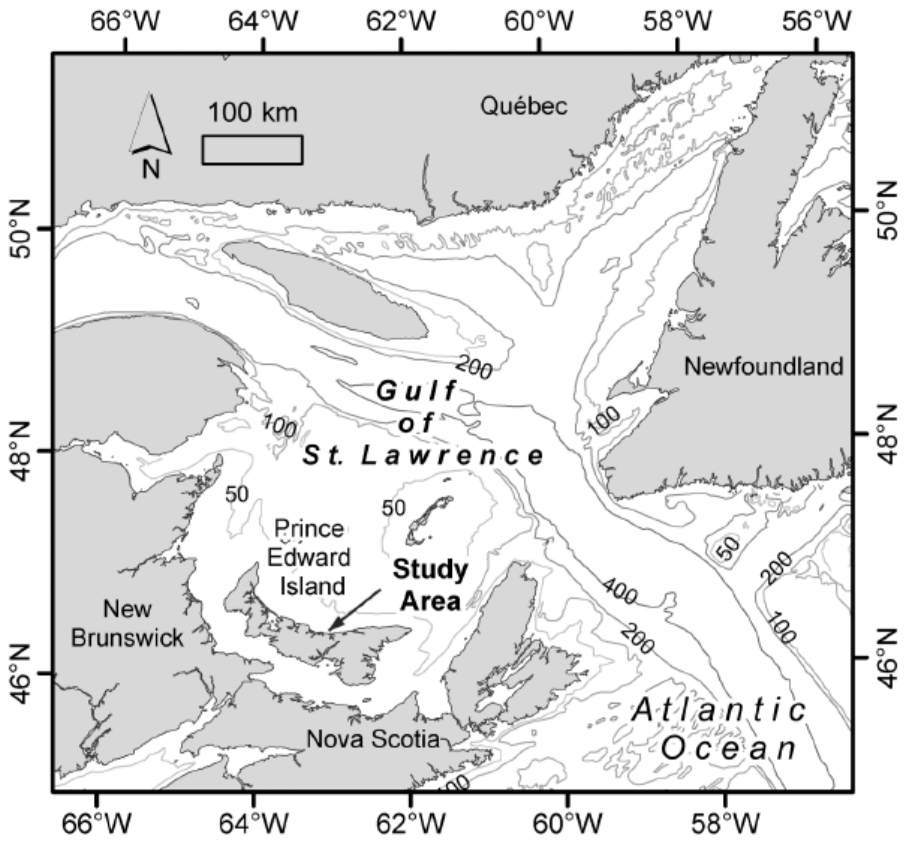
Forecasting Future Dredging Needs Amid Changing Climates and Sea Levels

Stantec

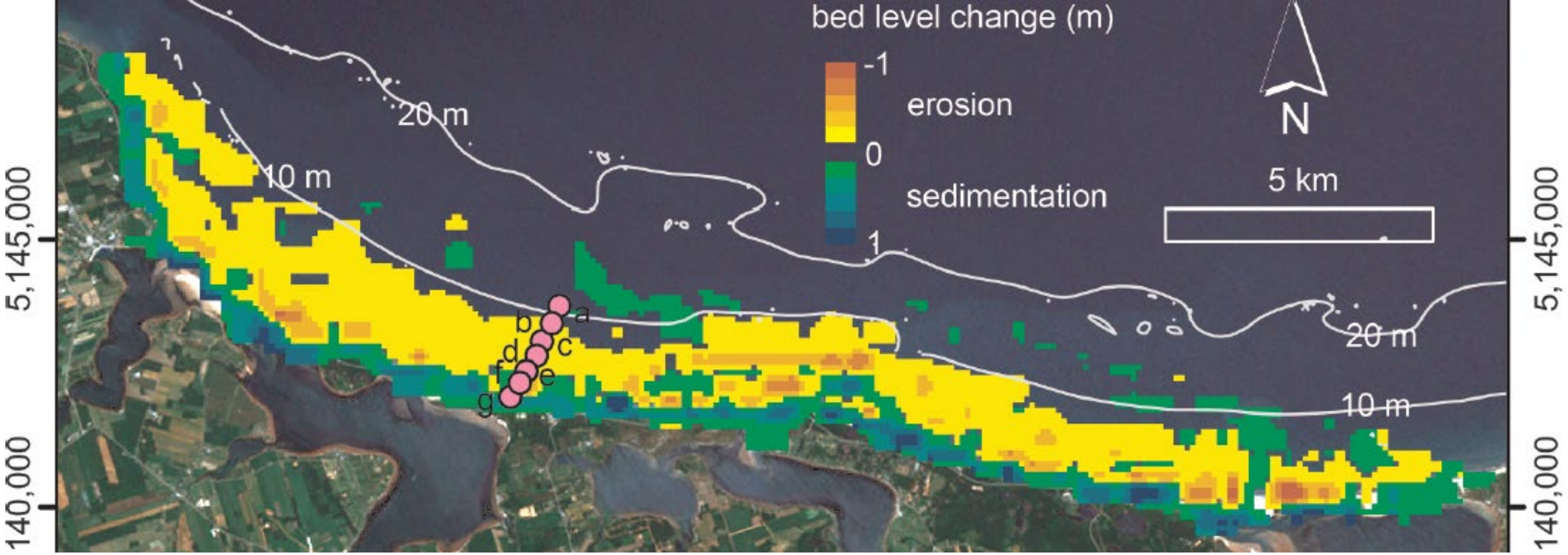
MANC



Prince Edward Island

- Small craft harbors in PEI provide the infrastructure for fishers to support the demands of the lobster fishery.
- The spring season accounts for approximately 80% of the annual lobster landings
- Given the relatively short period of the lobster fishing seasons, the inability to fish for extended periods because of insufficient water depth in the harbors due to sedimentation has a significant impact on productivity.

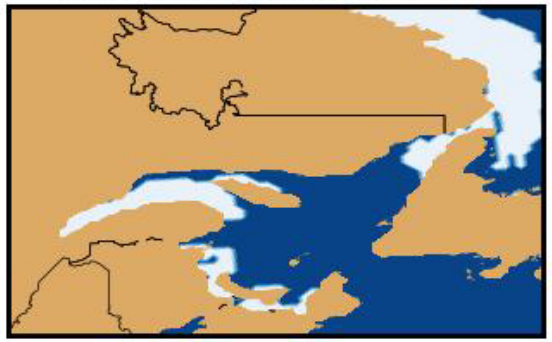
Small Craft Harbors in Prince Edward Island



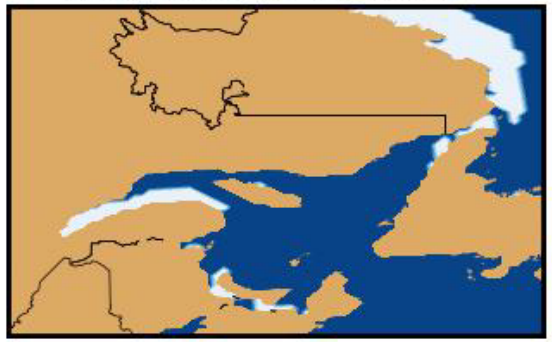
What is the source of sediment, and what processes move it to navigation channels?

- The research studies performed in PEI showed that wave-induced cross-shore sediment transport move offshore sediment into the navigation channels

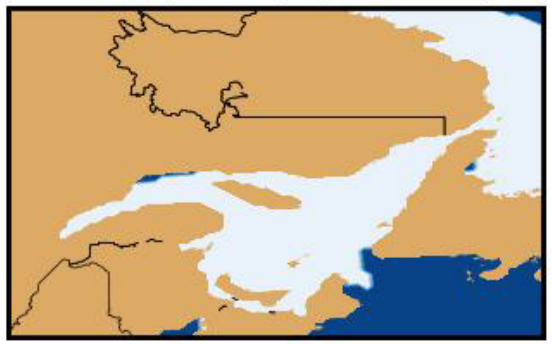
January Average (1958-2000)



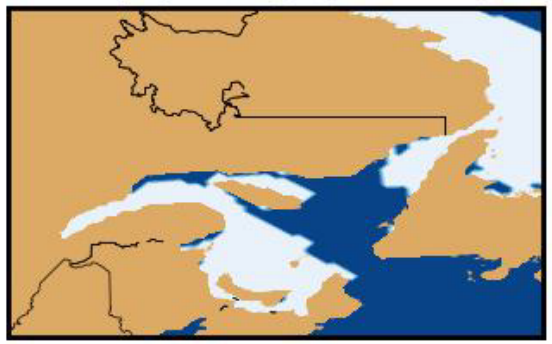
January Average (2001-2014)



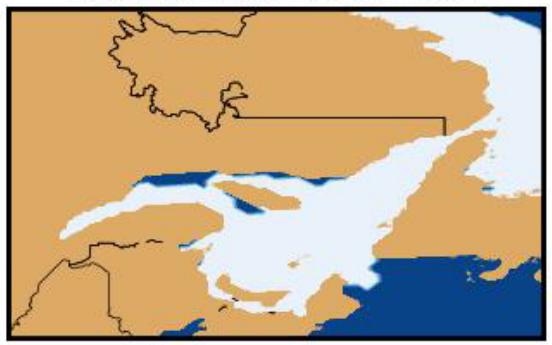
February Average (1958-2000)



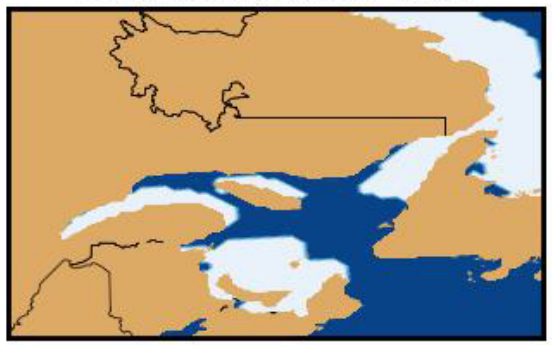
Febryary Average (2001-2014)

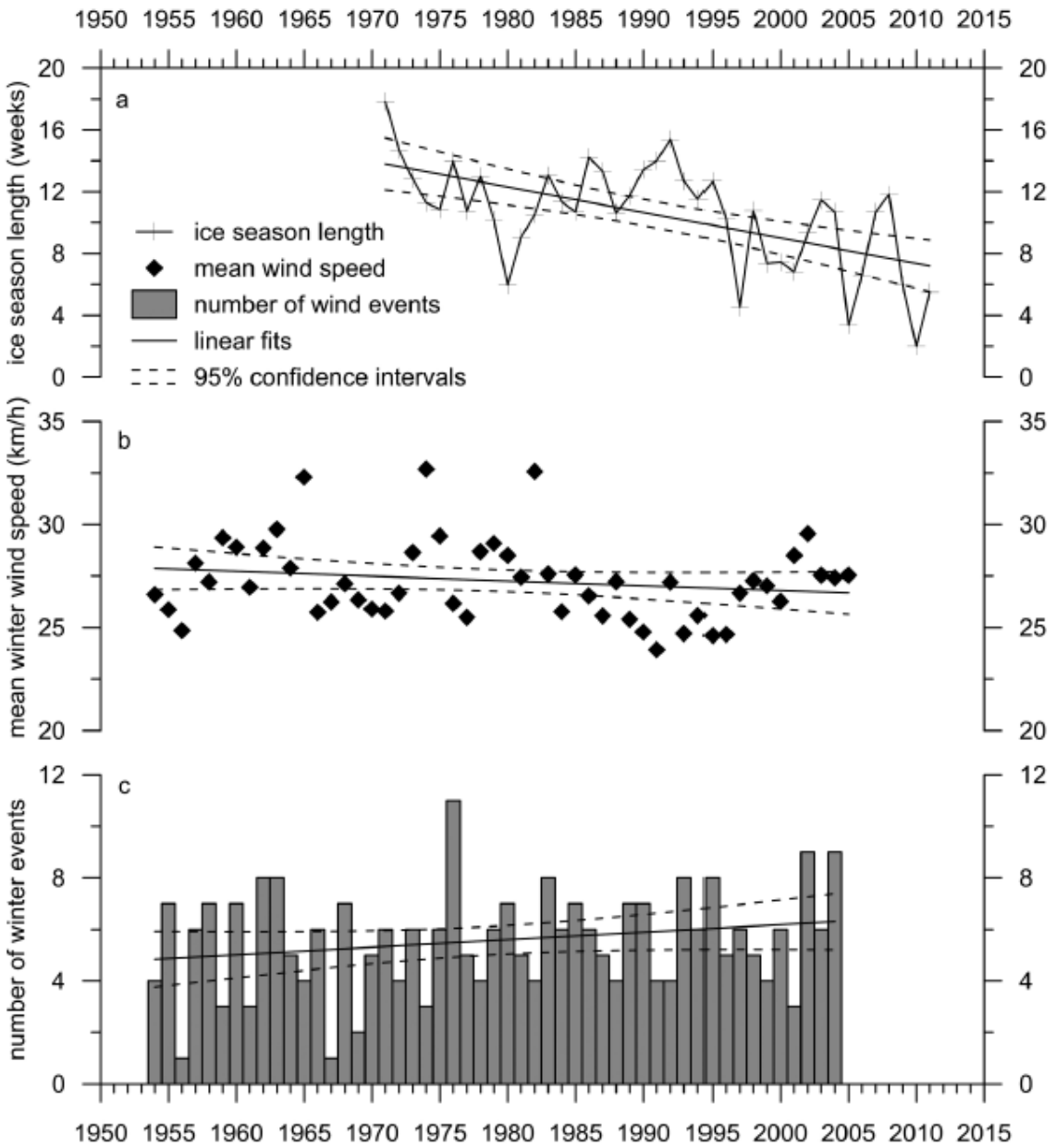


March Average (1958-2000)



March Average (2001-2014)

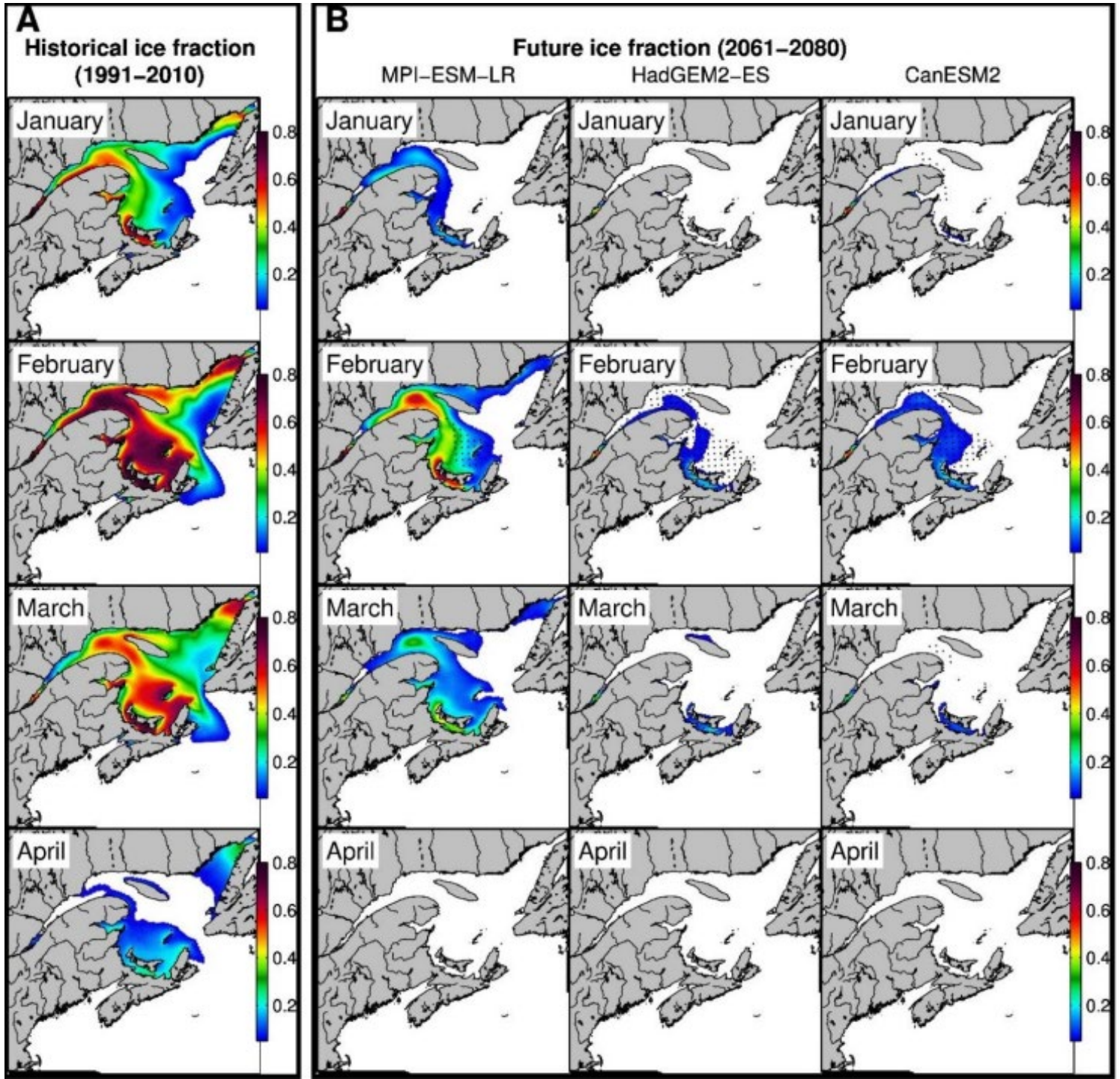




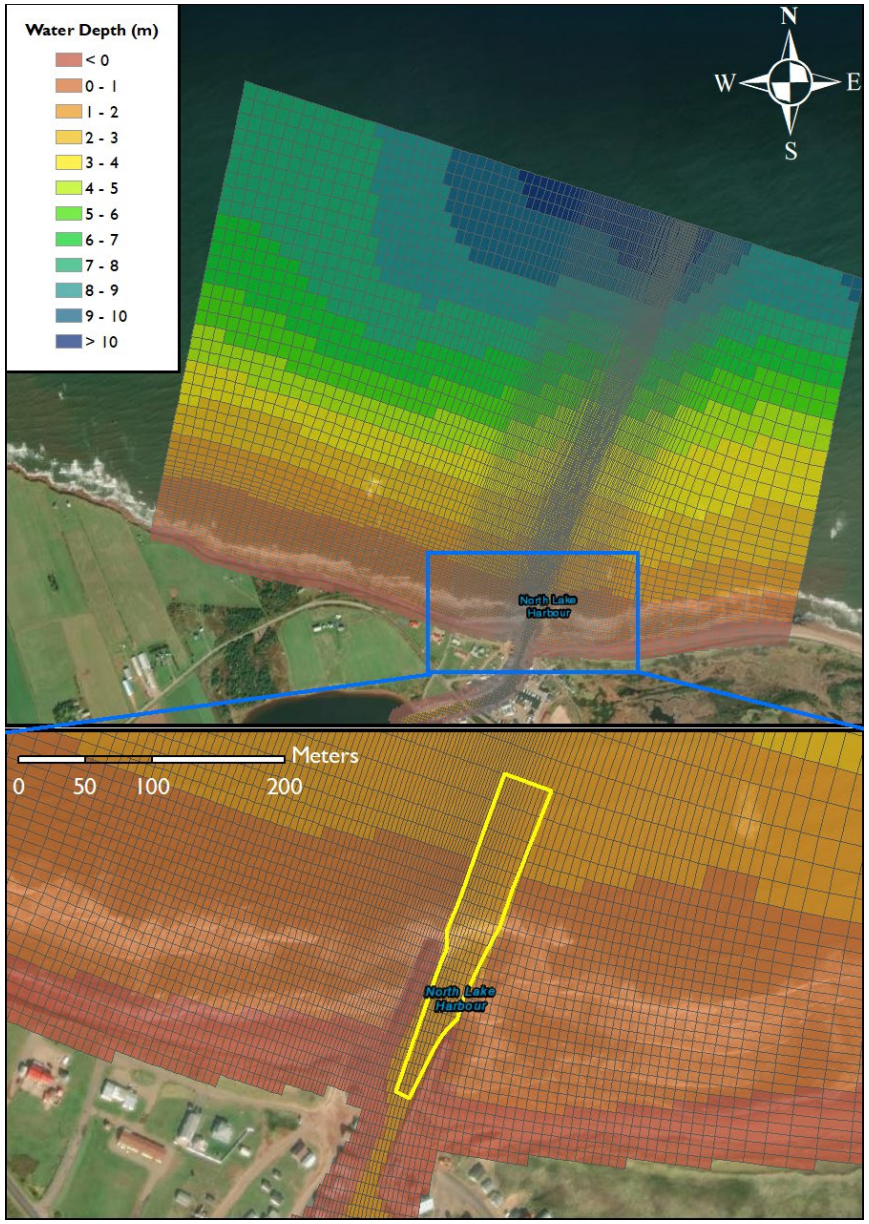
What changed?

How does the future look like?

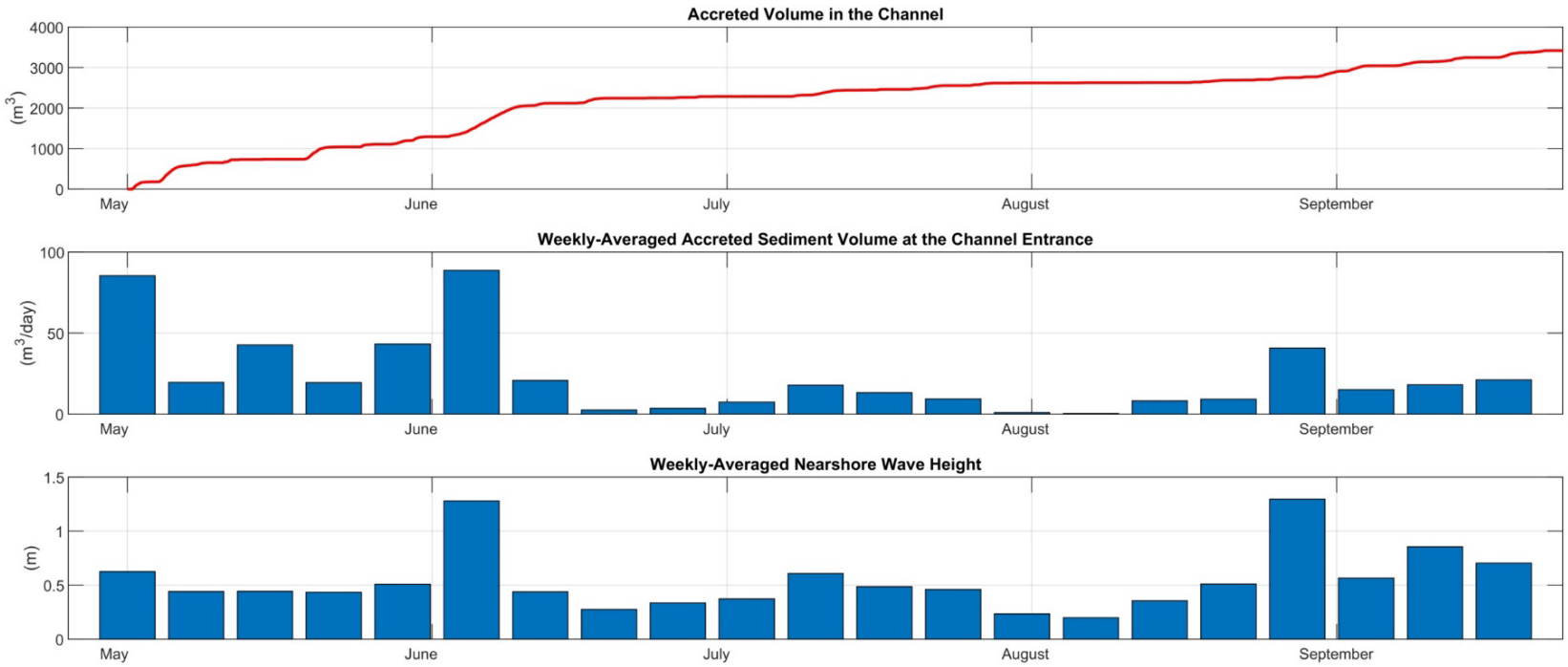
Region	Season	Current Wave Climate (1970-1999)	Projected Wave Climate (2040-2069)	Percent Change Relative to Current
		Maximum Expected Wave Height (m)		
North Lake	Winter	6.47	7.1	+9.7%
	Summer	4.87	4.72	-3.1%
Skinner's Pond	Winter	3.30	3.64	+10.3%
	Summer	3.01	2.98	-1.0%

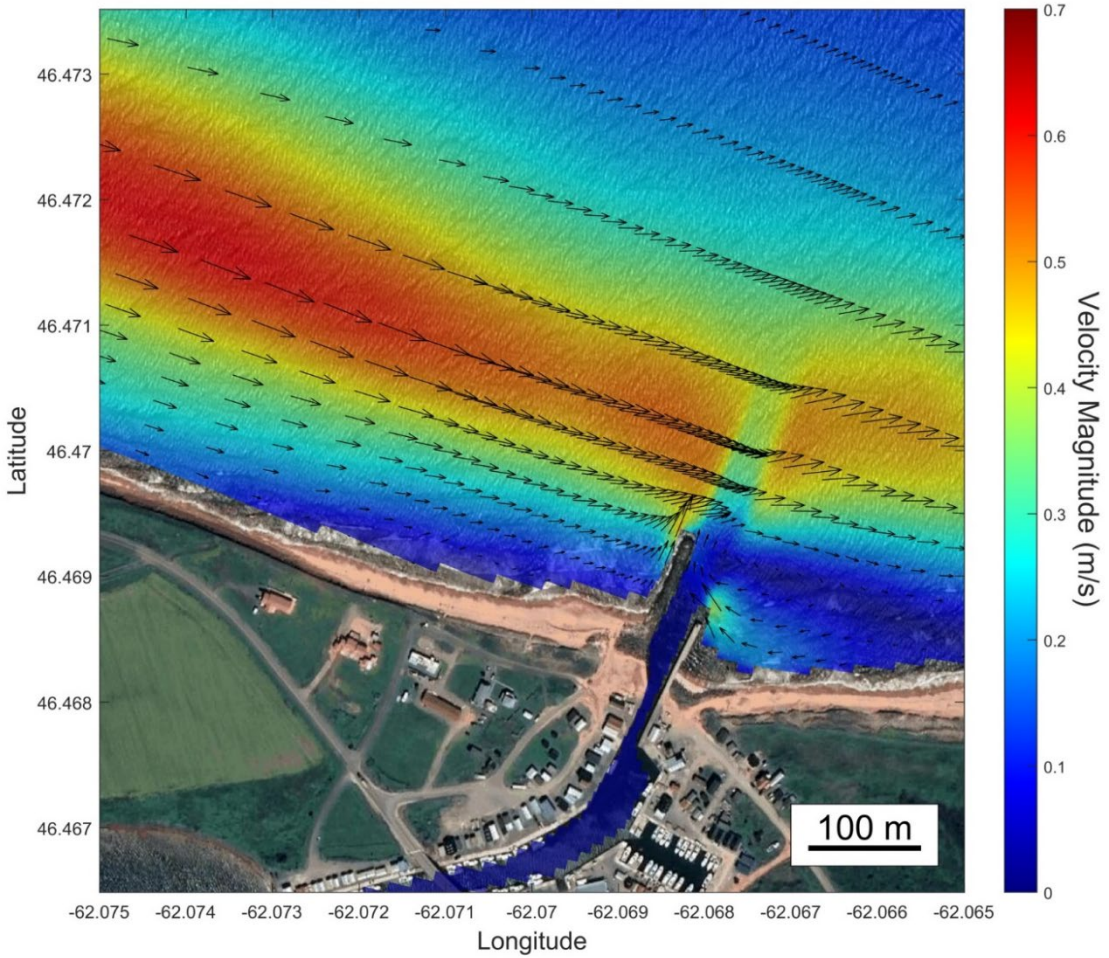


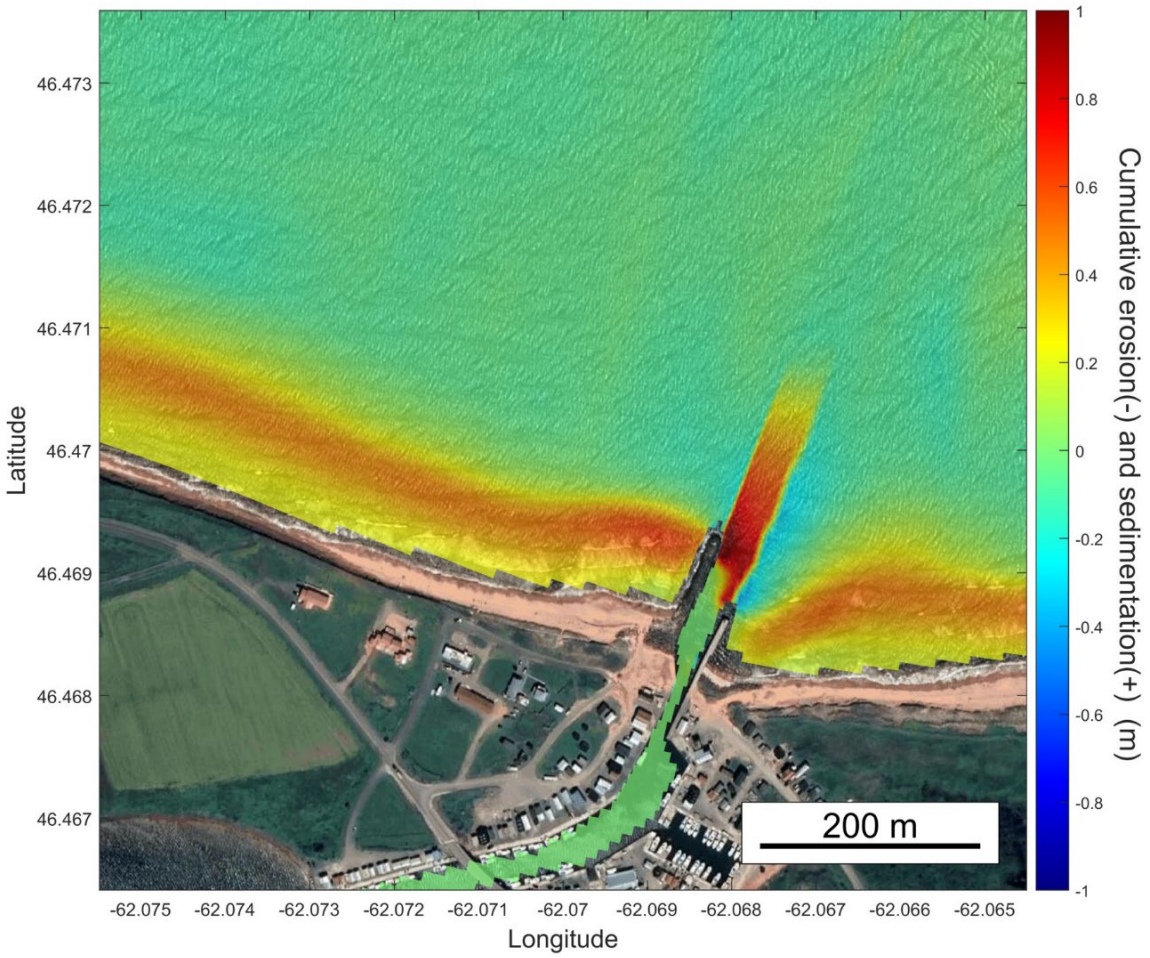
Model Development, Validation, and Calibration



Measured Dredge Volume in Fall 2020 (m^3)	Modelled Volume of Accretion at the End of Model Simulation (m^3)
3,760	3,555



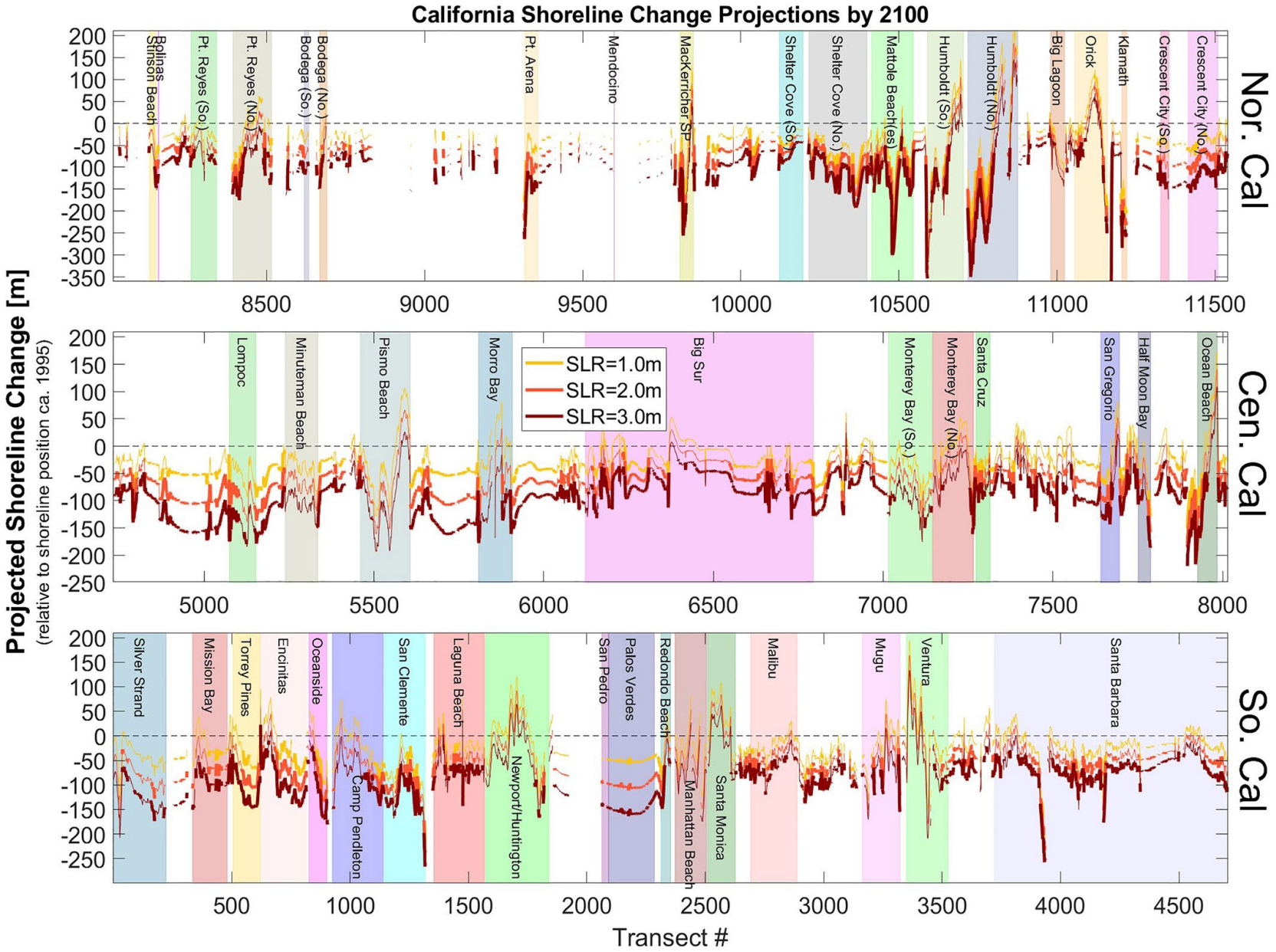




	North Lake		Skinner's Pond	
Scenario	Volume (m^3)	% Change	Volume (m^3)	% Change
Full Ice (2 Months)	5,767	0.0%	1,056	0.0%
Partial Ice (1 Month)	6,320	9.4%	1,271	20.7%
No Ice	6,700	15.9%	1,384	31.4%

Sea Level Rise

Rising sea levels associated with climate change can lead to increased erosion of coastal areas.



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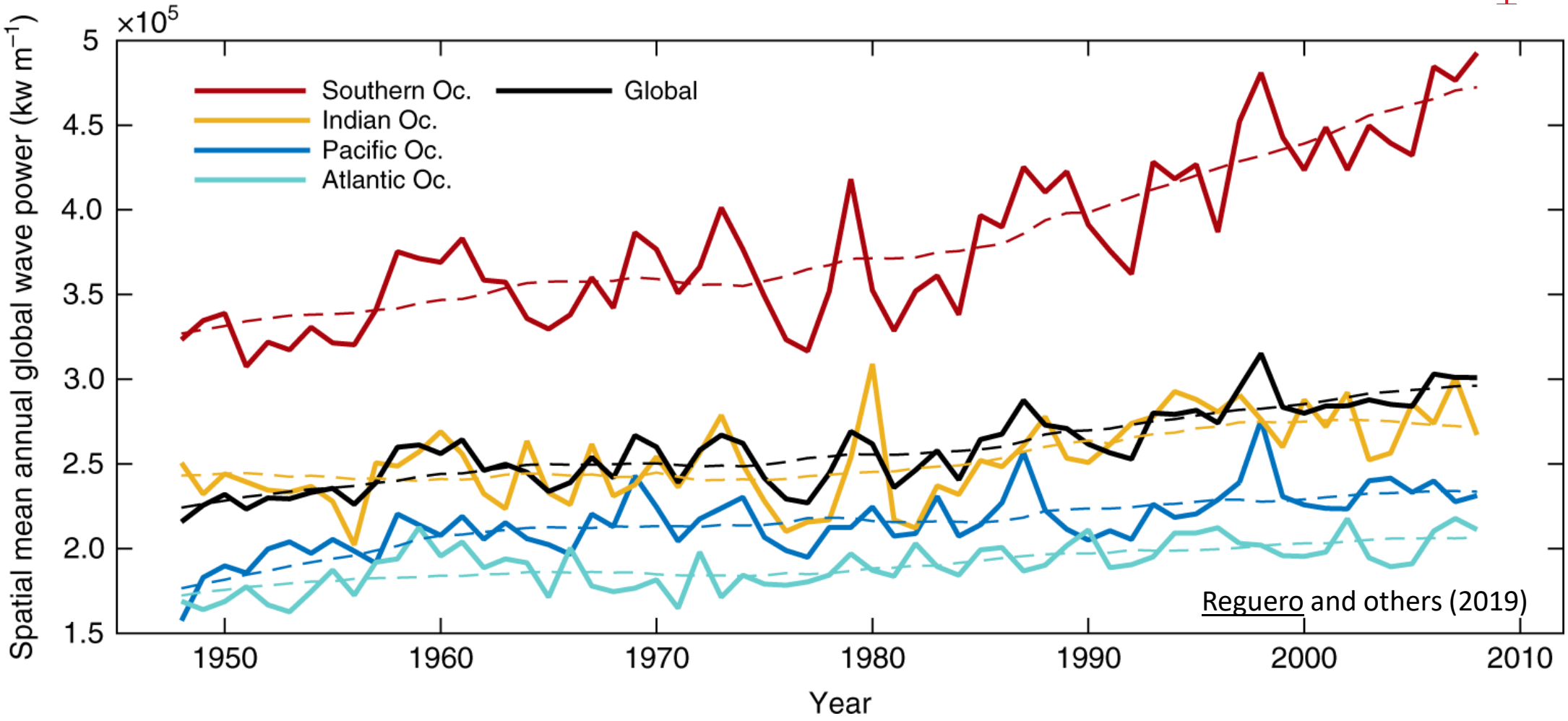
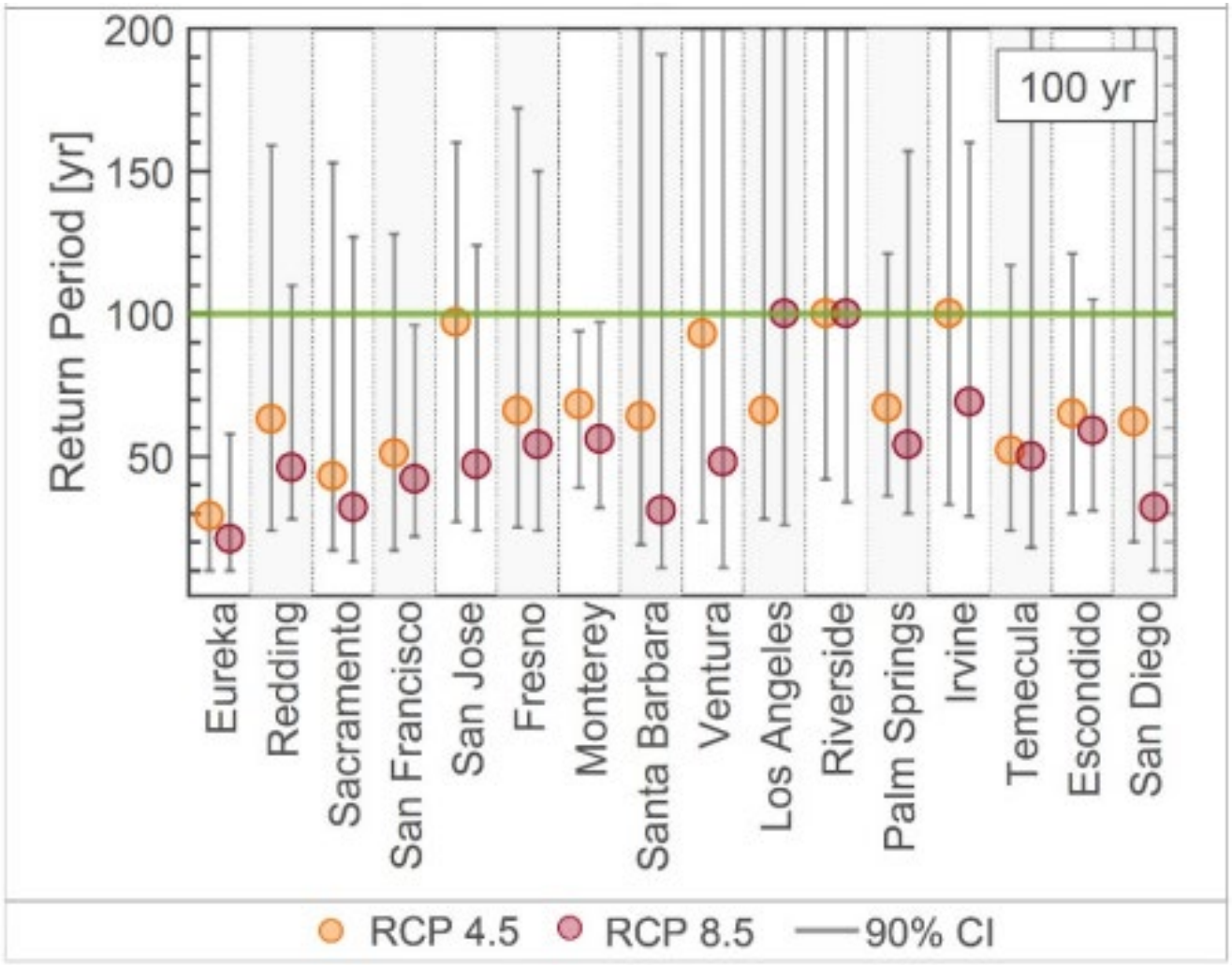
Wind and Wave Climate



Changing climate in California can alter the patterns and intensity of coastal winds and waves, potentially leading to increased sediment transport along the coast.

Increased Storm Intensity

- Increase in intensity, duration, and frequency of extreme precipitation can adversely impact the integrity of infrastructure and natural and engineered slopes.
- These storms can generate powerful waves and storm surges, leading to accelerated erosion and sediment deposition in harbors and navigation channels.



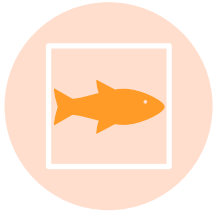
California's Fourth Climate Change Assessment, 2018

Other factors

Changes in precipitation patterns

El Niño and La Niña Events

Vegetation Changes

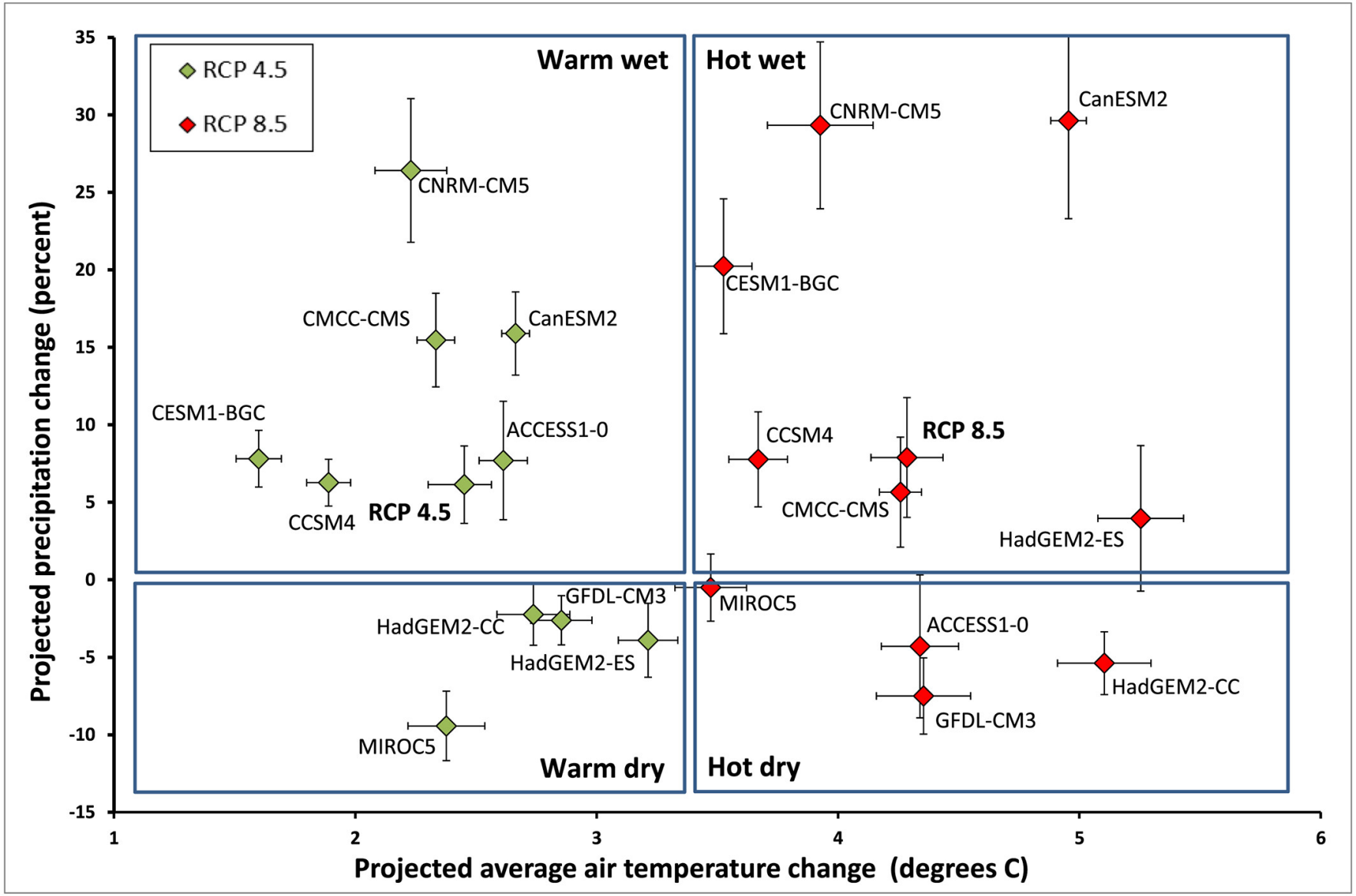


Altered Ocean Currents

Ocean Acidification

Infrastructure changes (Dam Removal)

Projected air temperature (degrees Celsius) and precipitation (percent) changes from the historical period 1980–2009 to the end-of-century 2070–2099 period for the 20 scenarios.



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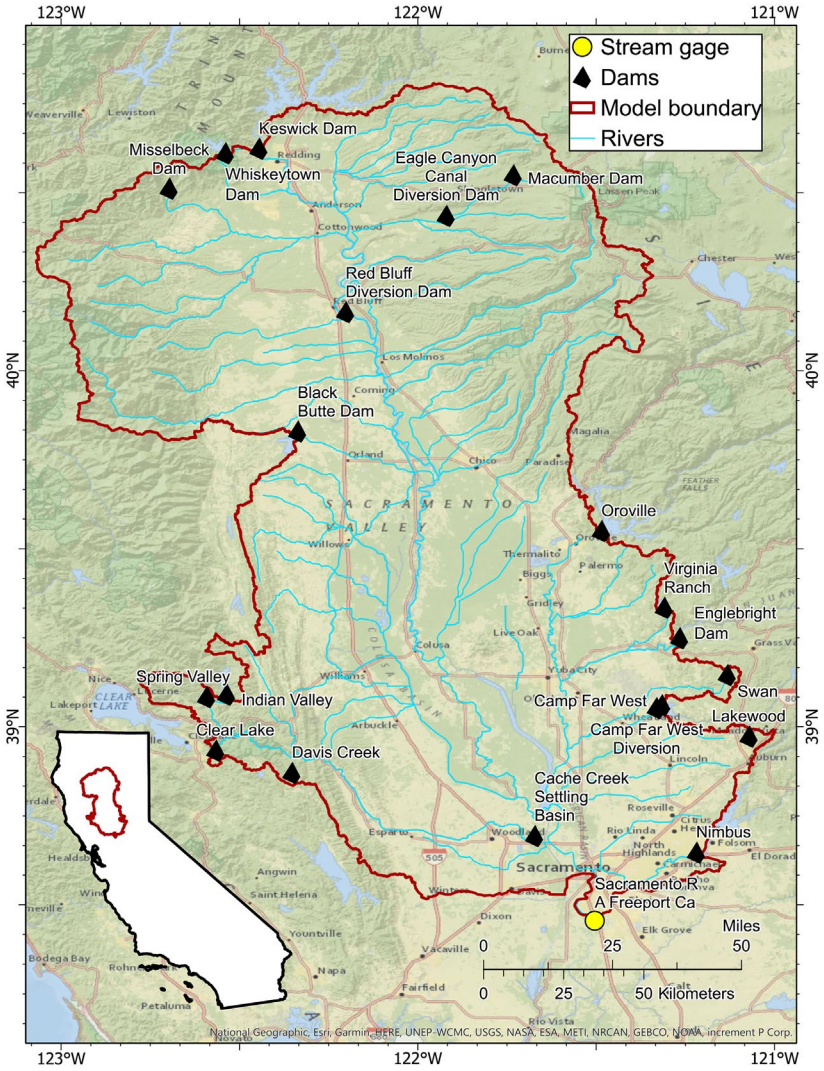
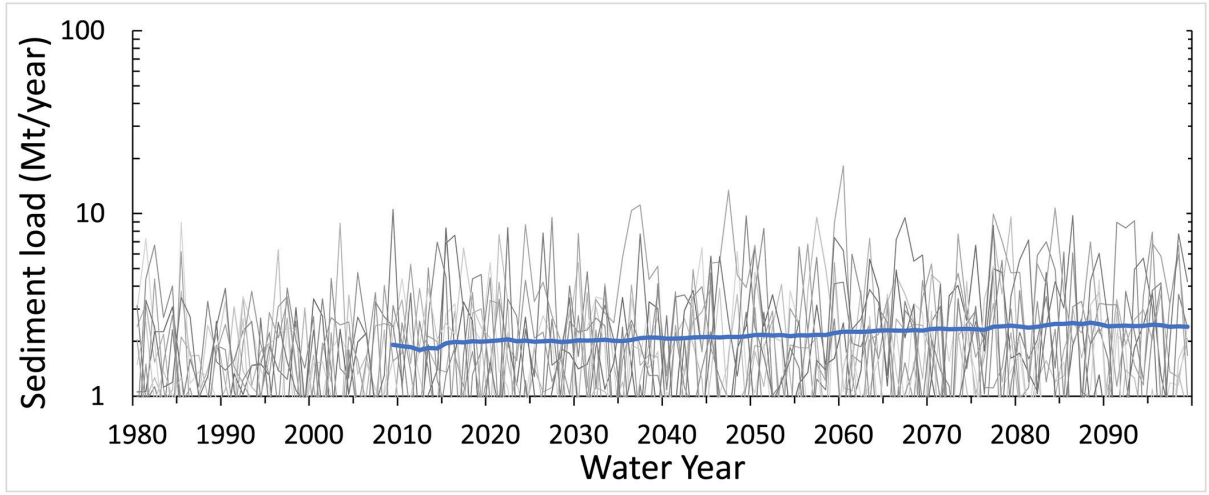
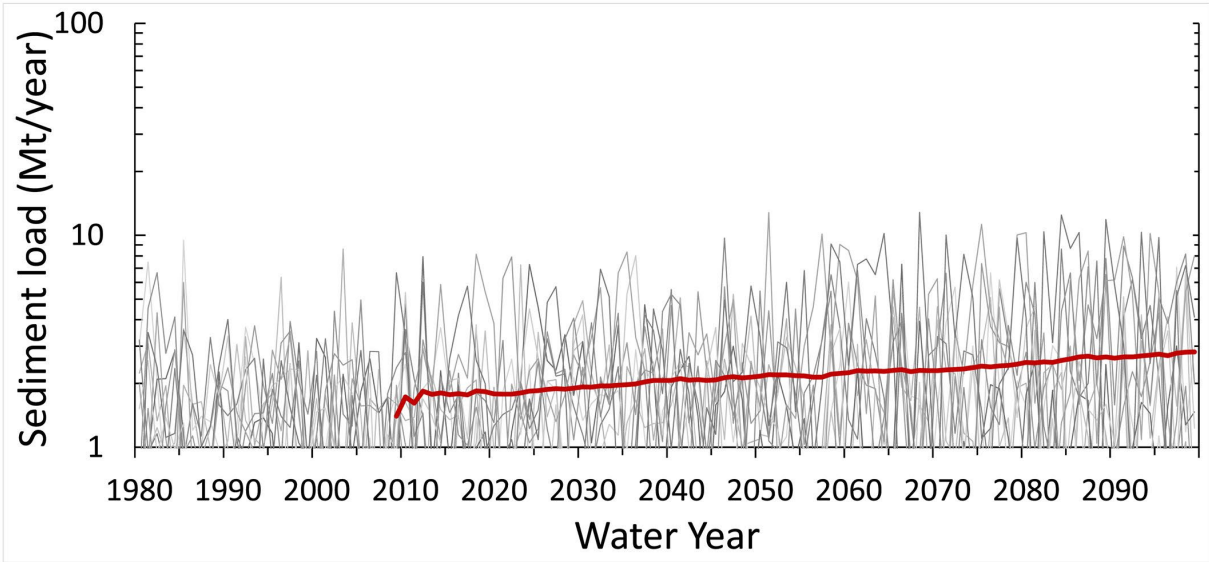
The Future of Sediment Transport and Streamflow Under a Changing Climate and the Implications for Long-Term Resilience of the San Francisco Bay-Delta







- Sediment transport increases by 39% and 69% by end-of-century for moderate- and high-emission scenarios, respectively

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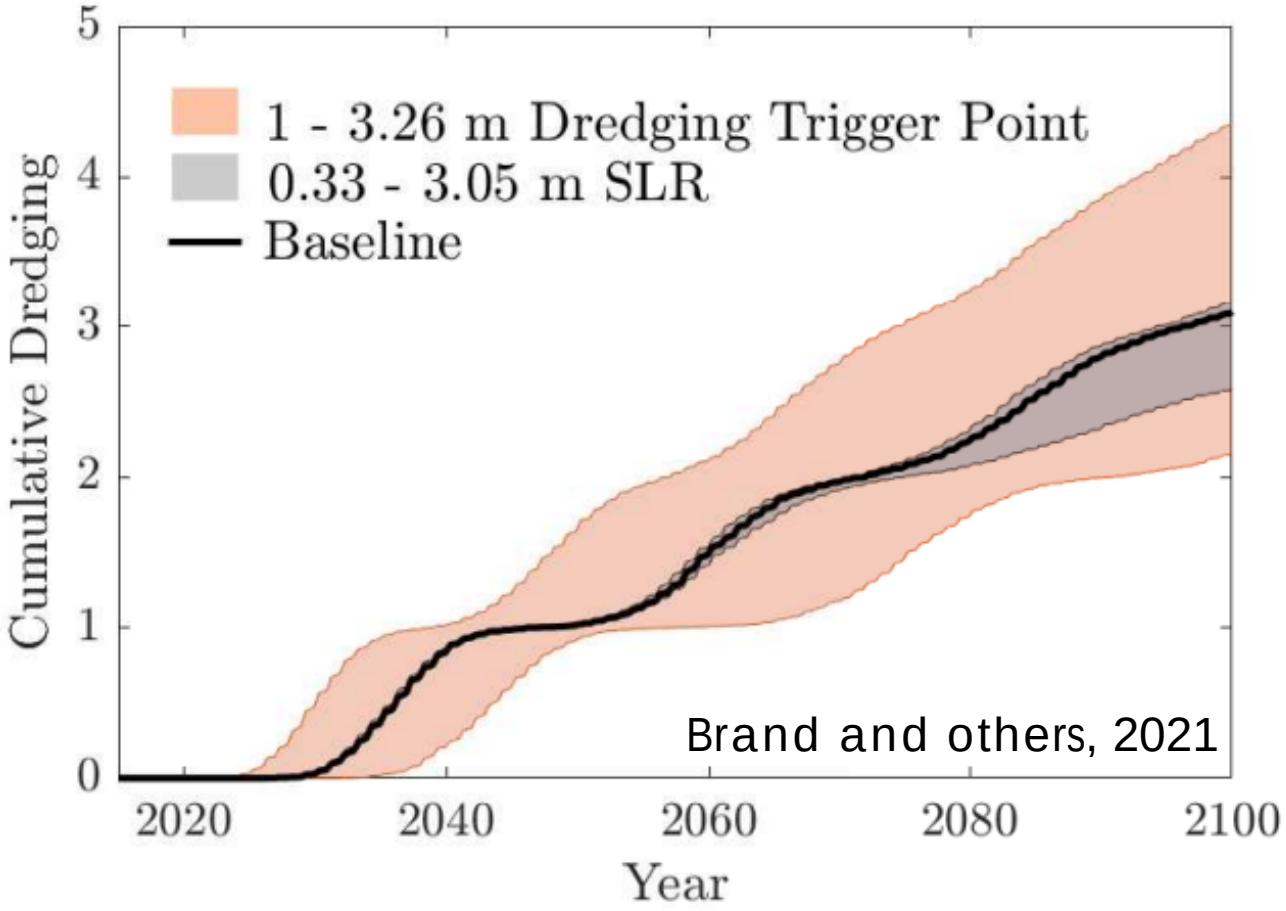

- the number of dredging events is not very sensitive to SLR until after 2050
- The higher SLR scenario (H++) requires less dredging (mean 2.58 total 319 dredging cycles) compared to the minimum SLR scenario (RCP 2.6, mean 3.17 dredging cycles).

When Albert Einstein's oldest son, Hans, told his father he wished to pursue sediment transport as a career – so the story goes – Albert reportedly said, "No, that's much too difficult!" So where are we now?

- Sediment transport models can predict morphological changes, if there is enough data to calibrate and validate them
- Future projections of sediment transport and dredging needs is not deterministic, but probabilistic answers are achievable.