Assessing Exposure and Impacts for Installation Resilience Planning

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NOAA NESDIS NCEI

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25 YEARS OF ESTCP

2019 | Enhancing DoD's Mission Effectiveness

Outline

- The Challenge
- Mission-based Protocol
  - Purpose and Scope
  - Critical Elements Assessment
  - Sensitivity Assessment
  - Exposure Assessment
  - Impacts Assessment
- Takeaways

Naval Station Norfolk 2003

Army Garrison Kwajalein Atoll 2008

Tyndall Air Force Base 2018

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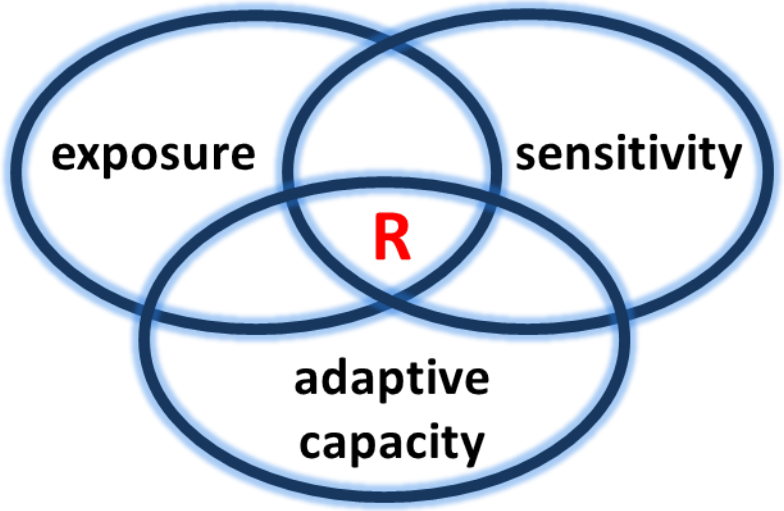
The Challenge

Get installation managers and planners **information that will** enable them to **meaningfully assess *Resilience (R)*** - *the ability of assets and activities to resist and/or recover from harmful effects attributable to coastal flooding*, and thereby enable them to **identify and prioritize actions** necessary to maintain a desired level of mission/operation readiness.



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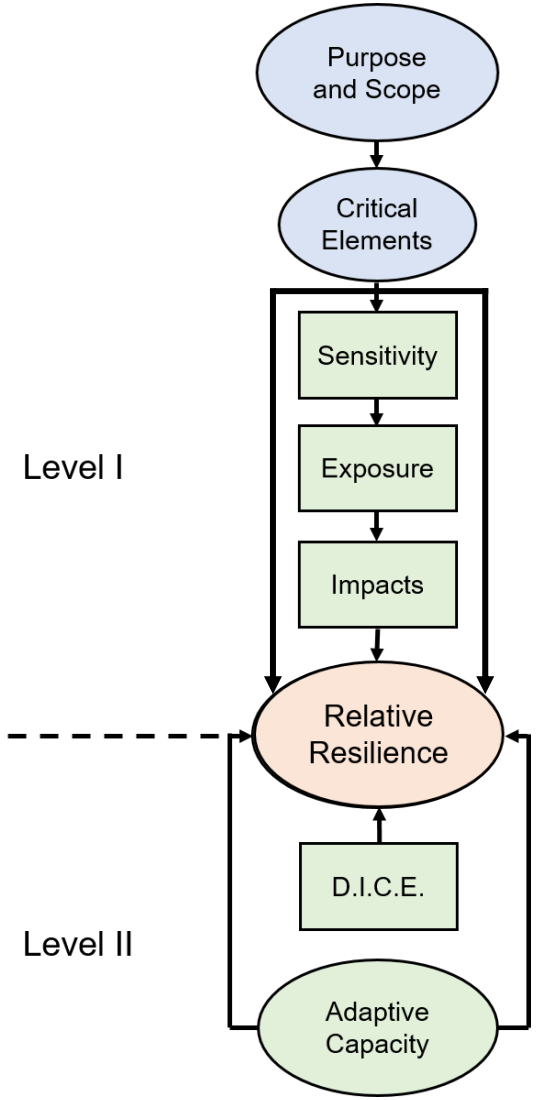
Mission-based Protocol for the Assessment of Resilience to Coastal Flooding at the Installation Level



What eventful impact will happen first… when?

Takes a **Values/Systems Approach** that:

- provides the level of **granularity** necessary to be actionable at the installation and mission/operation level;
- allows for consideration of **multiple forcings**; and
- provides for assessment of **dependencies interdependencies and cascading effects** (D.I.C.E.) as well as adaptive capacity.

Mirrors/embedded within an existing Regional and Installation Emergency Management construct to make it easier to adopt and implement.

From SERDP RC-2644, after RC-1701 and RC-1703

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Exemplar - Purpose and Scope

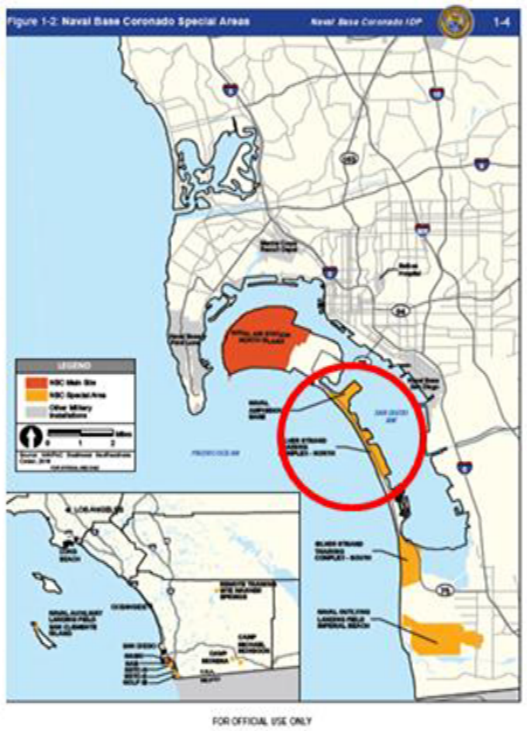
Purpose and Scope

Frame Requirements and Assess Resources

- Define desired objectives and outcomes.
- Identify decision-relevant impact metrics.
- Consider spatial/temporal scale, precision/accuracy, data/resource availability, etc.

For the Exemplar: **Maintain Mission Readiness**

- **Training and Testing** - Amphibious and clandestine training **at NABC and SSTC-N** in support of littoral, unconventional, expeditionary, and special warfare operations, *including administrative, operational, maintenance and repair, etc. facilities/services that support this mission.*
- Provide sufficient information to **allow command personnel to assess the sustainability of specific training/testing activities; and allow planning personnel to guide the physical development of the installation,** consistent with its mission and vision, for the next 25 years … as reflected in operational downtime/days and capital expenditures/dollars.



Naval Amphibious Base Coronado (NABC) and Silver Strand Training Complex-North (SSTC-N)

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Exemplar - Purpose and Scope

Purpose and Scope

Training and Testing Activities at NABC and SSTC-N

Commander, Naval Surface Force Pacific (**COMNAVSURPAC**) Expeditionary Warfare Training Group Pacific (**EWTGPAC**) **Ship to Shore Logistics Training** activities that include:

- Amphibious Operations (NTA 1.5.4).
- Construct, Maintain, and Operate Logistics Over-the-Shore (NTA 4.5.6).
- Physical Fitness Training (NTA 4.9.4)
- Force Protection (NTA 6.3.1).

Commander, Naval Special Warfare (**COMNAVSPECWAR**) Naval Special Warfare Center (**NSWC**) **Basic Training Command Basic Training** activities that include:

- Amphibious Operations (NTA 1.5.4).
- Naval Special Warfare (NTA 1.5.6).
- Tactical Reconnaissance and Surveillance (NTA 2.2.3).
- Mission Area (NTA 4.9.1).
- Physical Fitness Training (NTA 4.9.4)
- Force Protection (NTA 6.3.1).

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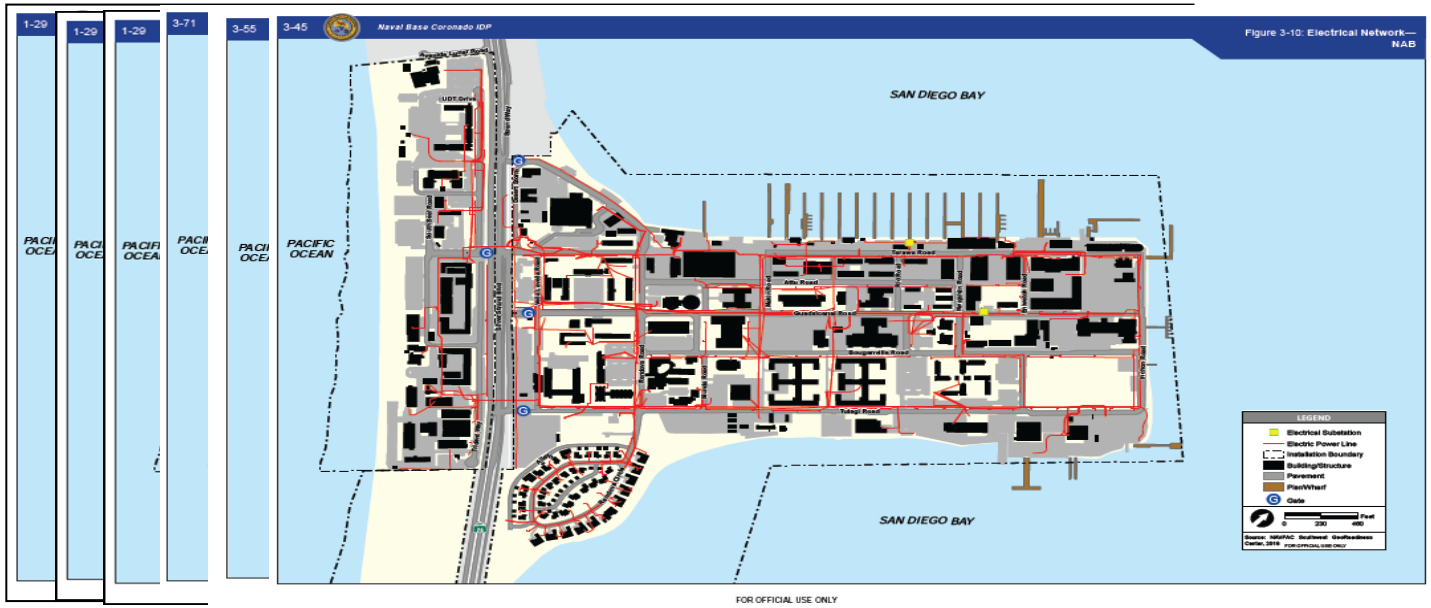
Critical Elements Assessment

Critical Elements

Identify the full range of Elements that support the essential mission.

This includes Training and Testing Lands/Waters, Buildings/Facilities, Waterfront Structures, Coastal Structures, Transportation Infrastructure, Utilities Infrastructure, *Natural Resources, and Personnel*

Rank/Prioritize *(e.g., based on the MDI).*



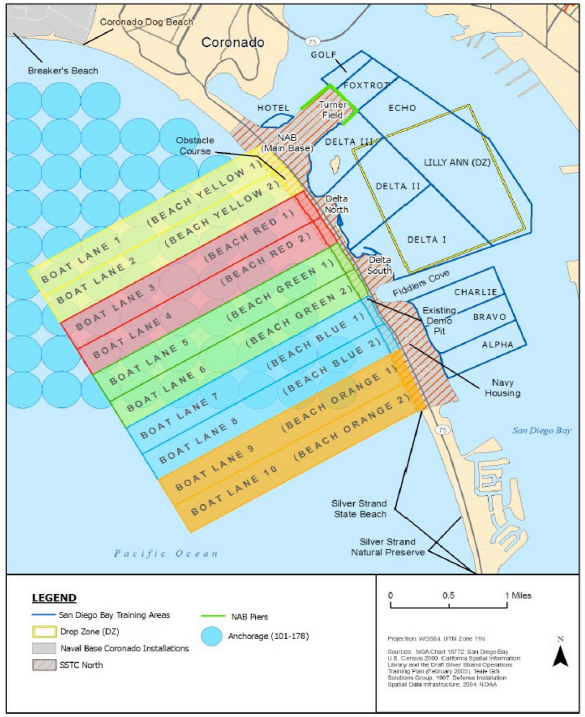


Figure 1-2: SSTC-N Training Areas

Sensitivity Assessment

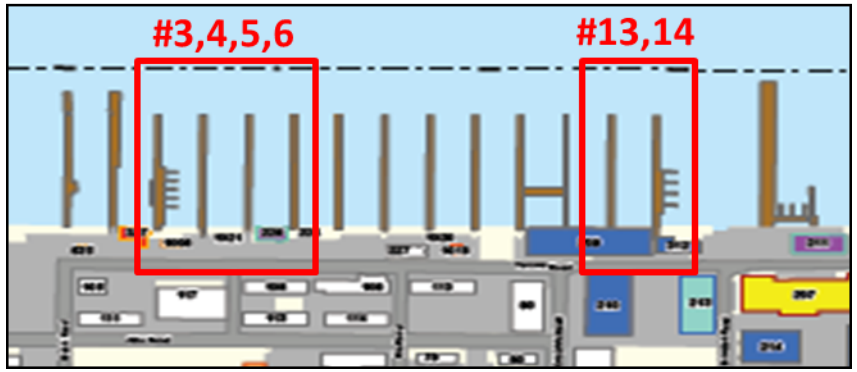
Sensitivity

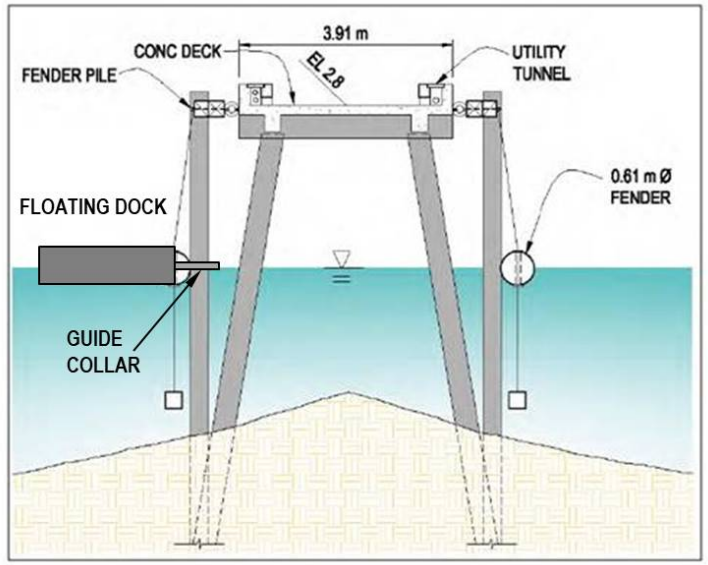
Identify Physical Effects …associated with elevated water levels on **Bayside** and **Oceanside**

Catalog Operational Characteristics, Limits, Restrictions, and Requirements

…establishing depth-consequence relationships is critical.

Using Waterfront Structures, specifically Small Craft Piers as an example.





Typical section through Pier No. 3 at NAB, Coronado

after RC-1703

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Sensitivity Assessment

Sensitivity

Depth-Consequence Relationships – Docks with Floating Decks

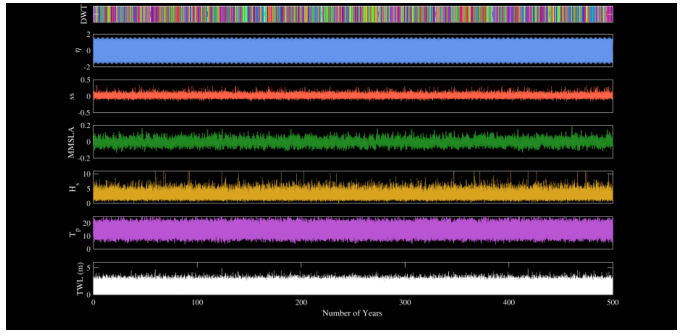
Physical Effects	none	Inundation; **Submergence**	Inundation; **Submergence**	Inundation, Flooding and Erosion: **Submergence and Surface Flow**
Depth Threshold	TPG - Top limit of Guide Piles; TOD - Top Of Deck	**TWL > 0.1m below TGP**	**TWL > 0.1m above TGP**	**TWL > 0.75m above TOD**
Damage State	Baseline	**Minor**	**Moderate**	**Major**
Superstructure- Main DECK (concrete)	Waves, water levels insufficient to inundate/overtop decks.	Waves, water levels insufficient to inundate/overtop decks.	Waves, water levels rarely inundate/overtop decks. No damage.	Waves, water levels sufficient to regularly inundate/overtop decks; minor damage to dock structure, operational loss of use, but no structural failure.
Substructure- Main Deck Load-Bearing Piles/Beams FIXED	Waves, water levels cause no vertical forces on deck/pile connection.	Waves, water levels cause minor vertical forces insufficient to cause deck/pile connection failure.	Waves, water levels cause minor vertical forces insufficient to cause deck/pile connection failure.	Waves, water levels cause vertical forces that may cause local damage to deck/pile connections.
Subsytems - FLOATING DECK attached to FIXED ELEVATION GUIDE PILES	Waves, water levels sufficiently below tops of guide piles/guide pile limit.	Waves, water levels close to tops of guide piles/ occassionally exceeds guide pile limit. Minor damage to guide collars; repair/replacement required. Deck use disrupted, unusable till repairs made.	Waves, water levels regularly exceed top of guide piles/above guide pile limit. Major damage to floating deck collars… *brow*. Brackets need to be replaced and minor repairs required for floating docks and guide piles. Deck use disrupted, unusable till repairs made.	Waves, water levels regularly above tops of guide piles/ guide pile limit. Severe damage to floating docks and guide piles…*brow*. Repair/replacement required. Deck use disrupted,unusable till repairs made.
Subsytems - Utilities (exposed BELOW deck)	Waves water levels insufficient to inundate utilities below deck	Waves water levels reach all utilities below deck. Wave action causes damage to attachment points and some utility lines. Dock has limited use till utilities repaired.	Waves water levels well above utilities below deck. Wave action and currents cause damage to attachment points and numerous utility lines. Dock has limited use till utilities repaired.	Waves water levels well above utilities below deck. Wave action and currents cause damage to all utility lines below dock. All utilities below deck must be replaced. Dock has limited use till utilities replaced.
Disruption *Utilities BELOW Deck*	Fully Functional	**Partially Functional - 3 days** loss of use.	**Partially Functional - 20 days** loss of use.	**Not Functional - 45 days** loss of use
Damage *Utilities BELOW Deck*	No Damage	**Minor Damage - 10% RPV of brackets** attaching floating deck to guide pile system **and 2% of fixed deck RPV.** Minor utility damage. Can be repaired.	**Moderate Damage - 100% RPV of brackets** attaching floating deck to guide pile system and brow, **and 5 % of fixed deck RPV**. Minor utility damage. Can be repaired.	**Major Damage - 75% RPV of floating deck,** guide piles and brow, **and 25% of fixed deck RPV**. Major utility damage Must be replaced.
Indirect Costs		*moderate cleanup*	*major cleanup*	*major cleanup including top of deck*

Exposure Assessment

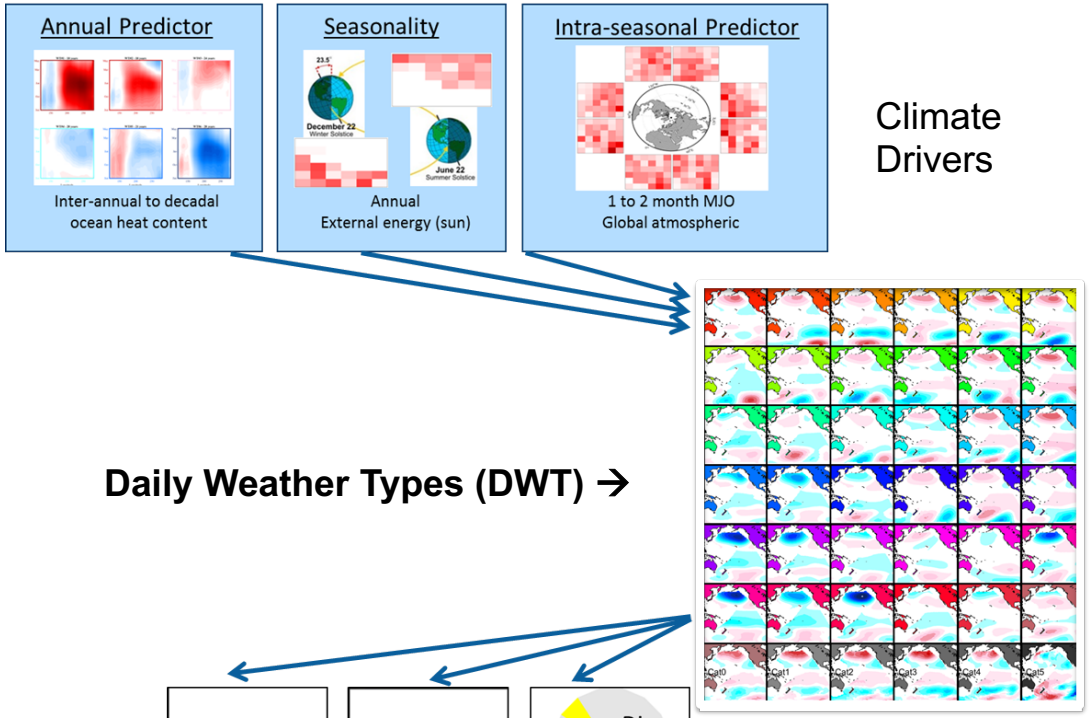
Exposure

Formulate Flood Scenarios …how high, how often, how long and when?

As part of this study we have developed a hybrid statistical/dynamical modeling technique to explore hypothetical flooding events not necessarily observed in the historical record –
Time-varying **E**mulator for **S**hort- and **L**ong-term **A**nalysis of coastal **flood**ing: **TESLA-flood.**



NABC **emulated record** - 500 years



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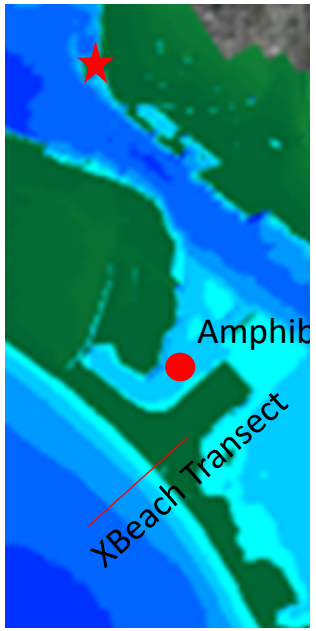
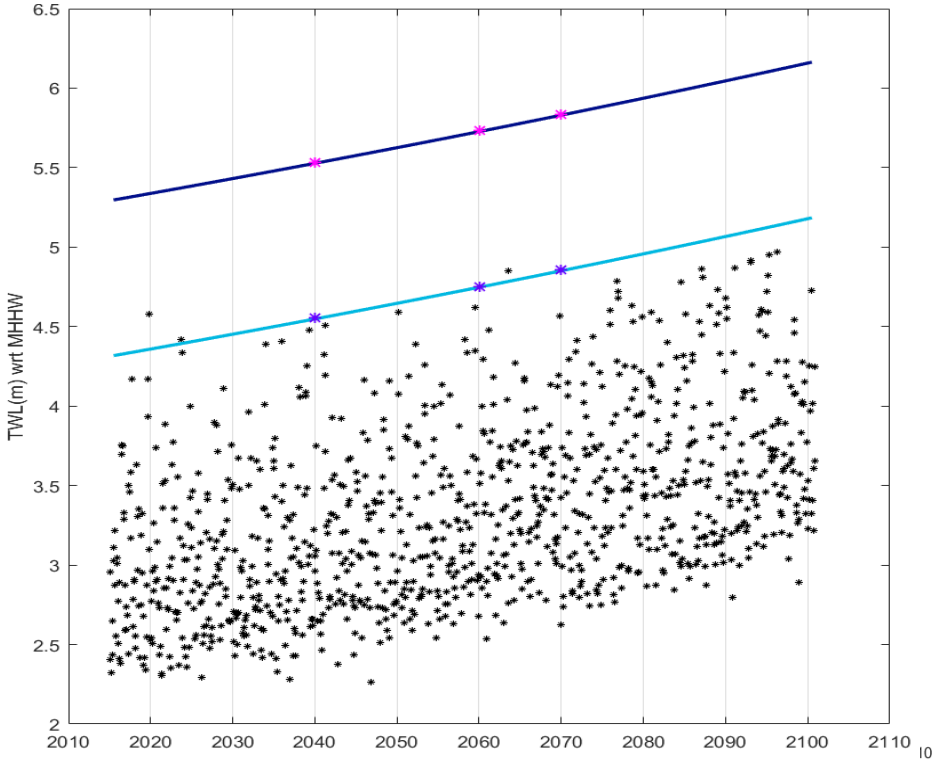
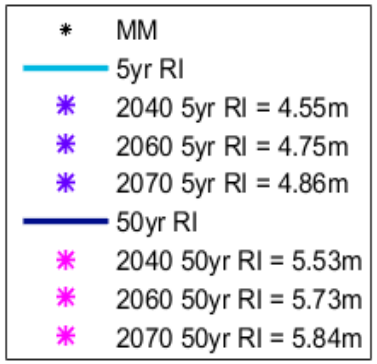
Exposure Assessment

Exposure



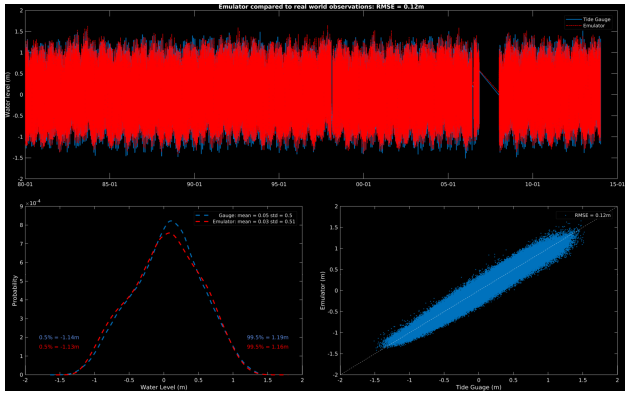
Projected TWL Elevation Return Intervals





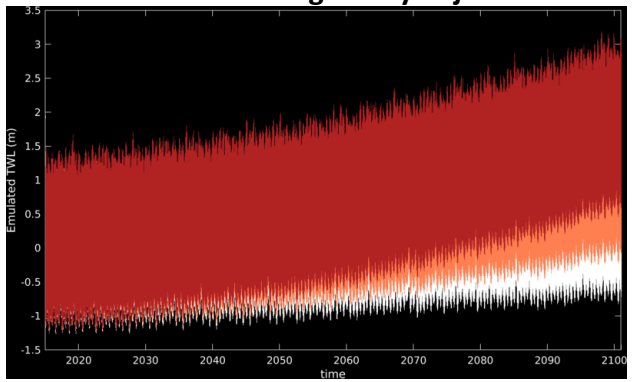
OCEAN

Emulated TWL compared to observations



★ San Diego Tide Gauge 1980 to 2015

Emulated TWL for regionally adjusted GSLR



Amphibious NW– 2015-2100 for 0.5, 1.0, 1.5m by 2100

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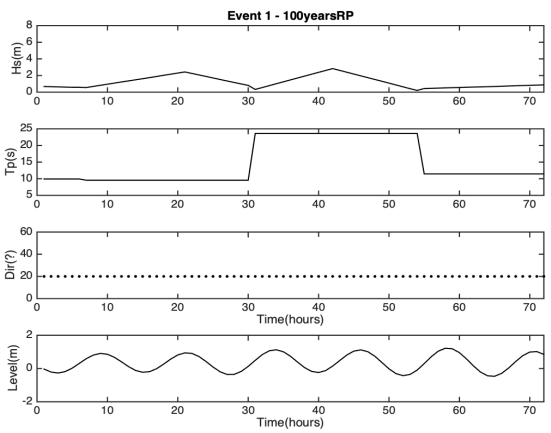
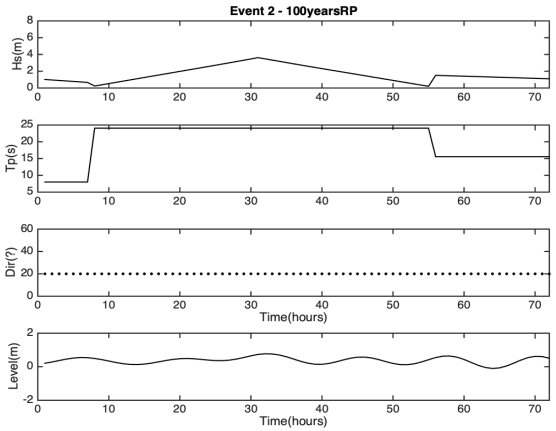
Exposure Assessment

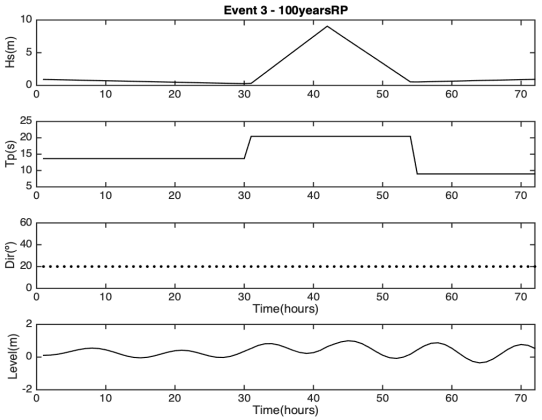
Exposure

Projected TWL Elevation Return Intervals …and then some.

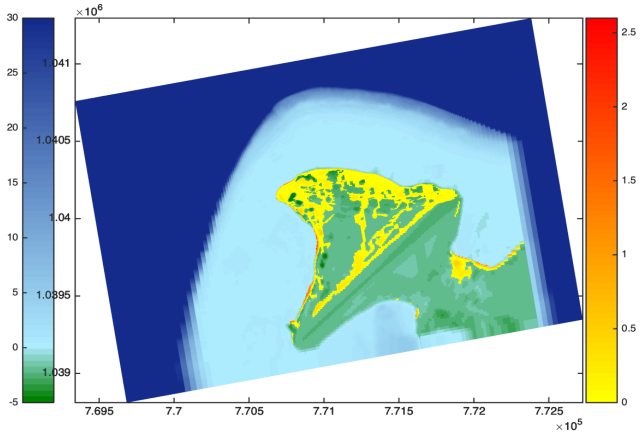
Not all "100 year" events are the same.







slr = 0.3m



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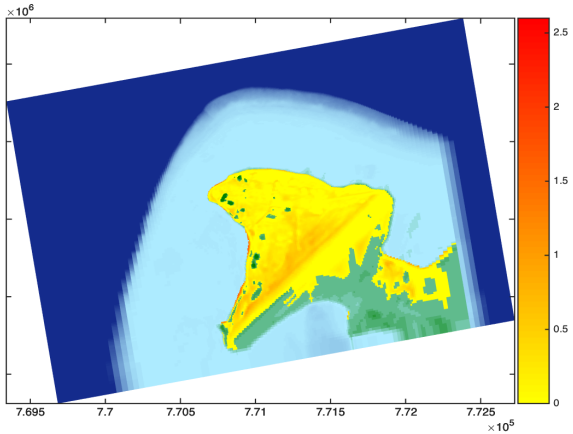
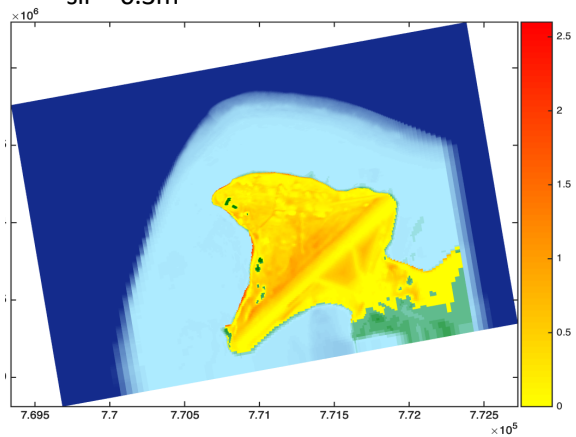


slr = 0.3m



Exposure Assessment

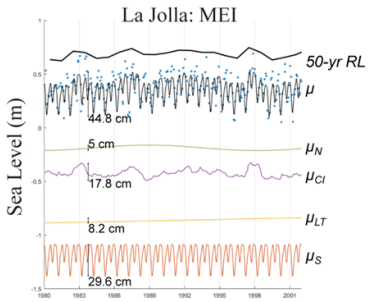
Exposure

Alternatives to TESLA-Flood

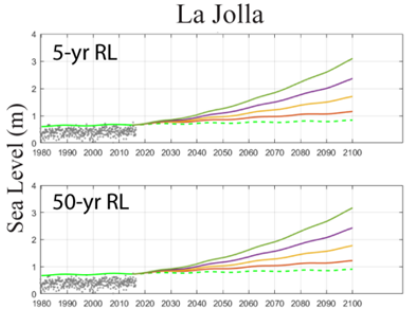
Traditional Approaches blending Observational Data with Empirical/Dynamical Models

Sea Level/SWL + Offshore Waves, Wave Transformation and Runup = TWL

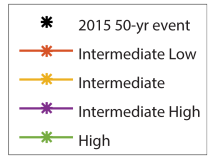
Diagnosis of and Prognosis of SWL Extremes from TG Records …that incorporate non-stationarity (SLR and Climate Variability)**.**

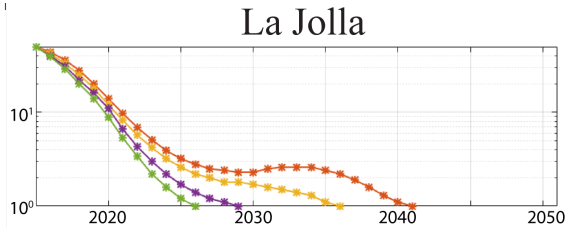


Historical Response of Location Parameter



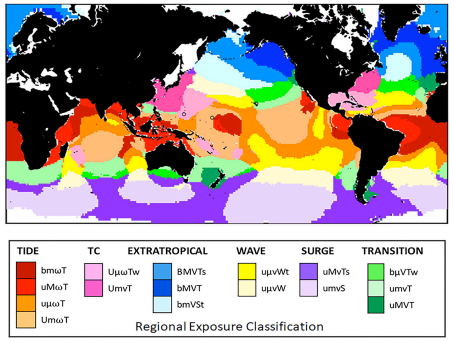
Projected SWL Return Levels



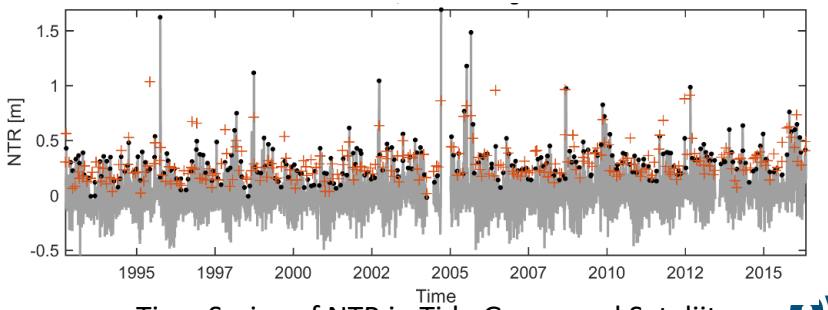


Projected SWL Frequency Decay

Regionalization Approaches to SWL Extremes Analysis …when TG records are short or do not exist.



Global Classification of Rueda et al., 2017



Time Series of NTR in Tide Gauge and Sateliite from Lobeto et al., 2018

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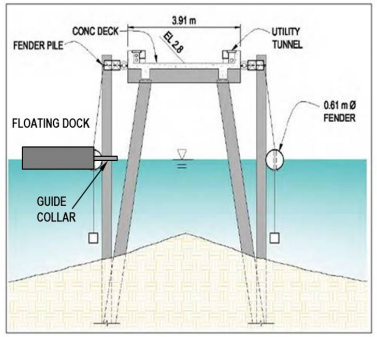
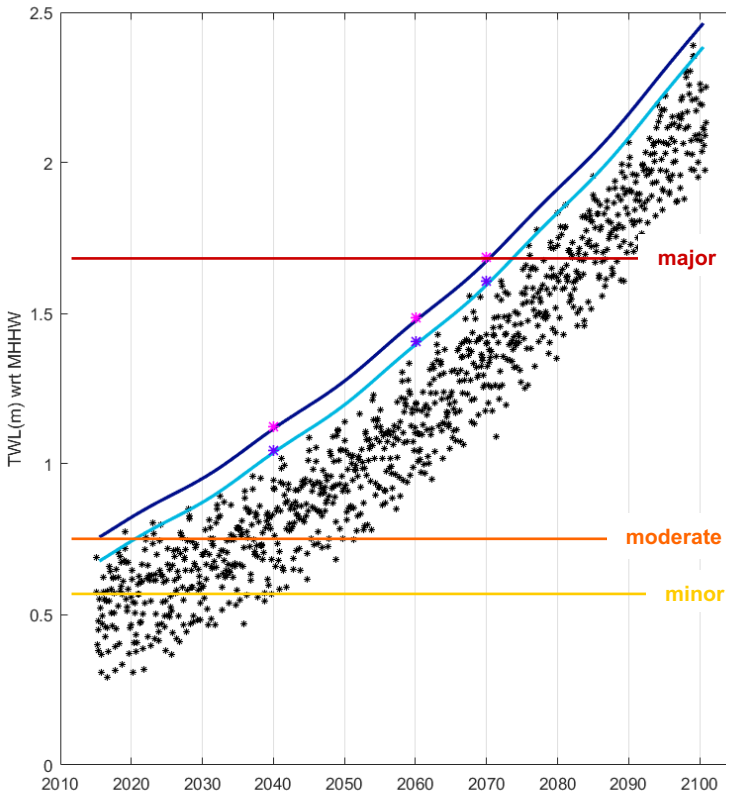
Impacts Assessment

Impacts

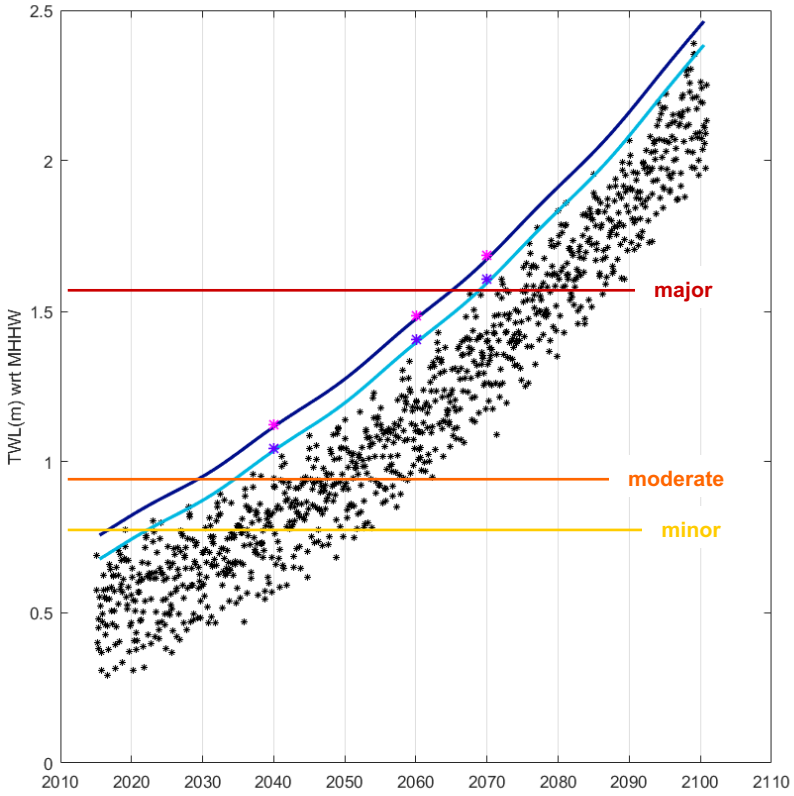
DOCKS - Amphibious NW Emulator, Run #2 of 20, 1.5m SLR



Typical section through Pier No. 3 at NAB, Coronado



Pier 3 Impact Thresholds



Pier 14 Impact Thresholds

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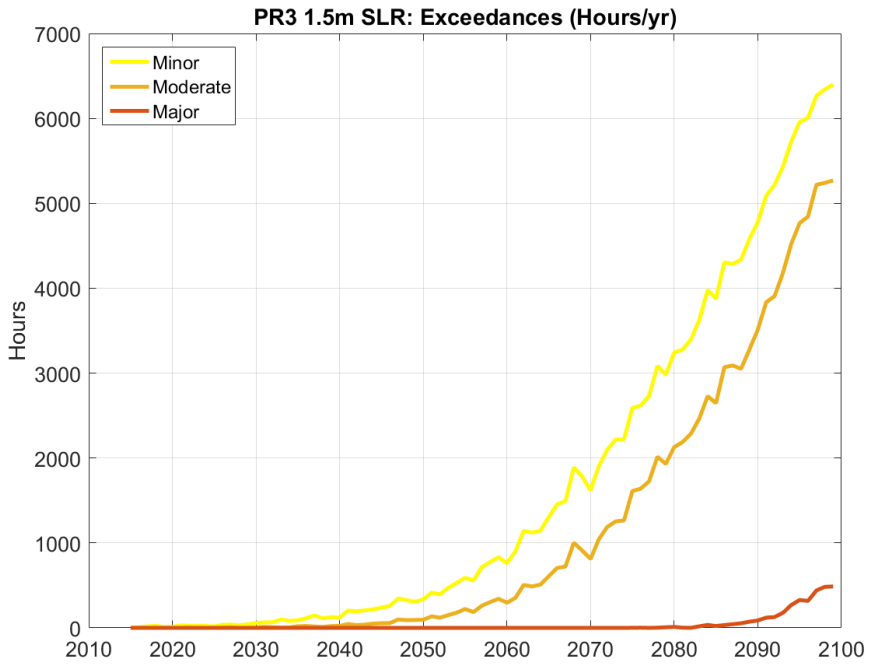
Impacts Assessment

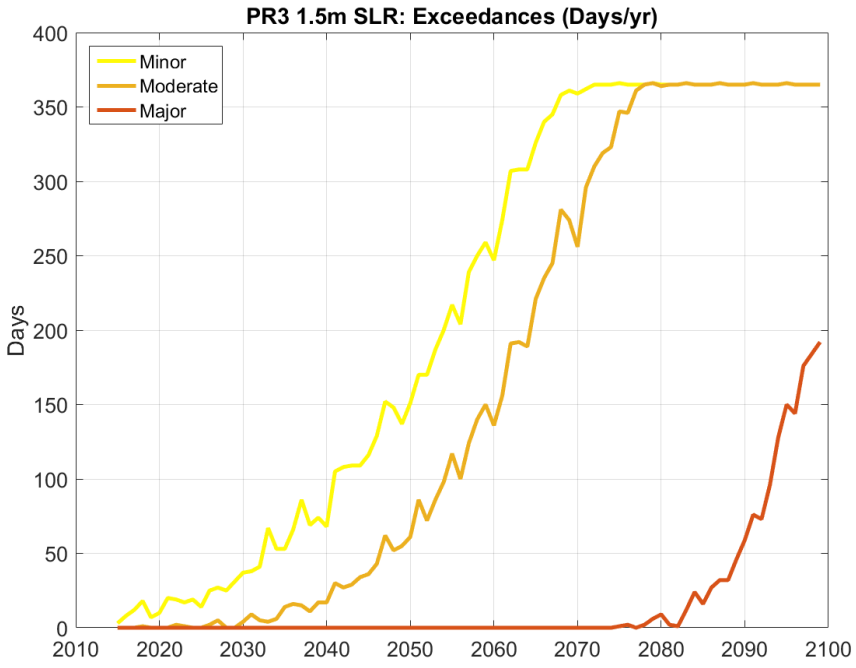
Impacts

DOCKS - Amphibious NW Emulator, Run #2 of 20, 1.5m SLR, Annual: May-April

Projected Frequency Counts by Event – Hours/Days above a Threshold



Hours/year



Days/year

Pier 3 Impact Thresholds

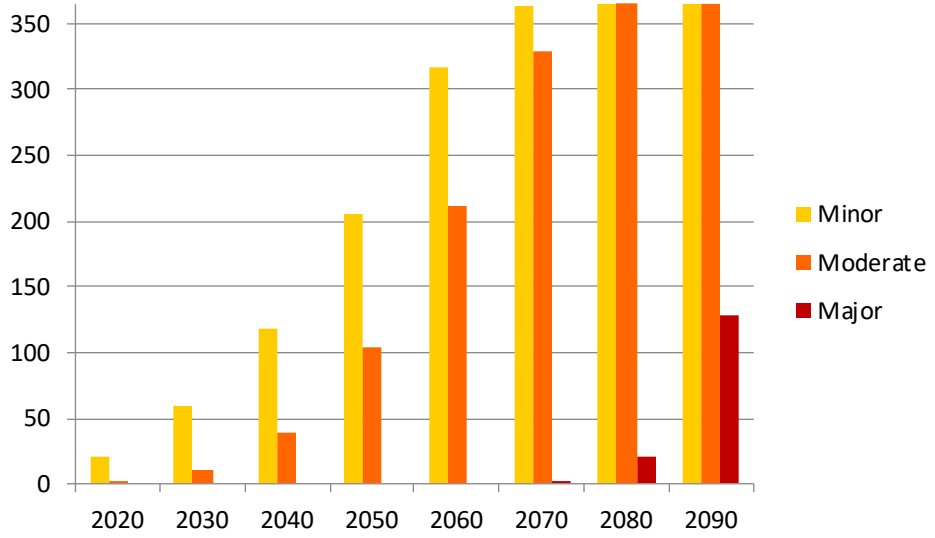
Impacts Assessment

Impacts

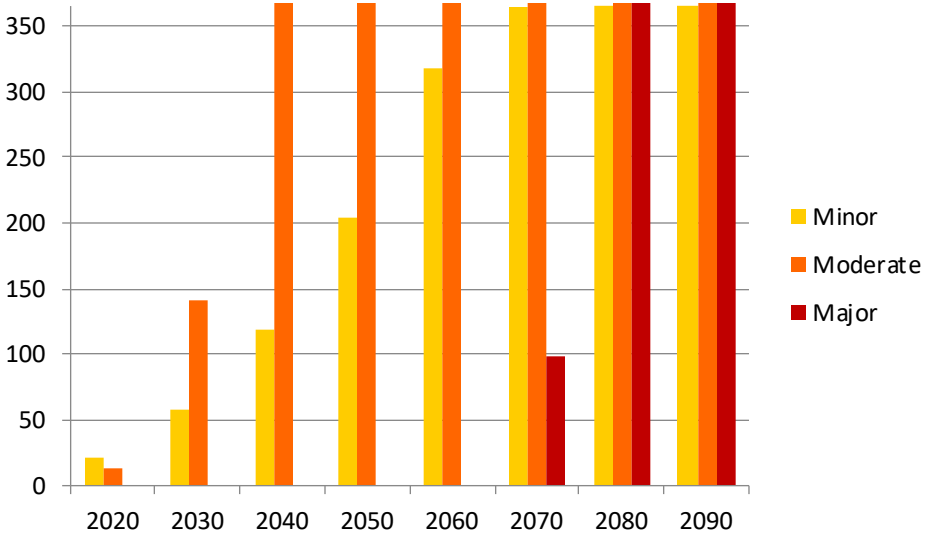
Projected Frequency Counts by Event – DOCKS

Run #2 of 20, 1.5m SLR (by 2100) Scenario, Amphibious NW Emulator, Annual: May-April

Threshold Days Per Year by Decade



Disruption - Days Per Year by Decade



Pier 3

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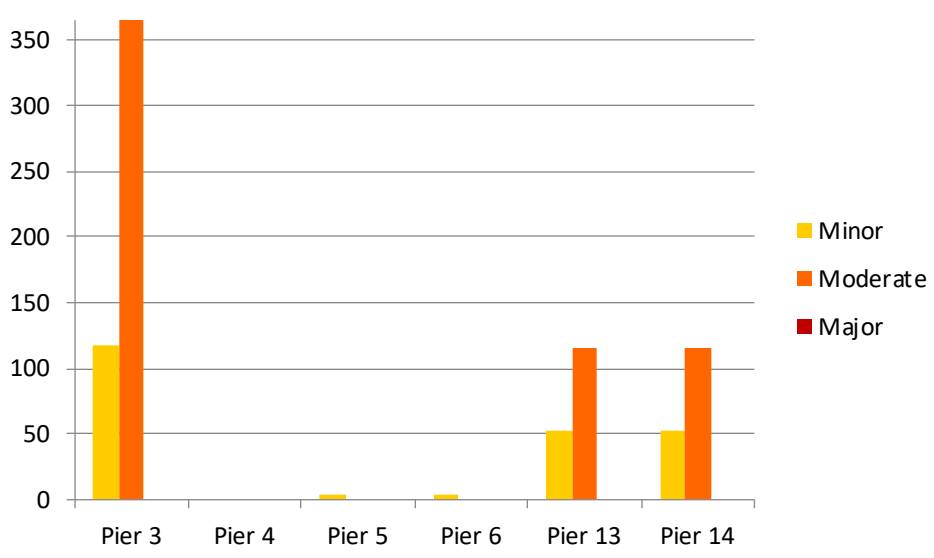
Impacts Assessment

Impacts

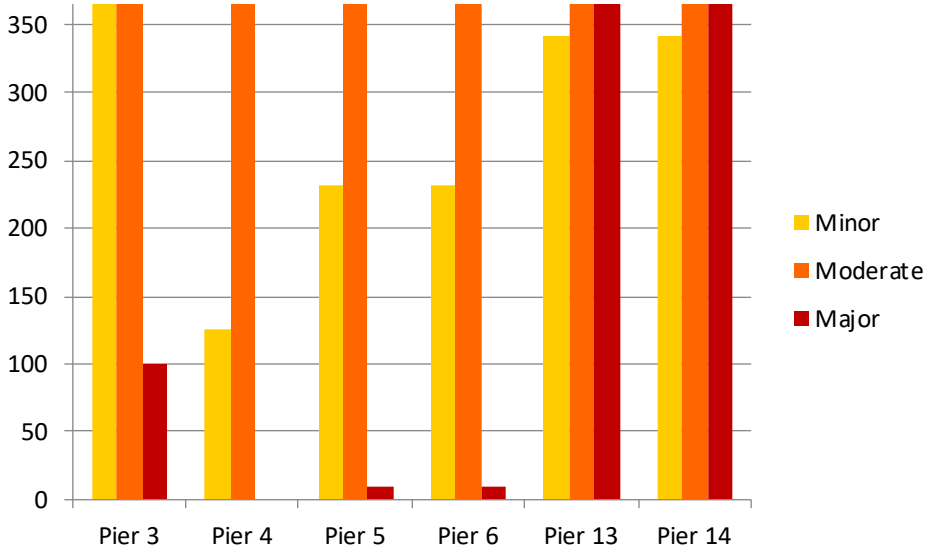
Projected Frequency Counts by Event – DOCKS

Run #2 of 20, 1.5m SLR (by 2100) Scenario, Amphibious NW Emulator, Annual: May-April

Disruption - Days Per Year by Decade



2040



2070

Small Boat Docks

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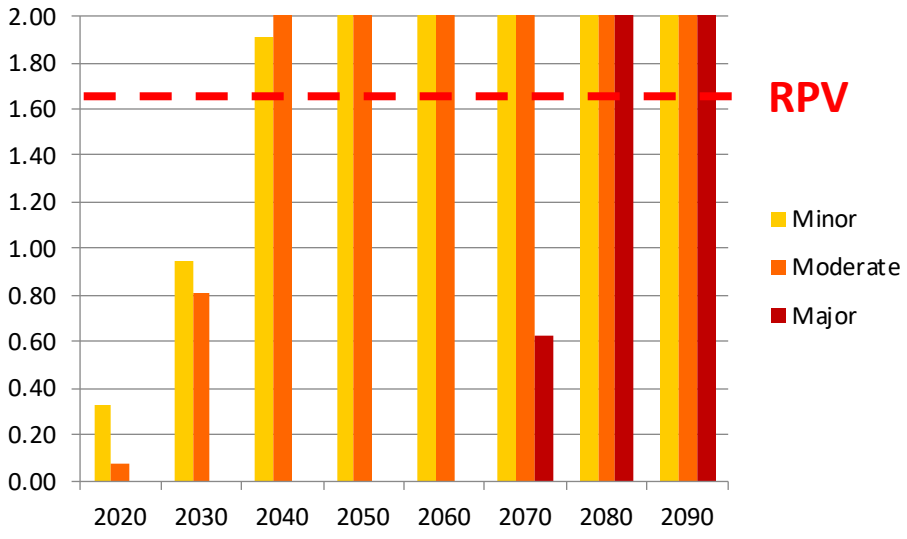
Impacts Assessment

Impacts

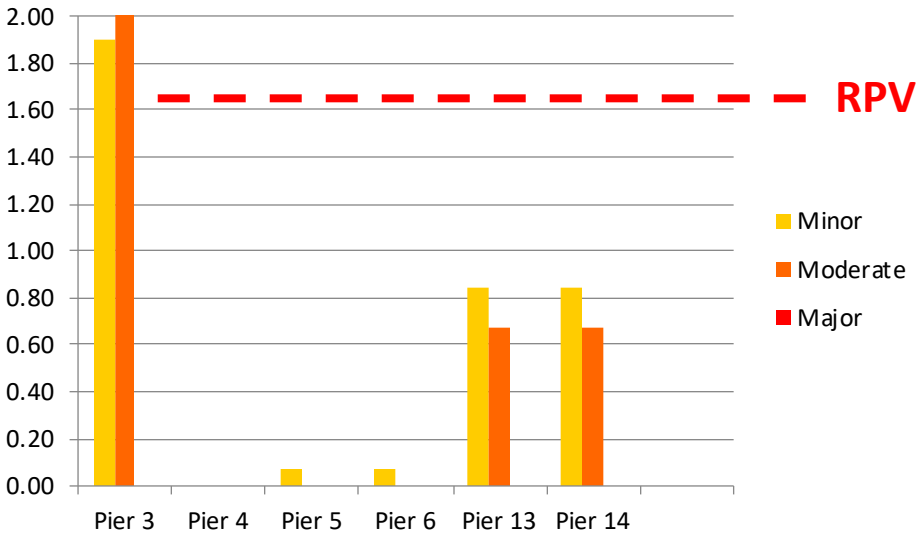
Projected Frequency Counts by Event – DOCKS

Run #2 of 20, 1.5m SLR (by 2100) Scenario, Amphibious NW Emulator, Annual: May-April

Damage - Cost (in millions) Per Year by Decade



Pier 3 ONLY over time



Small Boat Docks in 2040

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Relative Resilience Assessment

Relative Resilience

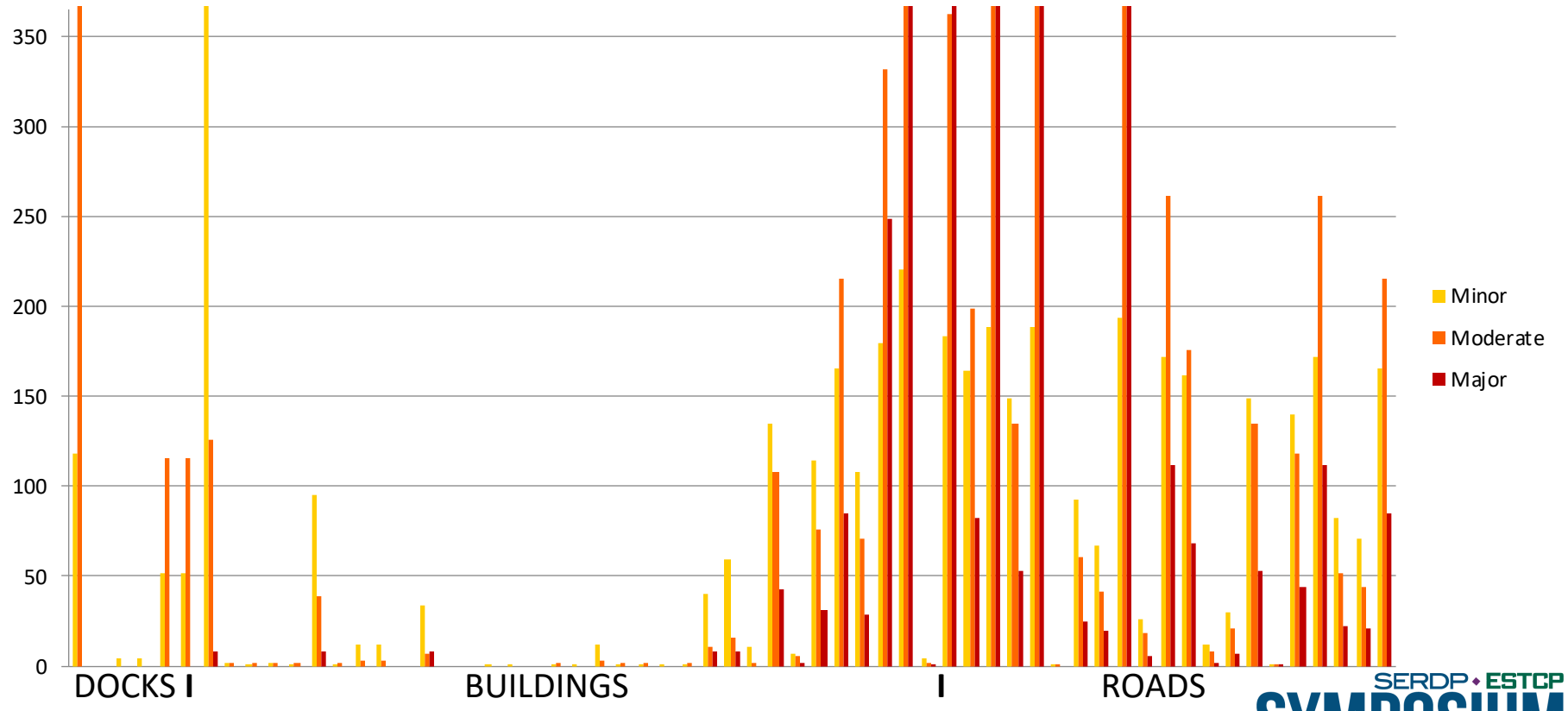
Projected Frequency Counts by Event – All Elements

Run #2 of 20, 1.5m SLR (by 2100) Scenario, Amphibious NW Emulator, Annual: May-April

Disruption - Days Per Year

2040

Without Berm



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Takeaways

Responds to an identified need for a methodology that looks at effects on operations/missions, **that is decision-relevant at the installation level**, and that is embedded within existing planning processes.

Draws on previous work (in particular RC-1701 and RC-1703), **reframes it, refines, revises it, expands it.**

Takes a Values/Systems approach that calls for attention to defining the purpose and scope, examining the complete systems of assets and activities, as well as the complete range of physical effects, **with the aim being to identify the weakest links.**

Needs to be transitioned from research to applications, via identification of pathfinding activities that help to ensure the methods and best practices are institutionalized and thereby acted upon.

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