INFLUENCES ON NATIONAL BEACH NOURISHMENT TRENDS

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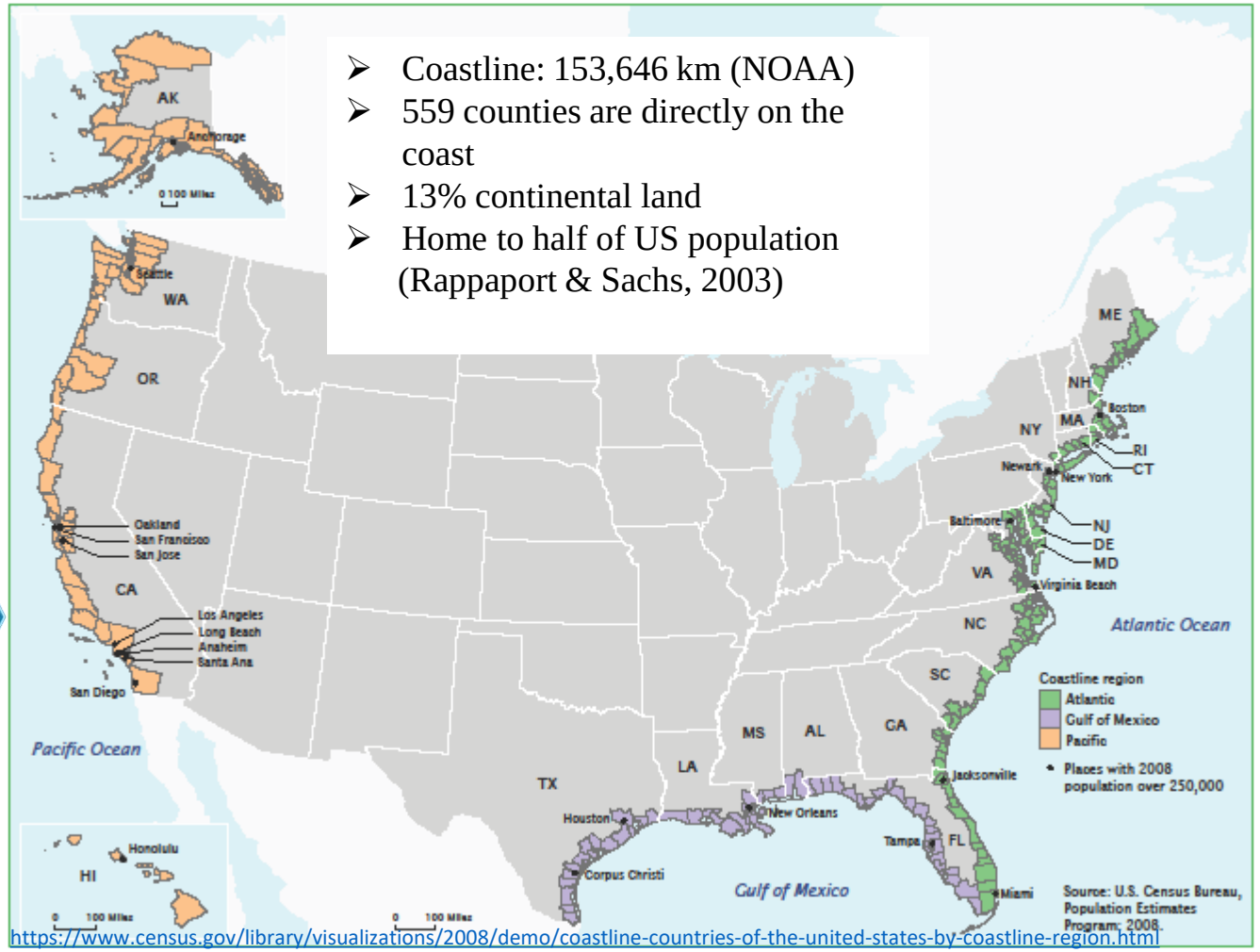
INTRODUCTION

- 76% of all trade through marine transportation
- 24,000km US coasts accommodate waterways, seaports, marine transportation
- 13 million industry jobs (NOAA 22)



- Coastline: 153,646 km (NOAA)
- 559 counties are directly on the coast
- 13% continental land
- Home to half of US population (Rappaport & Sachs, 2003)

https://www.census.gov/library/visualizations/2008/demo/coastline-countries-of-the-united-states-by-coastline-region.html

INTRODUCTION CONT.

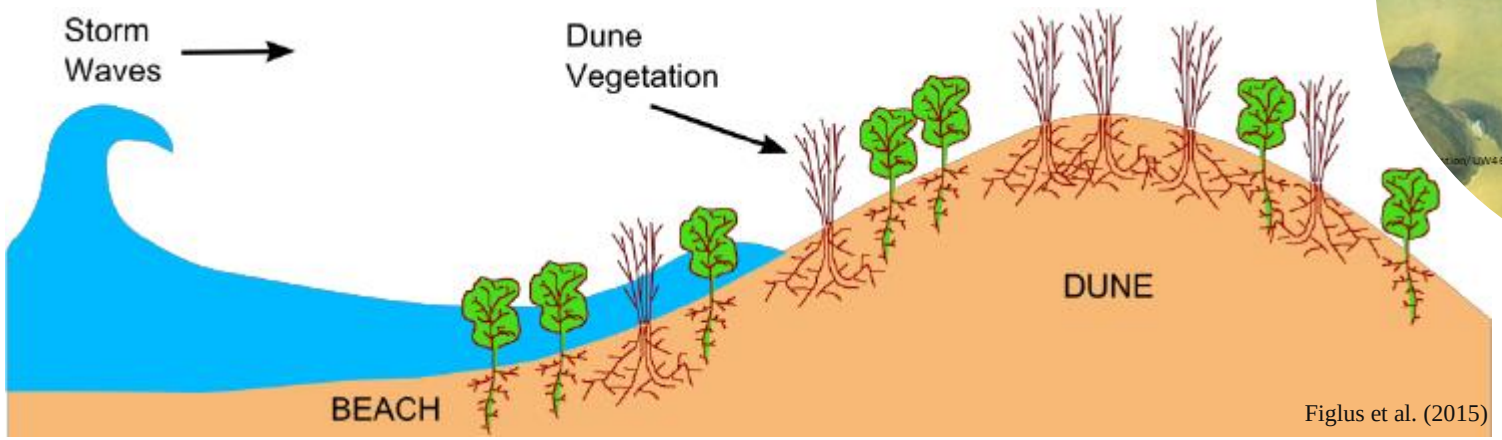
- Tourism also plays a vital role in the U.S. economy, particularly for counties within 40 km of the Atlantic, Gulf and Pacific coasts (Klein et al., 2004).

- California has the highest annual value of coastal tourism, followed by Florida and New Jersey (Klein et al., 2004).

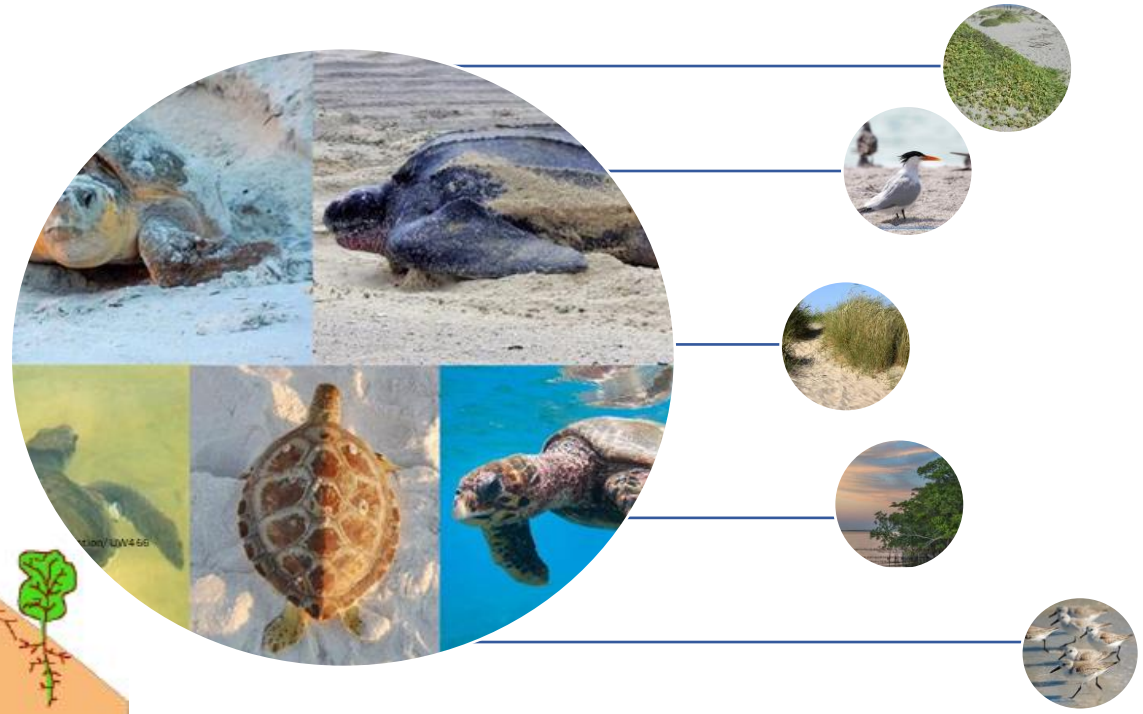
- Foreign tourism contributes to the second largest U.S. gross domestic product and the nation's largest employer (Kass and Okubo, 2000).

INTRODUCTION CONT.

- Coastal environments are home to myriad flora and fauna, many of which are considered threatened or endangered species like sea turtles, birds, and other animals.
- Coastal environments are also a natural buffer in reducing storm impacts .

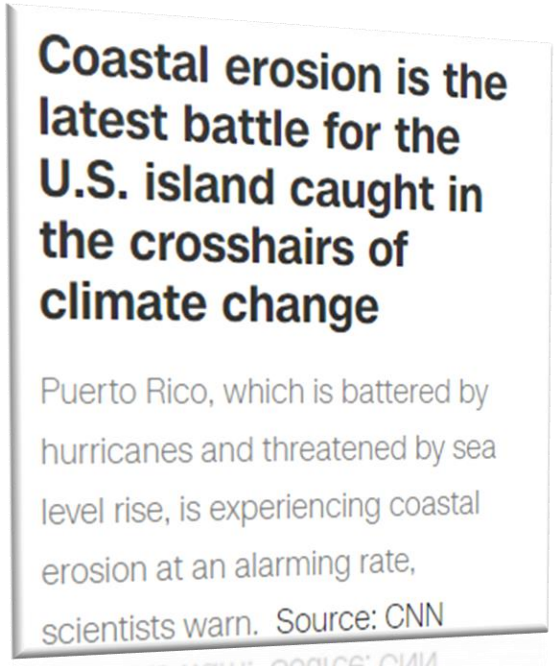


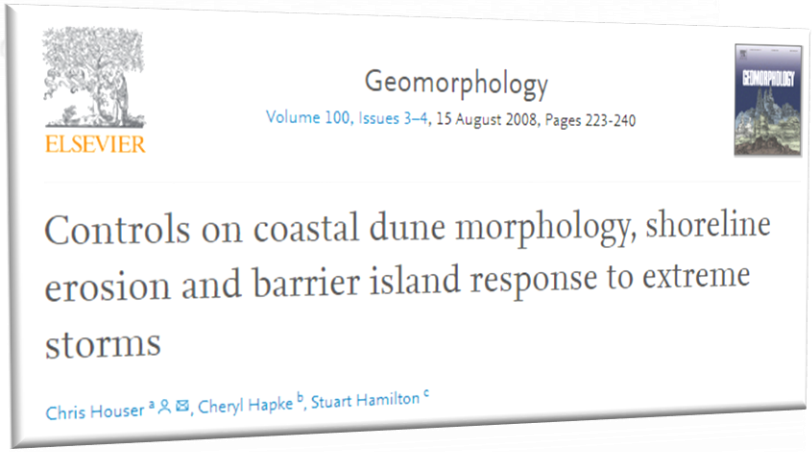
Figlus et al. (2015)



INTRODUCTION CONT.

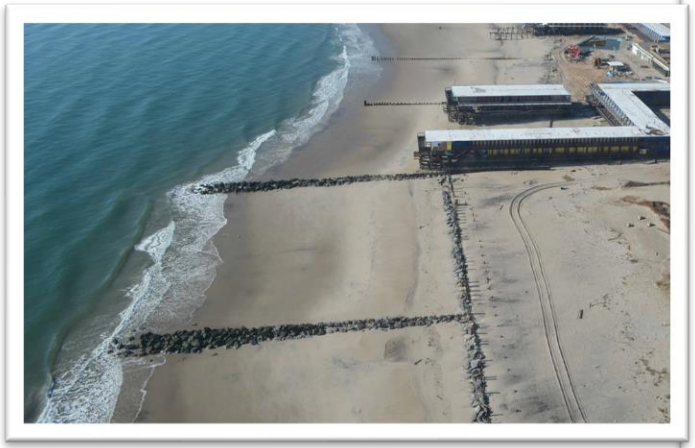
- Given the multitude of services provided by the nation's coasts, the threat of erosion or loss due to natural and anthropogenic drivers should be of the upmost interest to scientists, managers, policymakers, and various stakeholders.
- Coastal environments are increasingly threatened by climate change, sea level rise (SLR) due to global warming, storms, and hurricanes.
- According to U.S. Environmental Protection Agency more than 80% of beaches in United States are considered eroded.





INTRODUCTION CONT.

- Hard structures in some cases the can cut-off the natural longshore flow of sediment or interact with waves in a way that promotes erosion despite their purpose of shoreline stabilization.



- In last several decades, a soft engineering approach to shoreline stabilization technique called beach nourishment has been a dominant strategy for coastal preservation that can mitigate adverse impacts of erosion.

INTRODUCTION CONT.

- A significant effort has been made to address the trends and magnitudes of U.S. beach nourishment activities in the past: however, less attention has been given to the drivers that influencing these trends at a national scale including the role of natural (tropical storms and hurricanes, SLR) and anthropogenic (inlet stabilization and coastal engineering activities, policies) drivers.

Contents lists available at ScienceDirect

Ocean and Coastal Management

journal homepage: http://www.elsevier.com/locate/ocecoaman

A century of U.S. beach nourishment

Nicole Elko [a,*], Tiffany Roberts Briggs [b], Lindino Benedet [c], Quin Robertson [c], Gordon Thomson [d], Bret M. Webb [e], Kimberly Garvey [f]

Journal of Coastal Research	SI 39	57 - 64	ICS 2004 (Proceedings)	Brazil	ISSN 0749-0208

Beach Nourishment Magnitudes and Trends in the U.S.

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A Comparison of Beach Replenishment on the U.S. Atlantic, Pacific, and Gulf Coasts

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Beach Replenishment Activities on U.S. Continental Pacific Coast

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OBJECTIVES

- The objective of this study is to evaluate the natural (SLR, hurricane, tropical storms) and anthropogenic activity (policies and inlet stabilization) on beach nourishment trends at a national scale.

- Comparing the RSM and non RSM activities with the inlet availability.

https://www.visitflorida.com/travel-ideas/articles/boating-navigate-florida-inlets-channels/

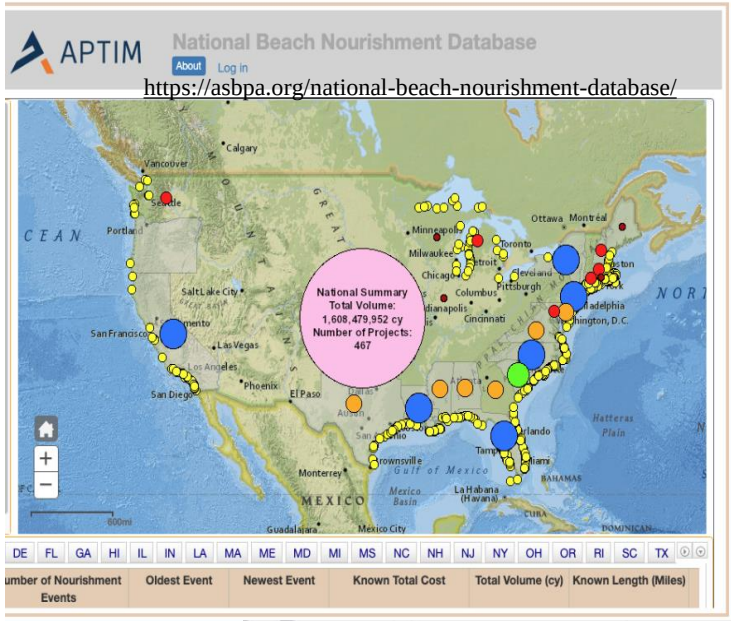
METHODOLOGY

Study Area

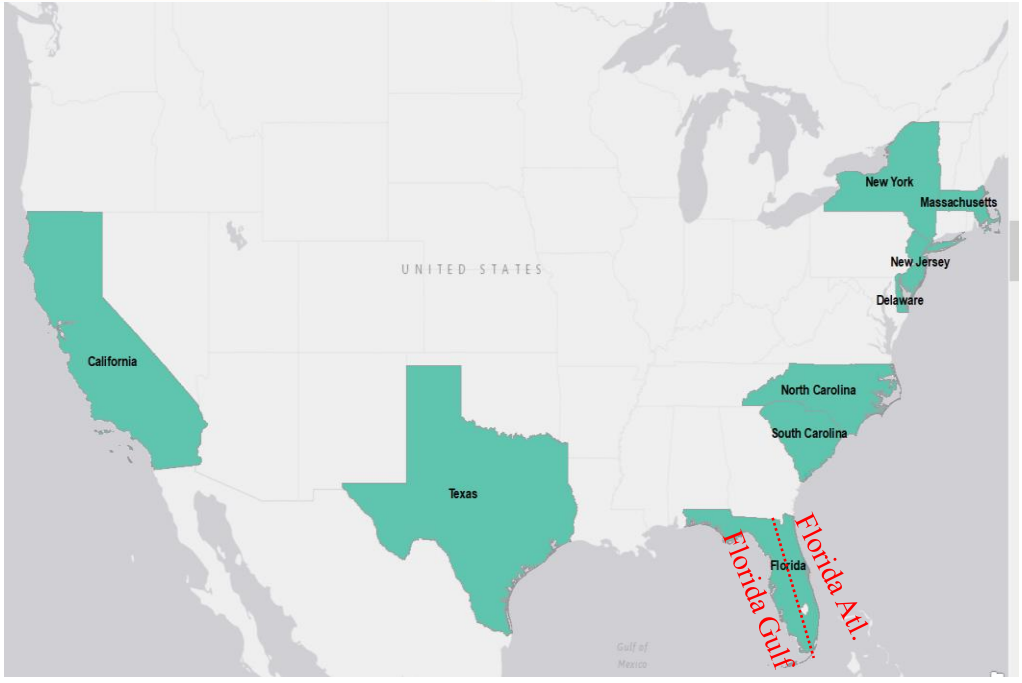
- The National BN database provides nourishment events with specific details ranging from date, length, cost, type of the nourishment (RSM/Non-RSM) etc.
- Top ten states with high nourishment activities were chosen for the study.

The top ten states considered for the study include

- California (542),
- Florida (Gulf. coast) (288),
- North Carolina (323),
- Florida (Atl. Coast) (392),
- New Jersey (293),
- Massachusetts (382),
- Delaware (250),
- New York (145),
- Texas (103), and
- South Carolina (86)



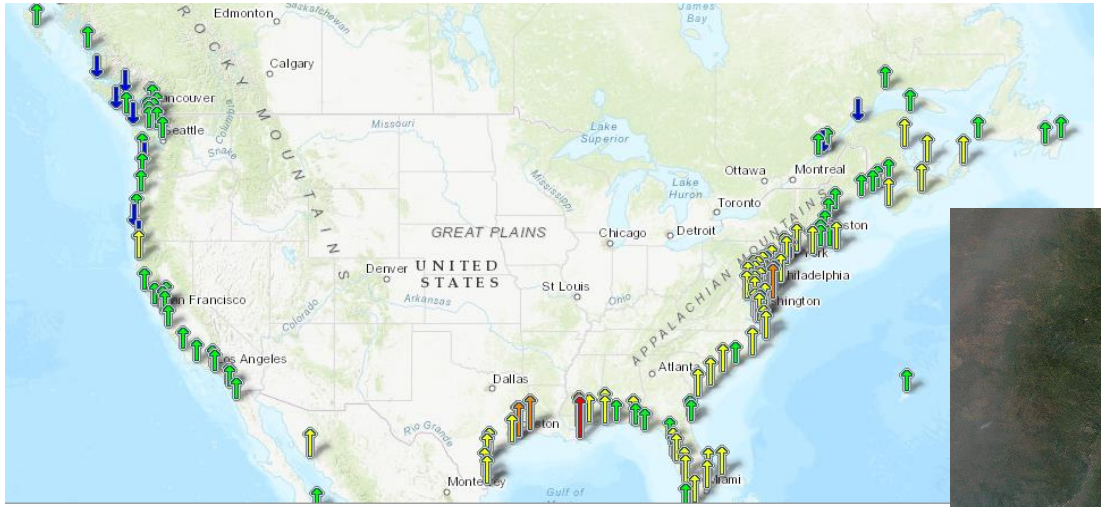
https://asbpa.org/national-beach-nourishment-database/



METHODOLOGY CONT.

Data collection

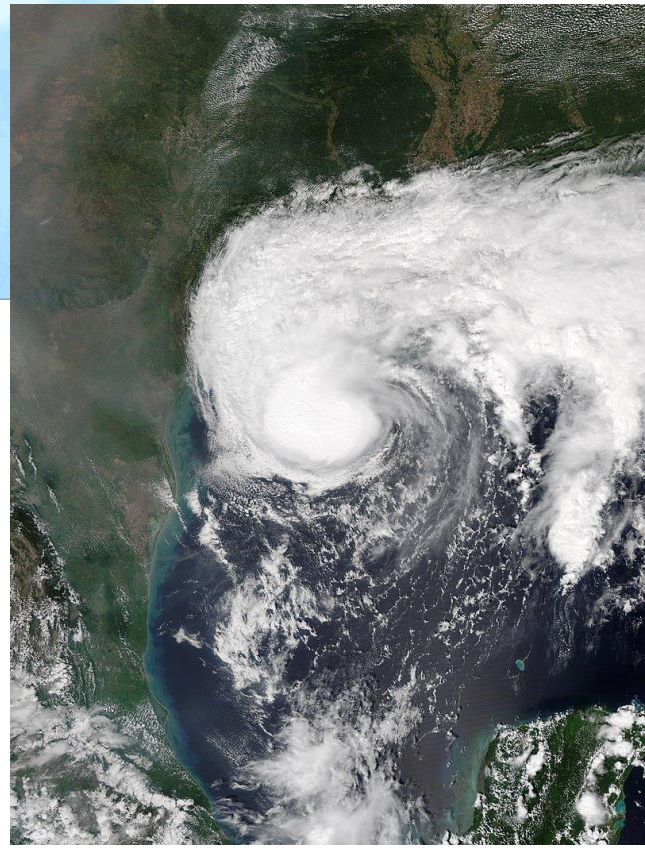
Sea Level Rise (SLR):data collected from NOAA



https://tidesandcurrents.noaa.gov/sltrends/

Hurricane: data collected from NOAA (National Hurricane Center (NHC) and online sources

Tropical storm: data collected from NOAA and online sources



NASA - https://worldview.earthdata.nasa.gov/

METHODOLOGY CONT.

Data collection

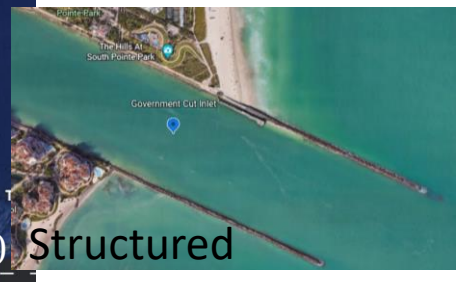
Polices by state for 16 states

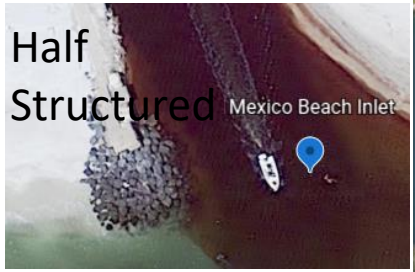
State	Coastal management Plan by state	NOAA approval
Alabama		1979
California	1975	1978
Connecticut	1978	1980
Delaware		1979
Florida, Atlantic Coast and Gulf Coast		1981
Florida, Atlantic Coast and Gulf Coast		1981
Hawaii Islands	1977	1978
Massachusetts	1974	1978
Michigan	1978	1978
New Jersey	1975	1978
New York		1982
North Carolina	1974	1978
South Carolina	1977	1979
Texas	1989-1995	1996
Virginia	1986	1986
Washington	1976	1976

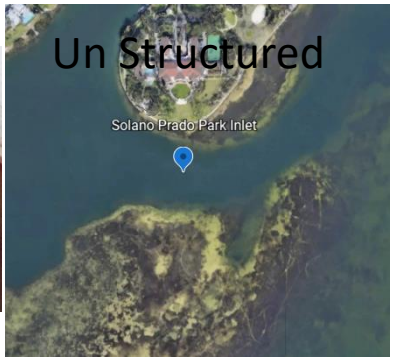
METHODOLOGY CONT.

Data collection

- Inlets were mapped on google earth (and designated as structured vs unstructured and half structured) for comparison with the nourishment trends for 16 coastal states (top ten with highest volume placement and 6 states from different coasts).







METHODOLOGY CONT.

Data Analysis

- The obtained data of hurricane, tropical storms and sea level rise were individually analyzed to obtain the first-hand knowledge of the decadal trends individually for top ten states.

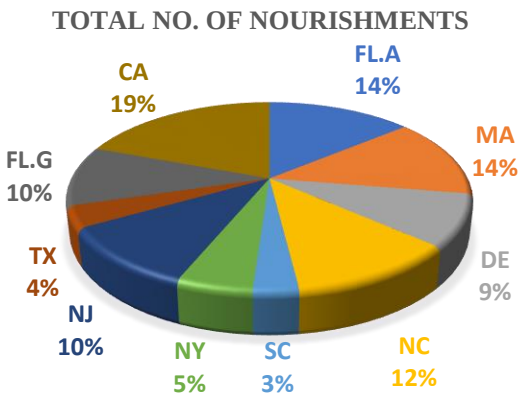
- In addition, all the factors was individually compared to the top ten states to see the overall trends with respect to the individual factor.

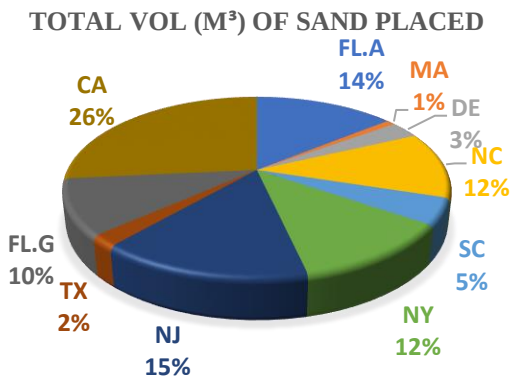
- Furthermore, a combined statistical analysis was conducted for the Florida Atl. coast as proof of concept to see the significant factor that influencing the state.

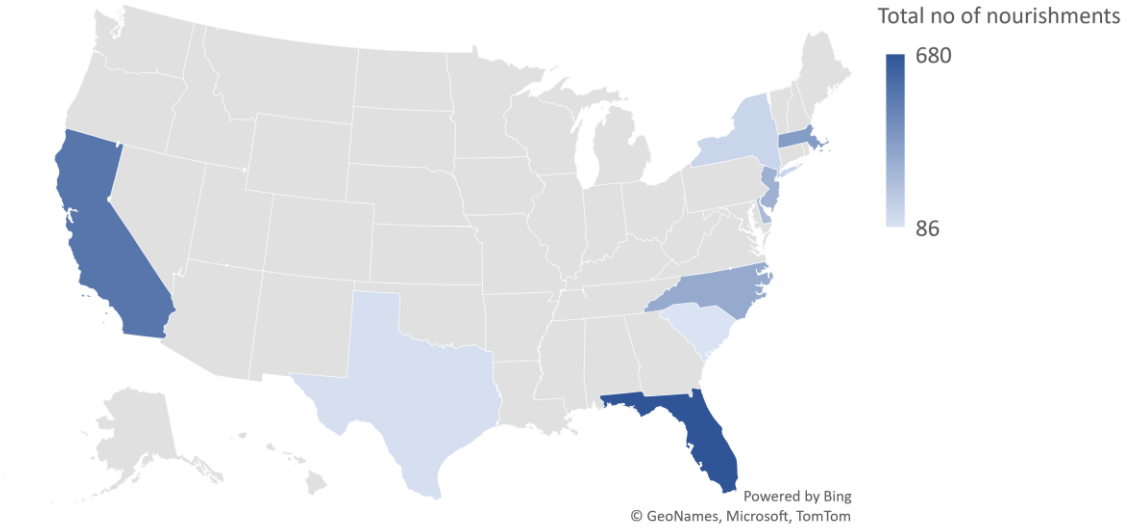
RESULTS

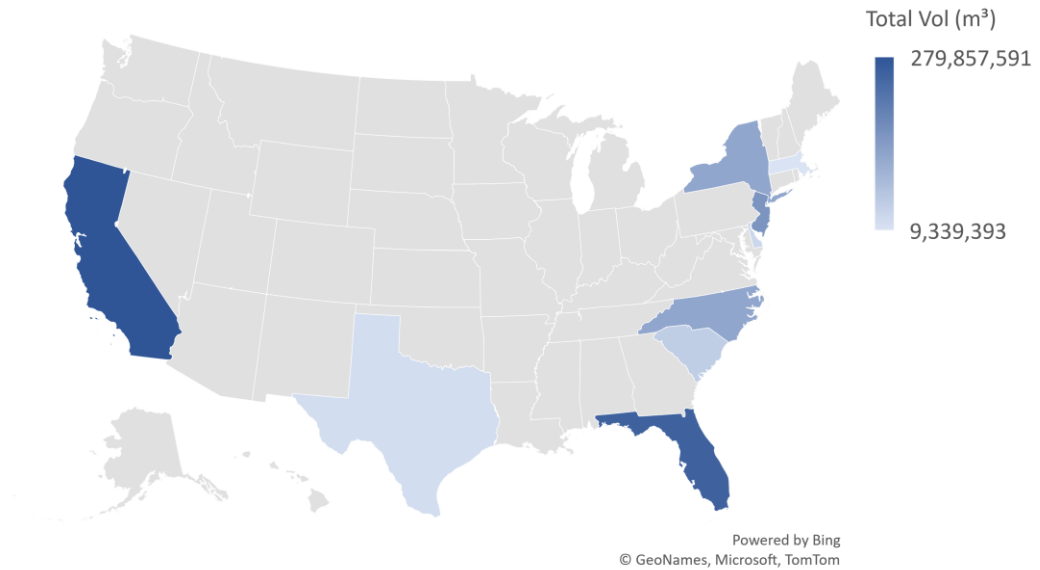
Total number of BN projects and volume of sediment placed in top ten states.

States	Total no. of BN	Total Vol (m³)
CA	536	278,780,333
FL.A	392	149,050,294
MA	366	9,143,851
NC	323	125,377,393
NJ	293	158,112,954
FL.G	288	105,776,492
DE	250	31,691,417
NY	145	125,246,471
TX	103	21,179,732
SC	86	49,679,669

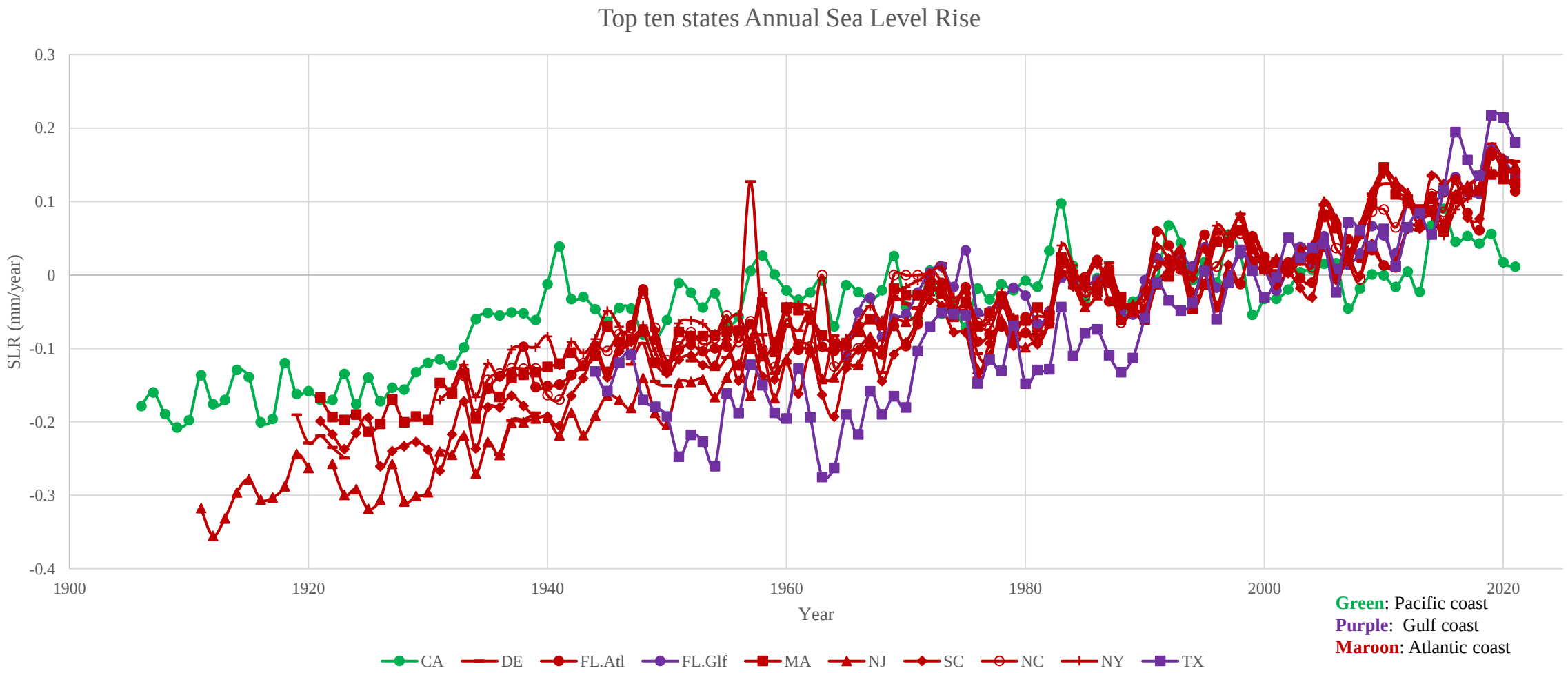




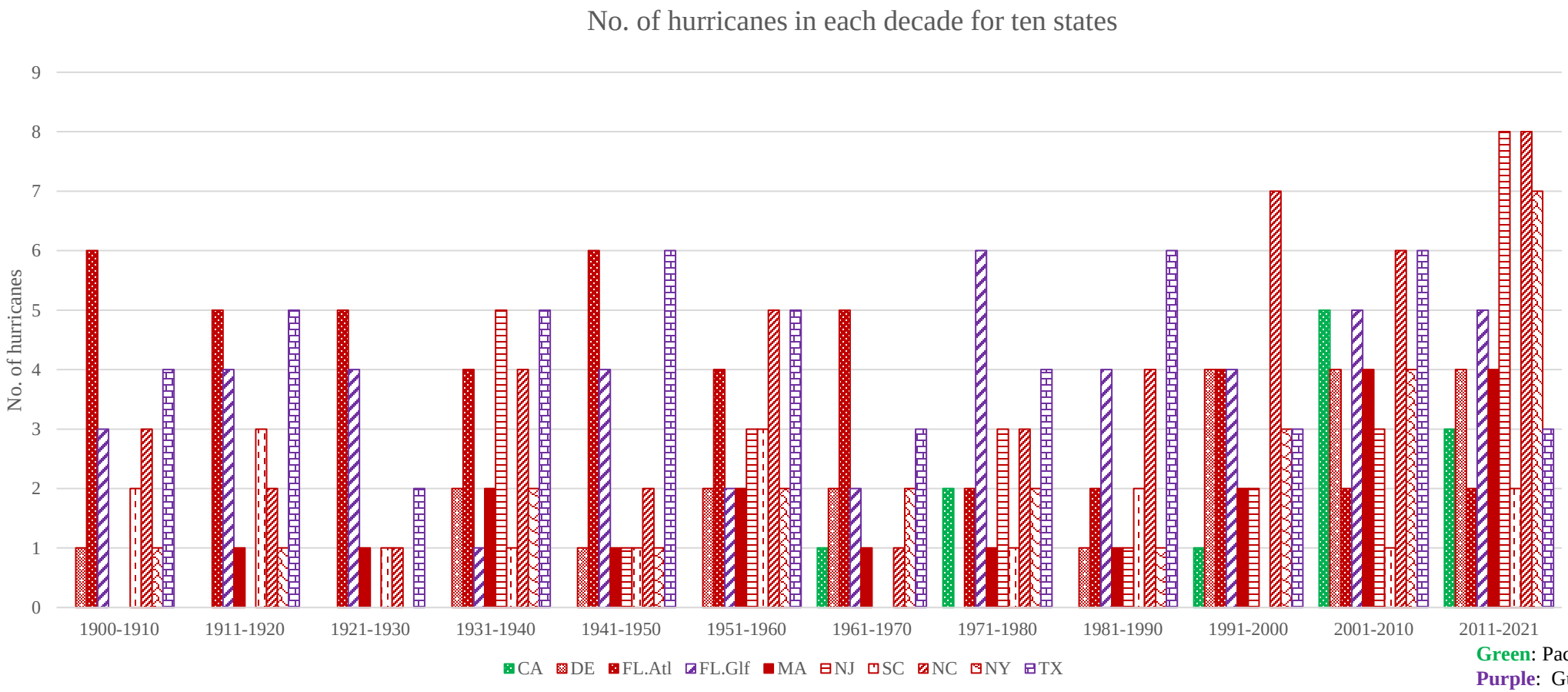




RESULTS CONT.

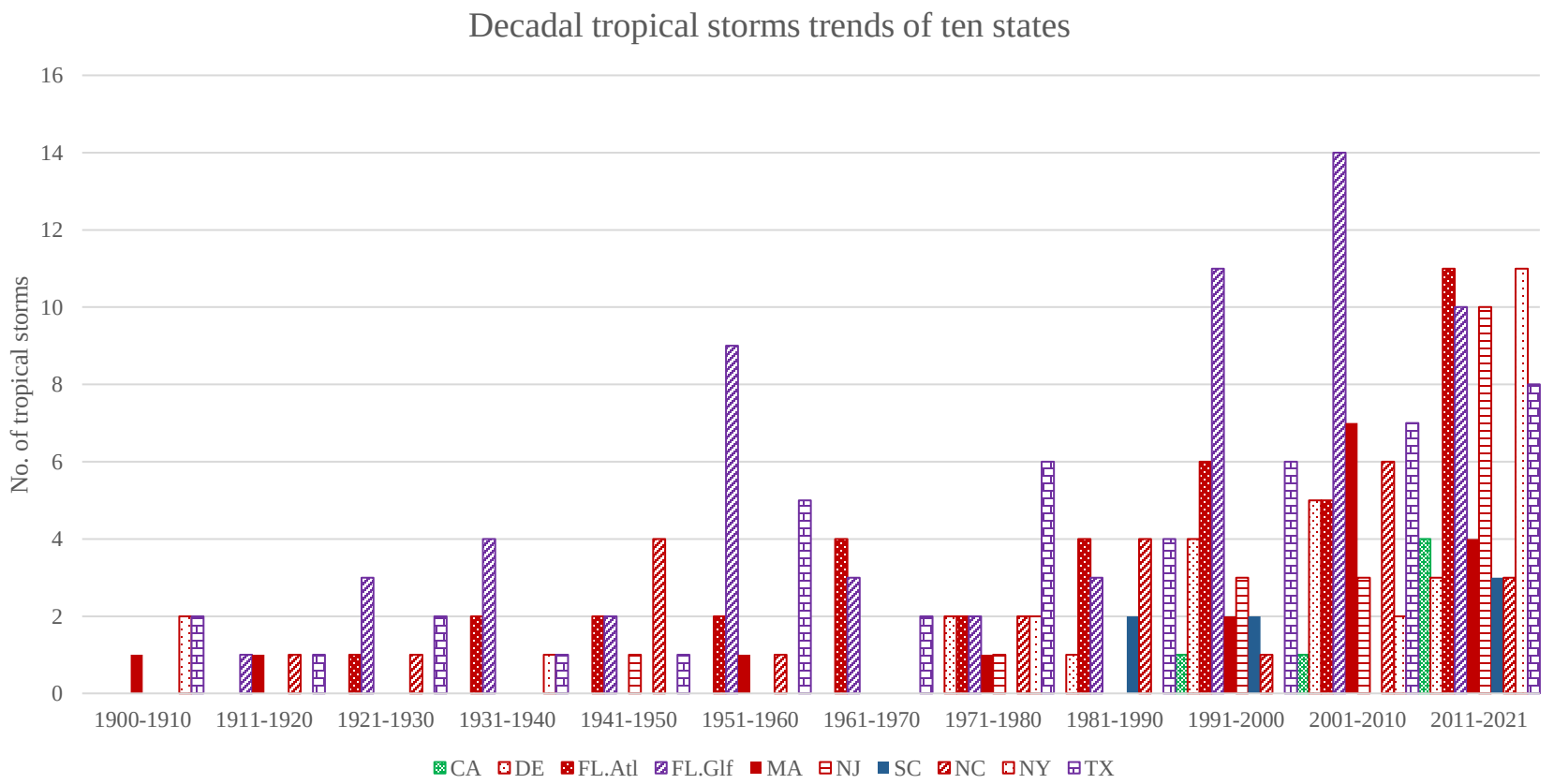


RESULTS CONT.



Green: Pacific coast
Purple: Gulf coast
Maroon: Atlantic coast

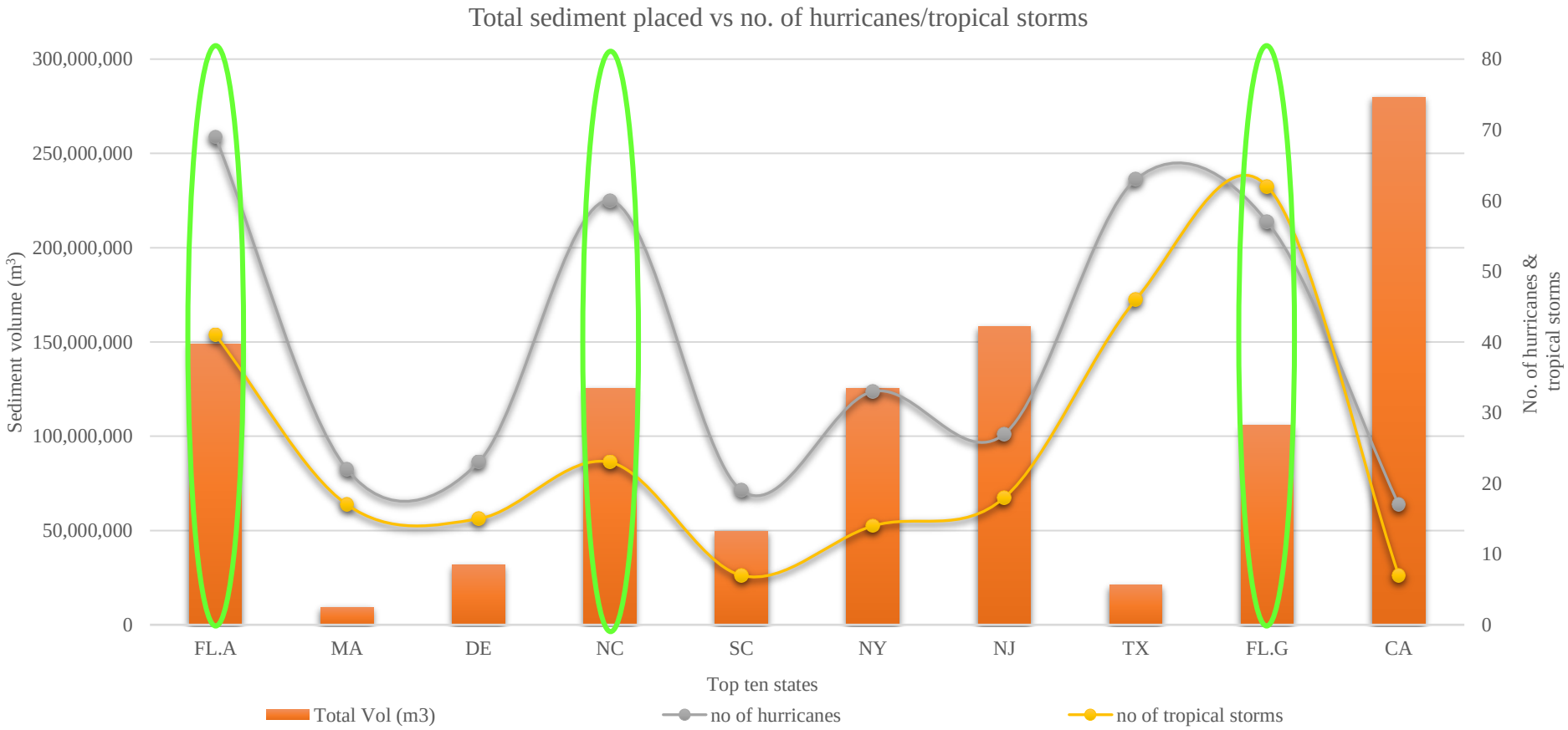
RESULTS CONT.



Green: Pacific coast
Purple: Gulf coast
Maroon: Atlantic coast

RESULTS CONT.

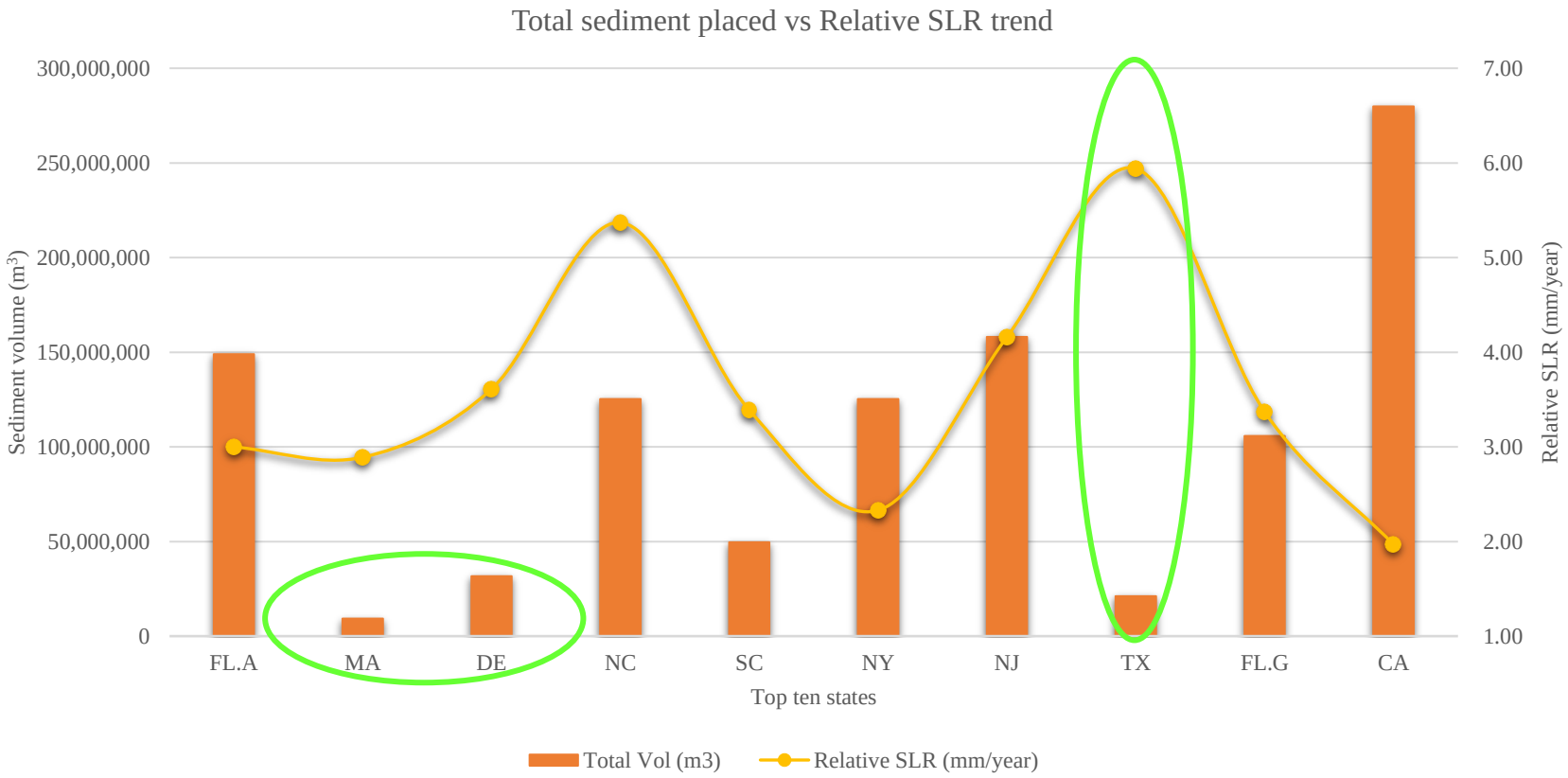
Influence of natural factors



BN trends vs number (no)of hurricanes and tropical storms for top ten states

RESULTS CONT.

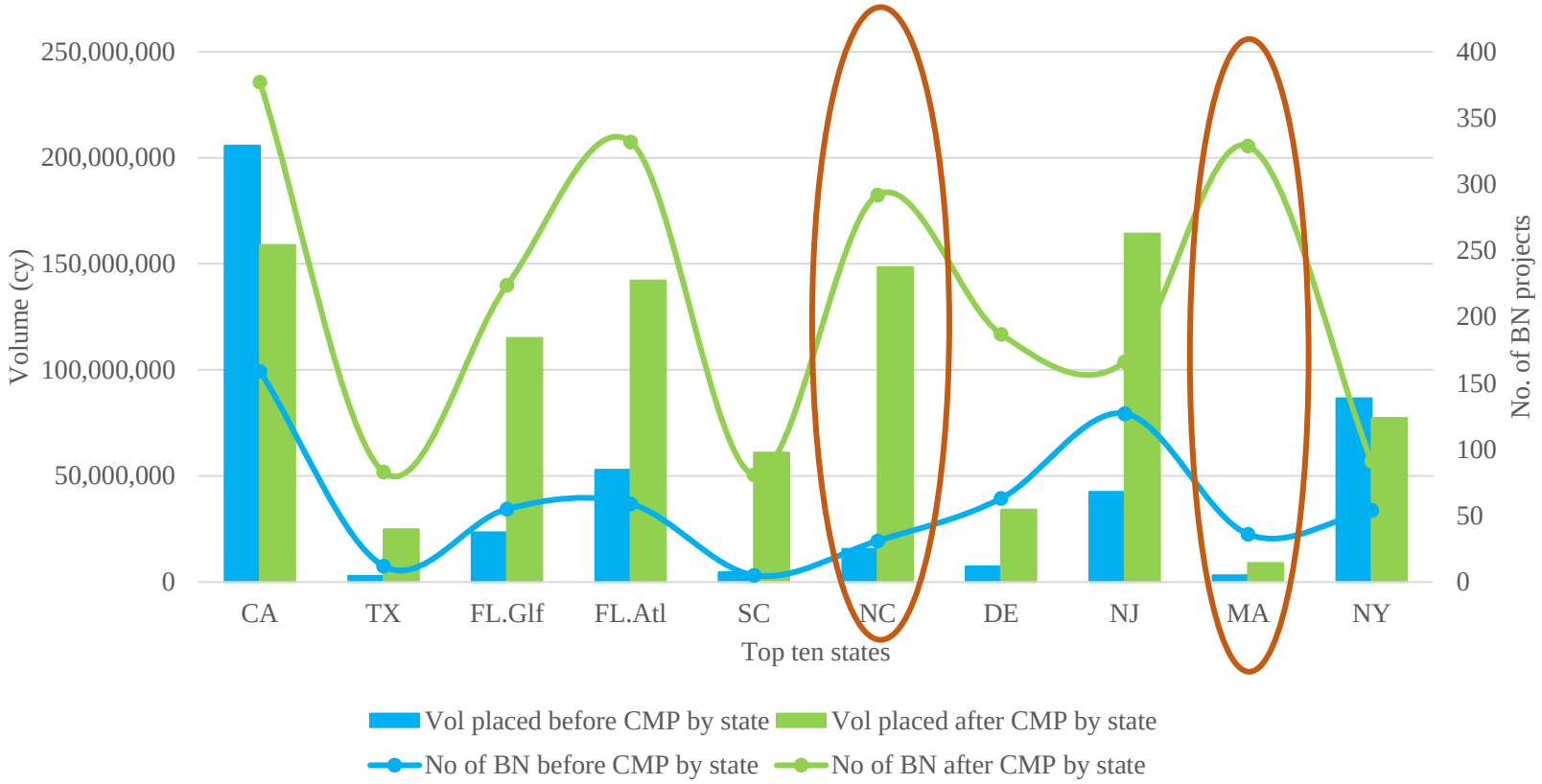
Influence of natural factors



BN trends vs relative SLR for top ten states

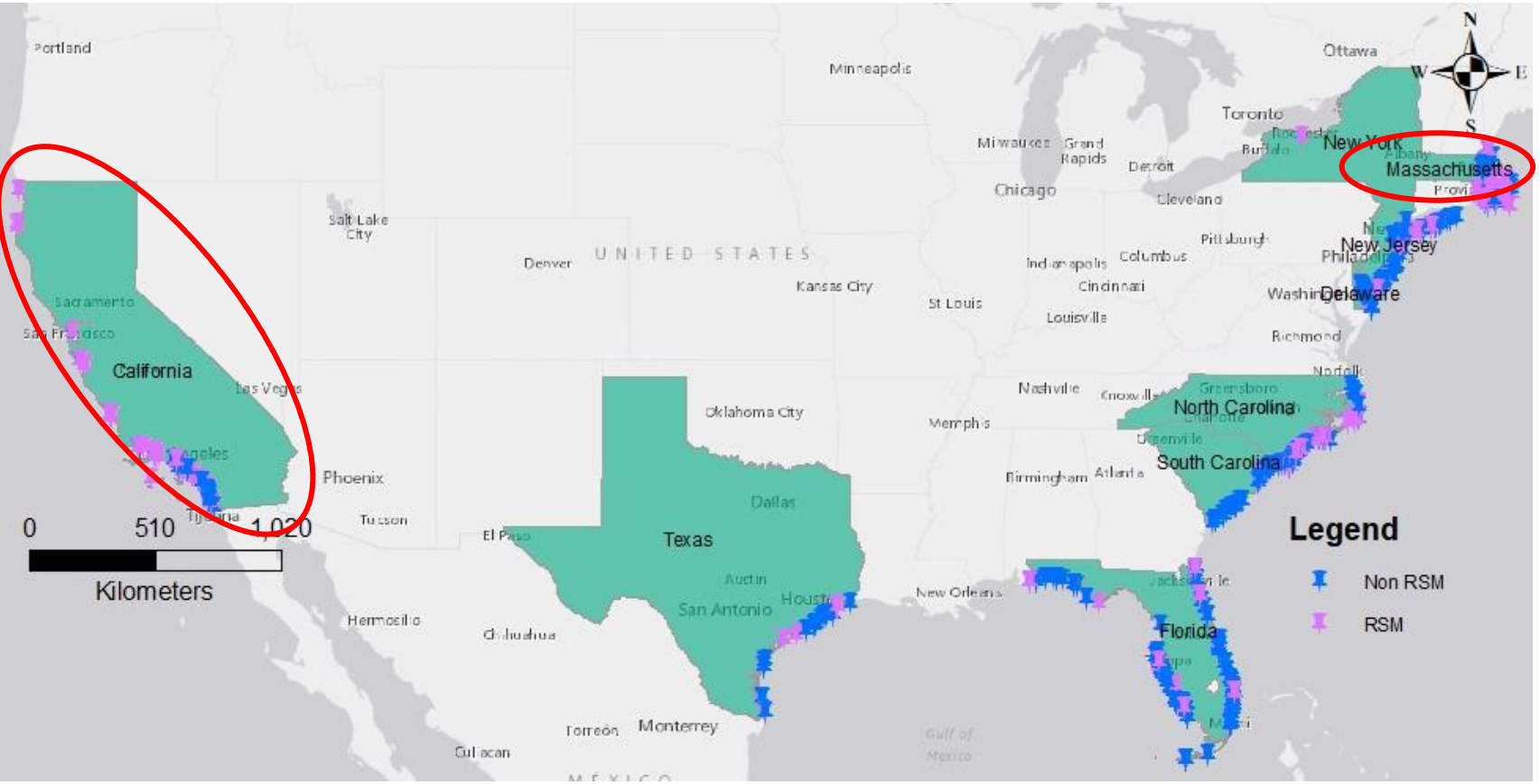
RESULTS CONT.

Influence of anthropogenic factors

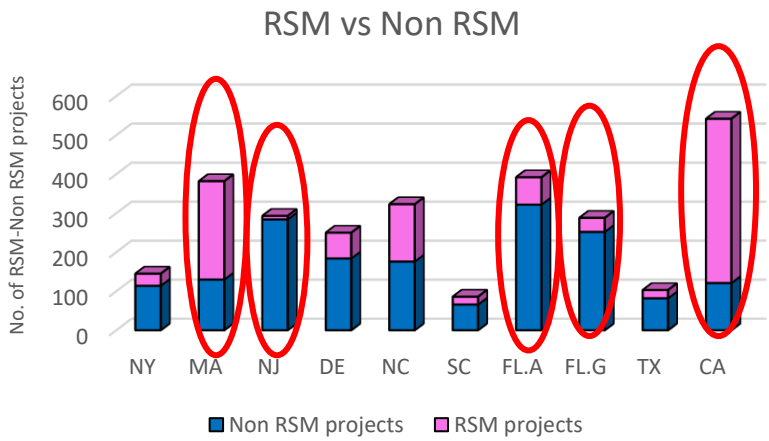


RESULTS CONT.

Influence of anthropogenic factors



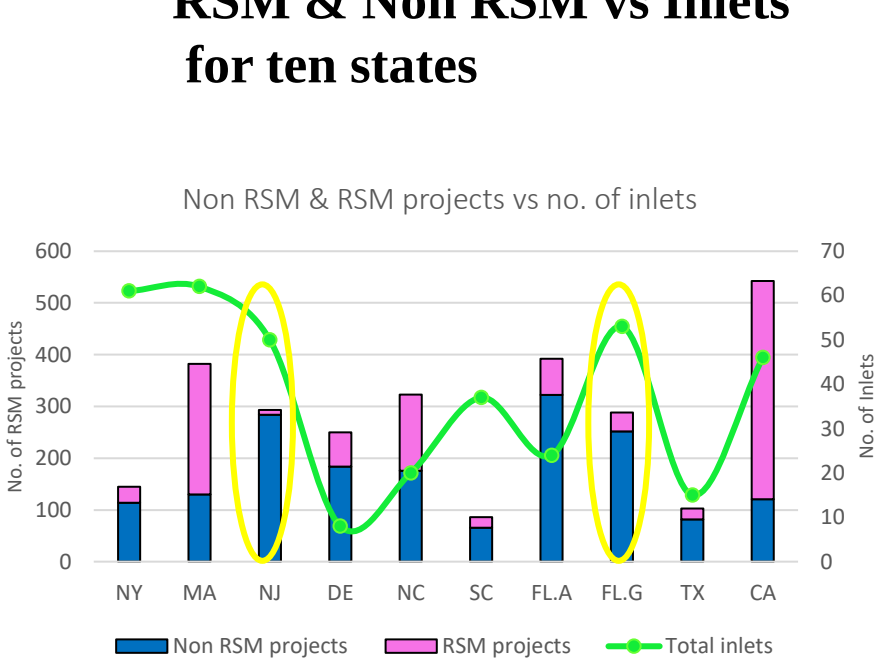
RSM vs Non RSM for ten states



1258 out of 2808 are RSM
45%

RESULTS CONT.

Influence of anthropogenic factors



RESULTS CONT.

However, evaluating each state individually for nourishment drivers rather than comparing states nationally may be more appropriate to elucidate trends. A statistically significant test (multivariant regression) shows that the tropical storms and sea level rise had a significant impact on the number of nourishment and volume of sediments placed in Florida.

Regression summary for no. of BN projects from R programming (lower the p value higher the influence of the factors on the no. of BN projects

	Estimate	Std. Error	T value	P value
Intercept	4.0930	0.4540	9.016	$4.49e^{-15}$
Hurricanes	-0.1747	0.7014	-0.249	0.80370
Hurricane Category	-0.4610	0.4029	-1.144	0.25487
Tropical storms	1.3241	0.4920	2.691	0.00816
SLR	32.4767	5.1766	6.274	$6.15e^{-09}$

The summary showed a high statistically significant influence of tropical storms (t-value=2.691, $p<0.05$) and SLR (t-value=6.274, $p<0.05$) on number of beach nourishment projects.

RESULTS CONT.

Regression summary for vol. of sediments placed from R programming (lower the p value higher the influence of the factors on the volume of sediments placed

	Estimate	Std. Error	T value	P value
Intercept	1488902	228680	6.511	$1.95e^{-09}$
Hurricanes	-127349	353325	-0.360	0.71918
Hurricane Category	-166486	202966	-0.820	0.41373
Tropical storms	514111	247833	2.074	0.04023
SLR	8186718	2607719	3.139	0.00214

Tropical storms (t-value= 2.074, $p<0.05$) and SLR (t- value=3.139, $p<0.05$) also had statistically significant influence on the volume of sediment placed.

CONCLUSIONS & DISCUSSIONS

- The volume of sediments placed in states like FL Atl., NC, SC, and NY were likely driven by storm impacts.
- However, TX and FL. Gulf did not show nourishment activities corresponding to the frequency of tropical storms and hurricanes.
- TX has a higher sea level rise rate compared to the any other state, which may had contributed to the state's status in the top ten for nourishment.
- Higher number of inlets correspond with higher RSM projects in CA, MA, and NC. However, FL and NJ had less RSM projects despite the presence of numerous inlets.
- The statistical analysis executed for the Florida Atl. coast as proof of concept suggested that only tropical storms and SLR were statistically influencing the BN trends.

FUTURE WORK

- The statistical significance of anthropogenic activities (no. of inlets) will be taken into consideration for future study.

- Future work will also be conducted to compare nourishment trends in other states and explore the role of storms, SLR, or inlet density.

- This study is beneficial for the future predictions of beach nourishment trends based on statistically significant factors.

THANK YOU

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