



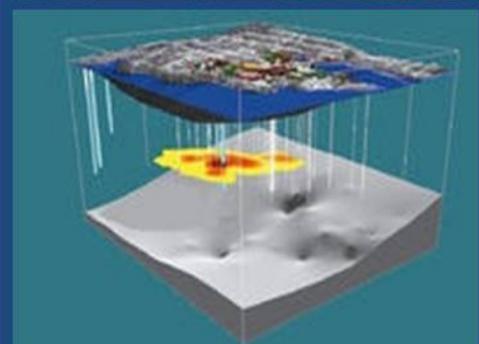
# Agency Needs for Scenario Products: DoD Coastal Installation Assessments

CCI/IA Workshop: Scenarios Session

John A. Hall, Ph.D. | August 1, 2013

ODUSD(I&E)/S&T

SERDP/ESTCP





# Presentation Outline

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- The Need for Actionable Science
- Policy Drivers
- SERDP and Funded Research
- Moving Forward on Assessments: Coastal Military Installations
- Next Steps—DoD and the Research Community





# The Need for Actionable Science

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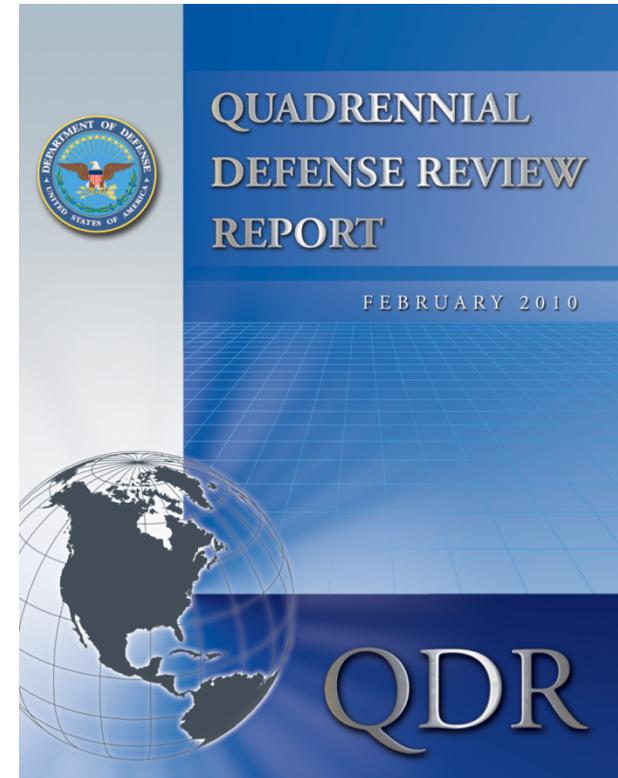
- Climate change is real, so now what?
  - ❑ Can't mitigate our way out of the consequences entirely, but we still have choices that will affect what future unfolds
  - ❑ Any particular response has associated uncertainty in the consequences manifested by the abiotic and biotic environment, but the range of potential human responses increases the overall uncertainty significantly
- So how do we proceed?
  - ❑ Predict then act versus various forms of risk-based framing. How are these two perspectives reconciled and communicated?
  - ❑ How do we enable science to do its thing while providing decision makers what they need?
  - ❑ Are we looking at a new paradigm or simply progression along a continuum?



# Quadrennial Defense Review (QDR) and Climate Change (February 2010)

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- “Climate change will affect DoD in two broad ways:
  - ❑ First, climate change will shape the operating environment, roles and missions that we undertake
  - ❑ Second, DoD will need to adjust to the impacts of climate change on our facilities and military capabilities.”
- ***“The Department must complete a comprehensive assessment of all installations to assess the potential impacts of climate change on its missions and adapt as required.”***
- “The Department will leverage the Strategic Environmental Research and Development Program, a joint effort among DoD, the Department of Energy, and the Environmental Protection Agency, to develop climate change assessment tools.”





# DoD's Environmental & Energy Research and Demonstration Programs

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## Science and Technology Research and Development

- DoD, DOE, EPA Partnership
  - ❑ Fundamental research to impact real world environmental management
  - ❑ Applied science and advanced technology development to address near-term needs



## Demonstration/Validation

- Demonstrate Innovative Cost-Effective Environmental and Energy Technologies/Methodologies
- Promote Implementation
  - ❑ Transition technologies/ methodologies out of the lab/field-plot scale
  - ❑ Create partnerships and test at DoD facilities and on DoD lands
  - ❑ Gain end user and regulator acceptance



# Program Areas

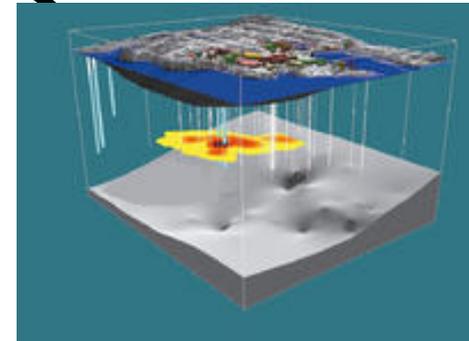
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## Weapons Systems & Platforms



## Energy & Water

## Environmental Restoration



## Resource Conservation & Climate Change



## Munitions Response



# SERDP Investments in Climate Change R&D

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- Ongoing Research and Development
  - ❑ Models and Tools for Assessing the Impacts of Sea Level Rise and Storm Surge on Coastal Military Installations
  - ❑ Regional studies on understanding impacts in the Southeast, Southwest, Pacific Islands, and Alaska
  - ❑ Decision Framework Pilot Studies
  - ❑ Ecological Forestry and Carbon Management
- Developed Coastal Assessment Report
- Science & Technology Directorate, in which SERDP is housed, is also the lead for DoD's Participation in the National Climate Assessment and updating of DoD's Climate Change Adaptation Roadmap



# SERDP Coastal Assessment Research

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## Physical Impacts

- Inundation
  - Wetlands and barrier islands
  - Erosion patterns & rates
  - Surface/ground water supplies
  - Water tables
  - Tidal flows & currents
  - Storm & flood damage
- Focus initially on assessment model/tool/process development
  - Four projects started in FY09; finished by end of 2013



- SLR/storm surge significant threats to coastal military installations
  - New methodologies required to fully assess impacts
  - Adaptation approaches required
  - Prescribed scenarios to 2100
    - ✓ 0.5m, 1.0m, 1.5m, 2.0m
    - ✓ Reflected plausible scientific assessment range



# Moving Forward on Assessments

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- QDR 2010 committed to do this at the installation level
- DoD has progressed in developing an understanding of how to do assessments, but has yet to meet the QDR mandate
- Can't do this all at once, nor should we
- Climate change potentially affects everything we do, so moving forward should be:
  - Strategic: reflect cross-Service interests, obvious vulnerabilities, and state of current knowledge
  - Provide a learning experience to inform future assessments
  - Balance cost against determining initial vulnerabilities under uncertainty
  - Leverage tools and knowledge across the federal community
  - Lead to clear next steps



# Initial Focus on Coastal Assessments at a Screening Level

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- Coastal military installations are on the front lines of climate change and its potential impacts
  - Sea level change
  - Tropical /extra-tropical storms
  - Interacting stressors (e.g., GW pumping)
- Coastal areas are a current focus of policy and scenario development outside DoD
  - US Army Corps Civil Works Program sea level change policy
  - National Climate Assessment global sea level rise scenarios
- SERDP' s initial investment in the climate change research arena facilitated the development of models, tools, and understanding to support coastal impact assessment across a variety of biophysical settings. → Basis for SERDP report on coastal assessment.



Coastal military installations are highly vulnerable to climate change

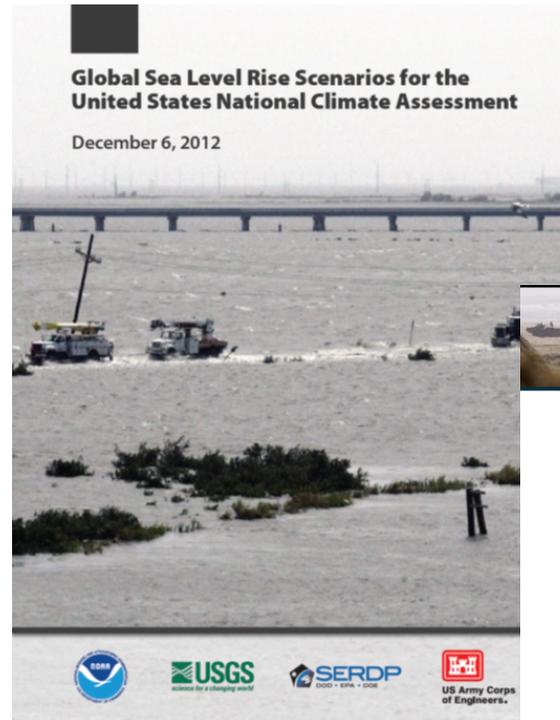


# Policy Relevant Documents

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## ➤ Coastal Assessments

- Global SLR scenarios released
- Policy implications report released
- Additional work planned for 2013 and 2014
  - ✓ Develop regionalized SLR scenarios and applications
  - ✓ Develop approach for conducting screening level vulnerability assessments



## Assessing Impacts of Climate Change on Coastal Military Installations: Policy Implications

Prepared by:  
Strategic Environmental Research and Development Program  
US Department of Defense

Pre-Clearance Draft Report  
November 30, 2012





# Technical and Institutional Considerations

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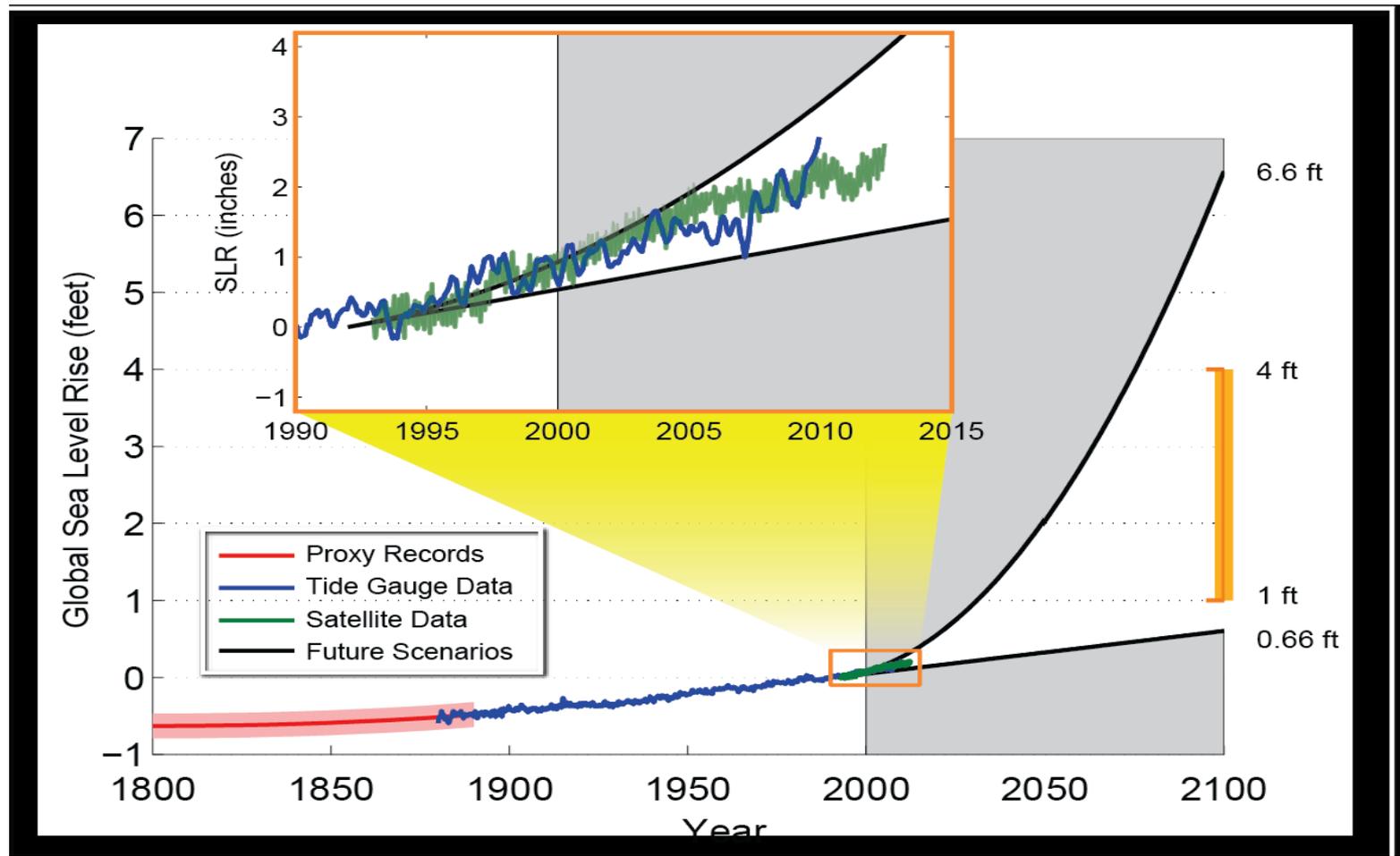
## Eight (8) Considerations to Inform Policy Development:

1. **Integrating climate change considerations** into planning and management decisions
2. Accounting for **regional variation** in assessments
3. Using **screening level versus detailed** assessments
4. **Selecting and applying future condition scenarios**
5. **Matching analysis timeframes and spatial scale** to decision types and planning horizons
6. Ensuring **data quality**
7. Addressing **uncertainty**
8. Enabling the **ongoing use of climate science** in decisions



# Draft NCA Global Sea Level Rise Scenarios

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# Next Steps—DoD

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- Form Regional Scenarios Working Group
  - “Whole-of-government” plus outside experts and external review
  - Regionalize global scenarios for DoD installations worldwide
  - Identify approaches for addressing event driven (at various temporal scales) changes in total water levels and their return intervals in assessments
  - Leverage other efforts
  - Screening level first
  - Useful for others?
- Form DoD Assessment Guidance Working Group
  - Incorporate input from the RSWG and recommend assessment approaches
- Identify installations to be assessed
- Accomplish screening level vulnerability assessments for coastal military installations worldwide



# Next Steps—Climate Modeling Research Community

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- Reconcile scientific advances in “prediction” with needs of decision makers for risk-based framing information and analytic approaches to effectively use such information
  - Improve the resolution of information provided, even into the future, but...
  - Convey the importance of considering distribution tails (i.e., decision-relevant uncertainties) for risk management and...
  - Recognize risk tolerance differs by organization and decision
- Provide risk-framed information at the needed temporal and spatial scales to facilitate decision making
  - Does this present challenges for information provided at other scales, such as boundary conditions and the appropriate variables to consider?
  - How does this affect model inputs and outputs?
  - What are the limits to downscaling? Regional differences?
  - When is it appropriate to identify likelihoods and when is it not?



# BACKUP



# Climate Change Decision Framework Pilot Studies

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- **Problem:** Climate model predictions are often inadequate by themselves to provide the information needed by end users for planning and management decisions
- **Response:** Develop Climate Change Decision Tools for DoD Installations
  - ❑ Identify the type and value of climate-related information needed by DoD natural and built infrastructure planners and managers to assess future climate change risks and vulnerabilities,
  - ❑ Identify, enhance, and develop tools and methodologies that enable the generation of such information at the required spatial and temporal scales,
  - ❑ Use pilots to assess approaches to climate change risk-based assessment and decision-support strategies that are resilient in the light of the uncertainties.
- **Five projects initiated:** pilot installations located across the US.

**PRODUCT: Military installation-relevant decision frameworks, improved use of climate models and information, and other tools to guide decision making**



# SERDP Coastal Assessment Research

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- **Hamptons Road Area** (Norfolk, Langley, Ft. Eustis, Oceana)
  - Army COE ERDC
  - Detailed hydrological and coastal modeling; tidal basin without barrier islands
  - Multi-criteria, multi-hazard, risk assessment tailored to military interests
- **San Diego CA** (Coronado, Pendleton)
  - SPAWAR, UC-San Diego, San Diego State University, Terra Costa, USGS
  - Analysis methods for the aspects of SLR unique to the Pacific coast – El Nino and topography; coastal terraces (cliffs) behind beaches
- **Gulf Coast** (Eglin AFB)
  - Florida State University, URS Corporation
  - Large-scale numerical model for quantifying the hazard risk to coastal military facilities and probability models for quantifying and managing uncertainty; barrier island setting
- **North Carolina** (Camp Lejeune)
  - Woods Hole Oceanographic Institute (also working at Eglin AFB)
  - Geomorphological evolution of shorelines and barrier islands

**PRODUCT: Military installation-relevant framework and tools to guide decision making in the context of sea level rise and storm surge.**



# *SERDP Coastal Assessment Report Contents*

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- Report discusses:
  - Background sections
  - Foundational SERDP research (used to illustrate examples and lessons learned)
  - Key policy questions
  - Technical and institutional considerations



# Policy Questions

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1. How can **climate change considerations best be integrated** into planning and decision processes?
2. What **technical guidance is required** to support high quality assessments and adaptation planning?
3. What **degree of regional consistency** best balances the need for comparable results across assessments with the need for flexibility to address local conditions and decisions?
4. How can **future investment decisions** at the level of the installation and in aggregate ensure resilience of the military mission to climate change?
5. How can relevant **activities external to the installation** be properly accounted for?



# Consideration 1: Integrating Climate Change into Decisions

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- Vulnerability to climate change = one factor among many
  - Interacts with non-climate stressors
  - Must be considered an aspect of overall asset management—it's reach is ubiquitous
  - Integration should be ongoing and iterative (don't stovepipe it)
  - Incorporate its implications into extant planning, management, and design documents, instructions, etc. as much as possible



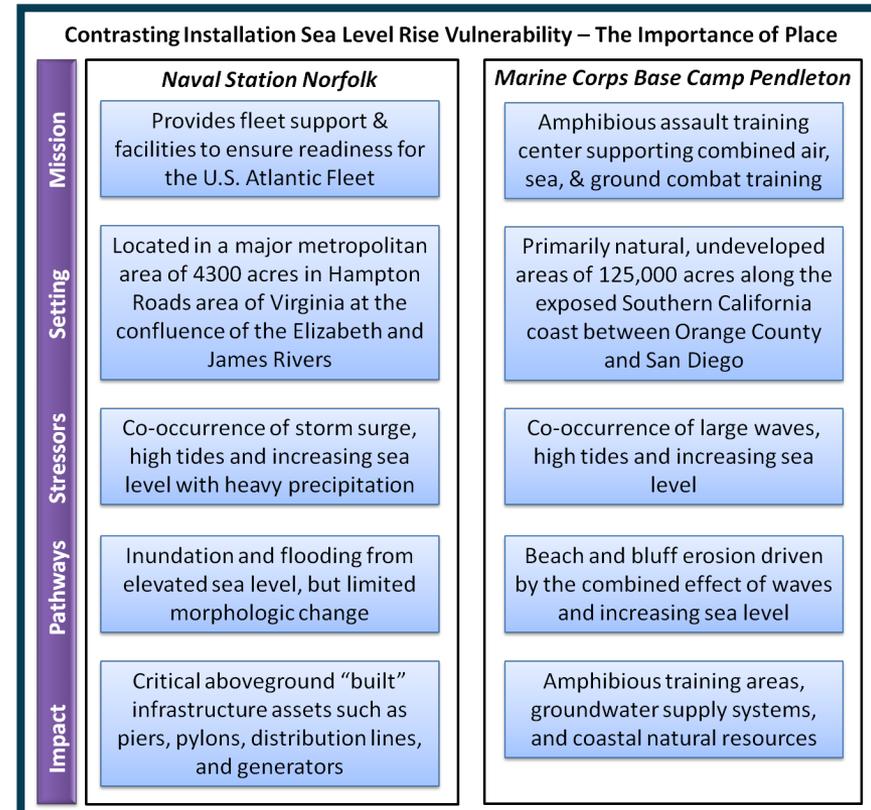


# Consideration 2: Accounting for Regional Variation

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- Contrasting needs:

Place-Based	Comparable / Consistent
Different climate change drivers	To standardize inputs within region
Unique biophysical characteristics	To compare / synthesize results
Different sensitivity / response	To prioritize action
Different non-climate stressors	
Different missions	



Contrasting missions, settings, stressors, pathways, and impacts for two installations emphasize the importance and challenge of using unifying frameworks to characterize vulnerability across installations while allowing for site-specific conditions and mission requirements in assessing individual installations.



# Consideration 3: Using Screening Level versus Detailed Assessments

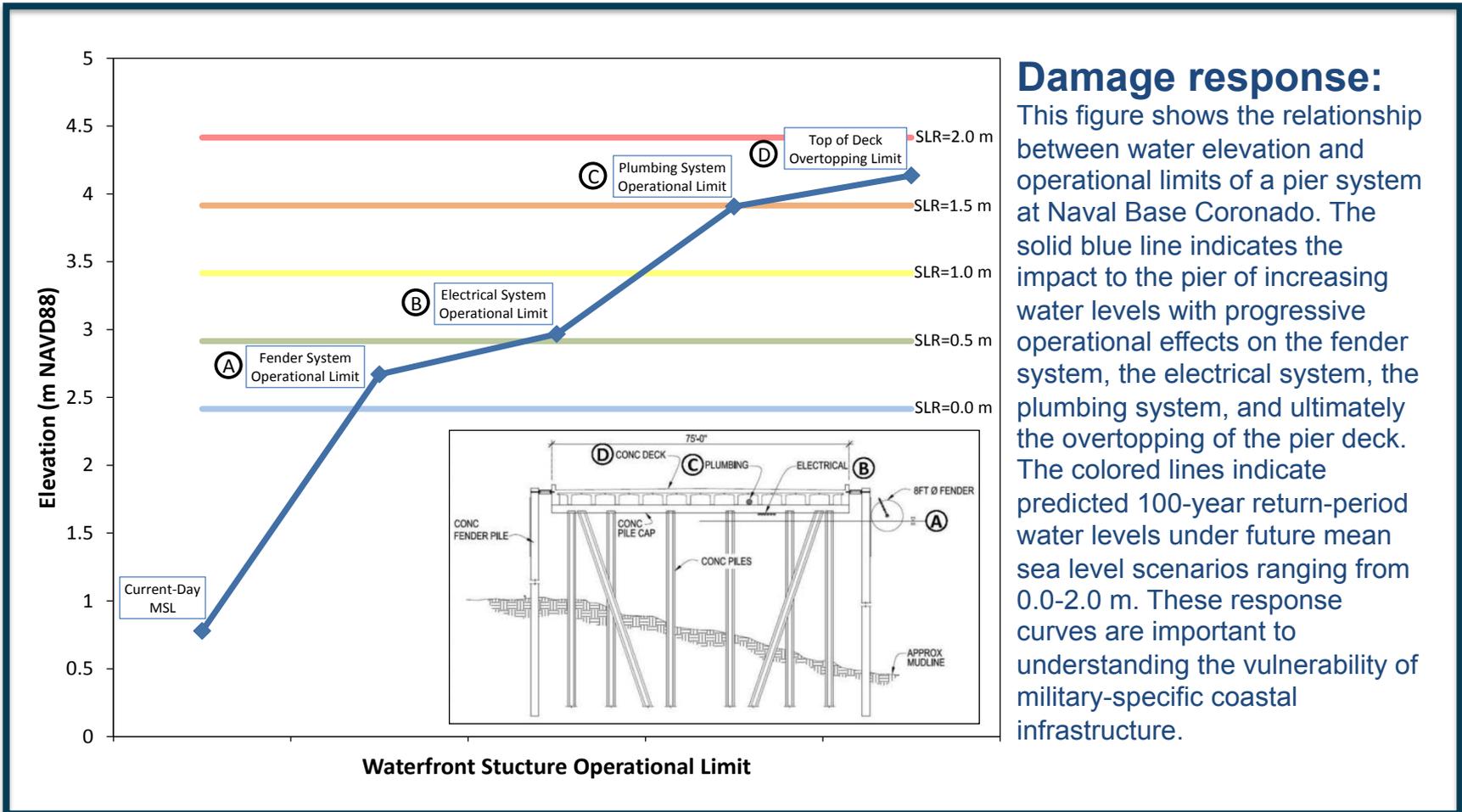
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- Degree of granularity required is determined by:
  - Type of decision to be made
    - Is the goal a general understanding of vulnerabilities versus designing and resourcing specific infrastructure investments?
    - What are the temporal (long- vs. short-term) and spatial scales (national vs. regional vs. individual installation) being considered?
    - What climate change drivers are of concern (e.g., SLR vs. extreme events)?
    - **Note:** Match confidence in decision to available data quality and simplifying assumptions
    - **Note:** Match model/tool complexity to data and decision
    - **Note:** Match assessment resources to decision—don't collect/assess more data than needed, but....
  - Degree of granularity required is determined by:
    - Criticality of the infrastructure
      - Focus on most critical assets and failure pathways first
      - But be alert that you may be surprised by where and when you're vulnerable
    - Threshold of risk that would require action 
      - Focus on assets with already-exceeded thresholds
      - Don't examine extreme scenarios when thresholds are already exceeded at lower scenarios
      - Be conservative when applying simplifying assumptions



# Illustration of Thresholds

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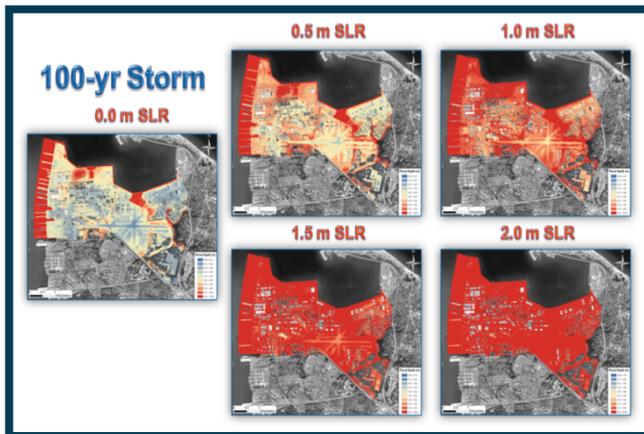




# Consideration 4: Selecting and Applying Future Condition Scenarios

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- Scenarios = plausible future conditions to enable considering a range of potential impacts (i.e., risk envelope)
  - Used as tool to address uncertainty (deterministic approach not appropriate; probabilistic approach not feasible)
  - Can integrate non-climate factors (e.g., installation priorities)



Flooding to Naval Station Norfolk under five different SLR scenarios.

Location/ Condition	Return Period	Baseline (m NAVD88)	Future MSLR (m)			
			0.5 > 2046	1.0 > 2069	1.5 > 2087	2.0 > 2100
NBC Exposed Shoreline Total Water Level	Week	2.2	2.7	3.2	3.7	4.2
	Month	2.5	3.0	3.5	4.0	4.5
	Year	3.0	3.5	4.0	4.5	5.0
	Decade	3.5	4.0	4.5	5.0	5.5
	Century	3.7	4.2	4.7	5.2	5.7

Future scenarios for exposed shoreline at Naval Base Coronado. The red outlined values show the influence of increased MSL on the frequency of high water events.



# Consideration 4 cont'd: Selecting Future Condition Scenarios

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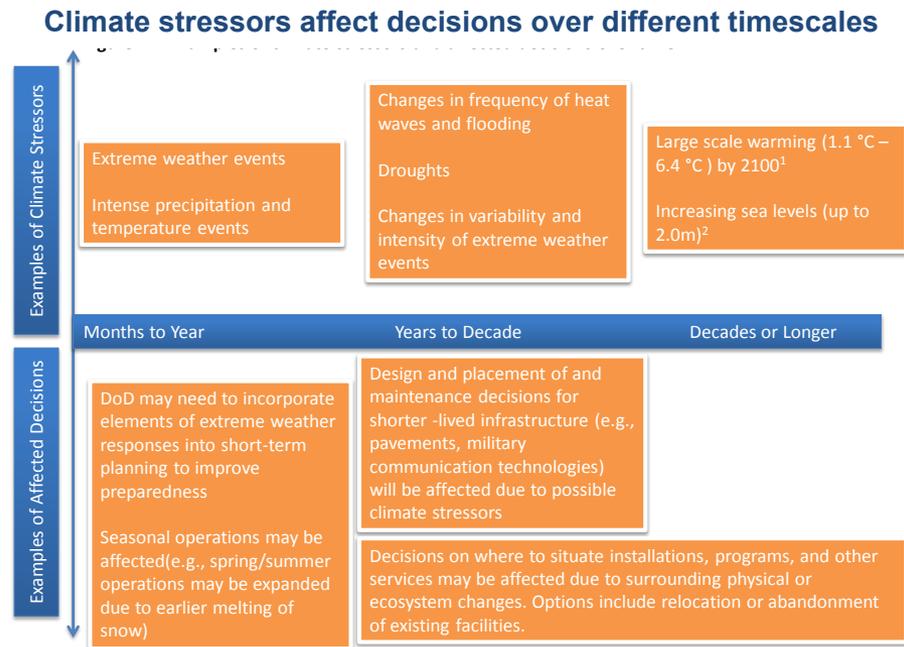
1. Identify available and credible scenarios/projections
  - E.g., Army Corps of Engineers, National Climate Assessment (NCA), Intergovernmental Panel on Climate Change
2. Articulate decision-making considerations
  - Timescale—intermediate timescales may be more of concern than distant endpoints
  - Risk tolerance
3. Identify regional/local information to translate global information
  - E.g., subsidence/uplift, storm history, past observations (NOAA, USGS)
4. Integrate scenario planning into other long-range planning activities



# Consideration 5: Matching Analysis Timeframes and Spatial Scale to Decisions

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- Construct scenarios based on scale of decision
  - *Time scale*: Constructing long-lived infrastructure vs. seasonal/annual operations
  - *Spatial scale*: Single installation vs. regional/national
- Consider planning horizons, expected service lifetimes
- Understand (often longer-lived) secondary commitments
  - ◆ E.g., armoring shoreline to develop facility
- Understand degree of flexibility of decision
- Monitor climate change impacts and responses over time



1 IPCC, 2007: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D.Qin, M. Manning, Z.Chen, M. Marquis, K.B. Averyt, M.Tignor, H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

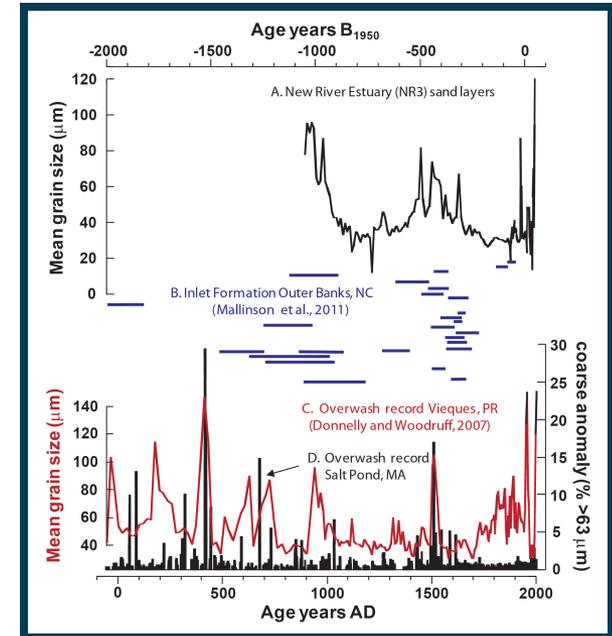
2 U.S. Army Corps of Engineers, 2011. Sea-level Change Considerations for Civil Works Programs. Circular No. 1165-2-212. Washington, D.C., USA. Available online at <http://planning.usace.army.mil/toolbox/library/ECs/EC11652212Nov2011.pdf>



# Consideration 6: Ensuring Data Quality

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- Characteristics of good data quality
  - Reputable, reliable, defensible
  - Consistently collected over time, via similar methods
  - Available and accessible to DoD
- Data needs
  - Biophysical information: DISDI, NOAA, NASA, USGS, installation
  - Facility information: existing systems used for other purposes
  - Unique local data
- Common deficiencies
  - Short data record, gaps in record
  - Changes in observation location, protocol, or equipment
  - Projection uncertainties
- Solutions
  - Combine multiple data sources
  - Interpolate from surrounding area data
  - Fully, explicitly account for uncertainty in conclusions
- In coastal environs, good quality & high spatial resolution elevation & location data are paramount 28



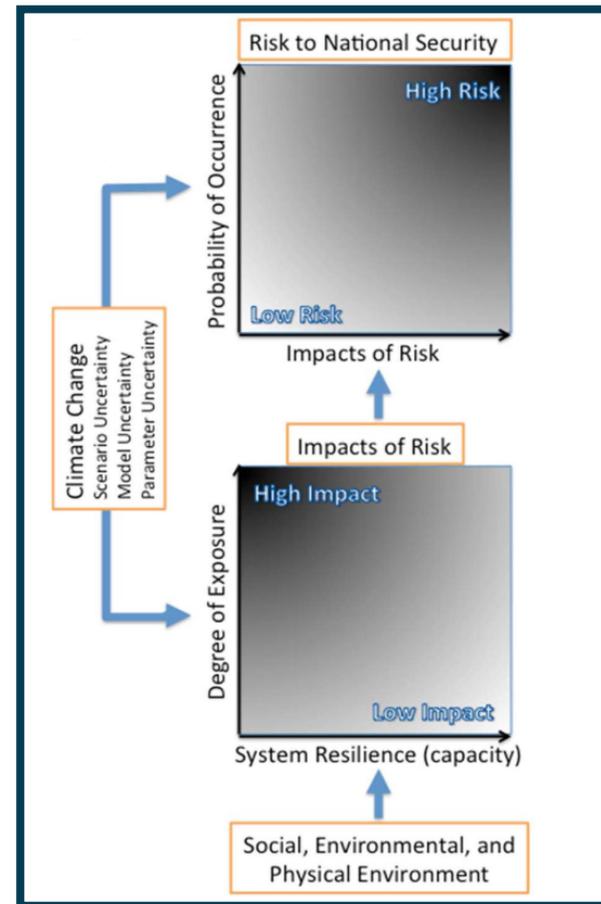
Use of the sedimentary record to obtain long-term storm histories.



# Consideration 7: Addressing Uncertainty

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- Uncertainty overview:
  - Uncertainty is inherent
  - Documenting uncertainty is critical
  - Uncertainty does not preclude action
- Understand what is/is not uncertain
  - E.g., direction of change may be known
- Use Adaptive Management Approach
  - Ongoing, iterative approach
  - Phased actions taken
  - Conditions monitored and adjusted
  - Apply experience with other uncertainty



Uncertainty about climate change affects our knowledge of impacts and risk to national security.



# Consideration 8: Enabling the Ongoing Use of Climate Science

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- Climate science is evolving rapidly
- Actual climate change impacts and DoD responses must be continually monitored —metrics are needed that should be assessed over time (build off of NCA indicator system?)
- Climate change information must be applied to changing mission requirements and assessed for how it may change the mission (e.g., Arctic)
- Adaptation decision frameworks as well as vulnerability and impact assessment frameworks are needed
- Strategies and approaches must evolve over time with due consideration for scientific advances but also unresolved uncertainties
- The science – policy interface needs to be institutionalized