Users and Uses of SLR information: A Typology

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How have users acted on SLR science?

- Consideration of SLR in policy, planning, design (Berke et al., 2019; Herb et al., 2019; Fu et al., 2017; Woodruff & Stults, 2016)
- Adaptation actions by different users
- Neither specific with regard to choices regarding scientific basis for decisions

So far, we've found:

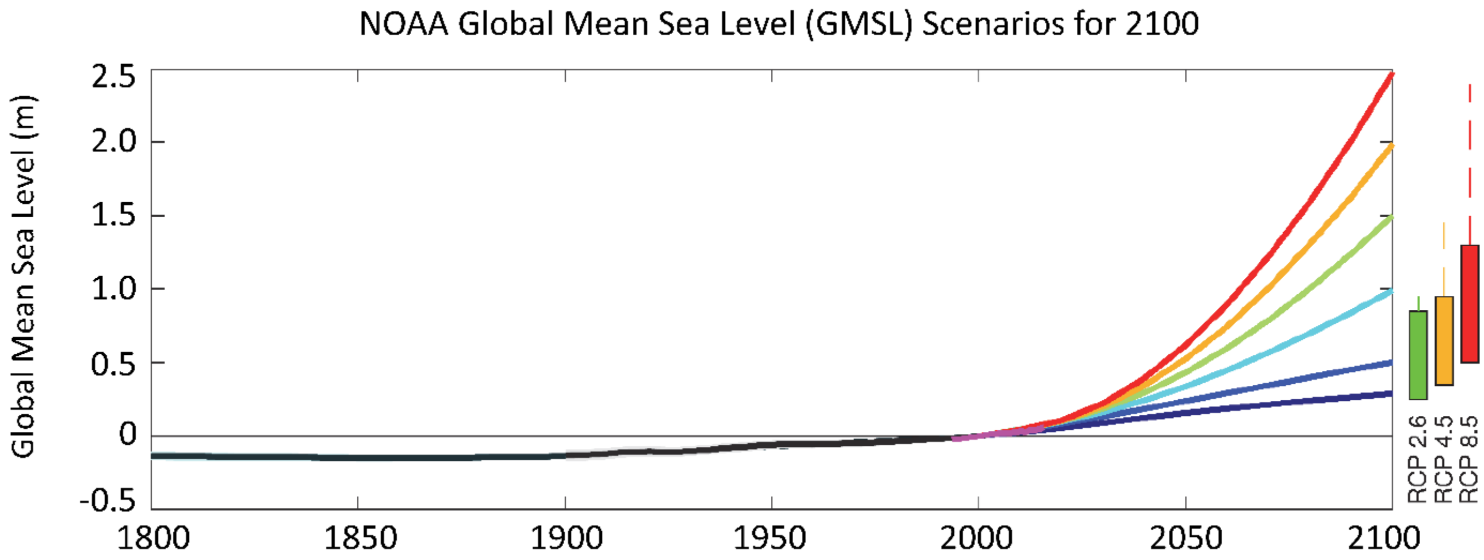
1. Three basic approaches to using SLR science
   a. 1 Line
   b. 1 Curve
   c. 2+ Curves
2. Science is actionable, but different "actions" have different needs with regard to scientific basis for SLR

We use thematic coding to analyze users' documents

- United States
  - Policy and Management Documentation
  - Environmental Consents Documentation
- Federal, State, Local/Project Scale
- Published after 2013

- Thematic Coding
  - Geographic Scale
  - Authorities / Governance
  - Action (e.g., planning, design, etc.) (Biagini, 2014)
  - Scientific Basis
  - Planning Horizon
  - Risk
  - Uncertainty

Users act on both probabilistic and scenario-based science



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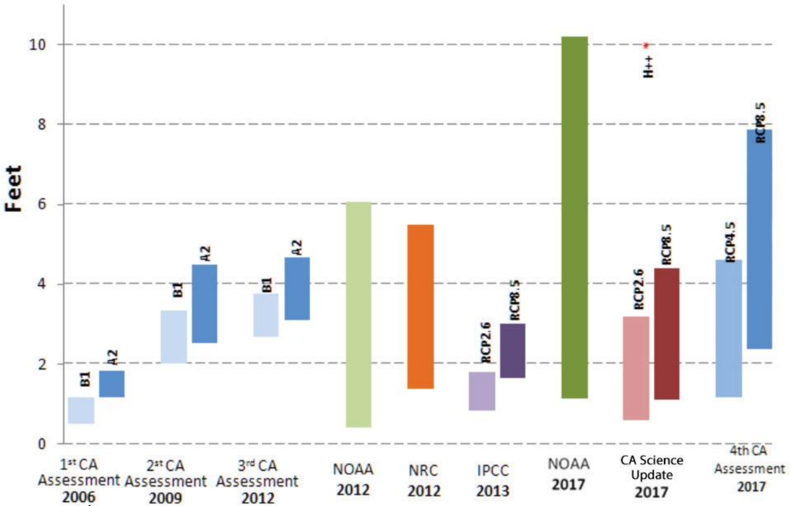

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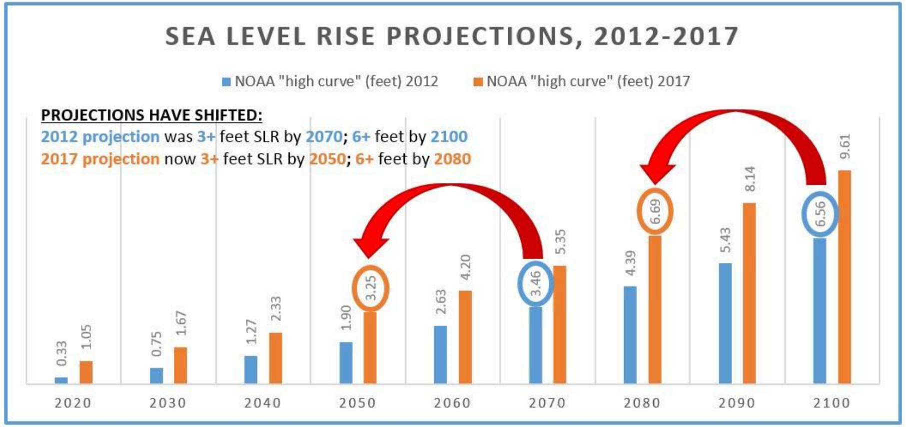


Rhode Island Coastal Resources Management Council Shoreline Change SAMP Volume I (2018)

Type 1

Linear Trend in SLR

Users weight empirical data greater than future modeled data or scenarios

Examples

- Monomoy Wildlife Refuge (Infrastructure)
- Delfin LNG EIS (Infrastructure)

Type 2

1 SLR Curve

User determination of “best available science” and a risk determination from user for each use

Examples

- Hudson Tunnel Project EIS (Infrastructure)
- NYC Resilience Design Guidelines (Policy)
- PANYNJ Design Guidelines (Management)
- Rhode Island SAMP (Policy)

Type 3

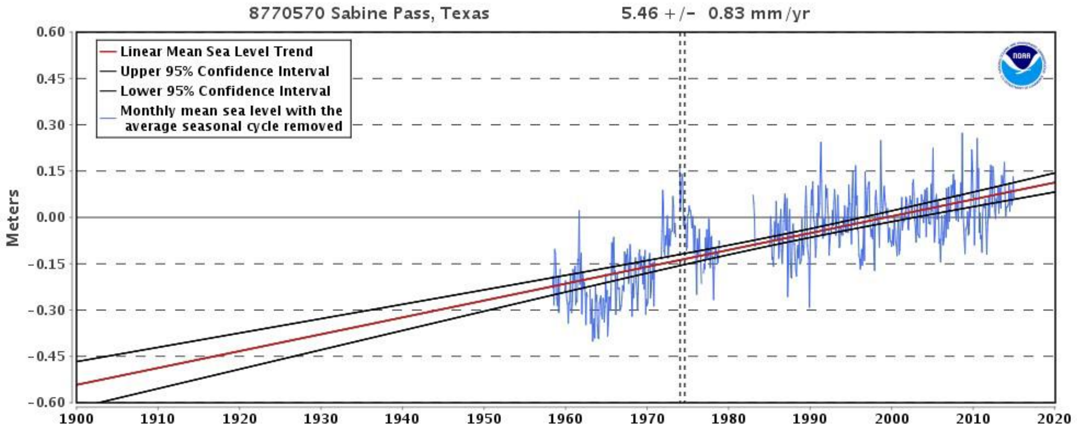
2+ SLR Curves

Provides a decision range for a user to examine adaptive capacity, cost sensitivity, or critical thresholds related to different uses

Examples

- San Francisco Capital Planning (Management)
- Calcasieu Lock (Infrastructure)
- Terrebonne Parish Levee (Infrastructure)
- NAVFAC Guidance (Management)
- California Guidance (Policy)

Type 1: Linear Trend



The mean sea level trend is 5.46 mm/year with a 95 percent confidence interval of ±0.83 mm per year based on monthly mean sea level data from 1958 to 2013. This is equivalent to a change of 10.7 inches in 50 years; however, the confidence level decreases as the projection progresses in time.

- Places weight of decision on empirical data
- Some users attempt to explicitly refute through management and planning and policy documents at the federal, state and local level
- No longer a justifiable **LOWER** bound?

Type 2: 1 SLR Curve

Table 4 - Determine the sea level rise-adjusted design flood elevation for critical and non-critical facilities[55]				
Critical* facilities				
End of useful life	Base Flood Elevation (BFE)[56] in NAVD 88	+ Freeboard[57]	+ Sea Level Rise Adjustment[58]	= Design Flood Elevation (DFE) in NAVD 88
Through 2039	FEMA 1% (PFIRM)	24"	6"	= FEMA 1% + 30"
2040-2069	FEMA 1% (PFIRM)	24"	16"	= FEMA 1% + 40"
2070-2099	FEMA 1% (PFIRM)	24"	28"	= FEMA 1% + 52"
2100+	FEMA 1% (PFIRM)	24"	36"	= FEMA 1% + 60"
Non-critical facilities				
End of useful life	Base Flood Elevation (BFE) in NAVD 88	+ Freeboard	+ Sea Level Rise Adjustment	= Design Flood Elevation (DFE) in NAVD 88
Through 2039	FEMA 1% (PFIRM)	12"	6"	= FEMA 1% + 18"
2040-2069	FEMA 1% (PFIRM)	12"	16"	= FEMA 1% + 28"
2070-2099	FEMA 1% (PFIRM)	12"	28"	= FEMA 1% + 40"
2100+	FEMA 1% (PFIRM)	12"	36"	= FEMA 1% + 48"
Additional analysis should be conducted to incorporate wave action and wave run-up in DFE calculations especially in areas that are located within the FEMA's 1% annual chance Limit of Moderate Wave Action (LiMWA) zone. Wave run up is the maximum vertical extent of wave uprush above surge.				

NYC Mayor's Office of Recovery and Resiliency (2018)

CRMC has adopted the high curve and 83% confidence interval, a worse-case scenario, for two reasons. First, NOAA (2017) has recommended using the "worst-case" or "extreme" scenario to guide overall and long-term risk and adaptation planning. Second, CRMC views use of worse-case scenarios as a way to hedge against the uncertainties inherent in projecting future SLR.

Rhode Island Coastal Resources Management Council (2018)

- Associated with:
  - Management and Planning, Policy
- Choices or based on asset lifecycle, asset type, or other dimensions of decision
- Choices based on risk posture:
  - Precautionary
  - "Likely"
  - Empirical / research base

Type 3: 2+ SLR Curves

Table 14-5
Projected Potential 1-Percent Annual Probability Flood Elevations
New York Sites (feet NAVD88)

Site	Current Base Flood Elevation[1]	NPCC Projection of Future Flood Elevations (Middle to High Range)[2]		
		2020s (+8" to +10" over Current BFE))	2080s (+39" to +58" over Current BFE))	2100 (+50" to +75" over Current BFE))
Portals and Existing North River Tunnel Vent Shaft	11'	12'	14' to 16'	15' to 17'
Twelfth Avenue Vent Shaft and Fan Plant	12'	13'	15' to 17'	16' to 18'

Sources: 1. FEMA, 2013.
2. NPCC, 2015.

Hudson Tunnel Project EIS (2017)

Assess Project Vulnerability to Permanent Inundation from SLR

10. Subtract MHHW (9) from the Project Elevation (6)

a) Difference in feet: 0.0_________ft

A negative number indicates that the project is below MHHW today and is at risk. If the number is positive, this is the amount of sea level rise needed to result in permanent inundation at your project location.

b) Is the Project vulnerable to permanent inundation during the functional lifespan using <u>the most likely SLR scenario</u>? (Yes if the value of question 7a is greater than the value of question 10a).

☒ **Yes**: The project is at risk and requires design considerations that address most likely sea level rise.

☐ **No**: Not at risk. Go to 10c.

The Project is vulnerable to permanent inundation during the functional lifespan if SLR raises MHHW above the Project Elevation.

c) Is the Project vulnerable to permanent inundation during the functional lifespan using the upper range SLR scenario? (Yes if the value of 7b is greater than the value of 10a)

☒ **Yes**: The project may be at risk at upper range SLR. This requires either a finding of adaptive capacity OR identification of adaptation strategies that address upper range SLR.

☐ **No**: Assess temporary flooding risk below.

Guidance for Incorporating Sea Level Rise into Capital Planning in San Francisco (2015)

- Associated with two different decision documents
  - Physical Infrastructure, "Green" Infrastructure
  - Public / multi-stakeholder processes or recommendations by expert panels
- Using 2+ Estimates allows for:
  - Adaptive management pathways
  - Critical thresholds
- Complicating factors:
  - Incorporating Type 2 actions where geographies or authorities overlap
  - Different jurisdictions adopt/update scientific basis on different timelines

Evolving bounds to science and policy approaches

Key Findings:

1. Users document at least three different approaches for taking action on sea level change
2. Recent policy and management actions from some users explicitly identify "Type 1" analysis as insufficient
3. What users "do" or "have done" remains allusive. Relatively few executed projects and audit mechanisms.

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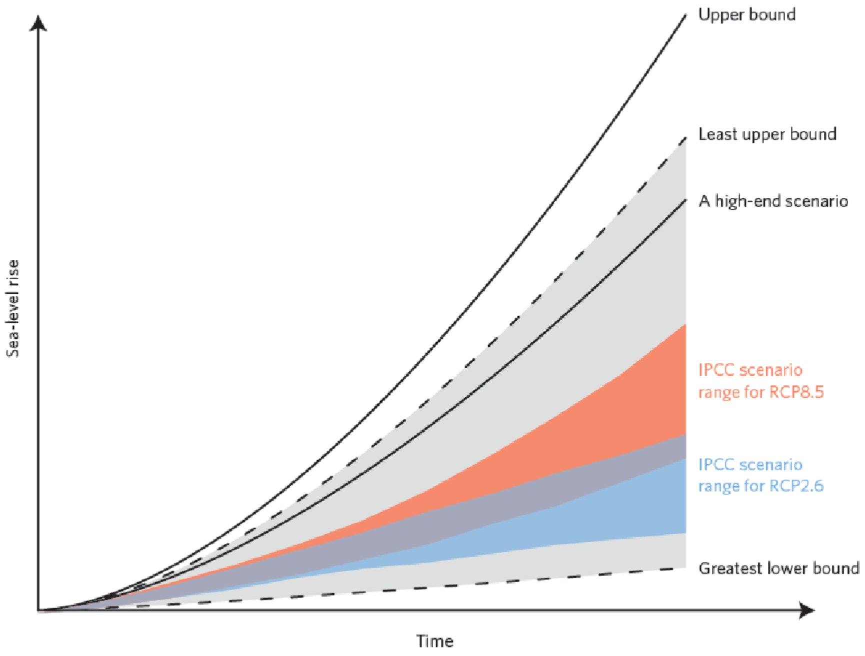
Evolving bounds to science and policy approaches

Key Takeaway: Selection of bounds for Users / Uses:

1. What is 'best available'?

2. What is a plausible **UPPER** bound?
   a. Uncertainty in SLR and low-probability, high consequence outcomes
3. What is a justifiable **LOWER** bound?
   a. How much adaptation is enough? (Hall et al., 2012)
   b. Justify through empirical data?
   c. Risk approach and authority (e.g., precautionary)?



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