Workshop on Resilience of Navy Waterfront Facilities in a Changing Climate
Potential Discussion Questions

General

(1) Background on Risk Category: ASCE/SEI 7 specifies Risk Category I to IV and assigns different Mean Recurrence Interval (MRI) or Annual Exceedance Probability (AEP), where MRI = 1/AEP for a stationary climate load.

Q--General –1: Should Cumulative Probability of Exceedance during a design service life (e.g., 50 years) replace MRI or AEP, when considering non-stationary loads?

Q--General –2: How is the Risk Category or Design Class defined for design of piers and wharves? Do we need Risk Category V?
(note: ASCE/SEI 7 specifies Risk Category for (i) the public safety (e.g., loss of life) and (ii) the functionality to support a public community (e.g., hospitals or fire stations). The waterfront facilities may be categorized for (i) the public safety (e.g., ferry terminals vs. private docks); (ii) the functionality (e.g., military ammunition piers, Risk Category V); (iii) environmental compliance (e.g., waterway pollution); and (iv) total owner's costs).

ASCE 61 uses Risk Category High (H), Medium(M), and Low (L).

Q--General –3: ASCE/SEI 7 switched from Uniform Hazard (e.g., seismic Level I and II) to Uniform Risk approaches (e.g., 1% collapse rate within 50-year design lifetime). Which approach should ASCE/COPRI design standard for piers and wharves follow?

(2) Background on Uncertainty: Figure 4.3 in [ASCE-NOAA Tech Memo (July, 2023)] shows that the effects of model uncertainties will relatively decrease when making a further climate projection, while the uncertainties associated with selection of the climate scenario will dominate the total uncertainty. The natural variations of the climate system are no longer important when the prediction timeframe beyond 30 years.

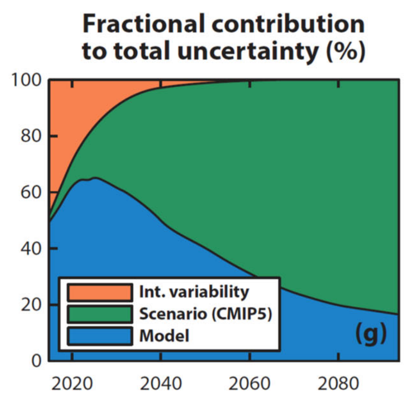

Figure 4.3. Estimates of the Relative Size of Three Sources of Future Uncertainty in Climate Projections Uncertainty may come from internal variability (the natural variations of the climate system on particular timescales), scenario uncertainty (the forcing from GHG and aerosols), and model uncertainty (the aspects of the climate system that are poorly understood and simulated). The graph starts in 2015 and runs to 2100. At 10 to 30 years in the future, scenario uncertainty accounts for 15 to 30 percent of total uncertainty.

Q--General –4: What is the appropriate timeframe for infrastructure resilience planning and design? 25 (UFC 4-151-10 General Criteria for Waterfront Construction), 50, 75 (USNA Installation Resilience Plan) or 100 years?

Q--General –5: Which climate scenario (e.g., global SLR varies 0.2m to 2.0m, depending on selection of climate scenario) should be selected? Alternatively, the target Sea Surface Temperature (SST) increase of 3 °C may be used without selecting a climate scenario and timeframe.
(note: no probability or weight associated with each of the climate scenario has been assigned because of uncertainties associated with global policies.)

Q--General –6: Structural safety and life-cycle costs are the primary considerations in current design codes, while rapid functionality recovery is the core value of infrastructure resilience planning and design. How to balance the differences between current design code requirements and the resilience planning at a community level?

Wind

(1) Background on Wind Hazard Maps: wind observation data associated with non-tropical storms (e.g., extratropical cyclones, mesoscale convective systems (i.e., thunderstorms or derechos), and other wind drivers) are included in current wind hazard maps

Q--Wind –1: Both historical observation data and climate projection model data must be used to generate the future wind hazard maps with non-stationary effects of climate change. How to ensure the quality of the wind speed database that the future wind hazard maps are based on?
(note: since the root causes of the uncertainties in these two types of dataset are different, the combination of the historical observation data and the wind speed data from climate projection models may yield unexpected results.).

Q--Wind –2: Should tropical storms be included for design of piers and wharves?
(note: ARA/NCAR/MIT/GFDL efforts among other tropical storm models may provide valuable information).

(2) Background on Wind Loads on Structures: Port of Long Beach (POLB) design code for piers and wharves specifies 95 mph for wind loads on structure, based on 2020 California Building Code (CBC) requirements (7% probability of exceedance in 50 years). Section 3.4.3 of UFC 4-152-01 refers to IBC for wind loads on structures.

Q--Wind –3: When the Sea Surface Temperature (SST) increase 1 °C, the wind speed will increase 15 to 30 mph IAW Pant and Cha (2018). If the target SST increase is 3 °C, what is the increased range of the wind speed?

(note: there is little consensus on how climate change might affect the extratropical storm and thunderstorm winds. The climate change impact of these storms is likely far less than the uncertainty associated with the historical record.)

Q--Wind –4: Is there a simplified approach to considering the surface roughness length upwind of the site or local turbulence for design of piers and wharves?
(note: the waterfront facilities most likely face a water surface with less wind channeling effects so that the historical observation data from the weather stations near airport runways may be better represent the actual design surface conditions.)

(3) Background on Wind Speeds on Mooring: POLB specifies 60 mph lasting 30 seconds for the mooring dynamic analysis (MRI = 25-year). UFC 4-159-03 specifies 40 mph (35 knots) wind speed in operation for Type I: mild weather mooring. ASCE/COPRI specifies different MRI for normal, severe, and limiting mooring.

Q--Wind –5: How should the highly correlation between the wind speed and the mooring load be considered?
(note: either joint probability distribution density or a scaling factor can be used.)

Q--Wind –6: How do extreme wind speed and SLR affect the mooring load direction?
(note: current design codes specify 30 degrees. In addition, the mooring cables apply tension forces to a structure only.)

Coastal Flooding and SLR

(1) Background on Coastal Flooding: ASCE/SEI 7-22 Supplement and ASCE/SEI 24 specifies the flood depths with different MRI in accordance with Flood Design Class (similar to Risk Category I to IV). The local/regional effects are included in FEMA flood insurance maps by National Flood Insurance Program (NFIP).

Q--Flooding –1: ASCE/SEI 7-22 Supplement provides a scaling factor or multiplier to consider non-stationarity in flooding load estimation, while Canadian design codes proposed an updated risk maps inclusive of non-stationarity and local/regional effects of climate change. Which approach should ASCE/COPRI design standard for piers and wharves take?

Table 5.2. ASCE/SEI 7-22 Flood Supplement MRI and Corresponding Amplification Factors CMRI When Maps Not Available

Risk Category	MRI (years)	Annual Exceedance Probability (percent)	Flood Scale Factor CMRI (Gulf of Mexico)	Flood Scale CMRI (Other)	Flood Scale CMRI (Great Lakes)	Flood Scale CMRI (Riverine)
I	100	1.00	1.00	1.00	1.00	1.00
II	500	0.20	1.35	1.25	1.15	1.35
III	750	0.13	1.45	1.35	1.20	1.45
IV	1,000	0.1	1.50	1.50	1.25	1.50

CMRI = Flood scale factor for mean recurrence interval (MRI)

Q-Flooding –2: The compound flooding consists of (i) coastal storm surge (Muis, et al. 2022) or run-up / overtopping in Pacific wave climate (USGS and NOAA), (ii) SLR (Sweet, 2022), (iii) coastal rivers and streams due to inland rainfall (NOAA Atlas 15), and (iv) erosion potential.

Which factor(s) are the most important for design of pile-supported structures?
(note: the flow velocity is an important design parameter for preventing from the foundation failure due to scour)

Q--Flooding –3: Extreme Water Level (EWL) (e.g., MHHW or MLLW) is an important design parameter for waterfront facilities. EWL is a function of {storm surge + tides + precipitation + subsidence or rebound + SLR + ship wake}.

Which factors are the most important factors when considering climate change? And How to use the available total water levels (down-scaled) at the entire West coast (Shop, et al. 2022) to determine EWL?
(note: NOAA is currently teaming with FEMA and DoD to define EWL MRI for CONUS, inclusive of future predictions under different SLR scenarios).

(2) Background on SLR: Interagency SLR report (Sweet, 2022) including NOAA (2017) SLR vs. DoD Regional Sea Level (DRSL) vs. UFC approaches.

Q--SLR –1: Which tools are available for SLR estimation? and what are the differences between them (e.g., NOAA (2017) SLR and DRSL)?
(note: the bulkhead design at USNA used the NOAA (2017) SLR, which was very close to DRSL (2022). For example, the 50-year SLR = 2.62 ft (NOAA) vs. 2.60 ft (DRSL); the 75-year SLR = 4.30 ft (NOAA) vs. 4.40 ft (DRSL), and the 50-year storm flood = 5.4 ft (NOAA) vs. 5.6 ft (DRSL))

Q--SLR –2: Current DoD practices allow both Freeboard approach and DRSL approach (based on 2065 SLR prediction). Which approach should ASCE/COPRI design standard for piers and wharves follow?
(note: based on ASCE Flood Design Class, the freeboard approach uses BFE + 0, 2 or 3 ft)

Q--SLR –3: Can the flood design level be the simple addition of 75-year SLR and 50-year storm flood?
(note: the bulkhead design at USNA used this approach.)