On Static vs. Dynamic Sea Level Rise

Scott C. Hagen

Peter Bacopoulos

University of Central Florida

Coastal Hydroscience Analysis, Modeling & Predictive Simulations Laboratory

CHAMPS Lab

http://champs.cecs.ucf.edu

To paraphrase a climate science motto:

> “The sea level is rising, the best we can do now is to manage the unavoidable and avoid the unmanageable.”

Ecological Effects of Sea Level Rise in the Northern Gulf of Mexico (EESLR-NGOM)

The Team

University of Central Florida
Scott Hagen (Science PI)
Denise DeLorme
Linda Walters
Dingbao Wang
John Weishampel
George Yeh

Florida State University
Wenrui Huang

University of Florida
Don Slinn

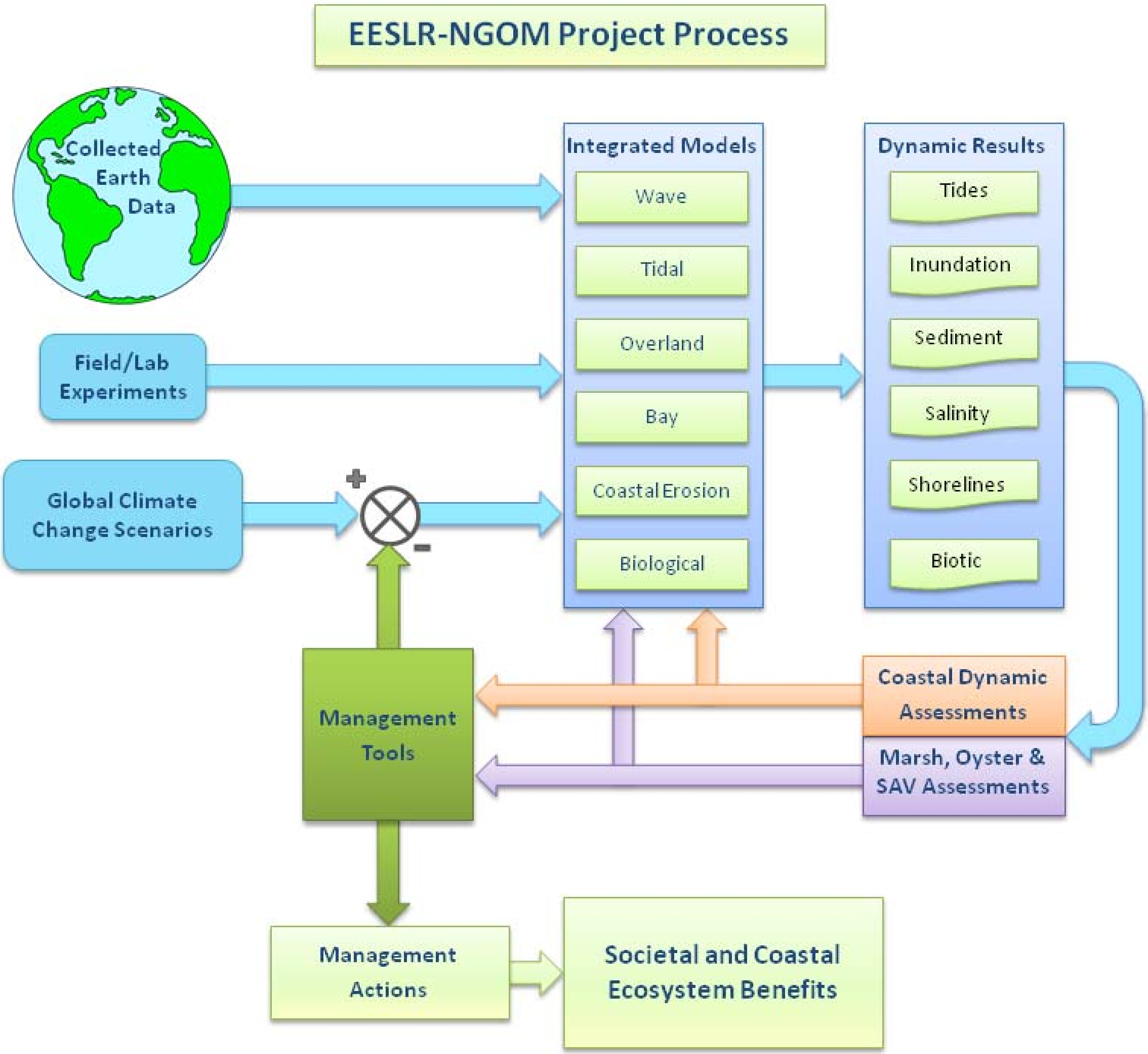
University of South Carolina
Jim Morris

Northwest Florida Water Management District
Graham Lewis (Applications PI)

Dewberry, Inc.
Jerry Sparks
Susan Taylor

The Goal

To assess the ecological impacts of SLR with an interdisciplinary and applications-based approach.


EESLR-NGOM Project Process
Collected Earth Data
Field/Lab Experiments
Global Climate Change Scenarios
+
-
Integrated Models
Wave
Tidal
Overland
Bay
Coastal Erosion
Biological
Dynamic Results
Tides
Inundation
Sediment
Salinity
Shorelines
Biotic
Coastal Dynamic Assessments
Marsh, Oyster & SAV Assessments
Management Tools
Management Actions
Societal and Coastal Ecosystem Benefits

Presentation Outline

- Discussion of recent FEMA flood plain analyses
  → Let’s use as a synergistic example.

- How do extreme variations of sea level rise impact tides & surge?
  → Let’s examine this for SLR of
  15.2 cm, 30.5 cm, & 1.0 m
  (6 in., 1.0 ft., & 3.28 ft.).

- Discussion, conclusions and implications.


Image NASA
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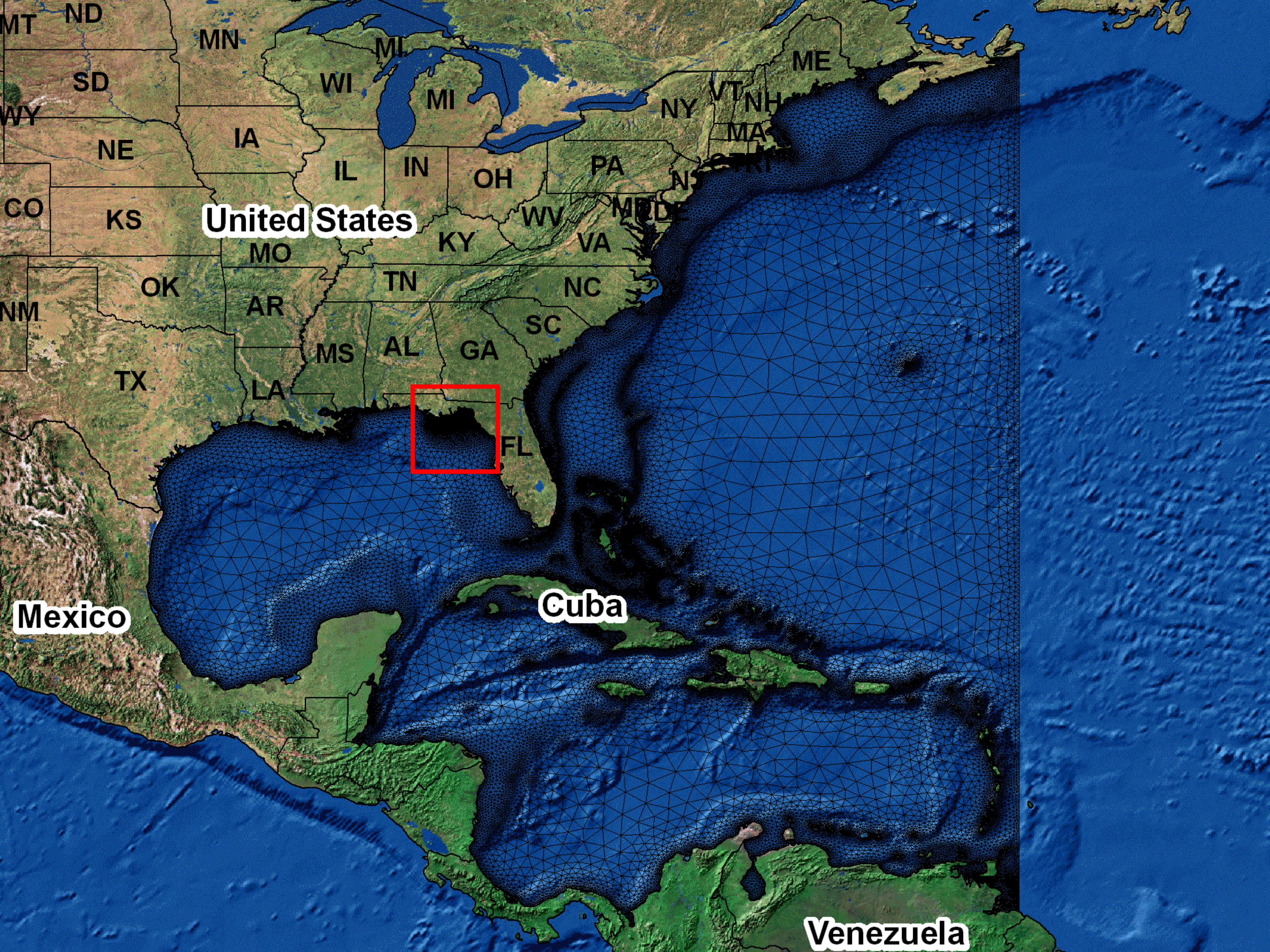
30°03'57.24" N 69°50'18.01" W
Eye alt 7678.35 km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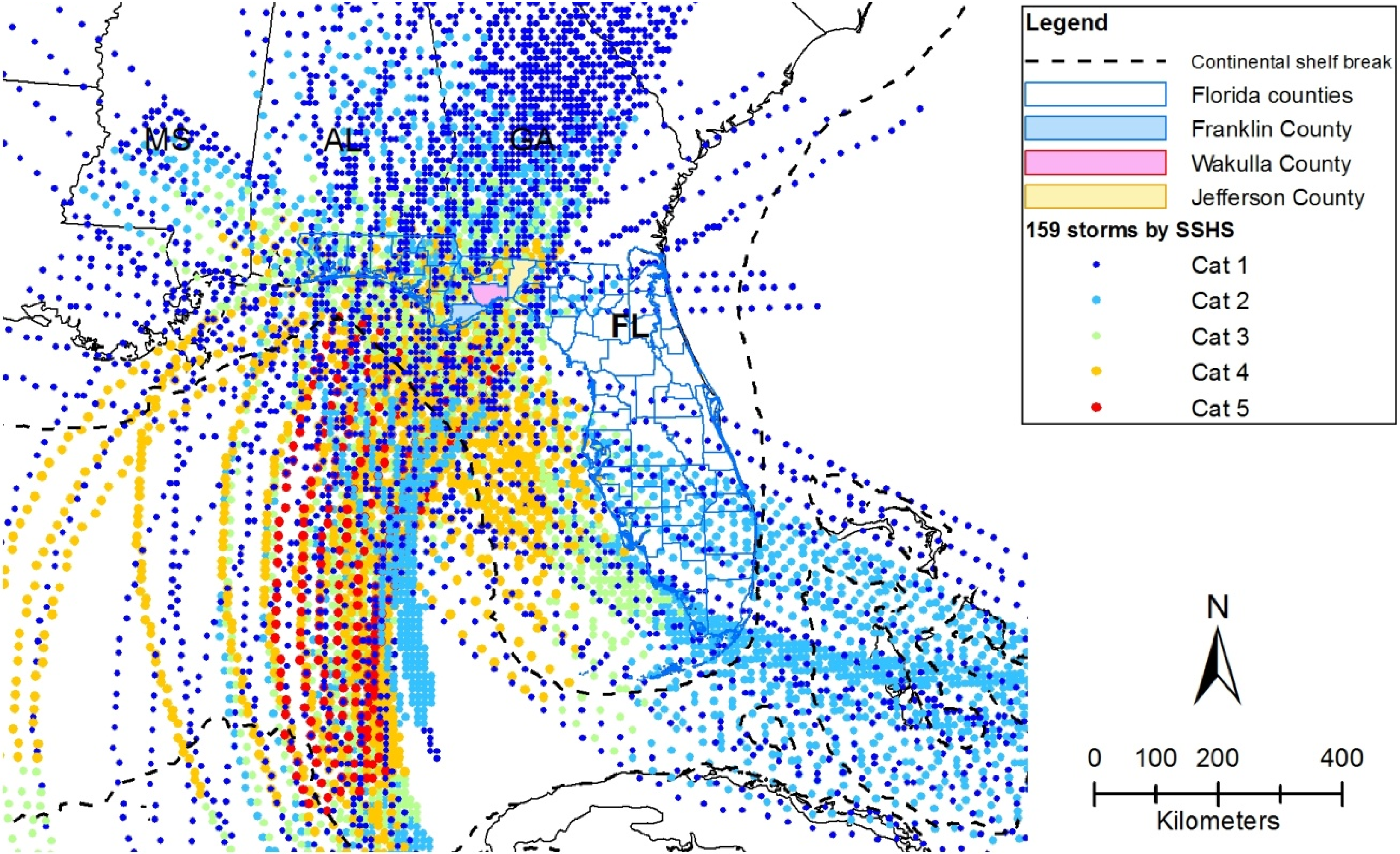
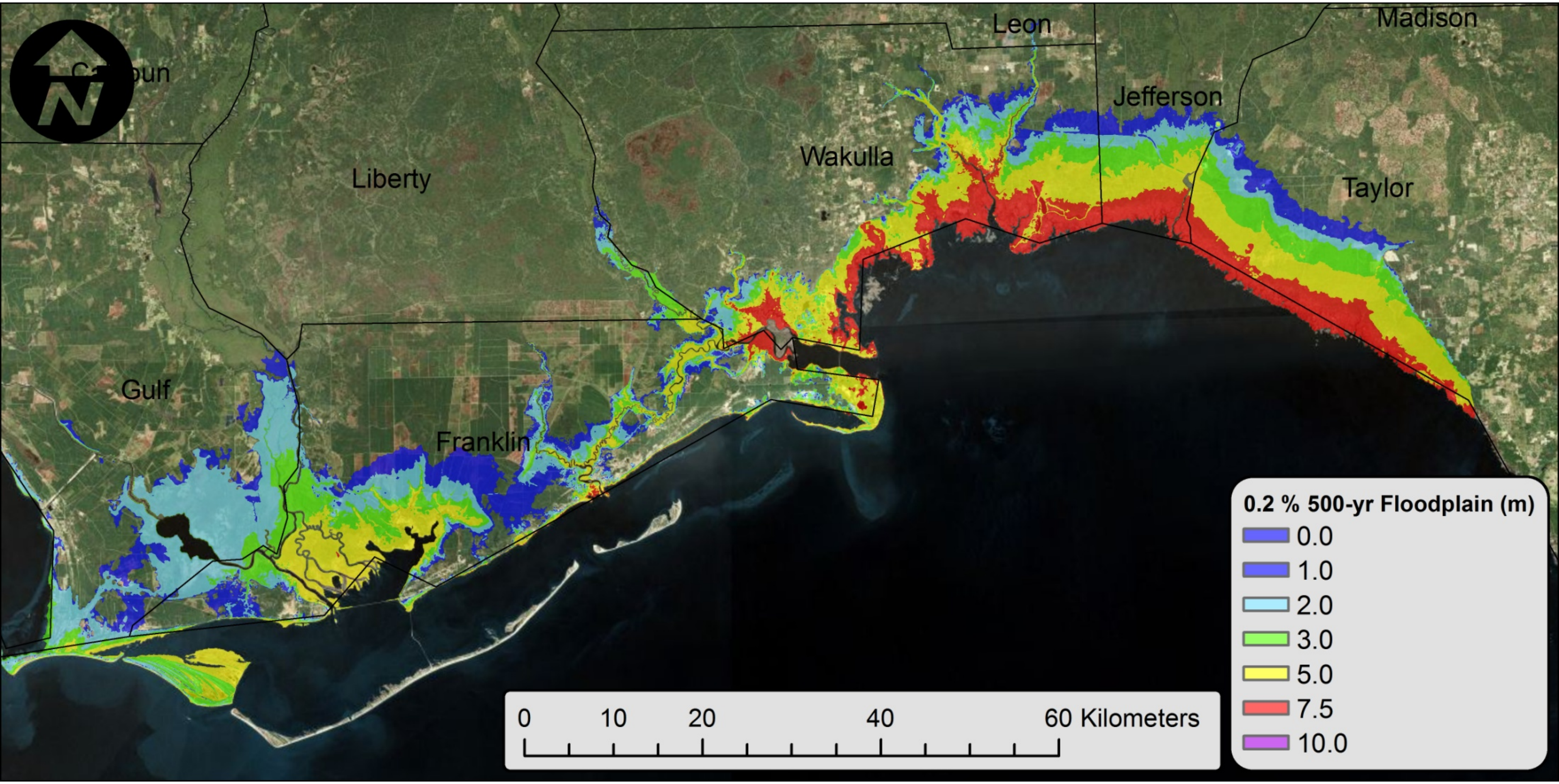
159 synthetic storms from FEMA floodplain analysis



0.2% (500-year) floodplain



For the 159 synthetic storms …

- Each produced a MEOW
  Maximum Envelope Of Water

- The MEOWs were compared to the 500-year floodplain

- The top 5 contributing storms were identified
  and contribute to 76% of the 500-year floodplain

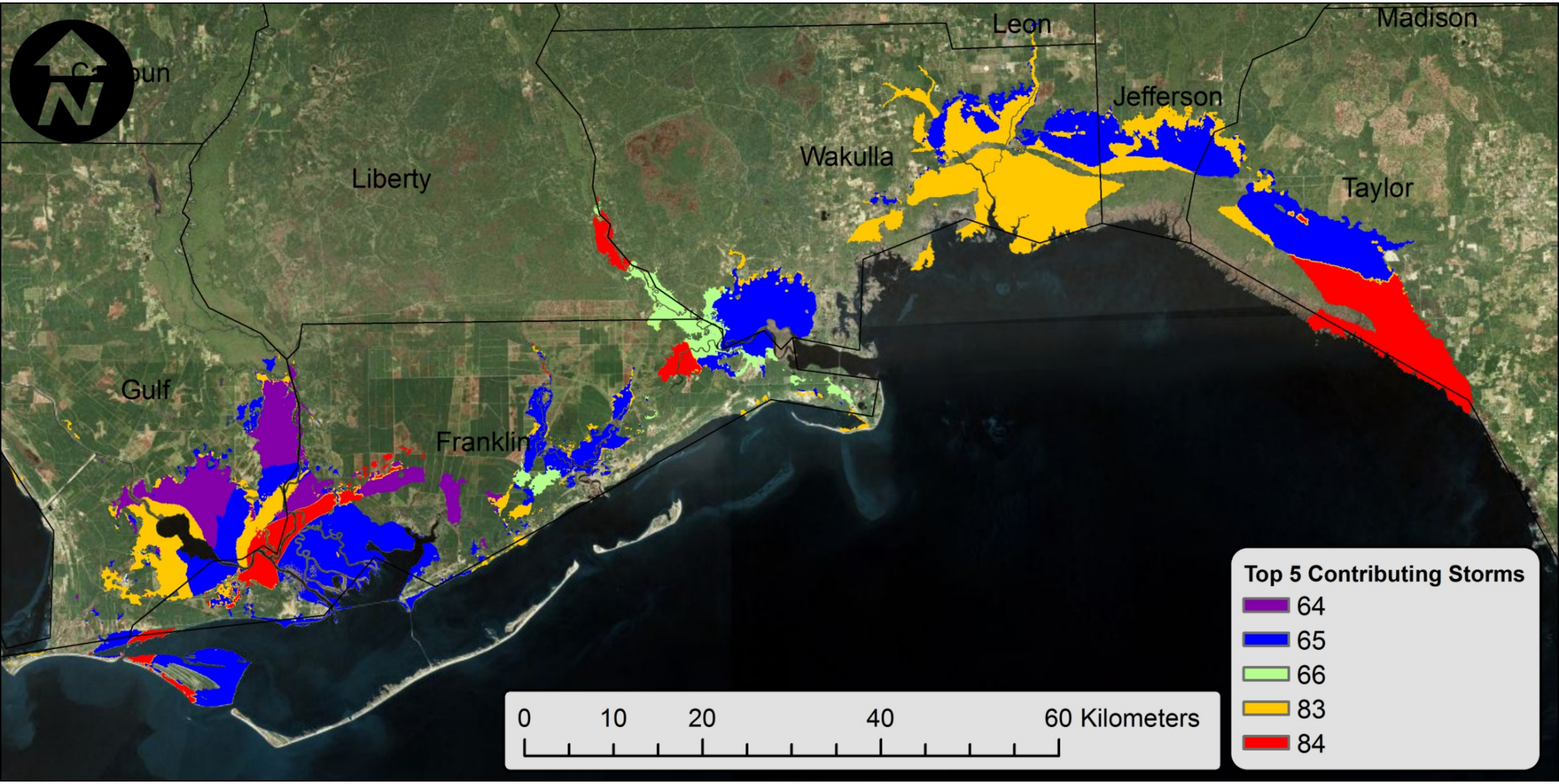
Ranking of contributing storms

	Rank	Storm number	% Contribution	Cum. % Contrib.
	1	65	25	25
	2	83	23	48
Top 5	3	84	12	60
	4	64	12	72
	5	66	4	76
	6	86	3	79
	7	82	3	82
	8	85	3	85
	9	75	3	88
	10	76	3	91
	11	77	3	94
	12	154	3	97
	13	78	2	99
	14	74	1	(fully covered) 100

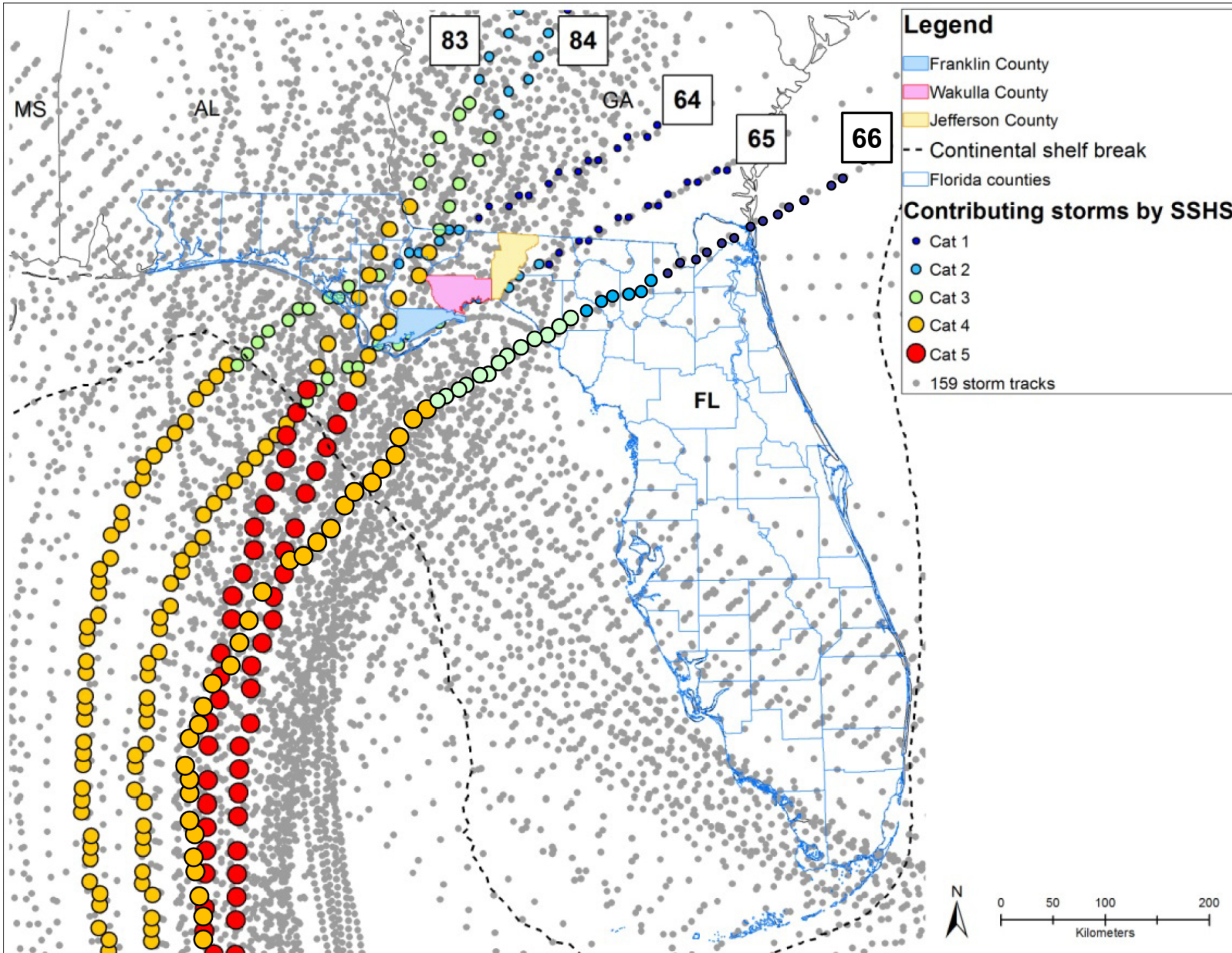
Attributes of top 5 contributing storms

Storm number	Central pressure deficit (hPa)	Radius to maximum winds (km)	Forward speed (m/s)	Saffir-Simpson scale
65	56	68	4.2	Cat 3
83	87	37	6.8	Cat 4
84	87	37	6.8	Cat 4
64	56	68	4.2	Cat 3
66	56	68	4.2	Cat 3
Min of all 159	13	18	2.1	Cat 1
Max of all 159	90	120	11.3	Cat 4

Top 5 contributing storms



Top 5 contributing storms

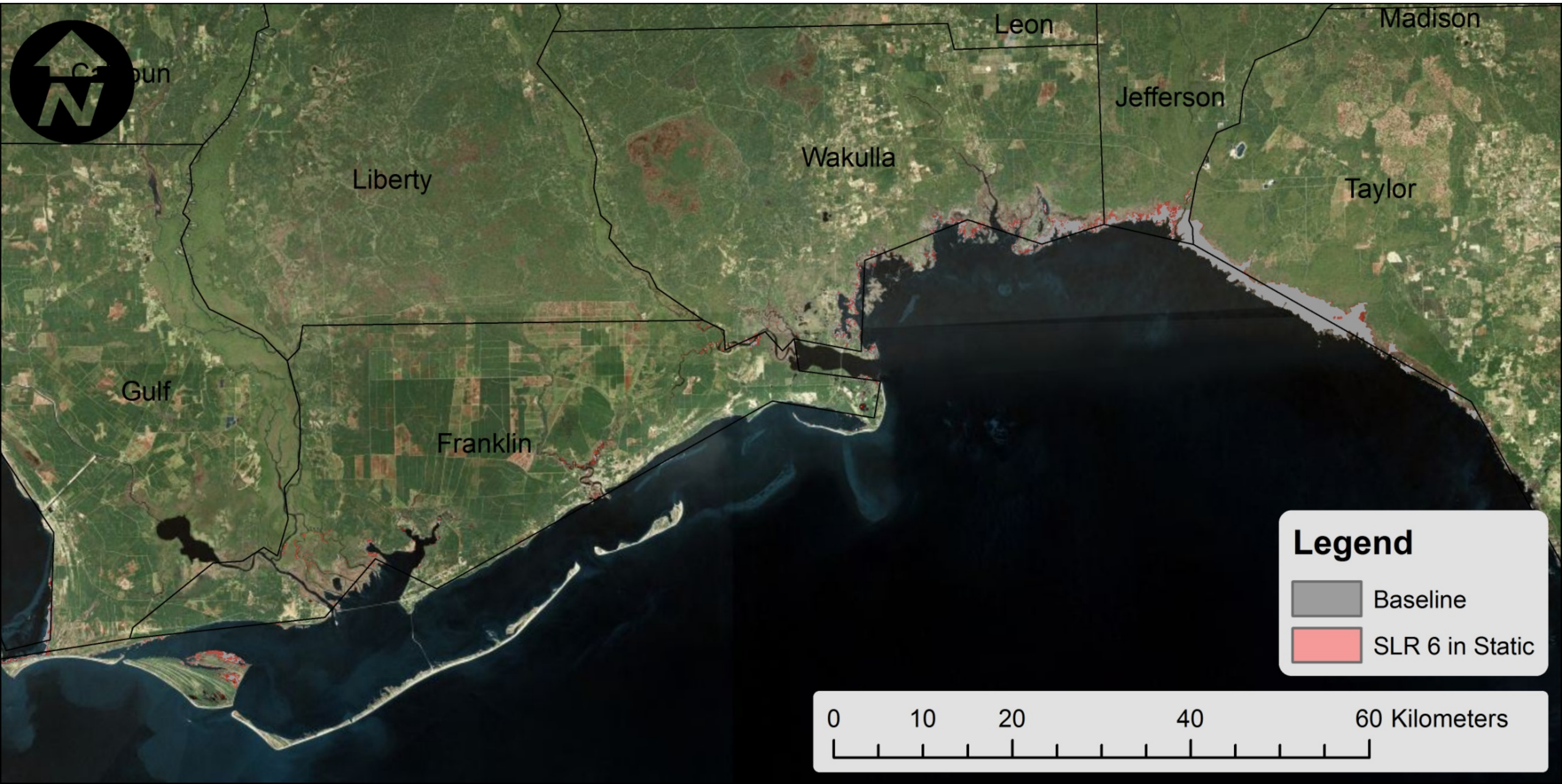


SLR Application

- SLR tests included 15.2 cm, 30.5 cm, & 1 m
  (Think 6 in., 1 ft., & ≈3.28 ft.)
- Static = existing MOM* was elevated by SLR
  *Maximum Of Maximums for tides & surge
- Dynamic = surge was simulated w/SLR included
  - Simulated astronomic tides
    + SLR incorporated as steric effect
  - Simulated surge from top five storms
    + SLR incorporated as steric effect

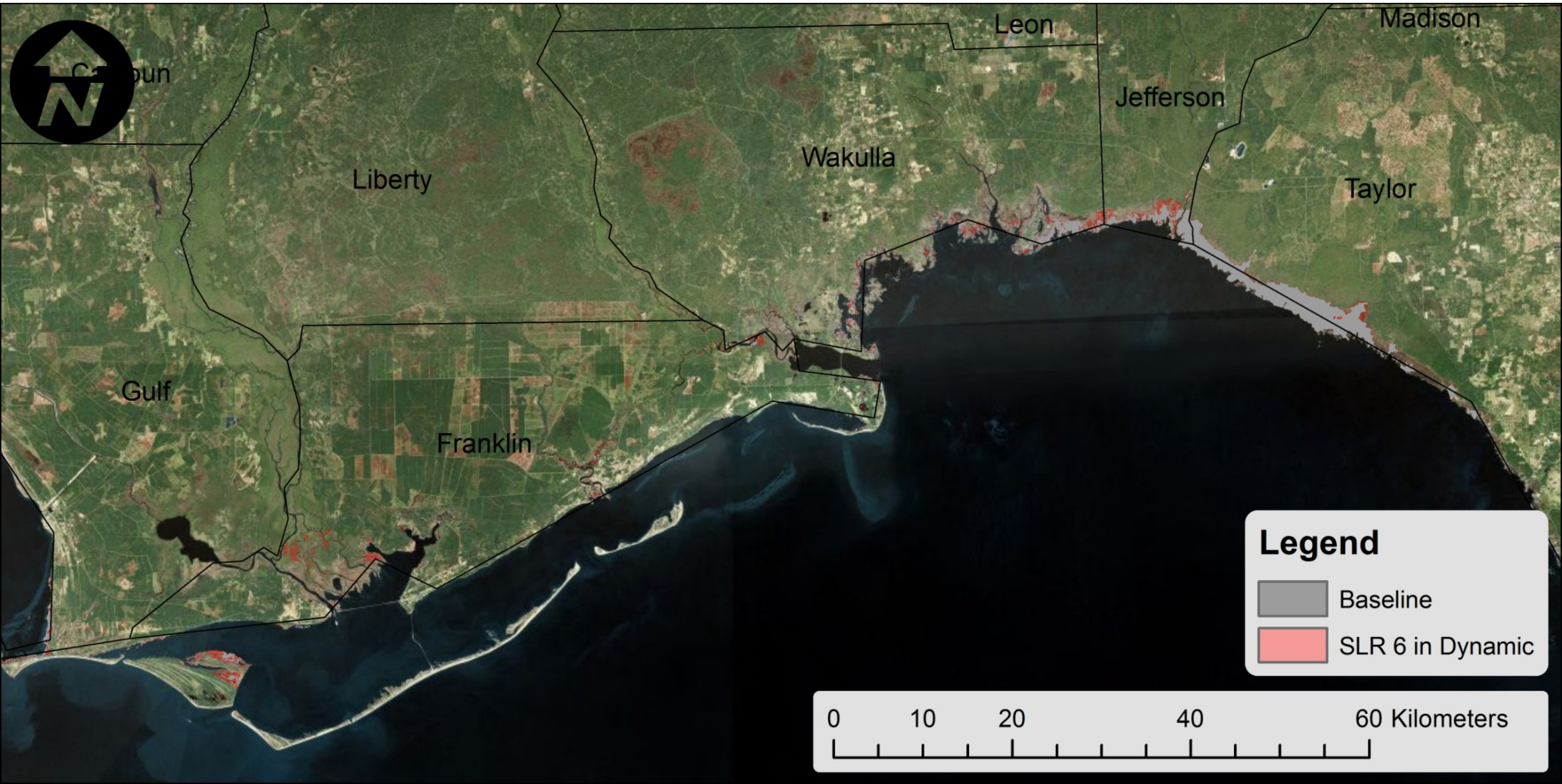
Tides w/15.2 cm SLR

Static



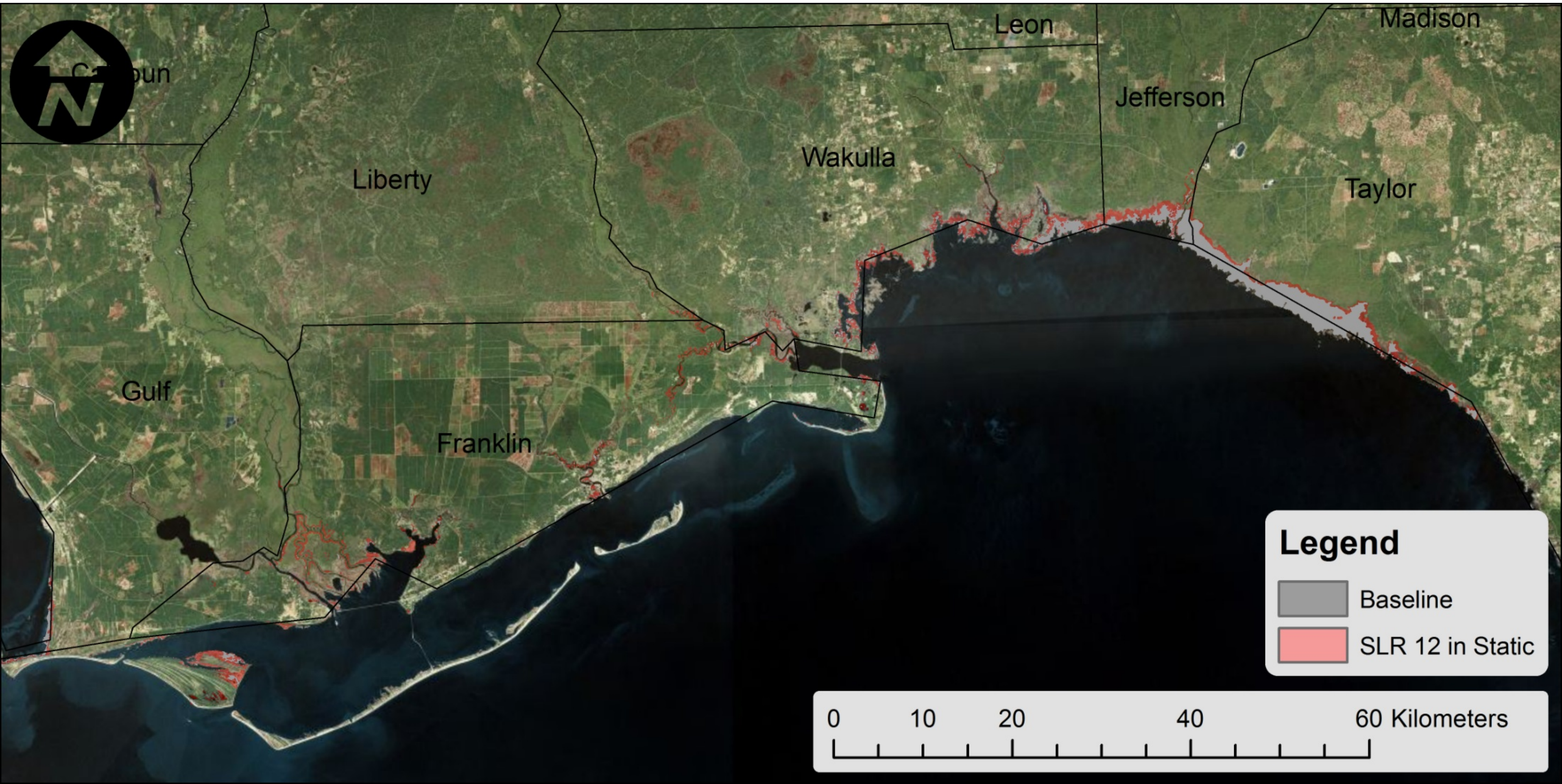
Tides w/15.2 cm SLR

Dynamic



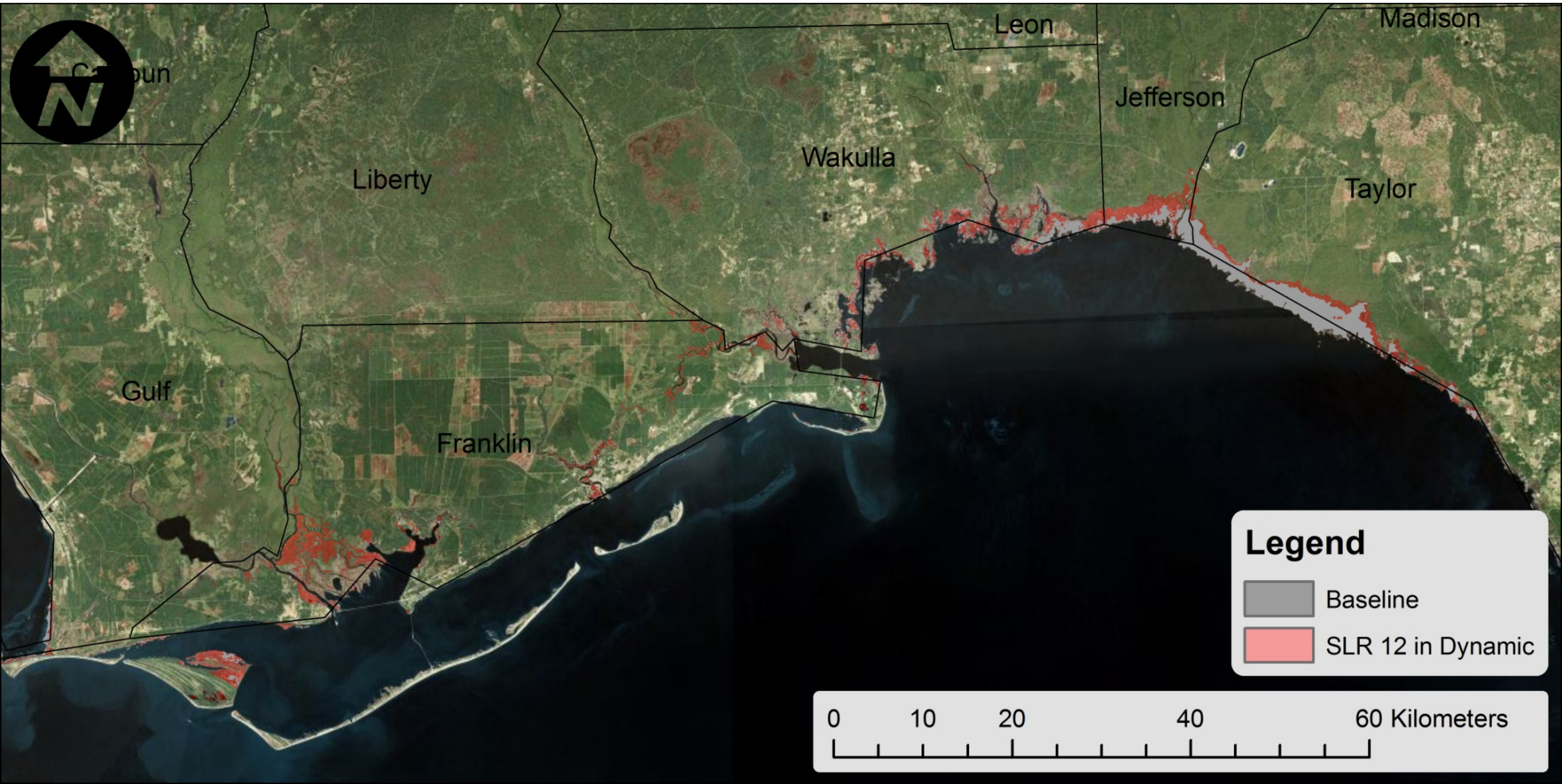
Tides w/30.5 cm SLR

Static



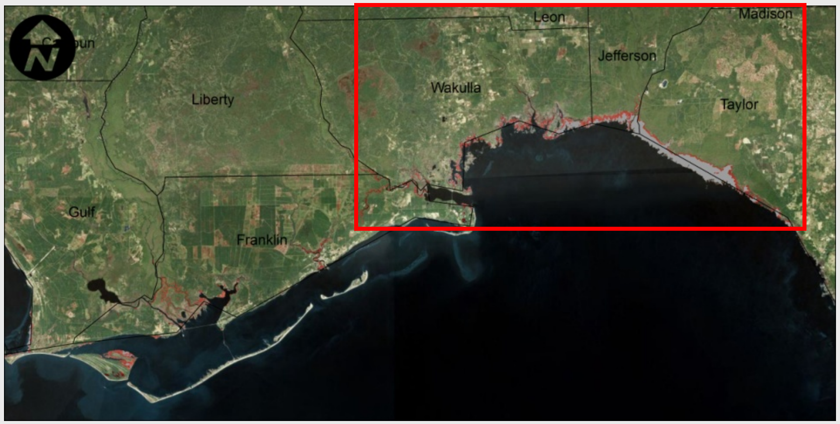
Tides w/30.5 cm SLR

Dynamic



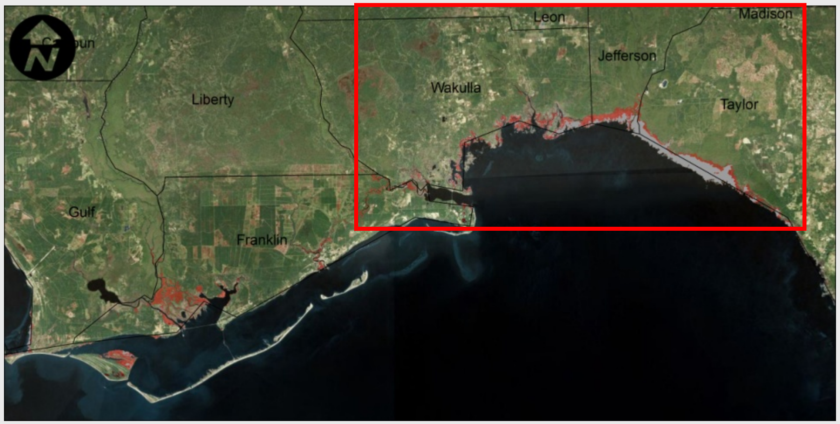
Tides w/30.5 cm SLR

Static



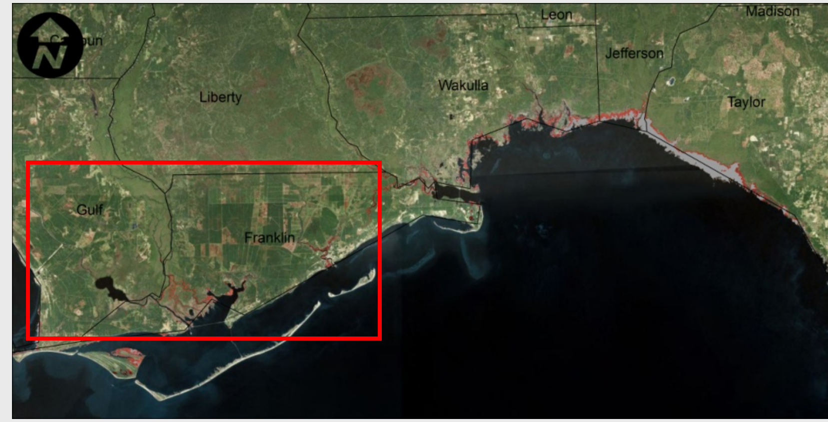
Tides w/30.5 cm SLR

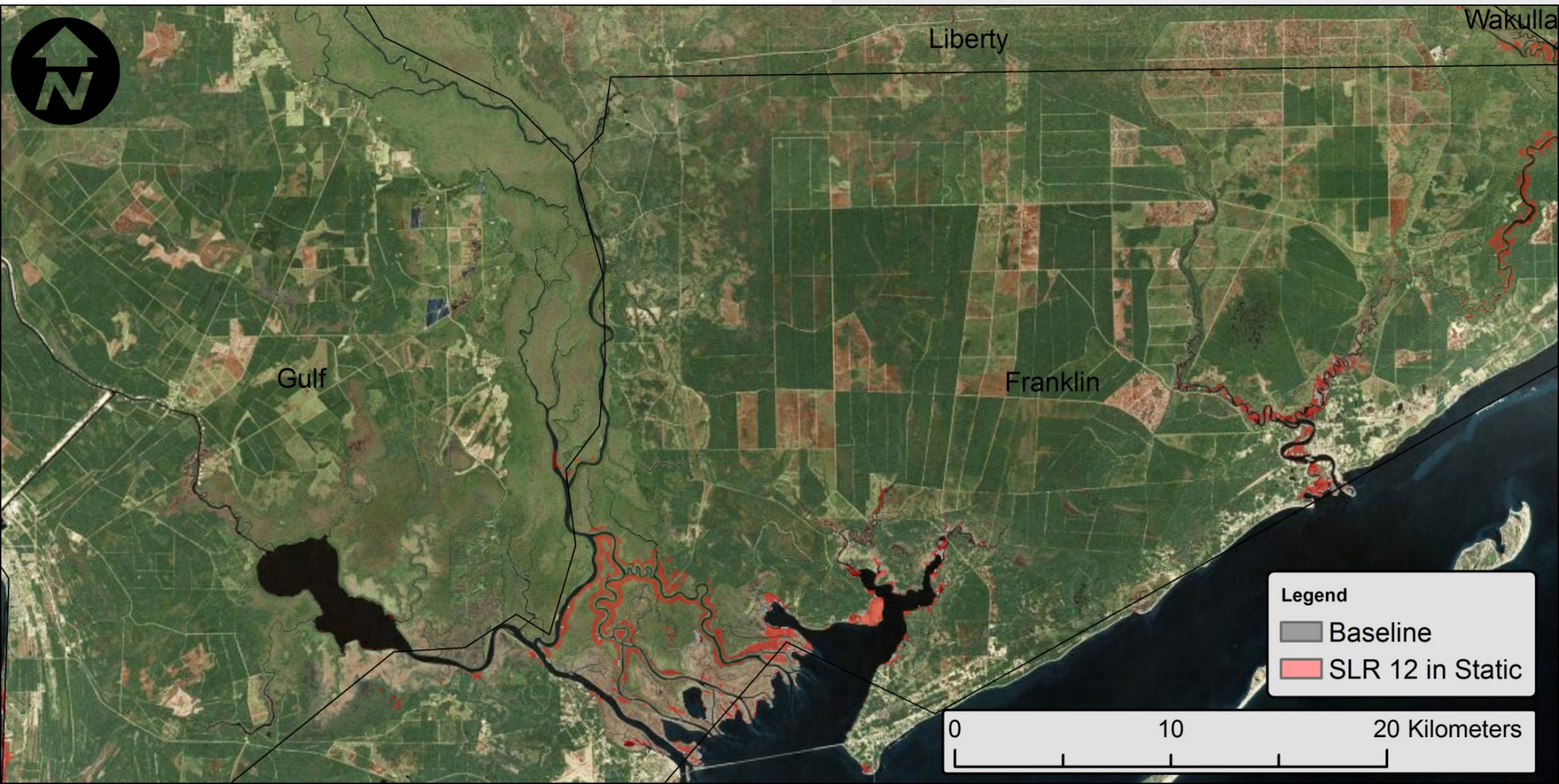
Dynamic



Tides w/30.5 cm SLR

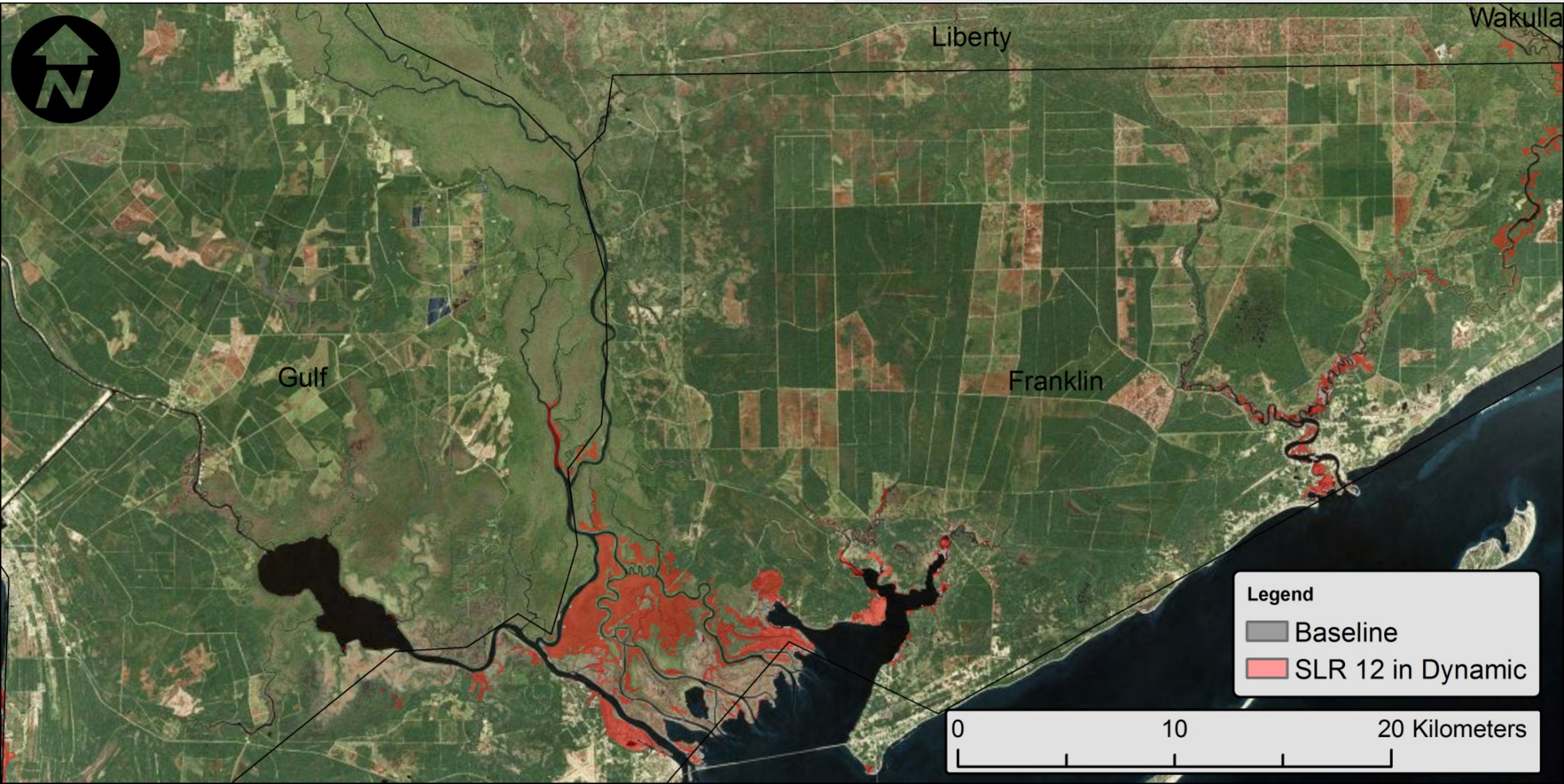
Static





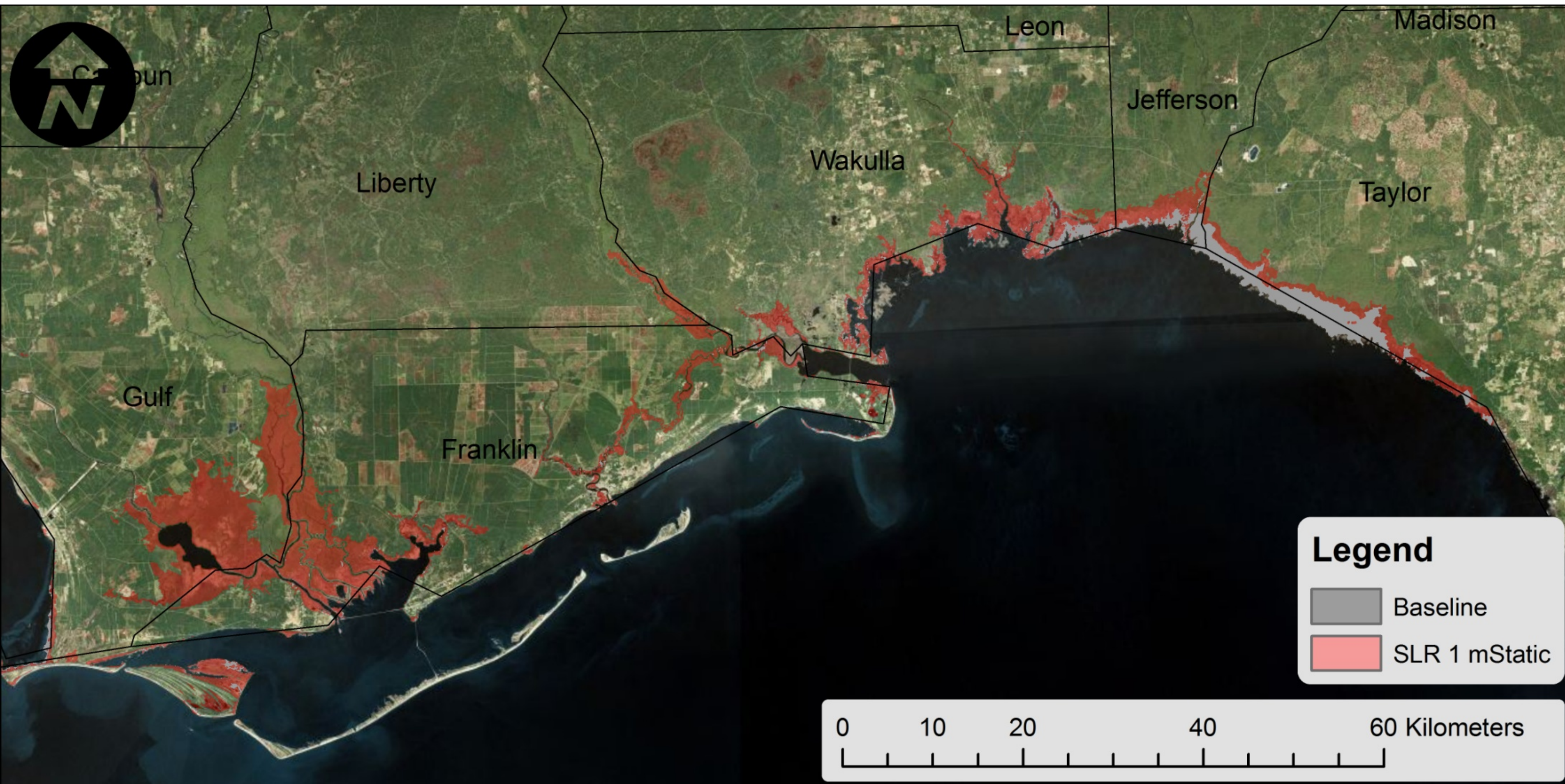
Tides w/30.5 cm SLR

Dynamic



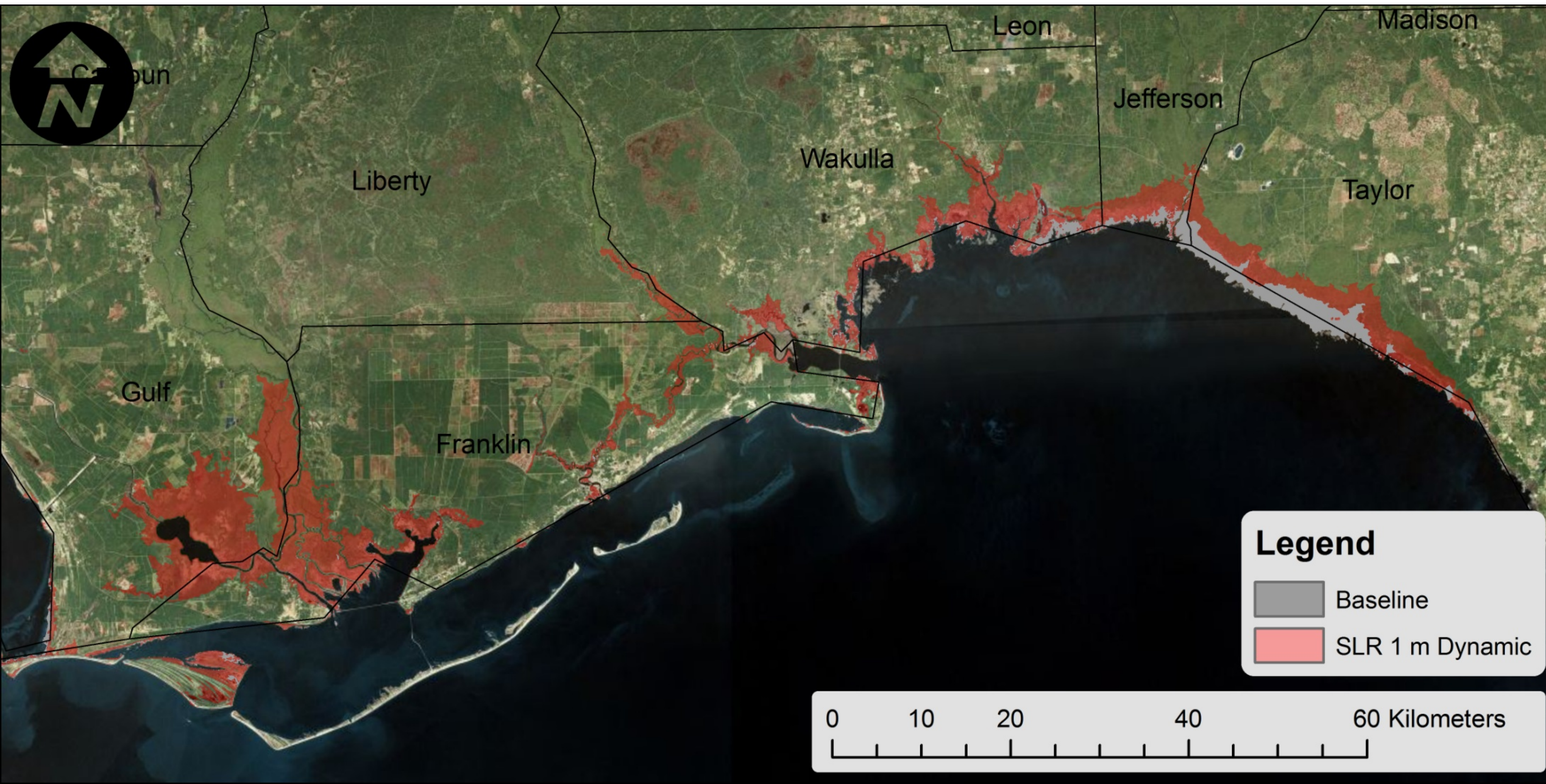
Tides w/1.0 m SLR

Static



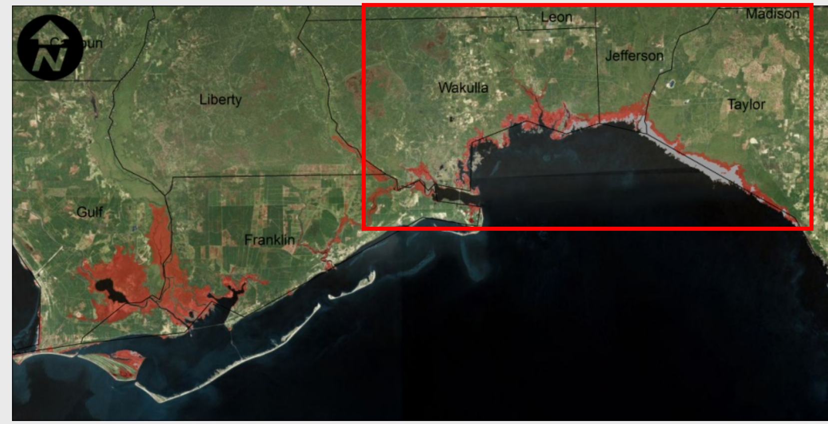
Tides w/1.0 m SLR

Dynamic

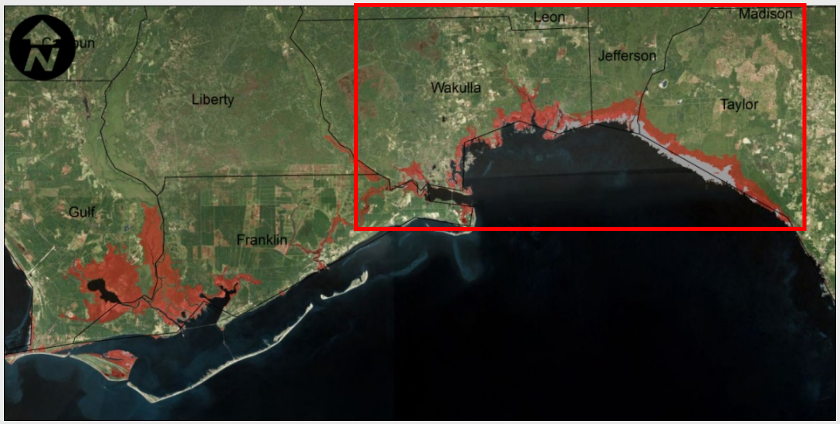


Tides w/1.0 m SLR

Static

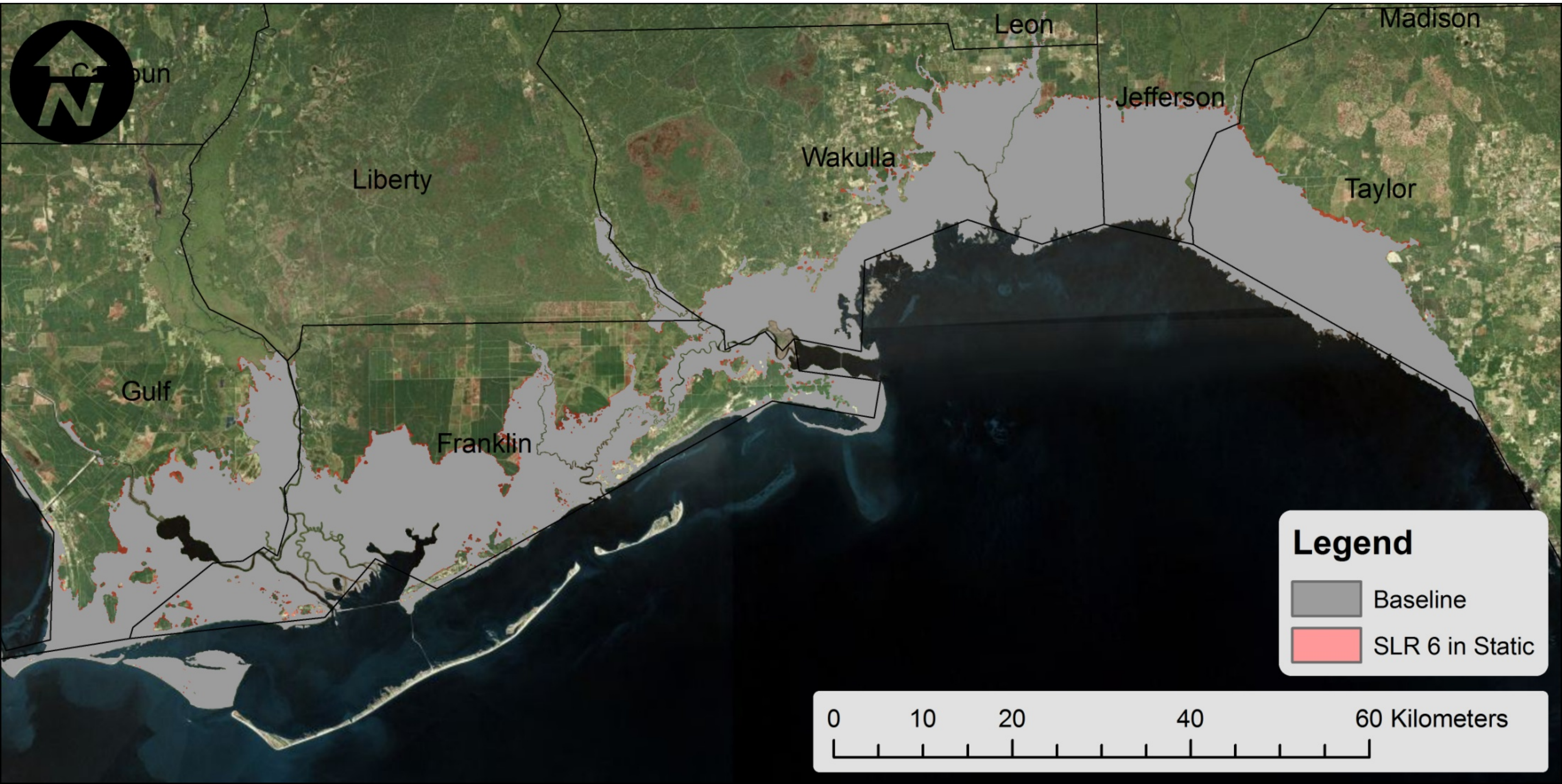


Tides w/1.0 m SLR Dynamic



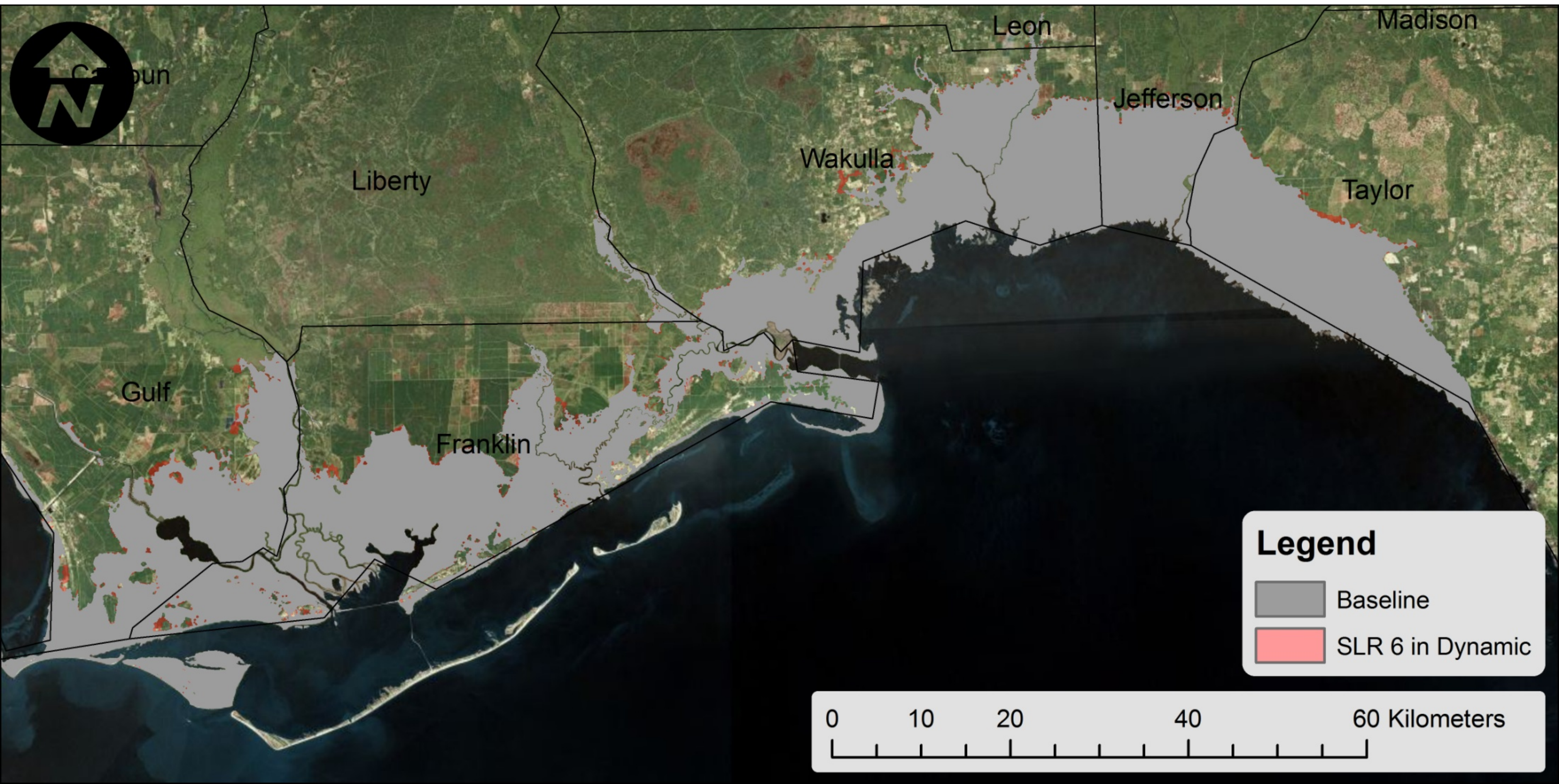
Surge w/15.2 cm SLR

Static



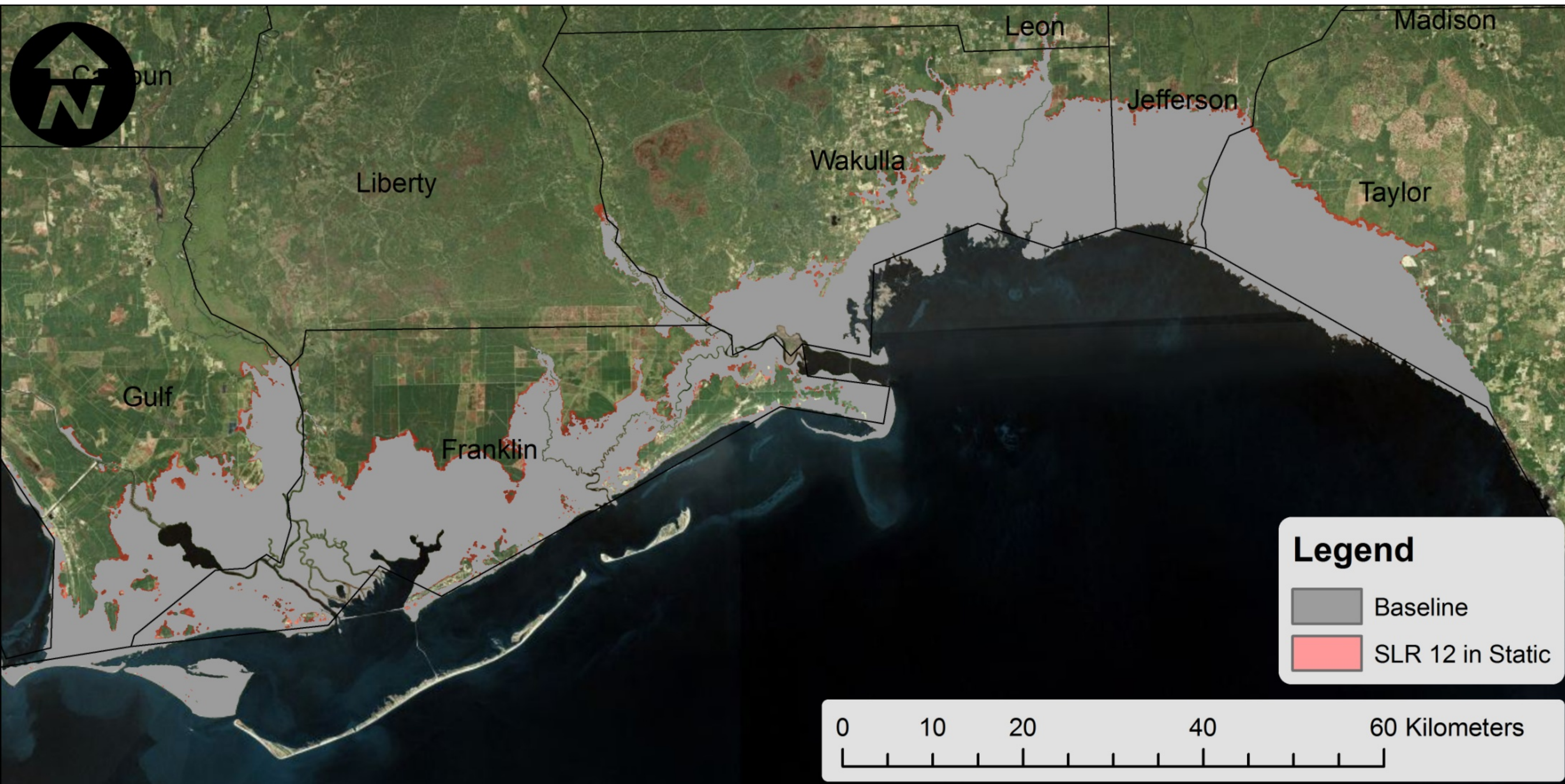
Surge w/15.2 cm SLR

Dynamic



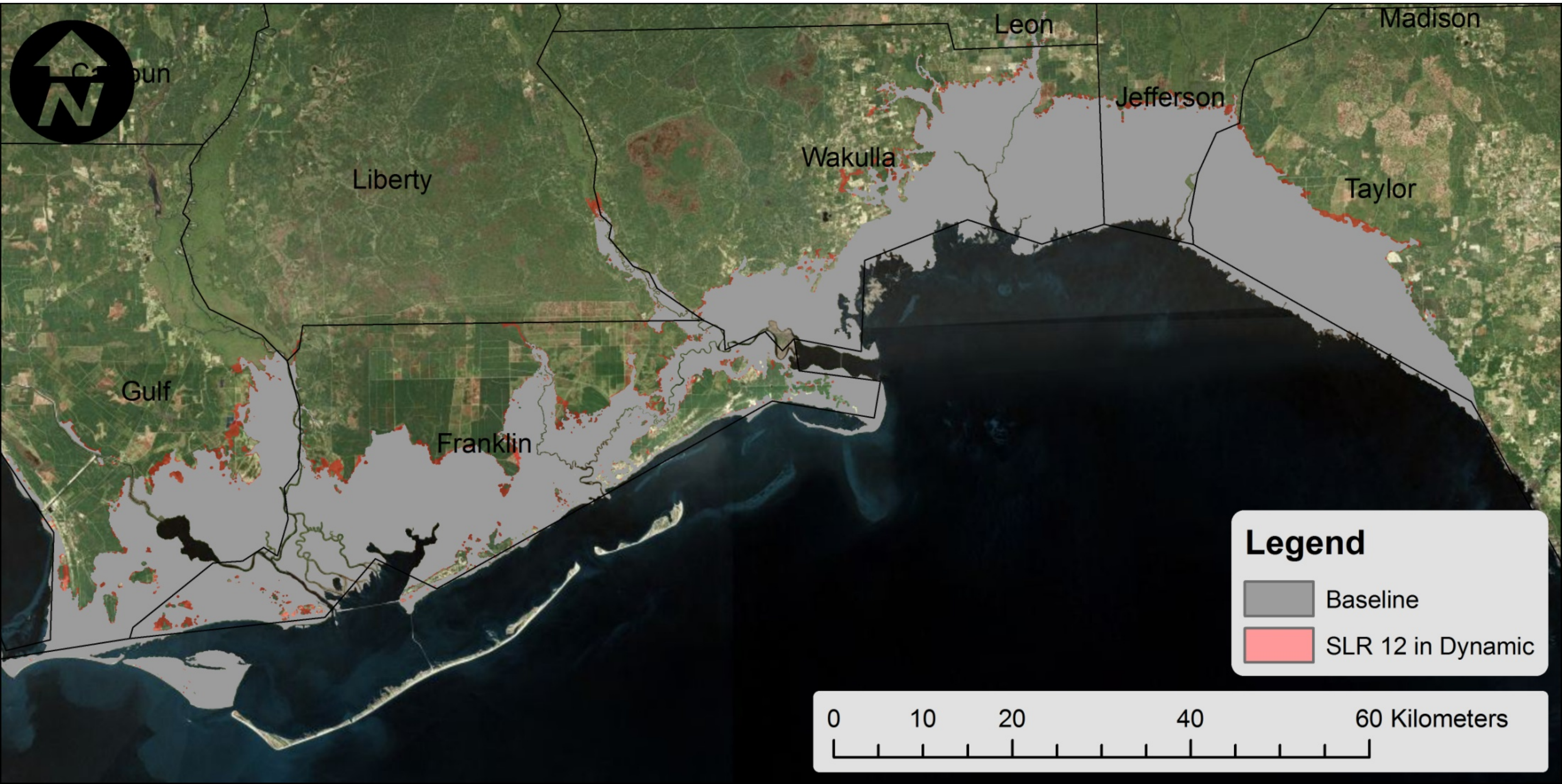
Surge w/30.5 cm SLR

Static



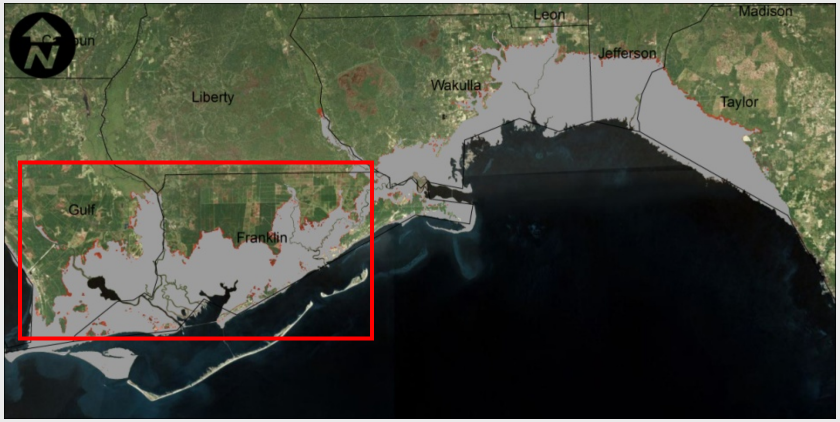
Surge w/30.5 cm SLR

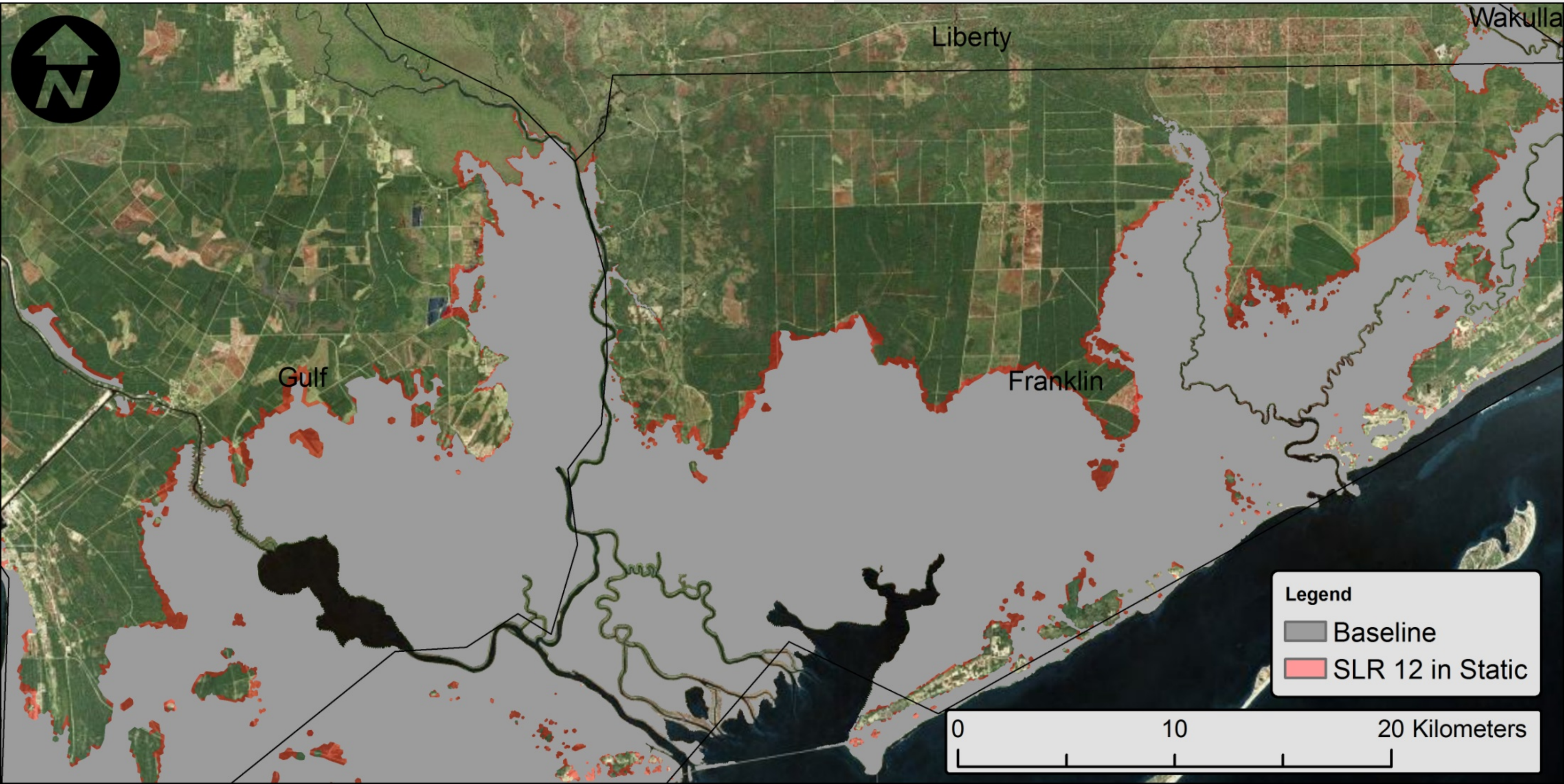
Dynamic



Surge w/30.5 cm SLR

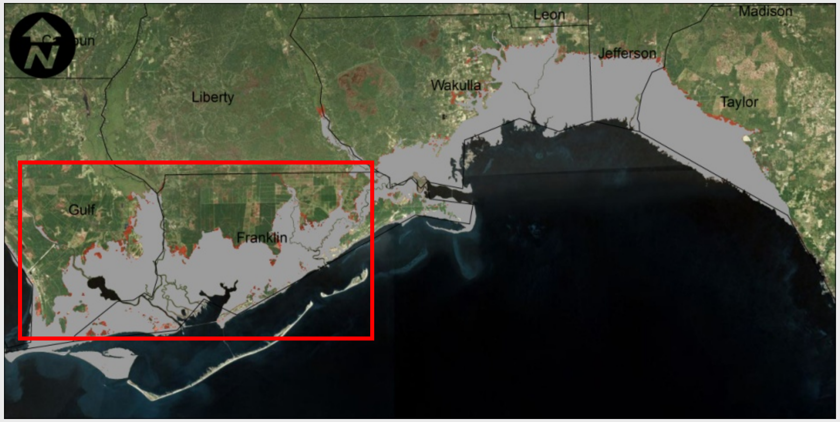
Static

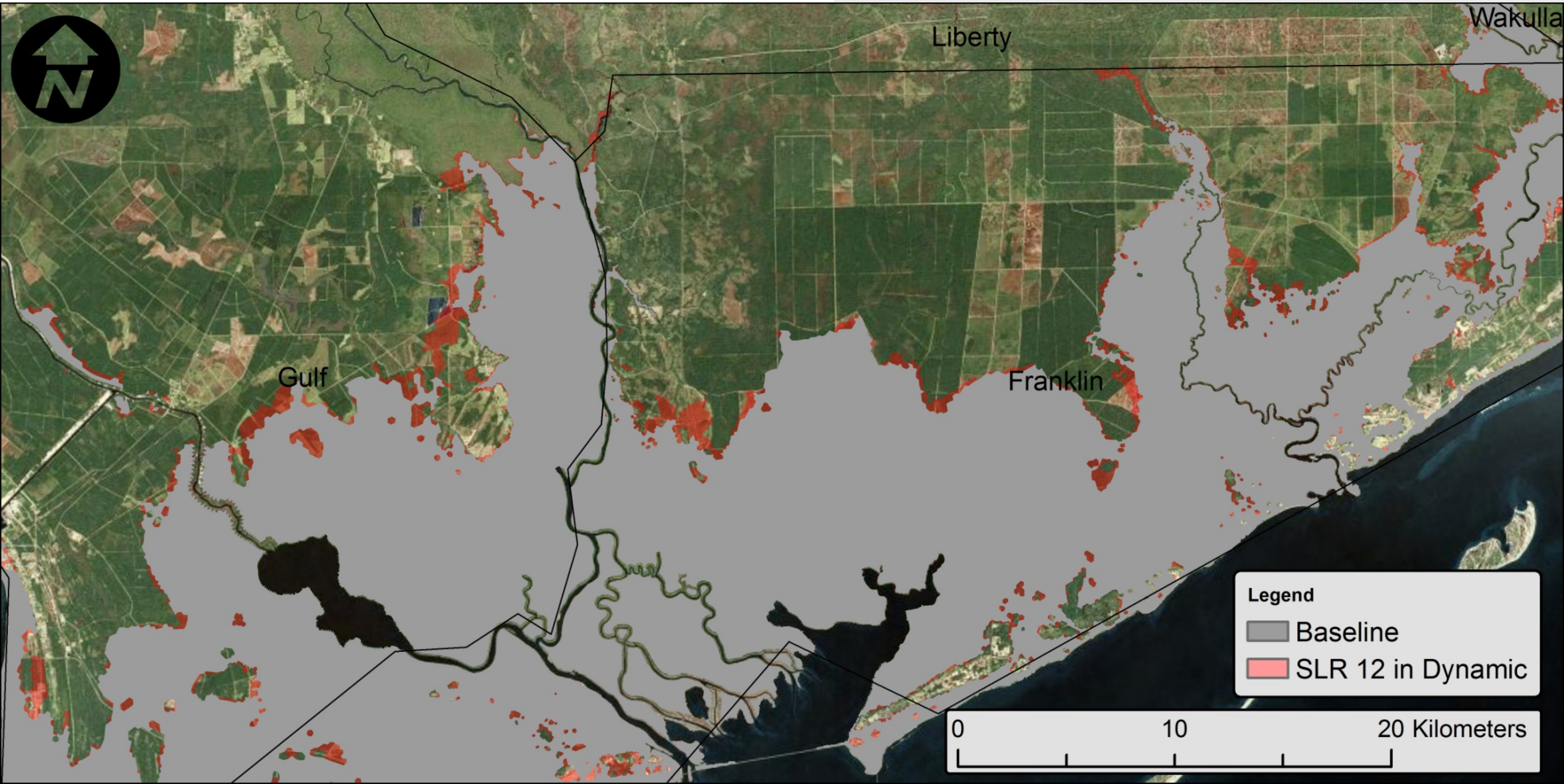




Surge w/30.5 cm SLR

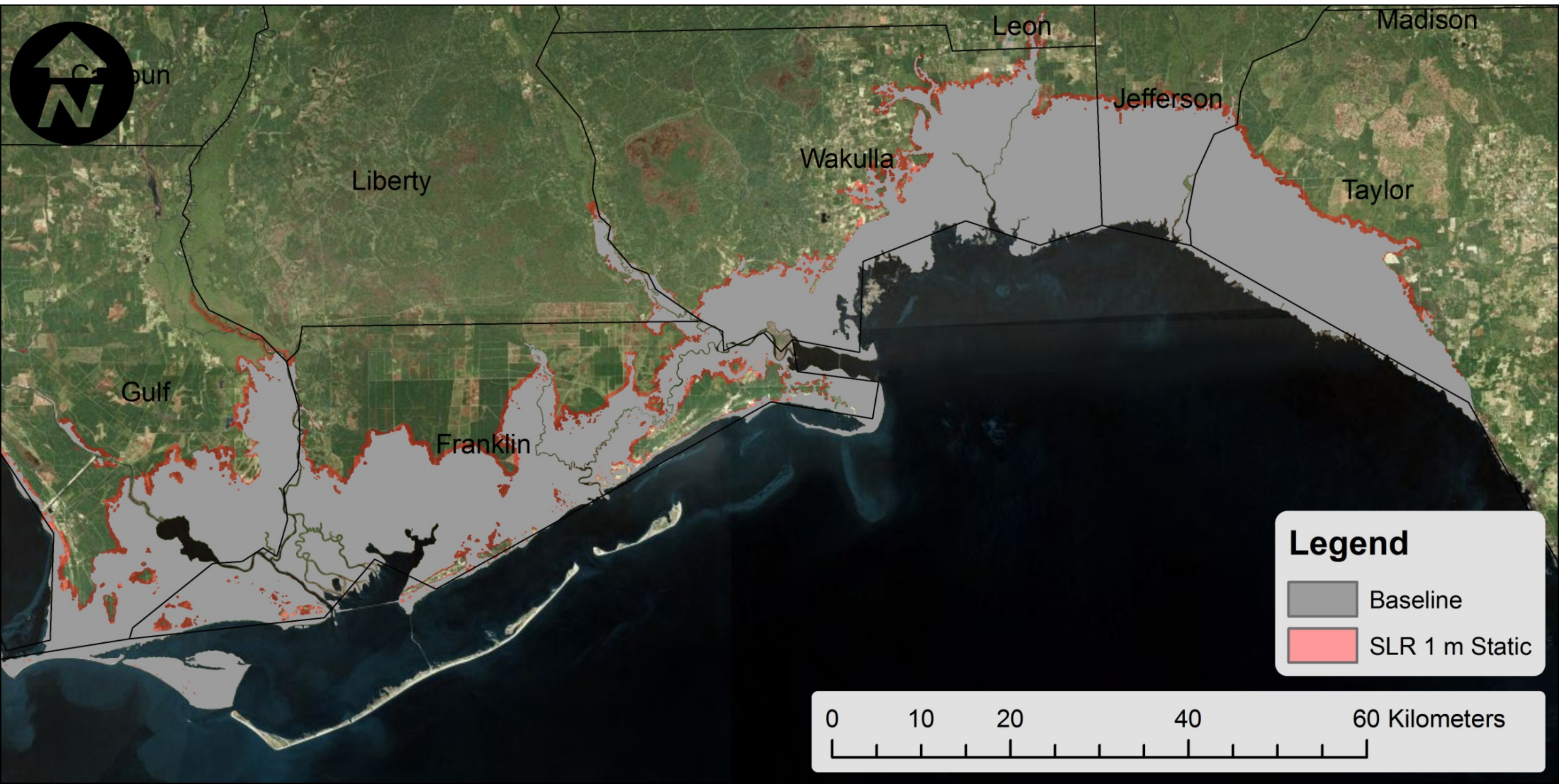
Dynamic





Surge w/1.0 m SLR

Static



Surge w/1.0 m SLR

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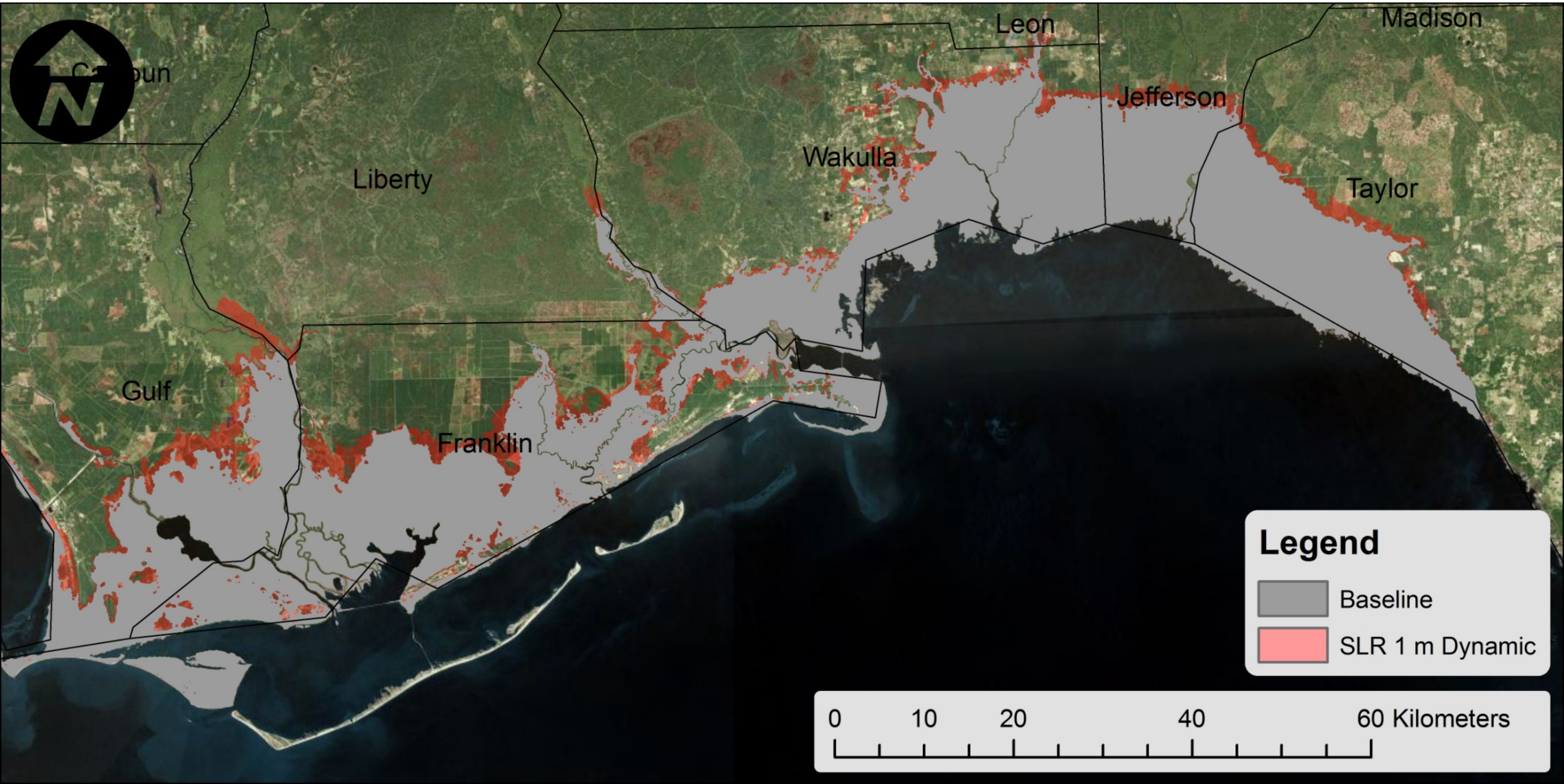
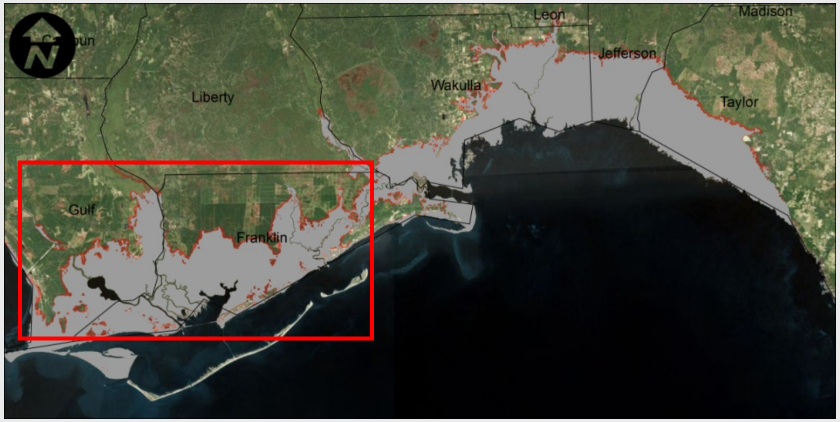
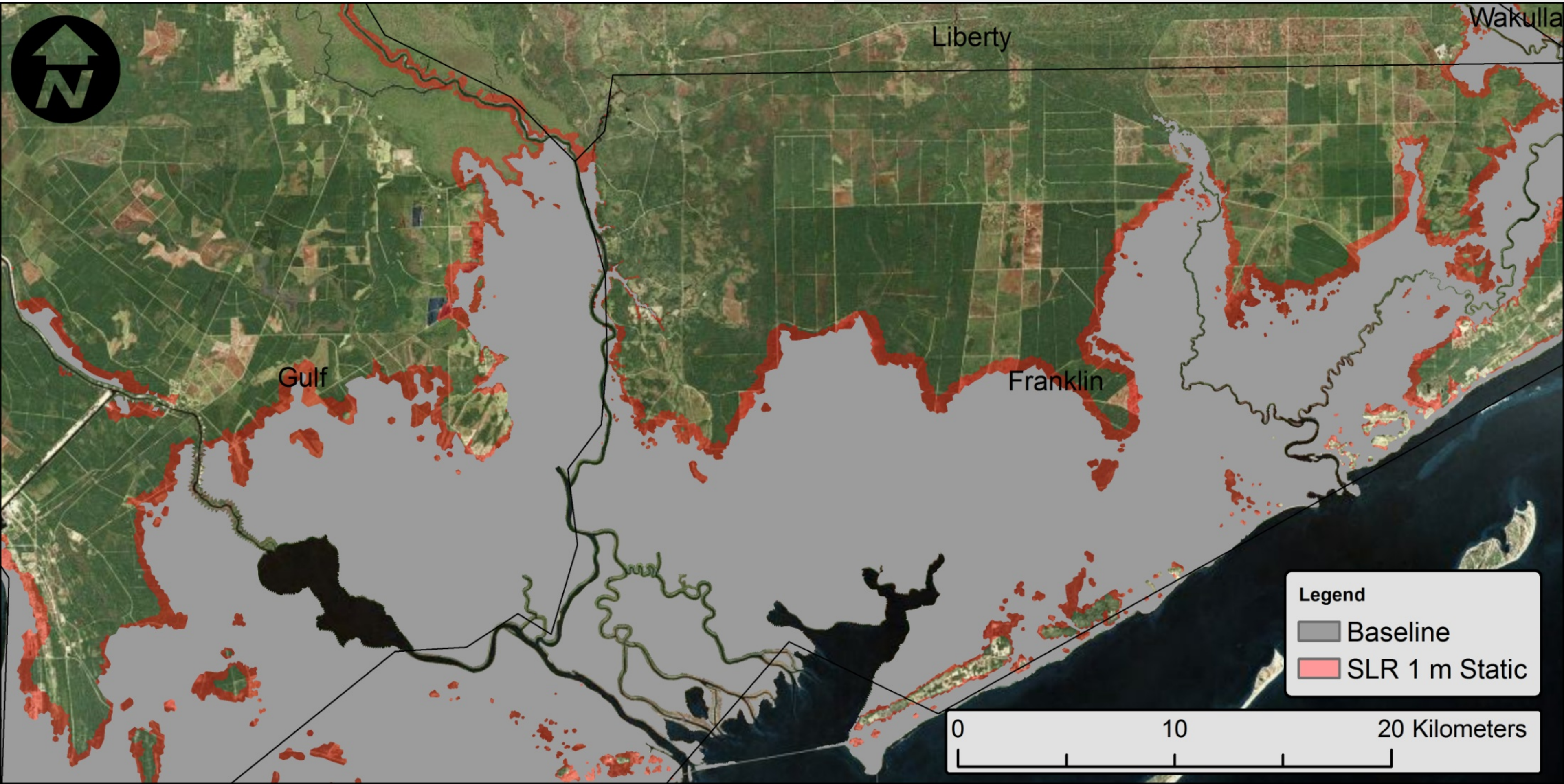


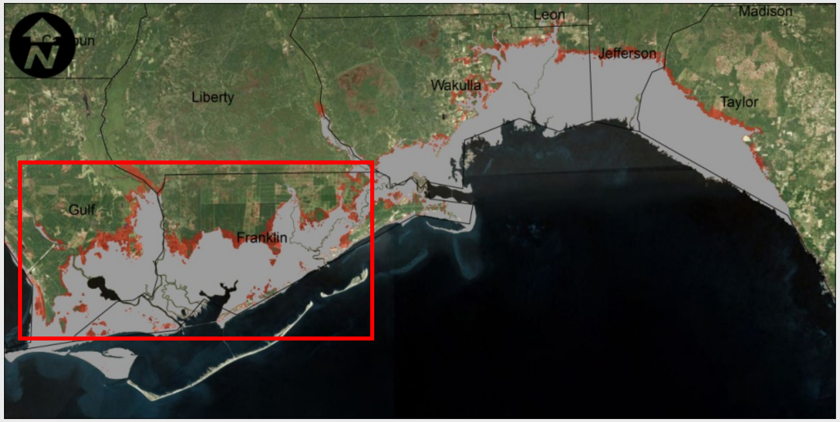
Surge w/1.0 m SLR

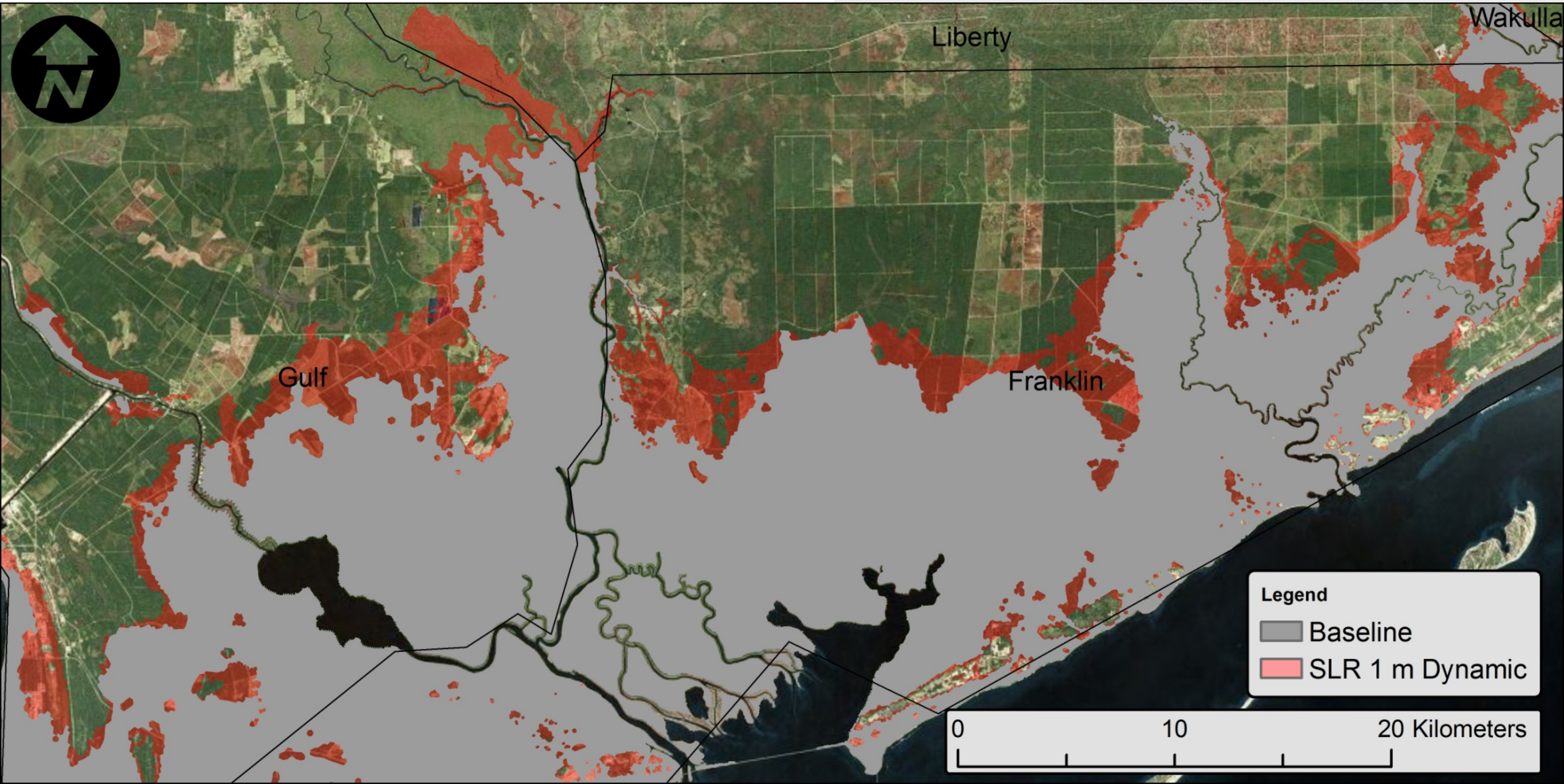
Static





Surge w/1.0 m SLR Dynamic





Surge w/1.0 m SLR

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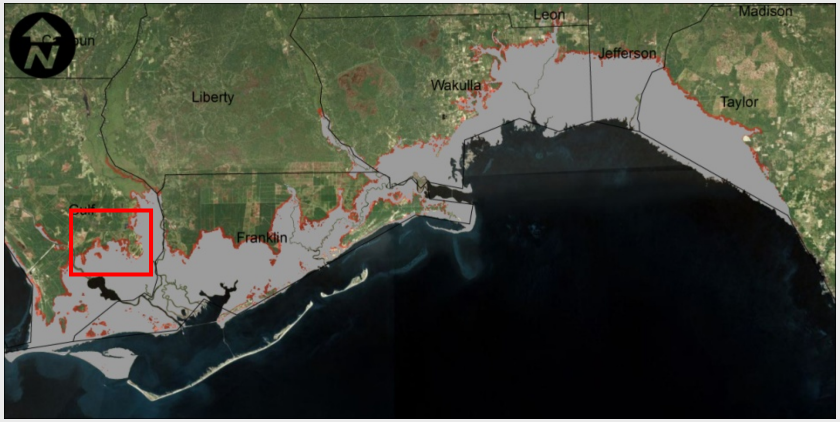
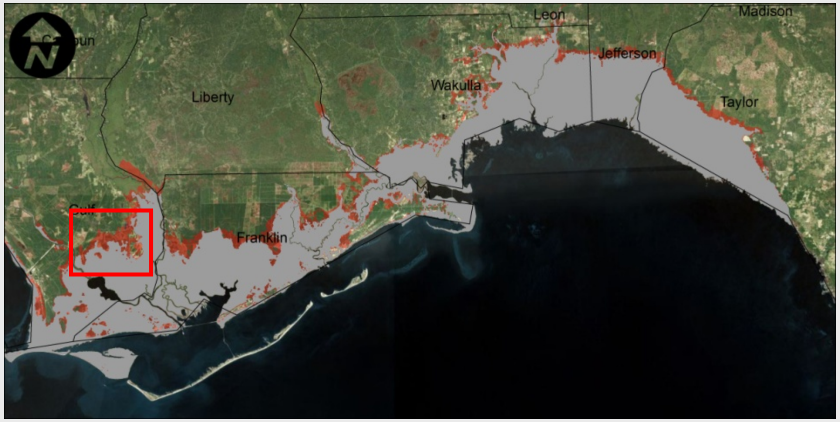
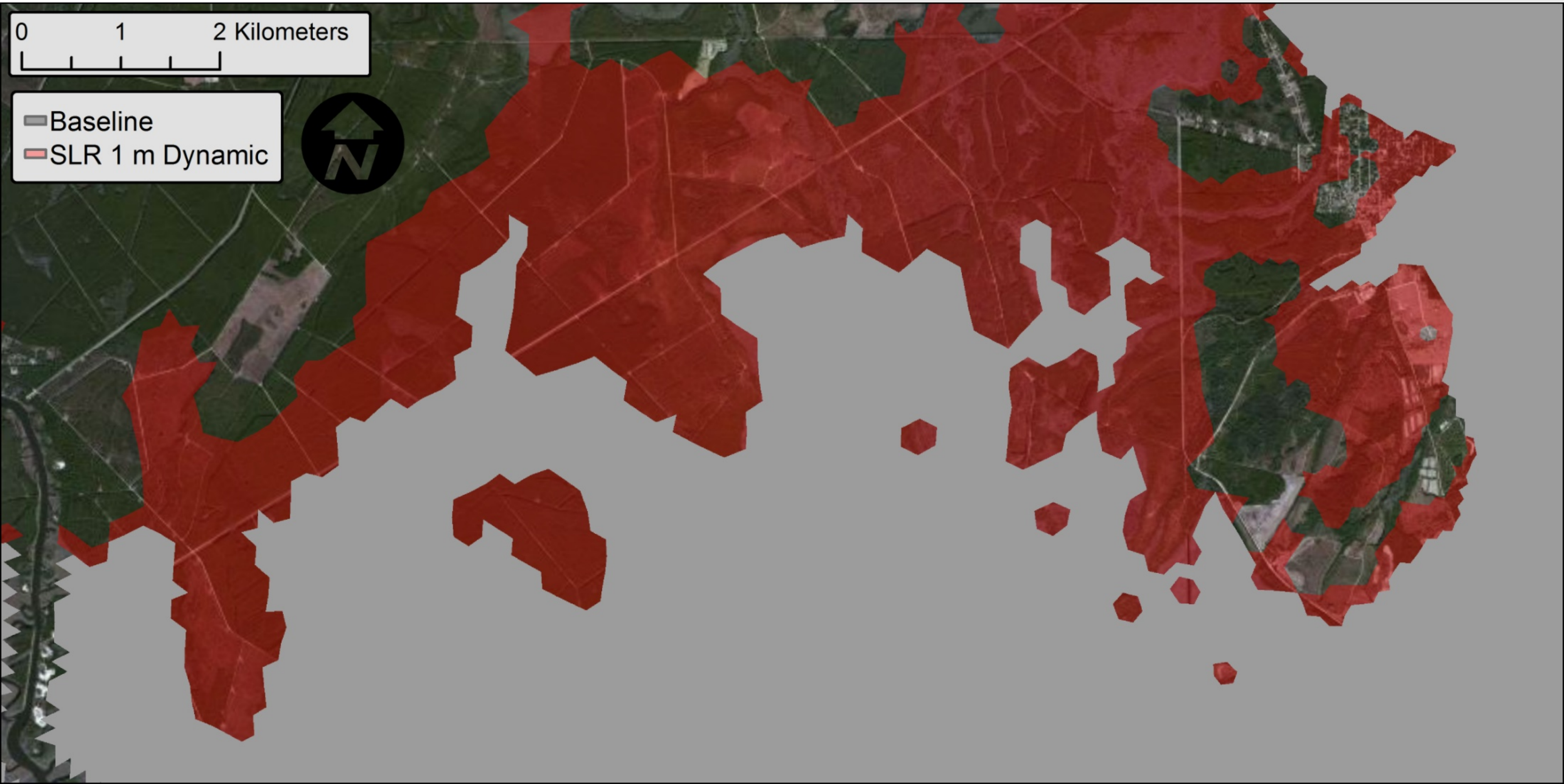


Surge w/1.0 m SLR Dynamic





Floodplain impacted by SLR

Sea level rise (m)	Approach	Area (km^2)
Astronomic tides		
0.152	Static	34
	Dynamic	41
0.305	Static	99
	Dynamic	137
1.000	Static	534
	Dynamic	626
Storm surge		
0.152	Static	58
	Dynamic	54
0.305	Static	102
	Dynamic	104
1.000	Static	247
	Dynamic	360

Discussion

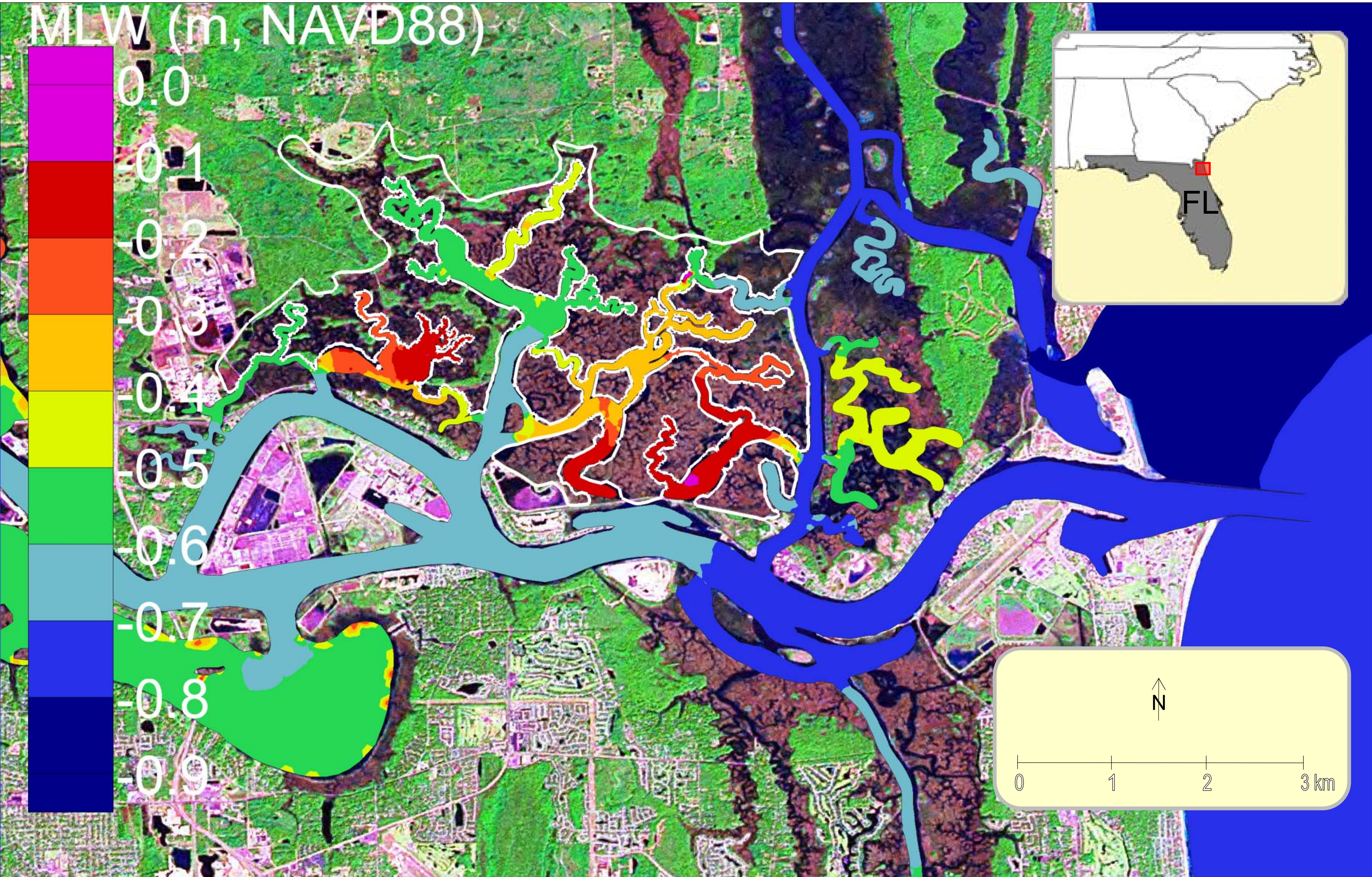
- Top contributing storms were identified,
  i.e., storms contributing to the 500-yr floodplain
- Of the top five contributing storms:
  - Two are Category 4
  - Three are Category 3
- More attributes than storm strength alone,
  - i.e., Saffir-Simpson scale is lacking
- In fact, landfall location relative to the floodplain is a critical factor towards surge inundation
  - leading to spatial variability surge inundation

Conclusions

- Tide & surge inundation are nonlinearly related to sea level rise (SLR)
- We recommend using a dynamic approach since it deterministically identifies impacted area*

* The following five slides demonstrate a biologically dynamic relationship in a coastal marsh region.

MLW in coastal St. Johns: Present Sea



MLW in coastal St. Johns: 30.5 cm SLR

Calculation procedure

MLW & MHW

are determined via analysis of simulated tidal record

Biomass production

is determined by applying biomass curve spatially

E_n elevation

obtained from DEM of hydrodynamic model

D_n relative elevation

$D_n = f(E_n; \underline{MLW_n \;\&\; MHW_n})$

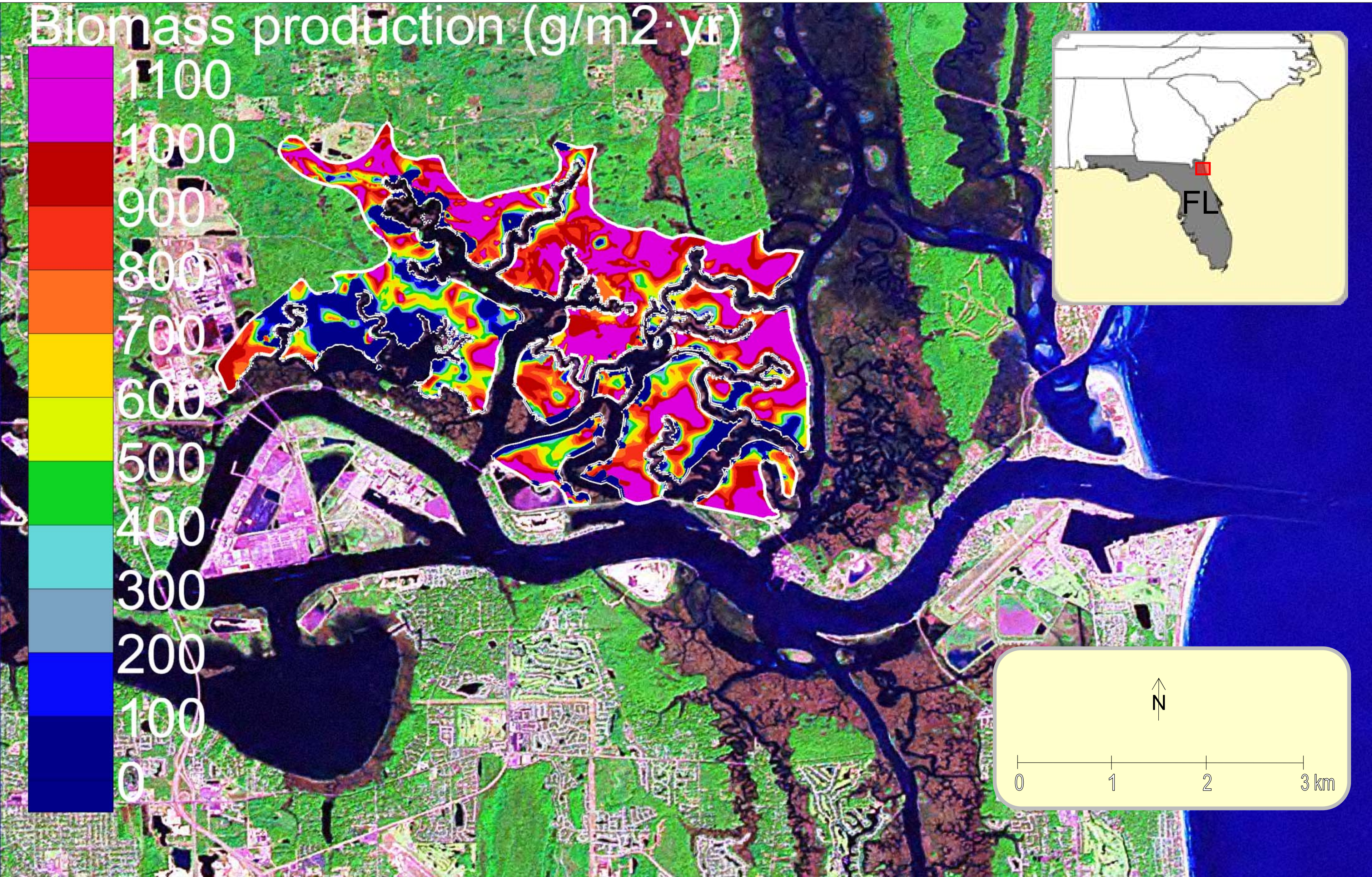
B_n production

$B_n = f(D_n; \underline{a_n, b_n, \;\&\; c_n})$

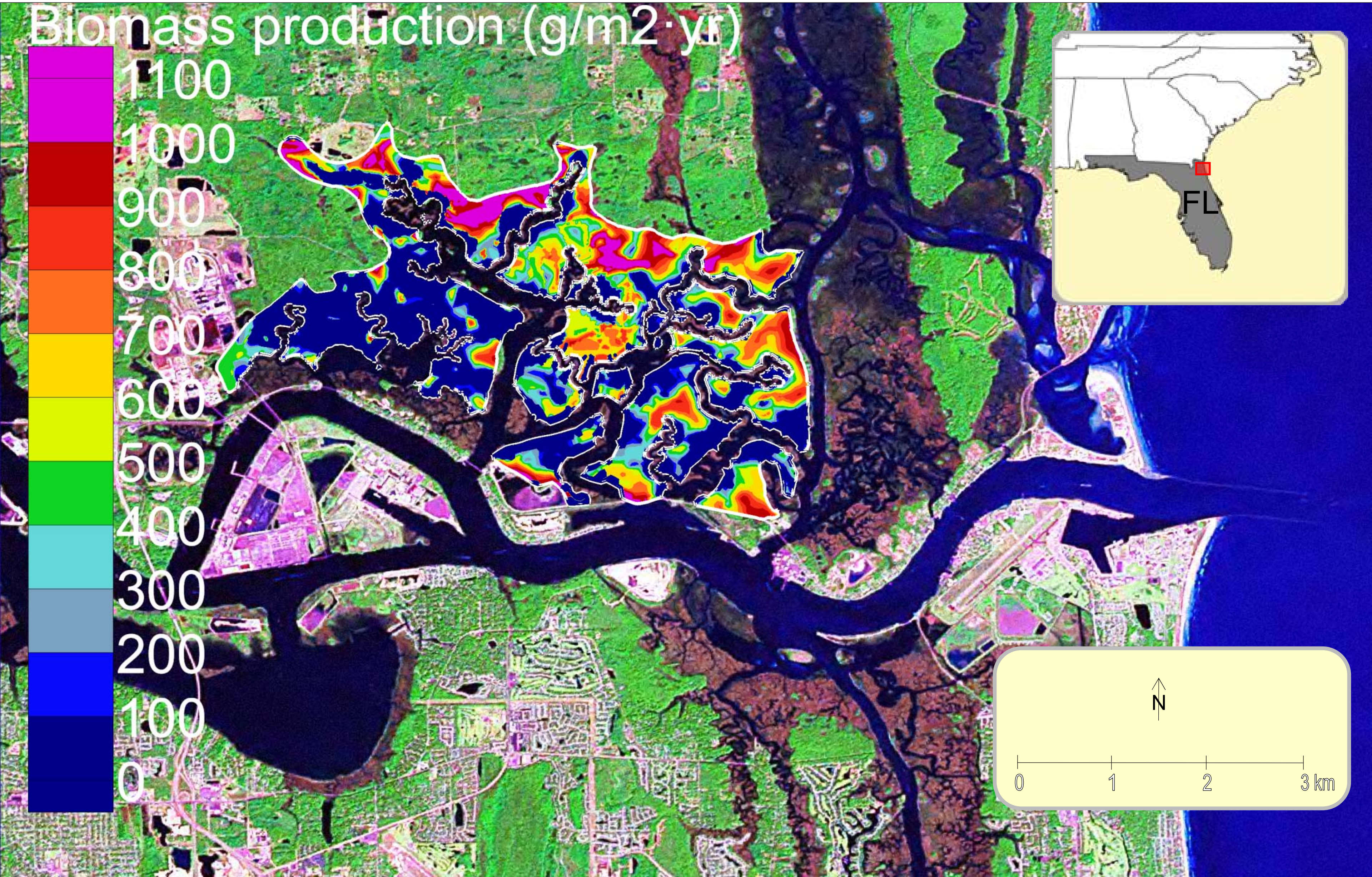
Tidal modeling & analysis

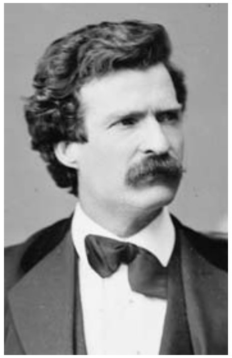
Biomass curve

Biomass production: Present sea state



Biomass production: 30.5 cm SLR.





Samuel Clemens
(a.k.a., Mark Twain)

"The smell of sulphur is strong,
but not unpleasant to a sinner."