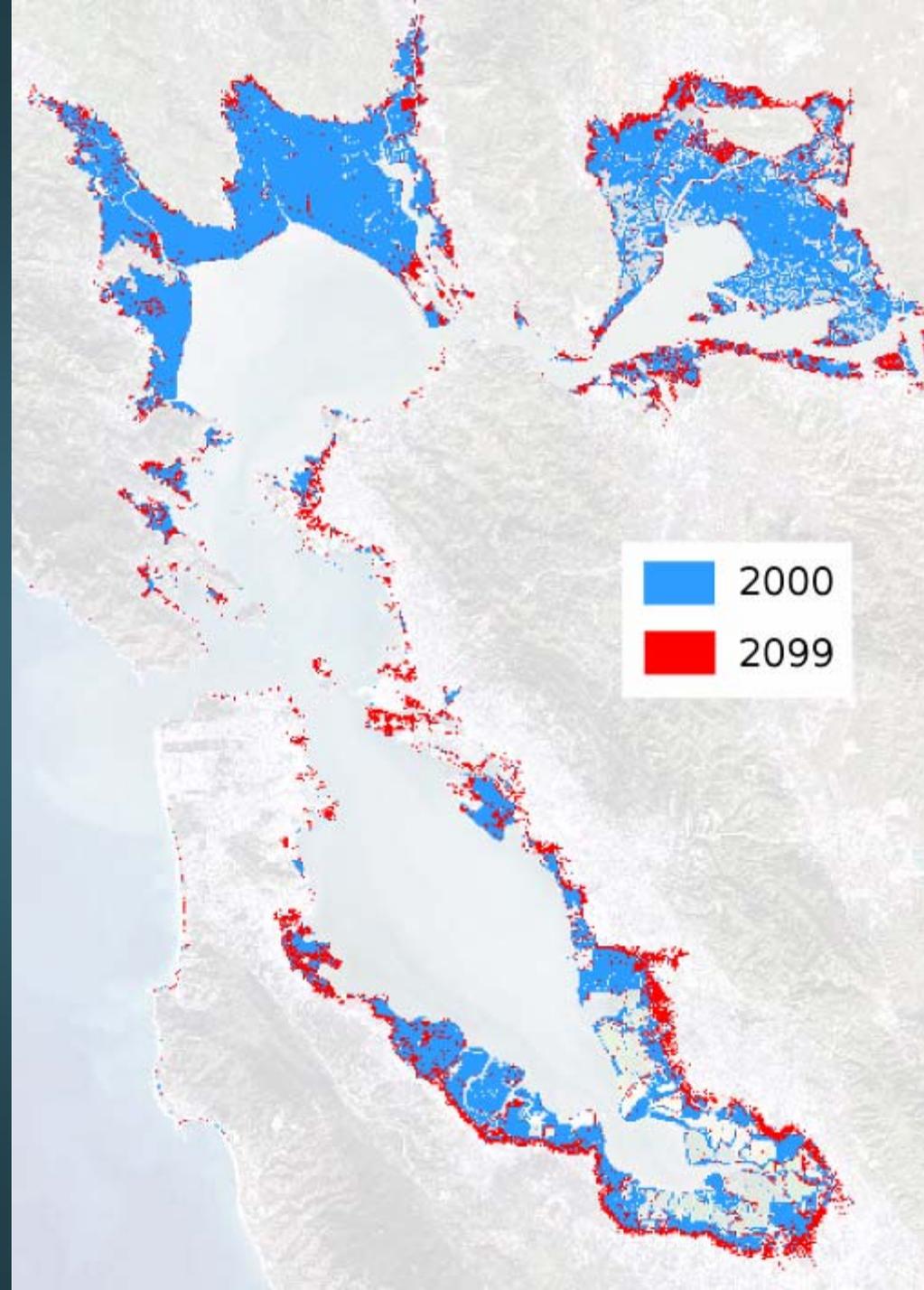
This sea level rise projection is from the Community Climate System Model (CCSM, v.3.0) using the A2 emission scenario. This projects a 4.5°C by 2100. The corresponding sea level rise projection is 140cm.

Modeling Sequence for SF Bay Study



Areas inundated or at risk of inundation by average yearly high-water levels, for both present-day (blue) and projected 2099 (red) conditions, corresponding to a 140cm sea level rise.

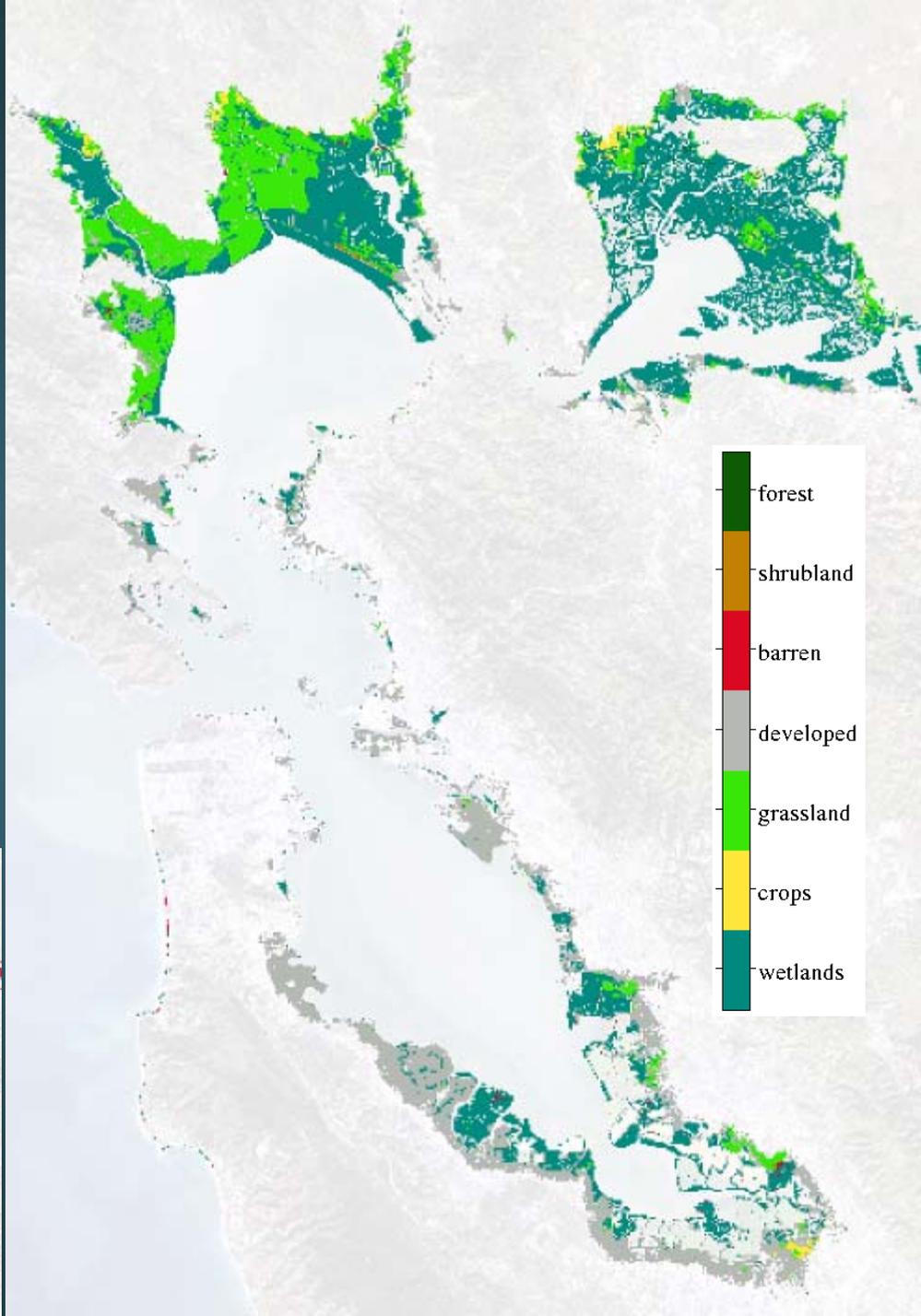
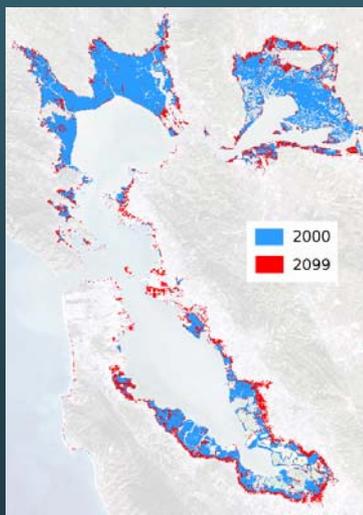
Many of these areas are currently protected by levees. They would be inundated only if those levees fail or are overtopped.



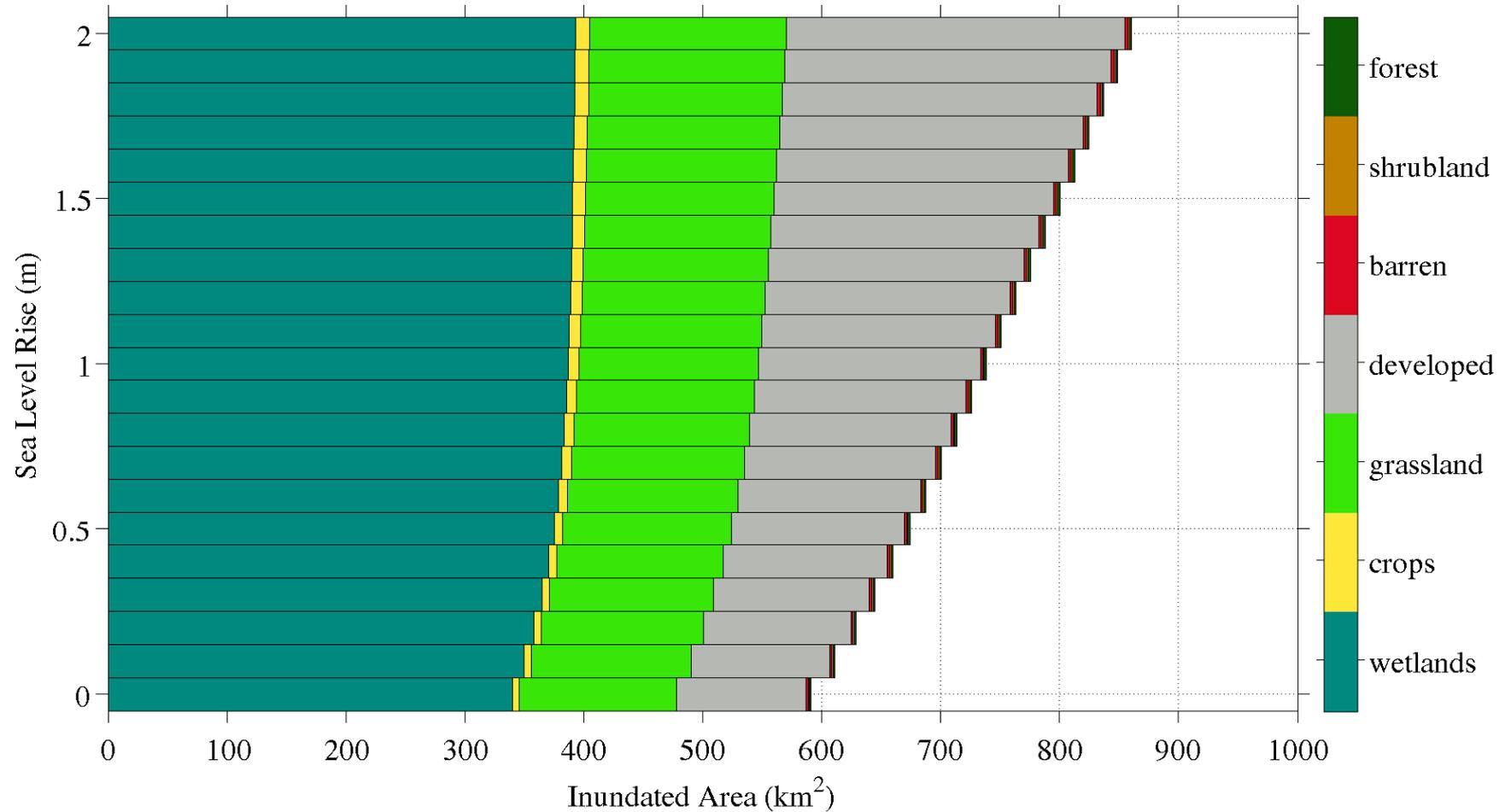
Areas inundated or at risk of inundation by average yearly high-water levels, under a 140cm sea level rise, coded by land cover type.

The bulk of vulnerable areas are composed of the wetlands and grasslands in North Bay.

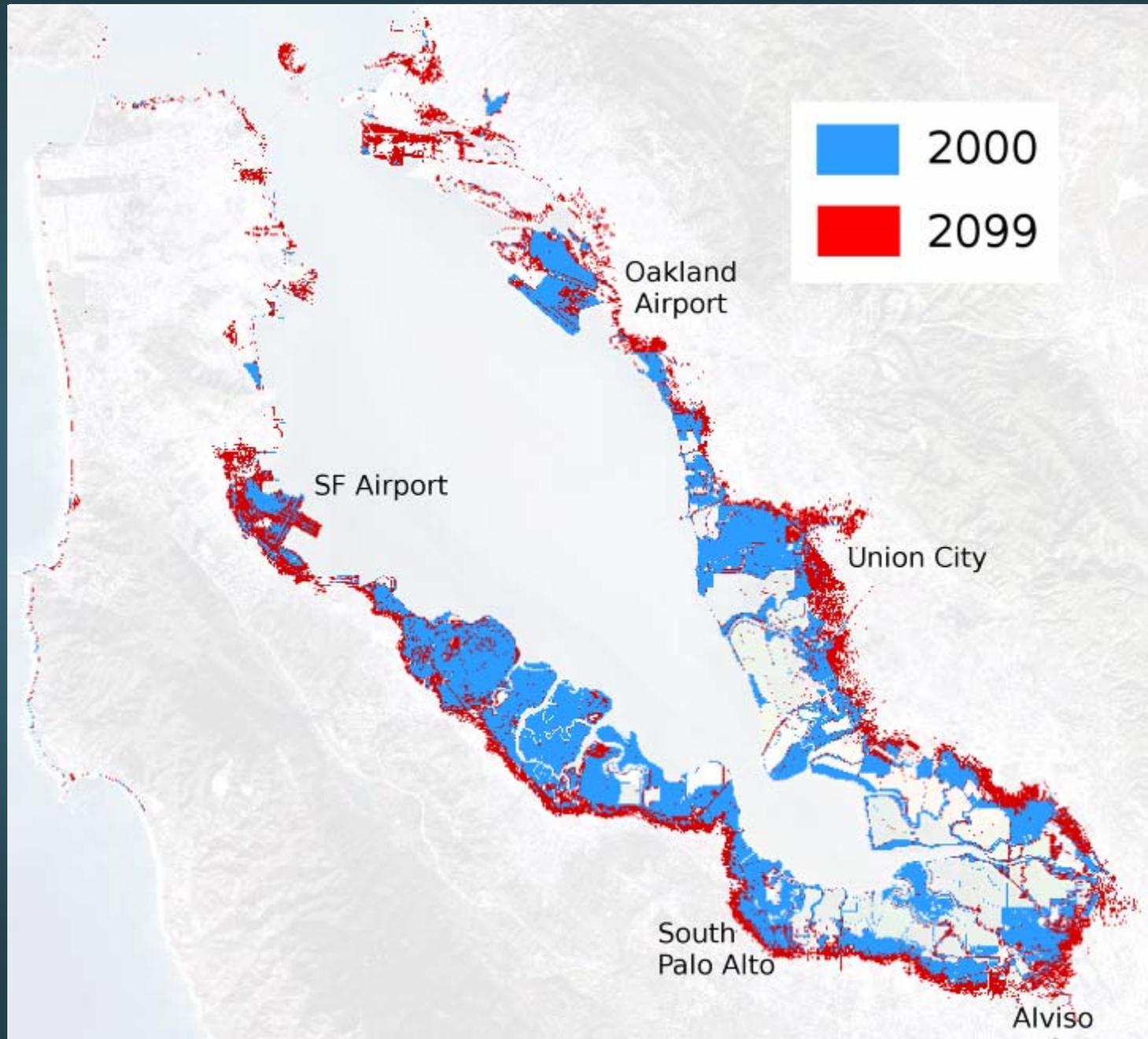
However, most *newly* vulnerable areas as a result of sea level rise are the developed areas surrounding Central and South Bays



We can also view the impacts in terms of land cover.
Main increase in at-risk area is in the “developed” land cover class.



South Bay: Salt Ponds and Developed Areas



South Bay: Oakland Airport and Alameda



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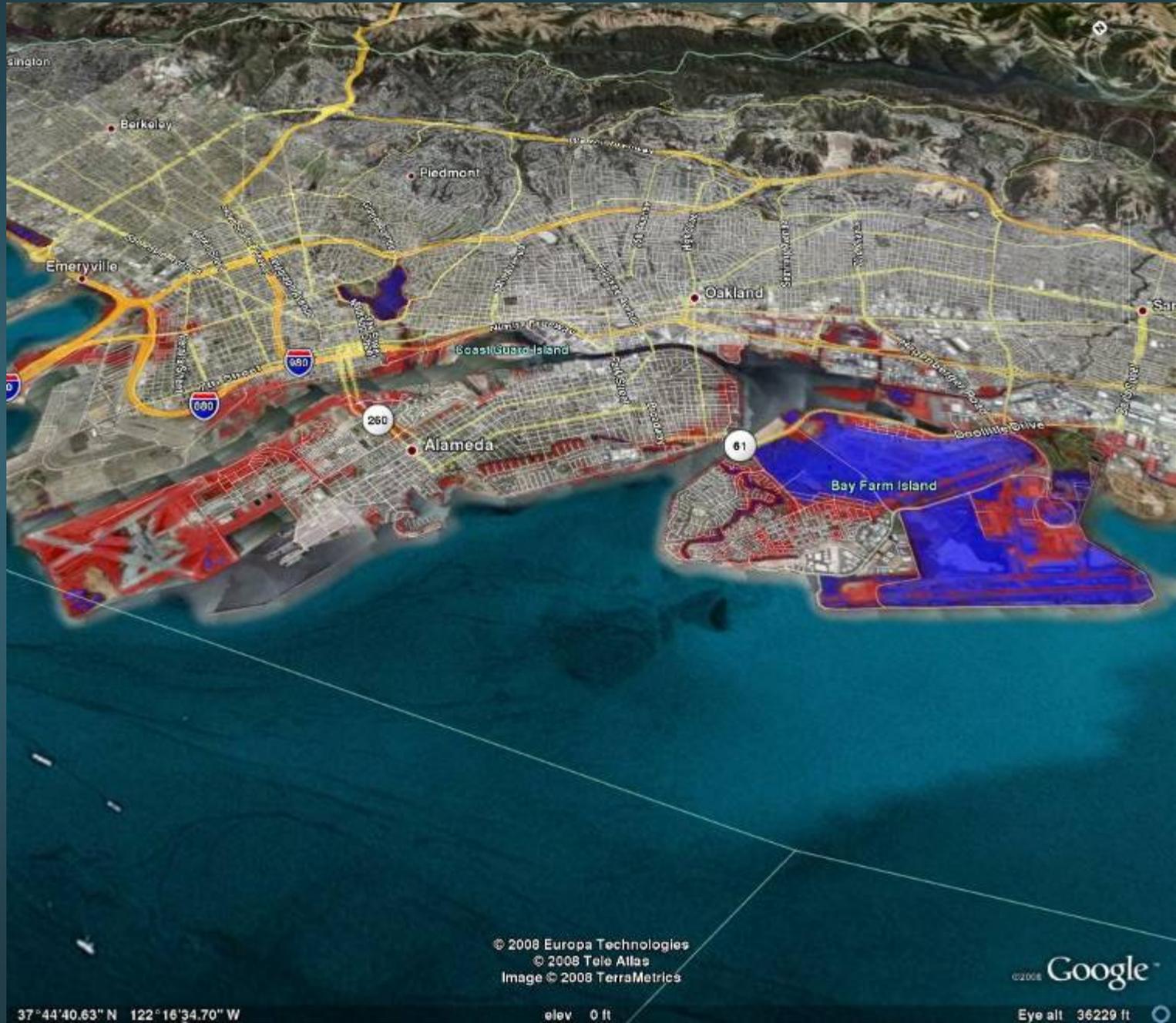
© 2008 Google

37°47'16.66" N 122°16'15.64" W

elev 10 ft

Eye alt 36229 ft

South Bay: Oakland Airport and Alameda



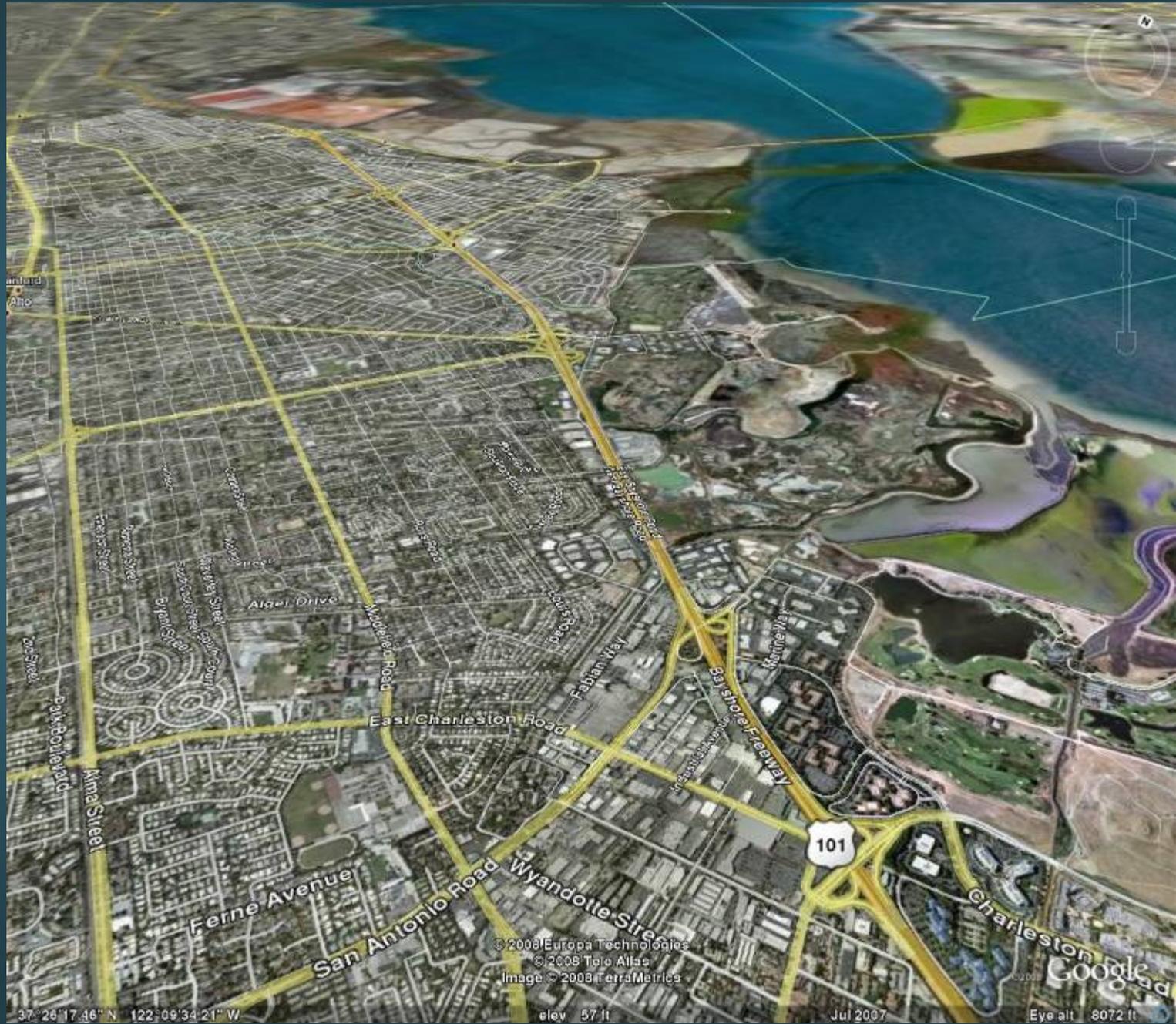
South Bay: Union City



South Bay: Union City



South Bay: South Palo Alto



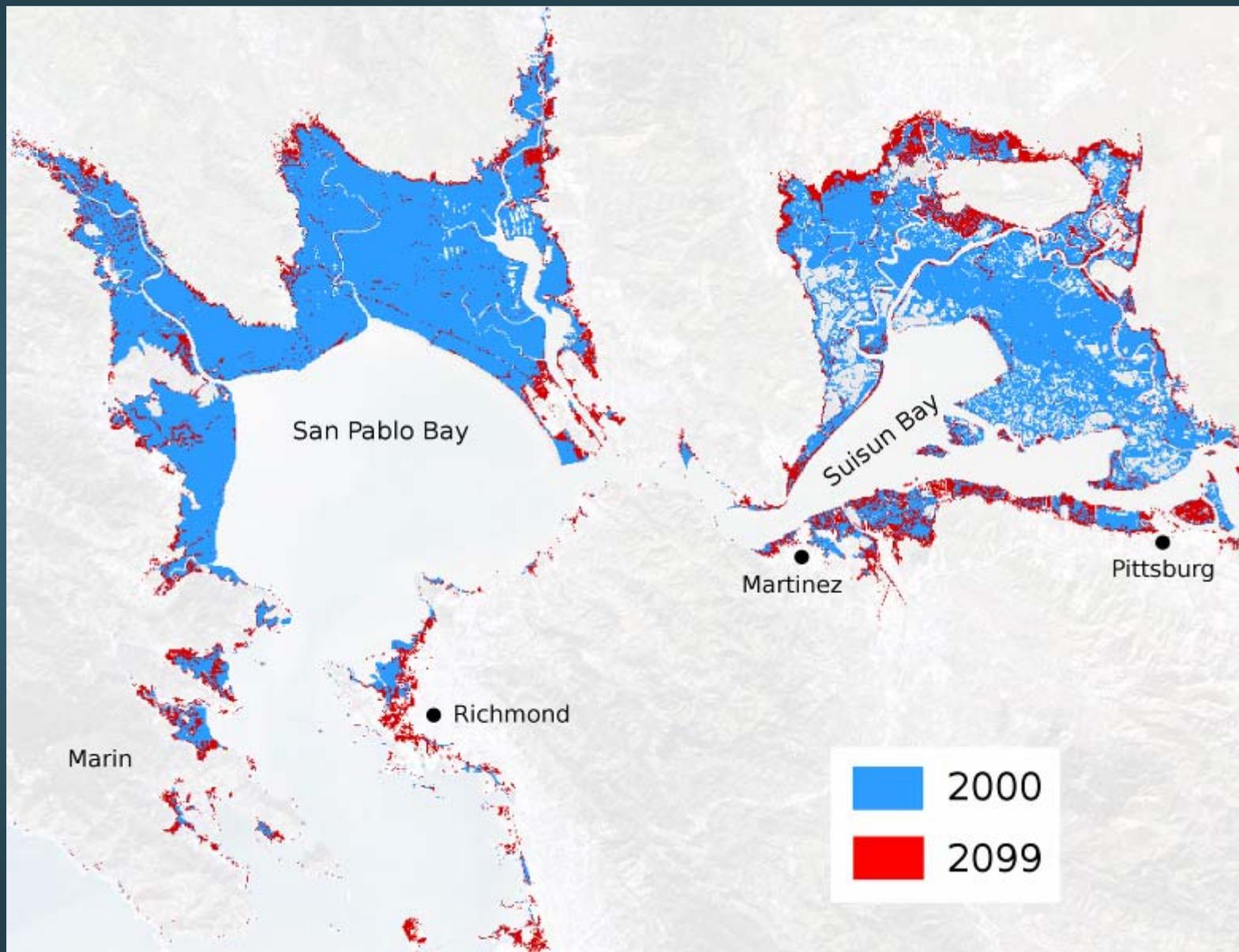
37° 26' 17.46" N 122° 09' 34.21" W

elev 57 ft

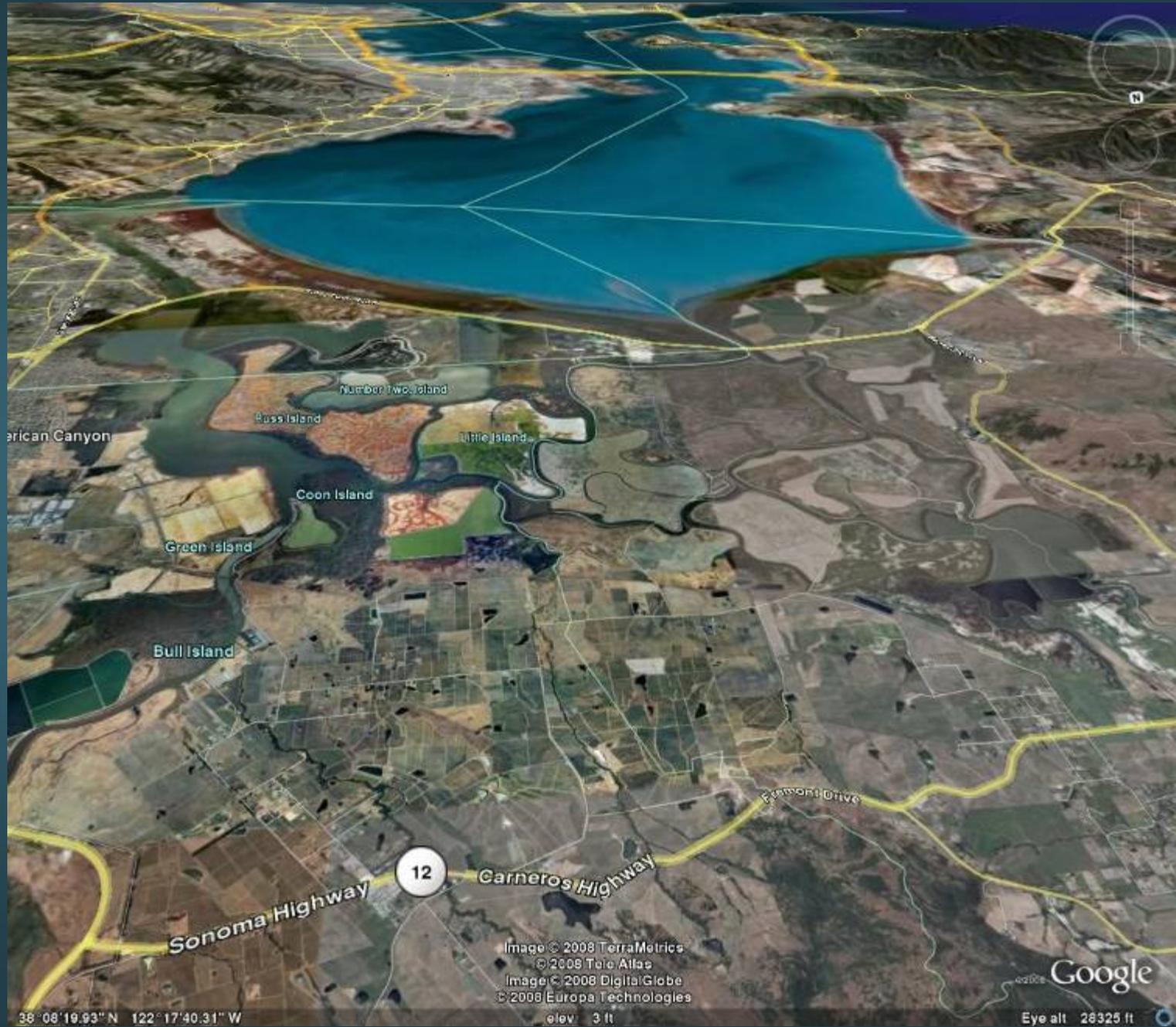
Jul 2007

Eye alt 8072 ft

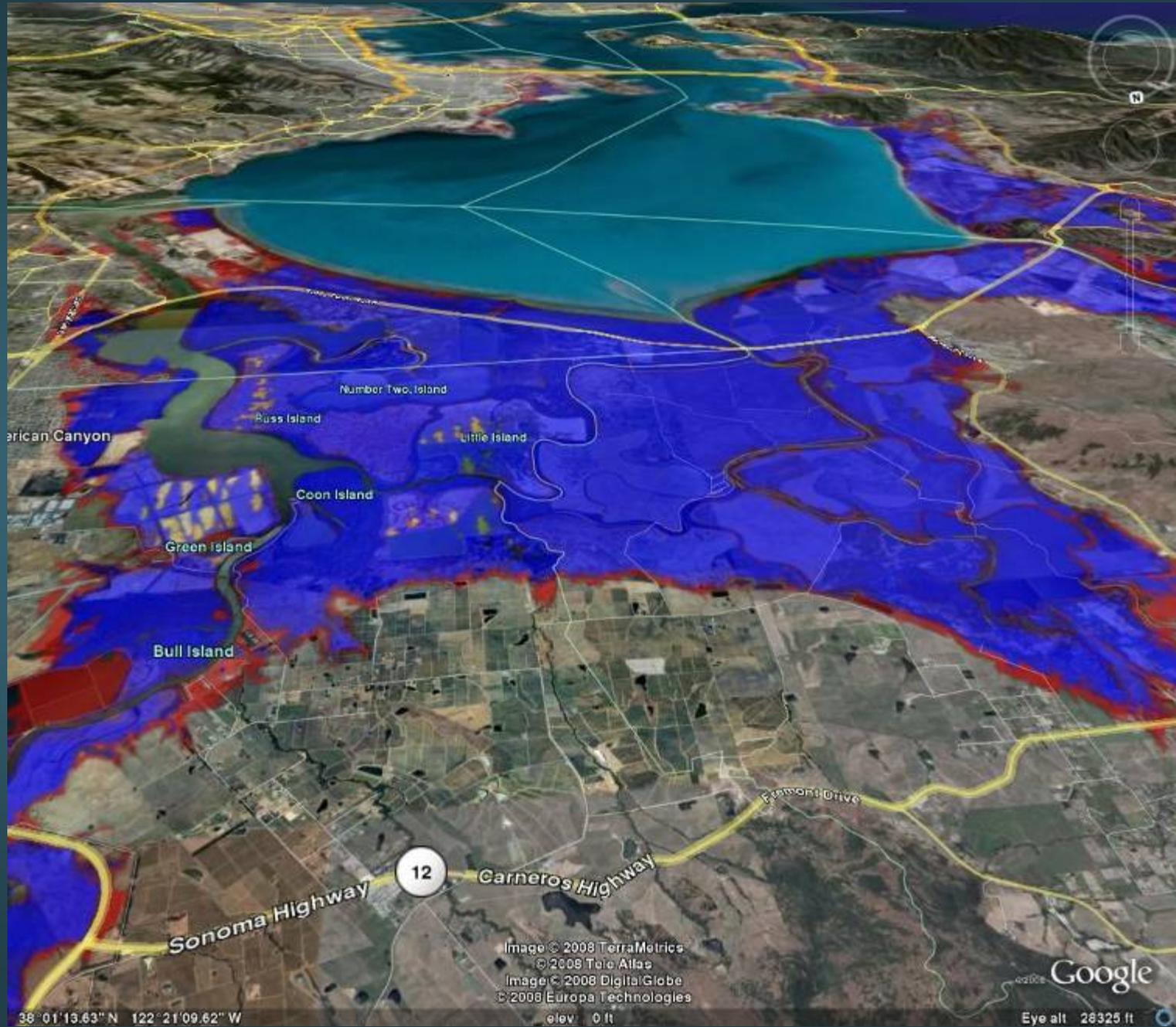
North Bay: Napa and Suisun Wetlands



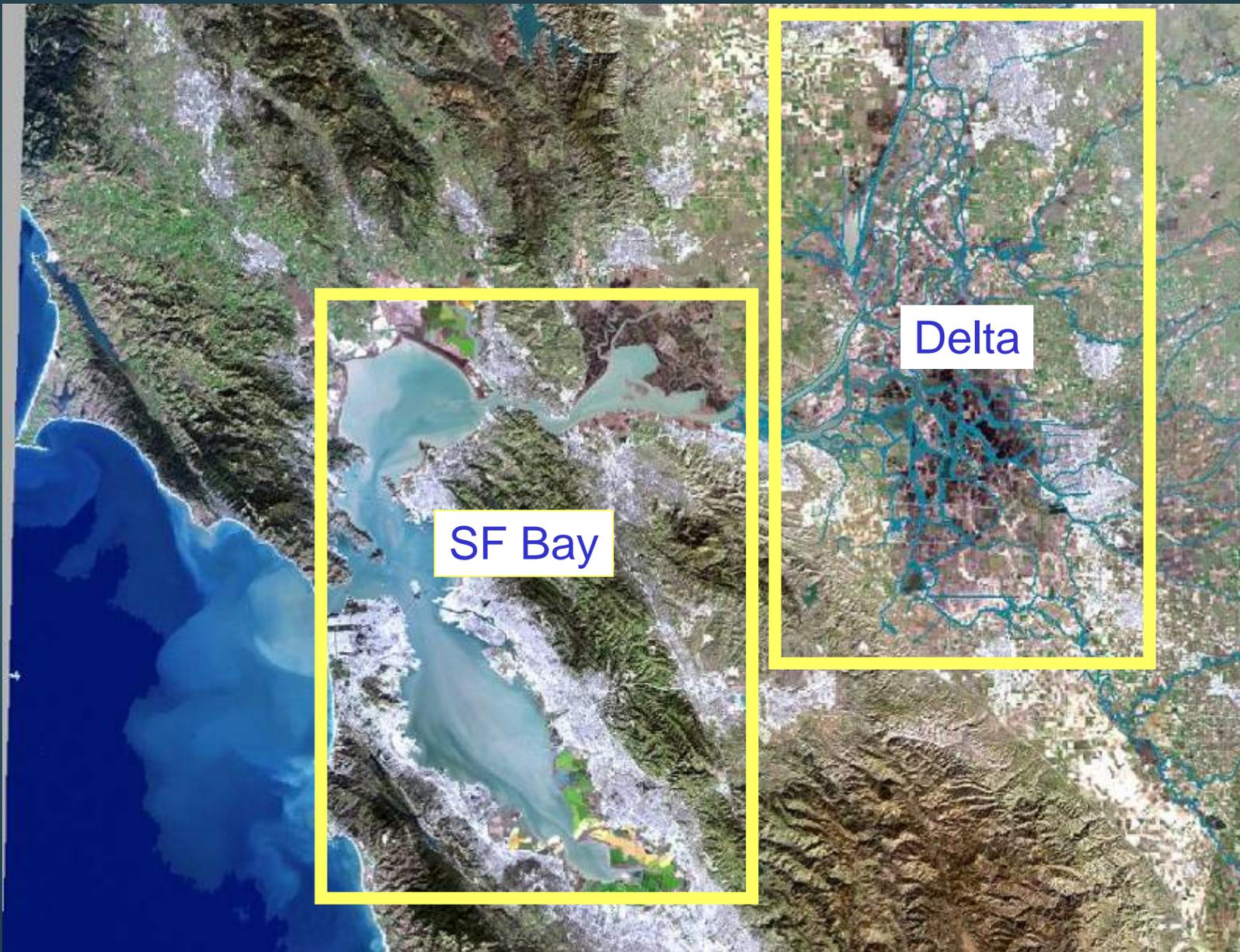
North Bay: Napa Wetlands



North Bay: Napa Wetlands

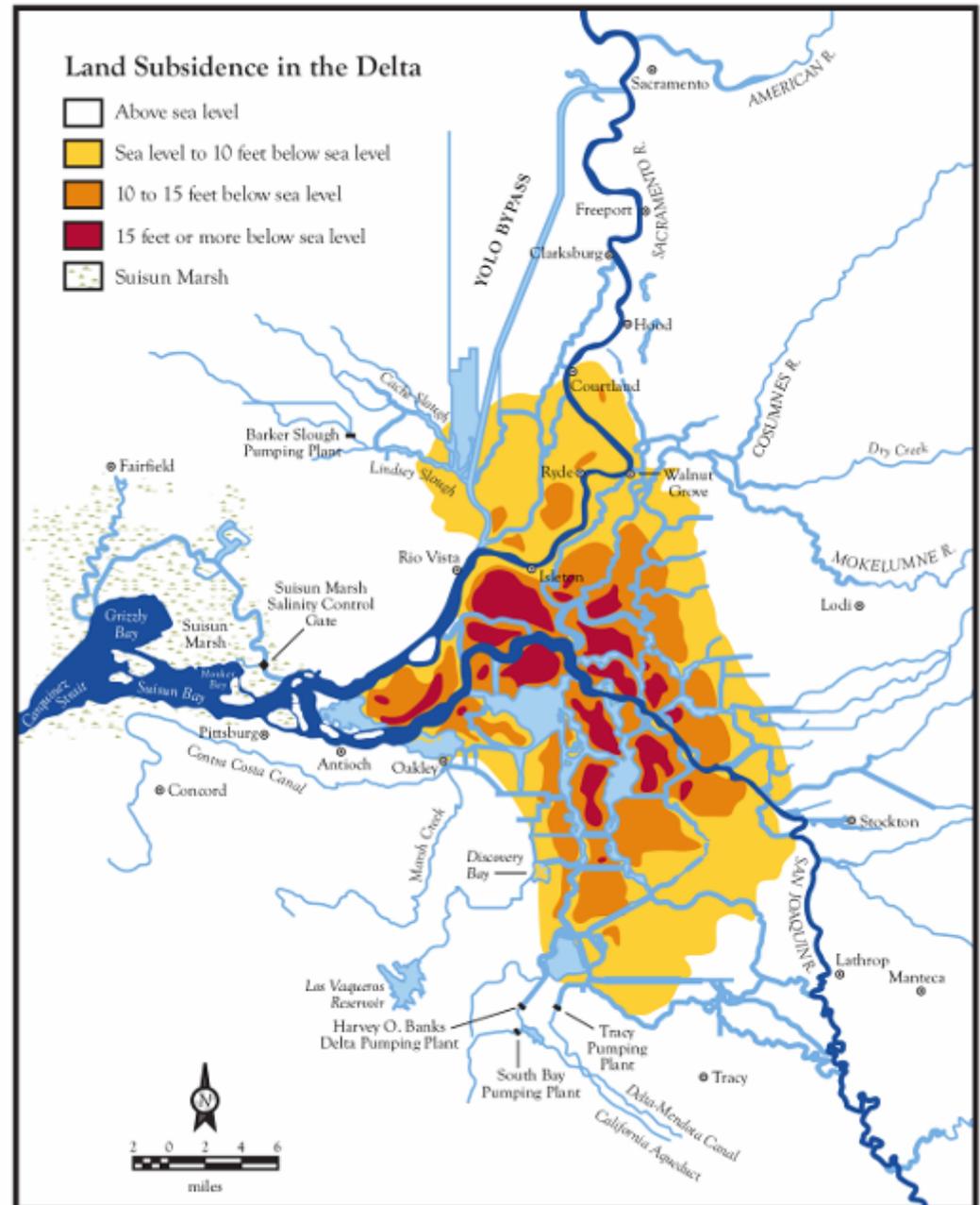
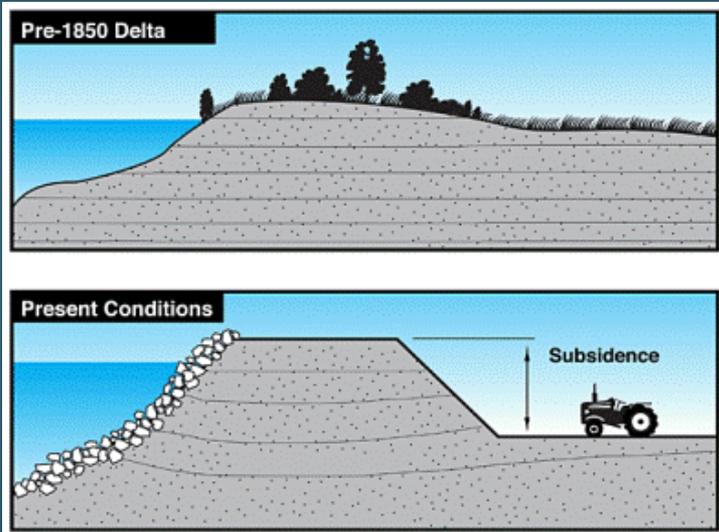


Sacramento-San Joaquin Delta



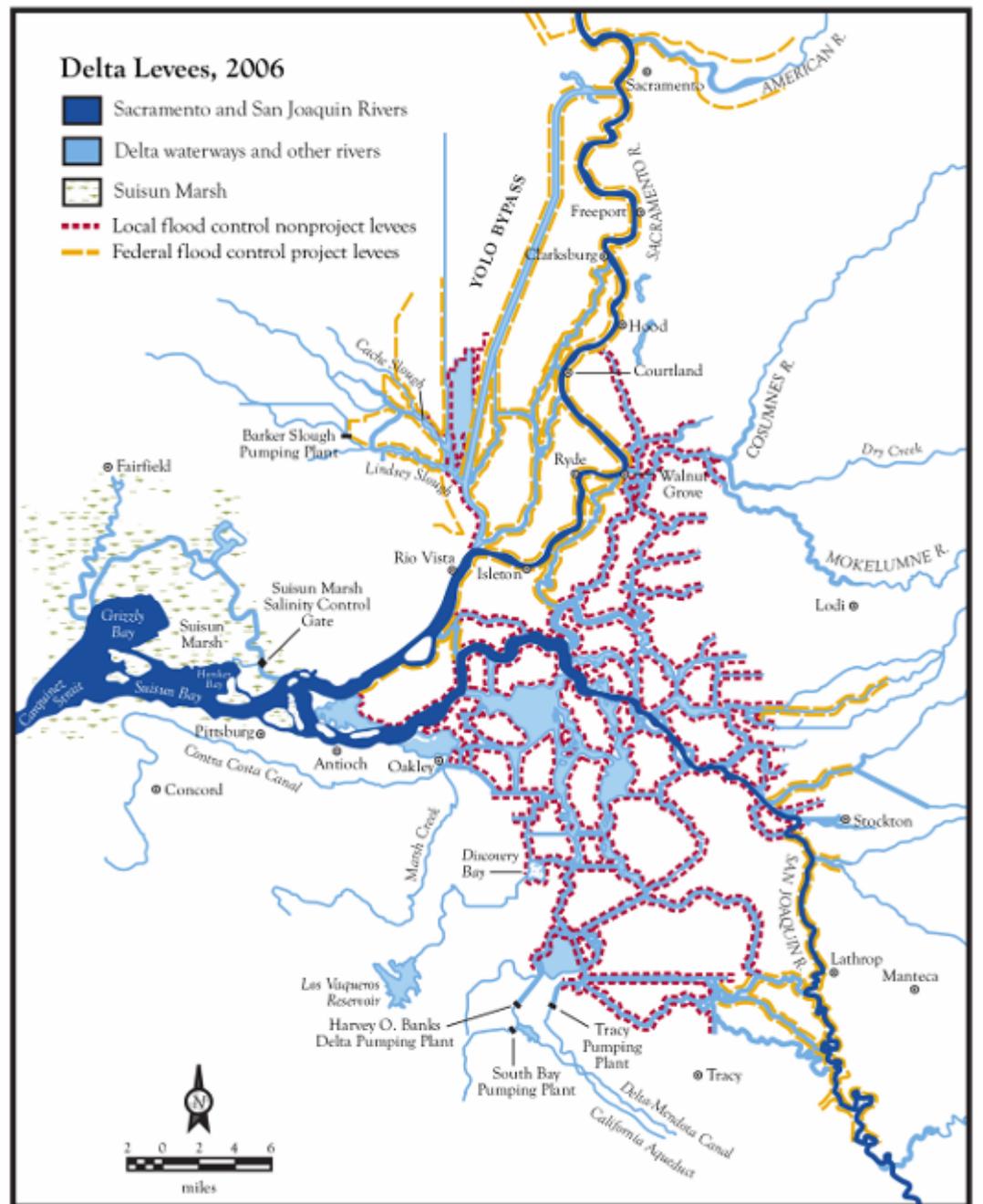
3. Potential Delta flooding and Bay impacts

150 years of agriculture has led to widespread subsidence.

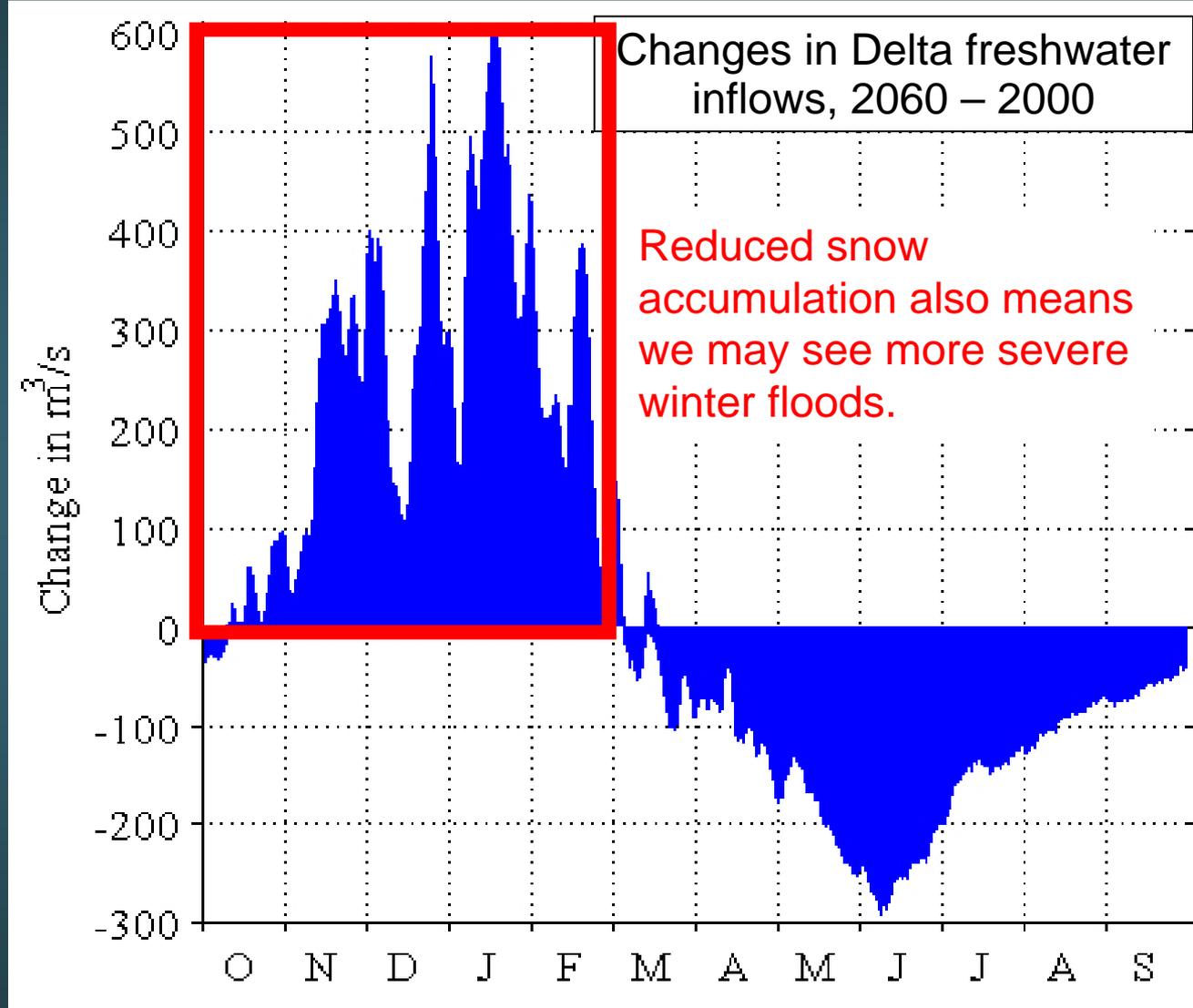


SOURCE: Department of Water Resources (1995).

1100 miles of levees currently protect these subsided Delta "islands".

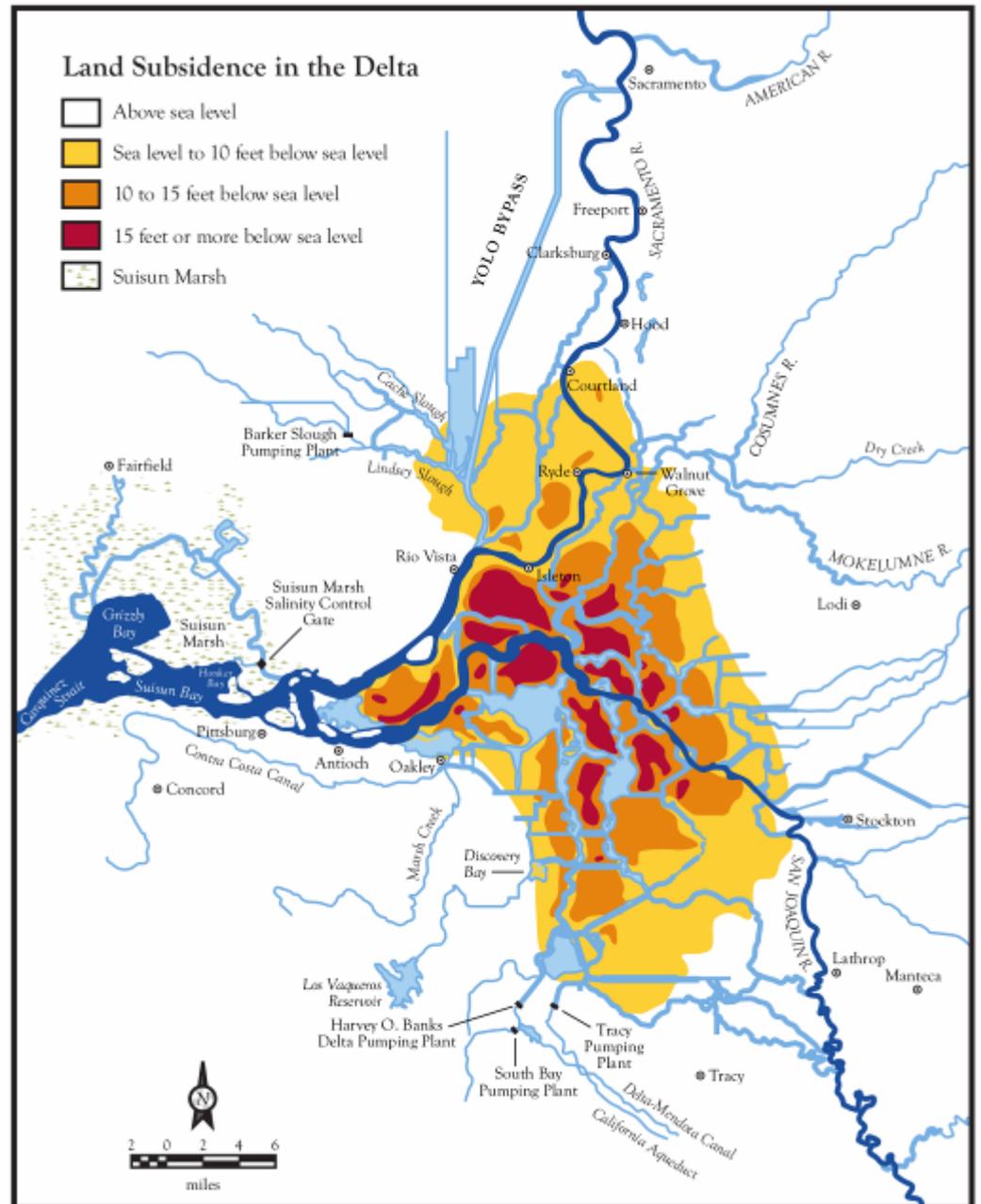


Reduced snowmelt runoff leads to changing Delta freshwater inflows



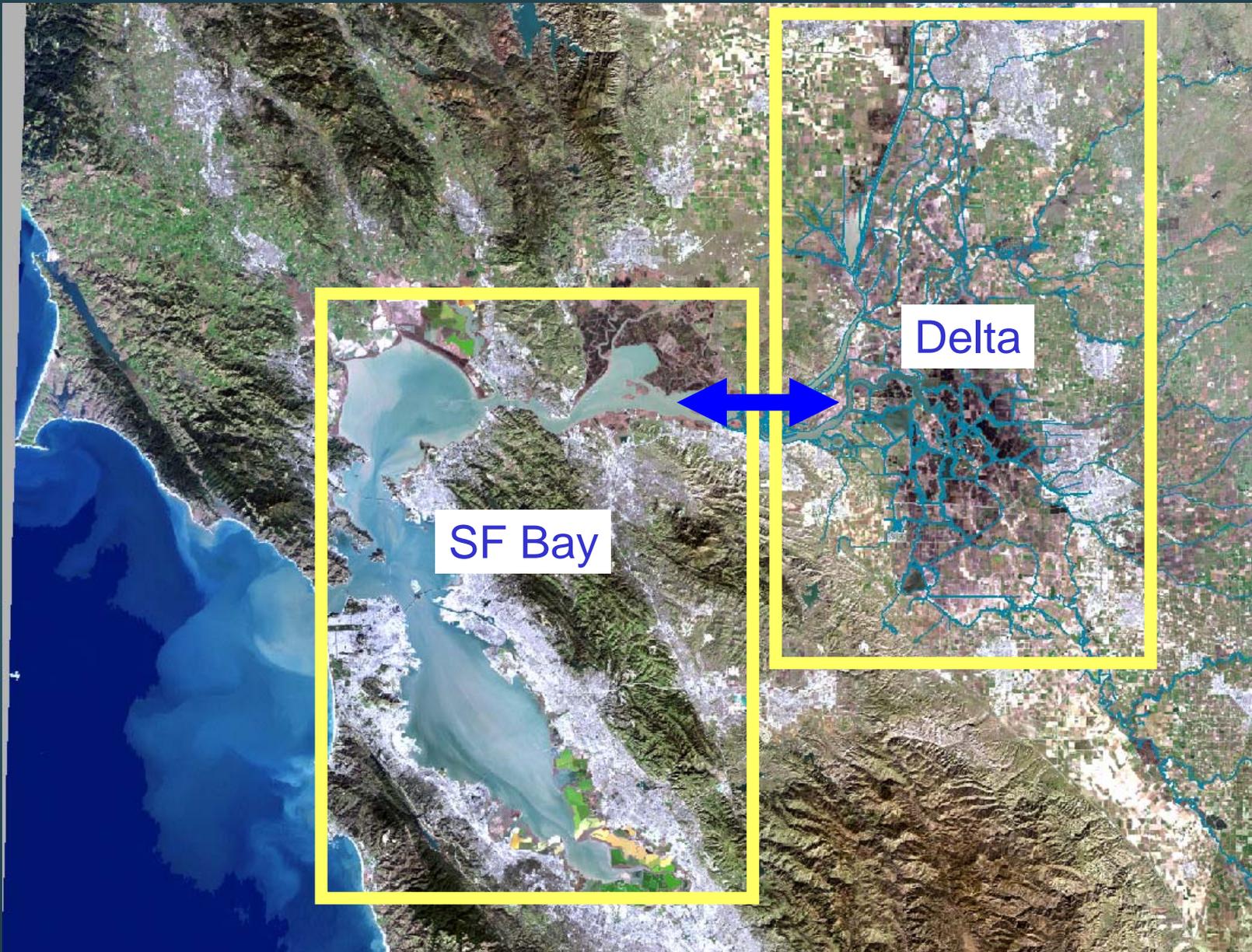
Higher winter flood peaks, combined with sea level rise, would greatly increase the risk of levee failure.

In a “perfect storm”, multiple levee failures could lead to widespread flooding and difficulties repelling seawater.



SOURCE: Department of Water Resources (1995).

A flooded Delta would have impacts in the Bay as well.



Summary

1. Drying trends, reduced snowmelt runoff and sea level rise would all contribute to higher Bay salinities.
2.
 - a. Sea level rise threatens to inundate low-lying areas around the Bay, including developed and agricultural areas.
 - b. Wetland survival is a key issue requiring further research.
3. A flooded Delta could have important implications for the Bay—an often-overlooked fact.

<http://cascade.wr.usgs.gov/data/Task2b-SFBay>

Knowles, Noah. 2008. Potential Inundation Due to Rising Sea Levels in the San Francisco Bay Region. California Climate Change Center. CEC-500-2009-023-F.

Thanks to Tom Coons for his work on the elevation dataset. Thanks also to the following who provided essential data: Joel Dudas, Bruce Jaffe, Amy Foxgrover, Theresa Fregosa, Cathy Ruhl, Brad Tom, Chris Enright, Bill Dietrich, Ionut Iordache, Tim Doherty, Jeff Mount, Ray McDowell

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