CoastWise Topic 1: Selecting and Integrating Sea Level Rise Scenarios

Photo: Matt Craig

Background

Selection of one or more sea level rise (SLR) scenarios is a fundamental element of the CoastWise Approach because long-lived infrastructure like road crossings must be designed to perform optimally during the structure's entire service life, which may last 75 years or more. SLR scenario selection is best accomplished using a criteria-based approach. CoastWise achieves this by providing a decision-making process based on site characteristics, access needs, and risk tolerance. It's also important to select an SLR scenario early in the project process to frame the context of important elements of the CoastWise Approach, such as identifying potential risk factors that can influence the crossing design considerably.

1. Select One or More Sea Level Rise Scenarios

In their December 2020 "Four-Year Plan for Climate Action"[1], the Maine Climate Council recommended that "the state consider committing to manage for 1.5 feet of relative sea level rise by 2050, relative to the year 2000, and 3.9 feet of sea level rise by the year 2100". They also recommended that the state "consider preparing to manage for 3.0 feet of relative sea level

[1] Maine Climate Council 2020. Maine Won't Wait: A Four-Year Plan for Climate Action.

rise by 2050, and 8.8 feet of sea level rise by the year 2100". The Council stated that "the high scenarios [3.0' of increase by 2050 and 8.8' of increase by 2100] are important for decisions about long-lifespan infrastructure and facilities that are critical for public safety and local economies".

These recommendations provide a rationale for projects to select any of several sea level rise scenarios (Figure 1) ranging from the Intermediate scenario (3.9’ by 2100) to the High scenario (8.8’ by 2100). Applying the recommendations to road crossing design process requires recognition that in many settings road crossings should ideally have a relatively long lifespan, especially at sites where there is low tolerance for interrupted service to critical services and other important assets as a result of flooding or other risk factors.

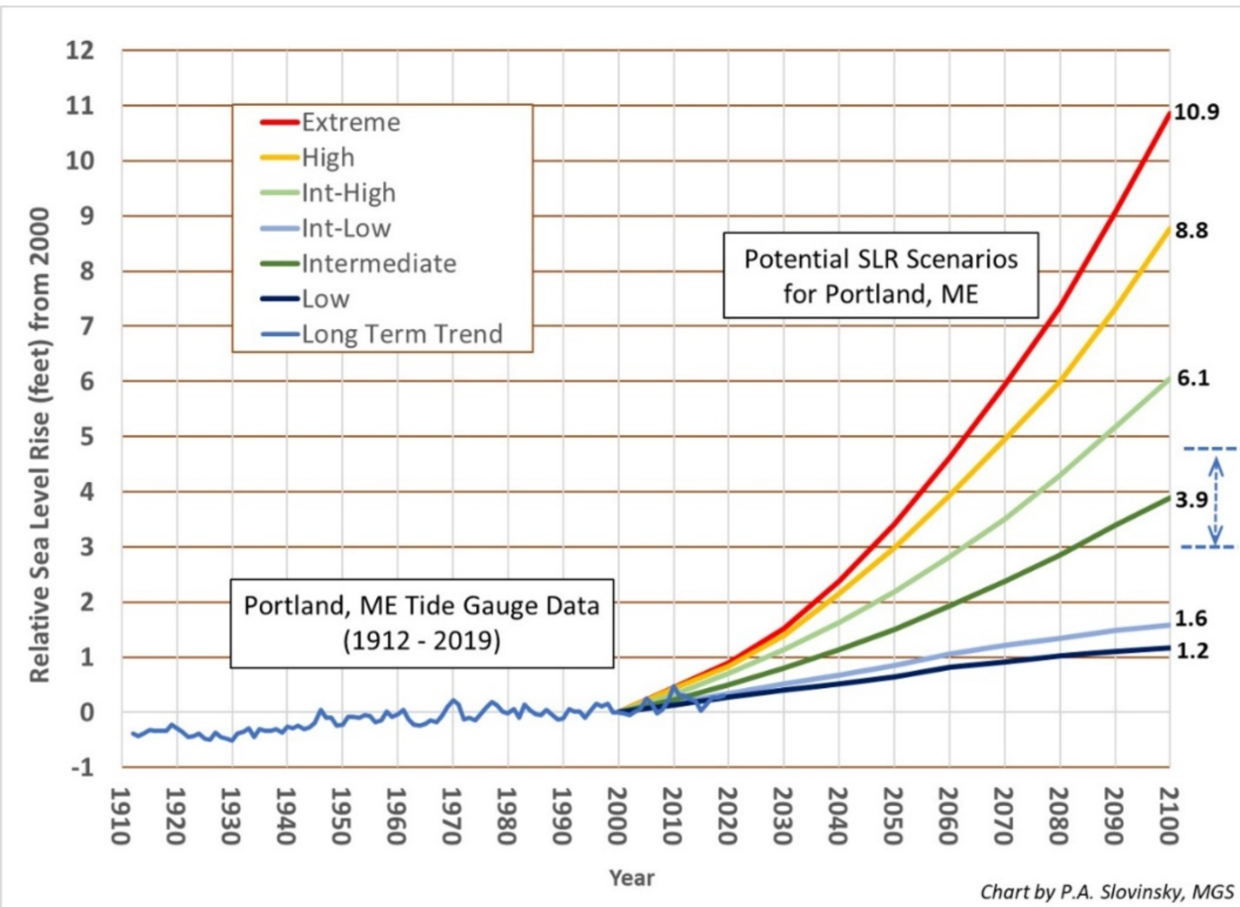

Figure 1. Sea level rise scenarios.

CoastWise provides a risk-based sea level rise selection process similar to New Hampshire's framework[2]. It assigns categories representing the local tolerance for flooding and other risk factors (high to very low) based on site characteristics (Table 1). CoastWise then aligns the Maine Climate Council's recommendations with tolerance categories to project sea level rise elevations in the coming decades (Table 2).

Table 1. Framework for determining crossing risk tolerance, adapted from New Hampshire coastal flood risk guidance[2].

	Risk Tolerance for the Crossing			
	HIGH	**MEDIUM**	**LOW**	**VERY LOW**
CROSSING CHARACTERISTICS	Access to low value or cost assets	Access to medium value or cost assets	Access to high value or cost assets	Access to very high value or cost assets
	Easy or likely to adapt	Moderately easy or somewhat likely to adapt	Difficult or unlikely to adapt	Very difficult or very unlikely to adapt
	Little to no implications for public function and/or safety	Moderate implications for public function or safety	Substantial implications for public function or safety	Critical implications for public function or safety
	Low sensitivity to inundation or scour	Moderate sensitivity to inundation or scour	High sensitivity to inundation or scour	Very high sensitivity to inundation or scour
ACCESS TYPE	Access to residential area			
	Access to conserved or working lands (agriculture, forestry, etc.), temporary or accessory structures, minor storage	Access to light commercial or industrial	Access to school, community center, public gathering facility, care facility, childcare, commercial hub, sensitive storage or industrial	Access to hospital, public safety, power generating facility, emergency shelter, drinking water supply, essential communications facilities, storage of potentially hazardous or toxic materials
RECOMMENDED COASTAL FLOOD RISK PROJECTIONS	Lower magnitude, higher probability			Higher Magnitude, Lower probability

[2] NH Coastal Flood Risk Science and Technical Advisory Panel (2020). New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections. Report published by the University of New Hampshire, Durham, NH.

Table 2. Recommended relative sea level rise estimates (in feet above 2000 levels) based on Intermediate and Intermediate High scenarios from Sweet et al. 2017[3], project timeframe, and project risk tolerance.

TIMEFRAME	**HIGH** RISK TOLERANCE[a]	**MEDIUM** RISK TOLERANCE[b]	**LOW** RISK TOLERANCE[c]	**VERY LOW** RISK TOLERANCE[d]
	Plan for the following relative sea level rise estimates (ft)* *Compared to sea level in the year 2000*			
	Lower magnitude, higher probability	⟵⟶		Higher Magnitude, Lower probability
2030	0.8	1.0	1.1	1.4
2050	1.5	1.9	2.2	3.0
2070	2.4	2.9	3.5	5.0
2100	3.9	4.6	6.1	8.8

[a] Corresponds with Intermediate scenario, central estimate
[b] Corresponds with Intermediate scenario, upper end of “likely” estimates range (17% probability of exceedance).
[c] Corresponds with Intermediate High scenario, central estimate (50% probability of exceedance).
[d] Corresponds with High scenario, central estimate (50% probability of exceedance).

2. Apply Uncertainty and Risk Tolerance in Design Flood Elevations

Following determination of the sea level rise estimates, the CoastWise approach recommends generating sea level rise-adjusted design flood elevations based on flood risk tolerance. This approach uses mapped FEMA base flood elevations as the baseline and adds the selected sea level rise plus varying levels of freeboard according to the risk tolerance category to arrive at the estimated design flood elevation[4]. The base flood elevation and freeboard requirements match the recommendations of the ASCE Flood Resistant Design and Construction standard (24-14)[5], which vary by ‘flood design class’. The risk-based approach correlates risk tolerances levels with the ASCE flood design classes (Table 3).

By default, this approach integrates tidal and non-tidal contributions to coastal flooding. In some instances, it may be necessary or advisable to determine baseline flood elevations

[3] Sweet et al. 2017.
[4] NH Coastal Flood Risk Science and Technical Advisory Panel (2020). New Hampshire Coastal Flood Risk Summary, Part II: Guidance for Using Scientific Projections. Report published by the University of New Hampshire, Durham, NH.
[5] Highlights of ASCE 24-14 Flood Resistant Design and Construction. (2015). Published by FEMA. https://www.fema.gov/media-library/assets/documents/14983.

through different methods involving site-specific modeling of the combined effects of tidal and non-tidal flooding components. For instance, for crossings with substantial freshwater components, the Project Team may want to integrate predicted future precipitation trends into the estimated freshwater flooding component. There are multiple potential approaches to consider this in project design. Appendix B of the CoastWise manual discusses several modeling scenarios that combine varying extreme event conditions.

Table 3. Relative sea level rise adjusted design flood elevations (DFE), based on risk tolerance.

<table>
<tr><th></th><th>HIGH
RISK TOLERANCE</th><th>MEDIUM
RISK TOLERANCE</th><th>LOW
RISK TOLERANCE</th><th>VERY LOW
RISK TOLERANCE</th></tr>
<tr><td>IF PROJECT AREA IS LOCATED IN:</td><td colspan="4">Relative Sea Level-Adjusted Design Flood Elevation (DFE) =</td></tr>
<tr><td>A, AO, or AE Zone Not Identified as Coastal A Zone</td><td rowspan="2">Base Flood Elevation +
Relative Sea Level Rise</td><td rowspan="2">Base Flood Elevation +
Freeboard ≥ 1 foot
+
Relative Sea Level Rise</td><td>Base Flood Elevation +
Freeboard ≥ 1 foot
+
Relative Sea Level Rise</td><td rowspan="2">Whichever is Greater:

Base Flood Elevation +
Freeboard ≥ 2 foot
+
Relative Sea Level Rise

OR

0.2% Annual Chance
Flood Elevation
+
Relative Sea Level Rise</td></tr>
<tr><td>VE Zone and Coastal A Zone</td><td>Base Flood Elevation +
Freeboard ≥ 2 foot
+
Relative Sea Level Rise</td></tr>
</table>