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Fairfield WWTP (US Coast Guard)

Self-Regulating Tide Gate

Climate Change Background & Predictions

presented at

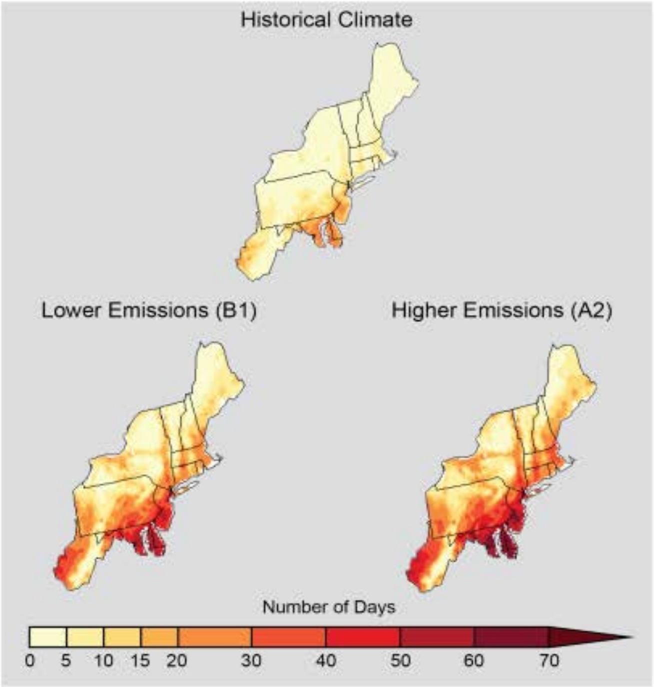
NEWEA Resiliency Planning Conference

September 26, 2017

Terminology

Climate change – the change in usual climate conditions

- Temperature



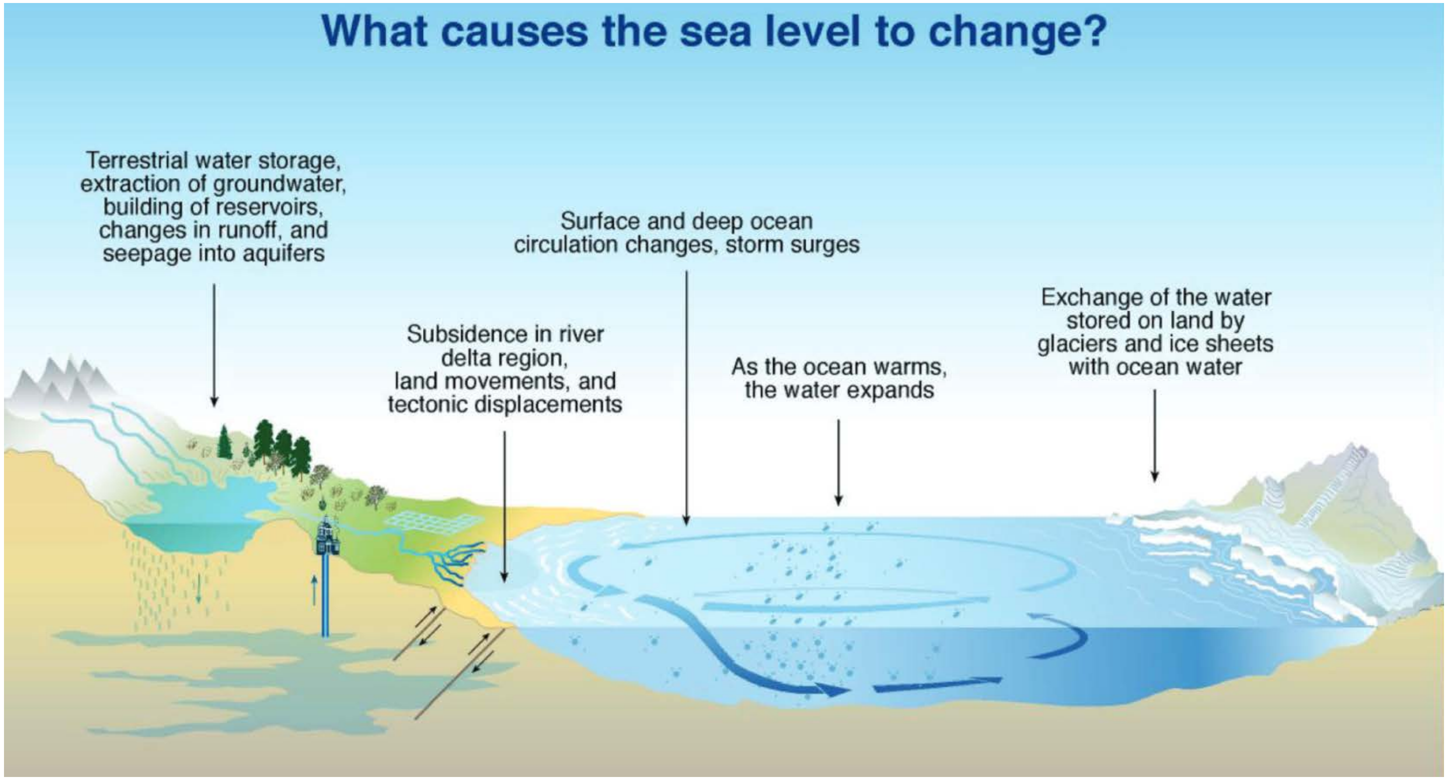
Projected increases in the number of days over 90 deg. F (National Climate Assessment [NCA], 2014)

- Sea Level Rise
- Rainfall Amount and Intensity
- Spatial /Geographical Changes in Weather Patterns

Sea Level Rise

Sea level rise is caused by

- Loss of land based ice
- Thermal expansion of oceans (with increased temperature)
- Land subsidence



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Terminology

Climate Resilience

– Capacity for a social/physical system to:

(1) Absorb stresses and maintain function in the face of external stresses imposed upon it by climate change

(2) Adapt, reorganize, and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts.

Beach Berm – Fairfield Beach, CT

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Terminology

Climate Resiliency requires multidisciplinary skill sets

- Planners
- Coastal scientists & engineers
- Hydrologists
- Ecologists and biologists
- Landscape architects
- Architects
- Civil engineers
- Structural & geotechnical engineers
- GIS/Geodatabase experts
- Land use attorneys
- Mostly, it requires political will and capital…

Terminology

Infrastructure Hardening

Floodplain Storage and Flood Walls
(Hartford, CT)

Hartford, CT Flood Control Dike,
Pump Stations, Storage Facilities

Terminology

Vulnerability Assessment

- Assess current vulnerabilities
- Project future conditions
- Evaluate processes and flood pathways
- Analyze system sensitivity and resiliency

Small Change -> large system response

System is prepared to accommodate

(Woods Hole Group)

Terminology

Vulnerability Assessment Requirements – Coastal Example

- Technically accurate baseline information and design parameters.
- Storm surge under existing and future conditions.
- Inundation depth, wave impacts, flood pathways, flood volumes , probability of occurrence.

Terminology

Preparedness / Adaptation

- **Develop Preparedness Plan over Time and Scale**
  - Managing risk in the face of uncertainty
  - Multiple scales: National down to individual buildings
  - Times to react: Actions now and into the future
  - Balance of robustness and flexibility
  - Identify adaptation options based on risk tolerance
    1. **No Action**
    2. **Accommodate ("Living with water")**
    3. **Protect ("Keep water out")**
    4. **Retreat**

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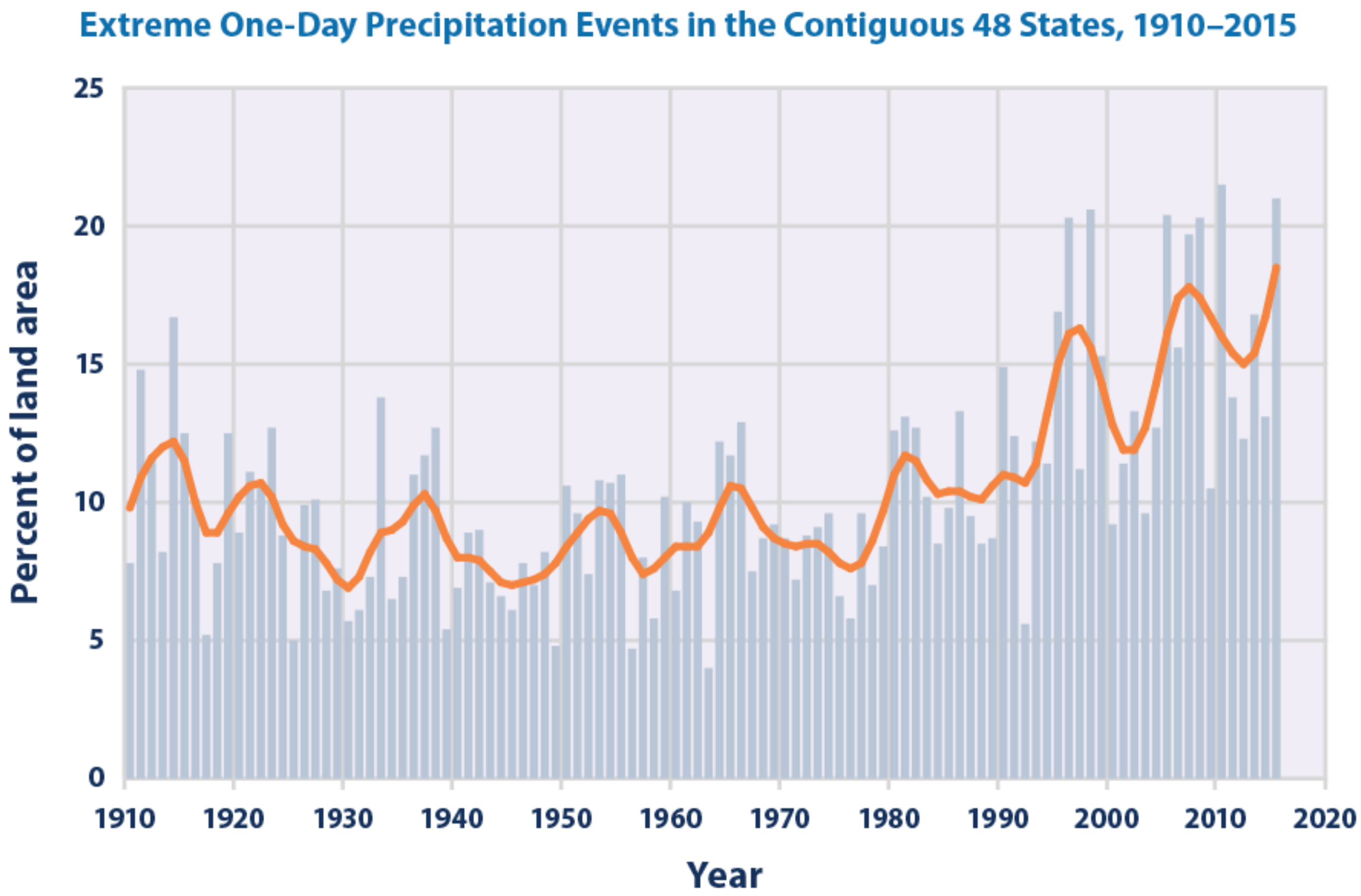
Dynamic, Probabilistic Model Approach

- Site-specific and detailed design parameters.
- Far exceeding traditional, more simplistic flood maps.
- Rooted in hydrodynamic modeling.
- Includes riverine flows, tide, waves, currents, winds, storm surge, sea level rise and wave set-up.
- Utilized to test the effectiveness of various engineering designs and adaptations.
- Green living shoreline alternatives.
- Traditional grey infrastructure (e.g., modular or adaptable seawalls).
- Can be stimulated individually or in combinations.
- Results optimize effectiveness of proposed designs, while also reducing construction costs.

Observed Climate Changes



Data source: NOAA (National Oceanic and Atmospheric Administration). 2016. U.S. Climate Extremes Index. Accessed January 2016. www.ncdc.noaa.gov/extremes/cei.

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

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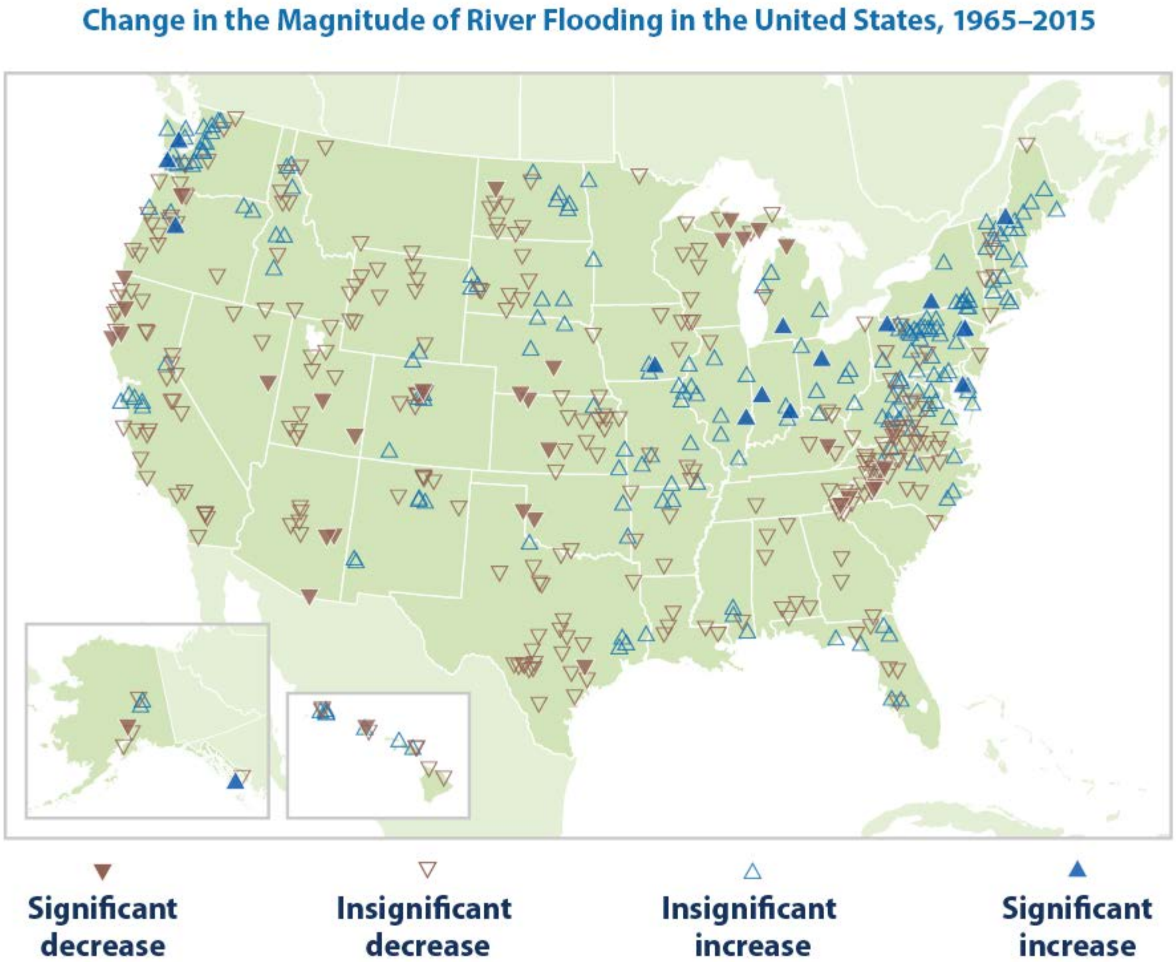
Observed Climate Changes

Increase in *Frequency* and *Magnitude* across the Northeast

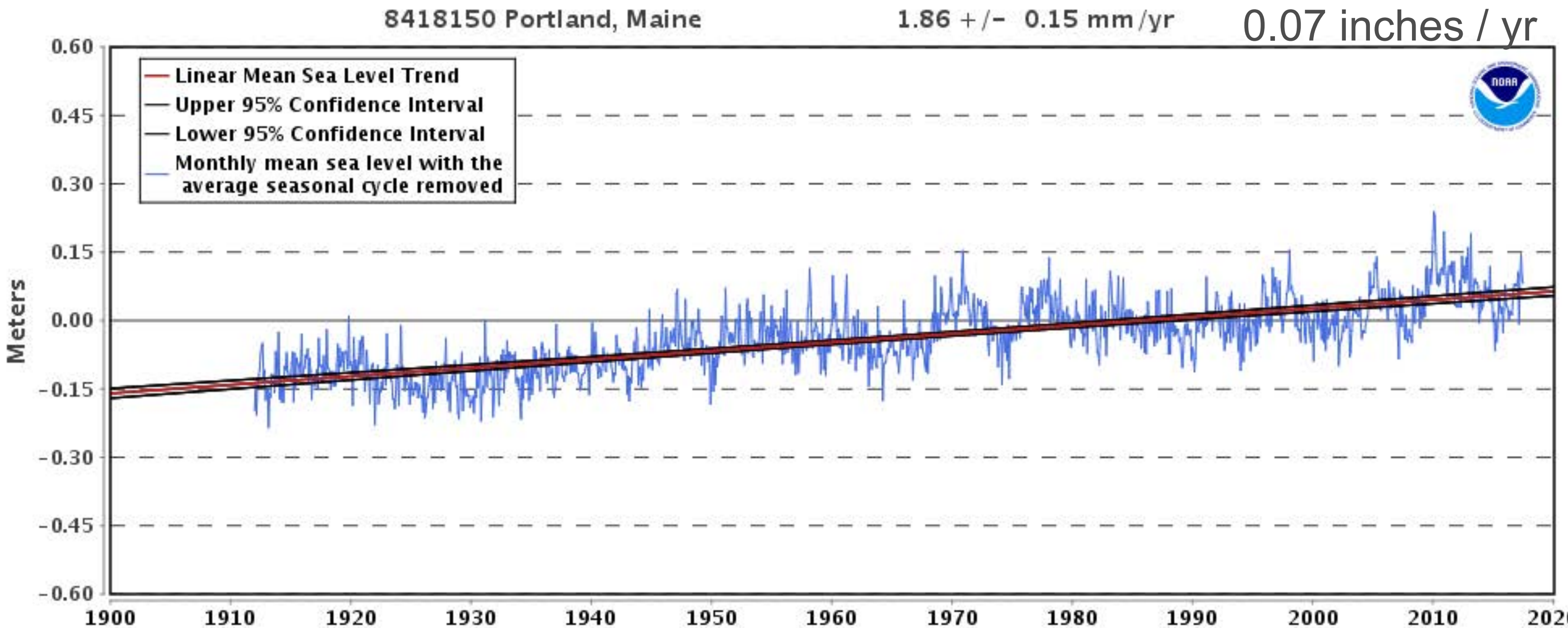


NCA, 2014

Observed Climate Changes

Sea Level Rise - ME

0.07 inches / yr



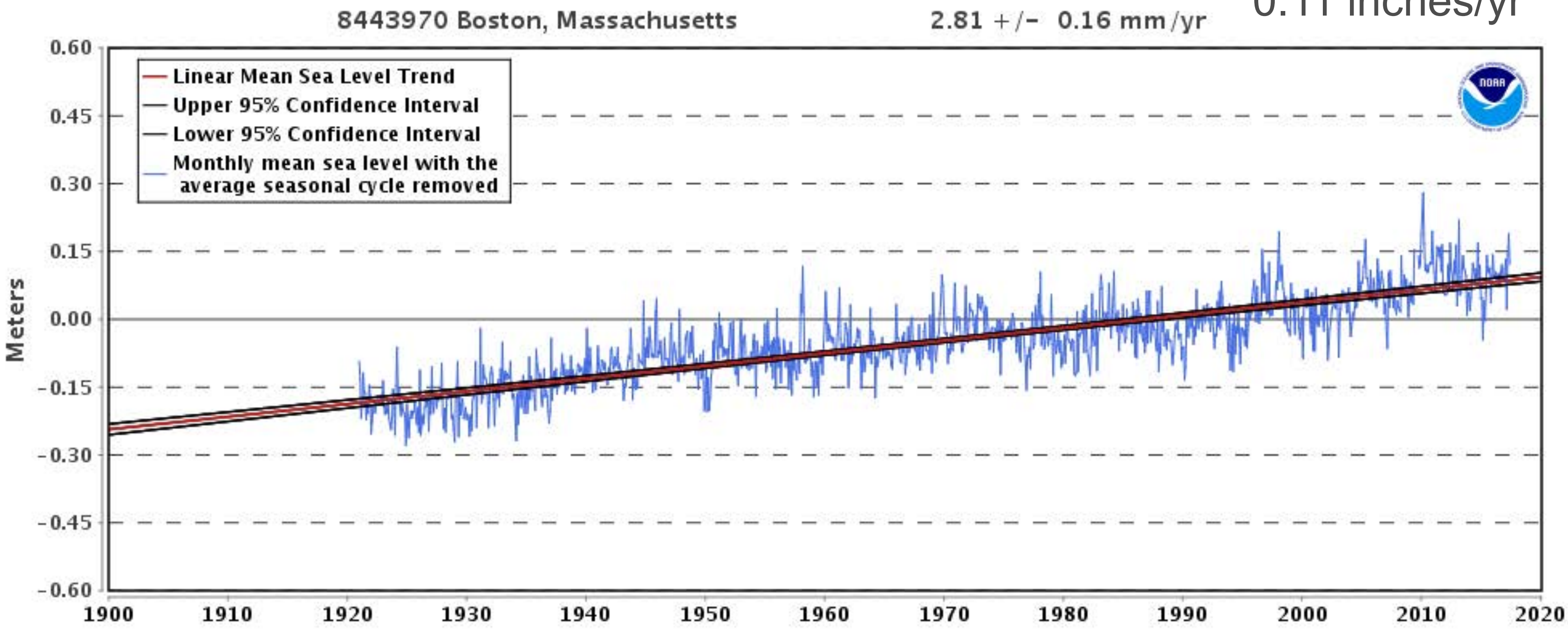
NOAA

FUSS & O'NEILL

Observed Climate Changes

Sea Level Rise - MA

0.11 inches/yr



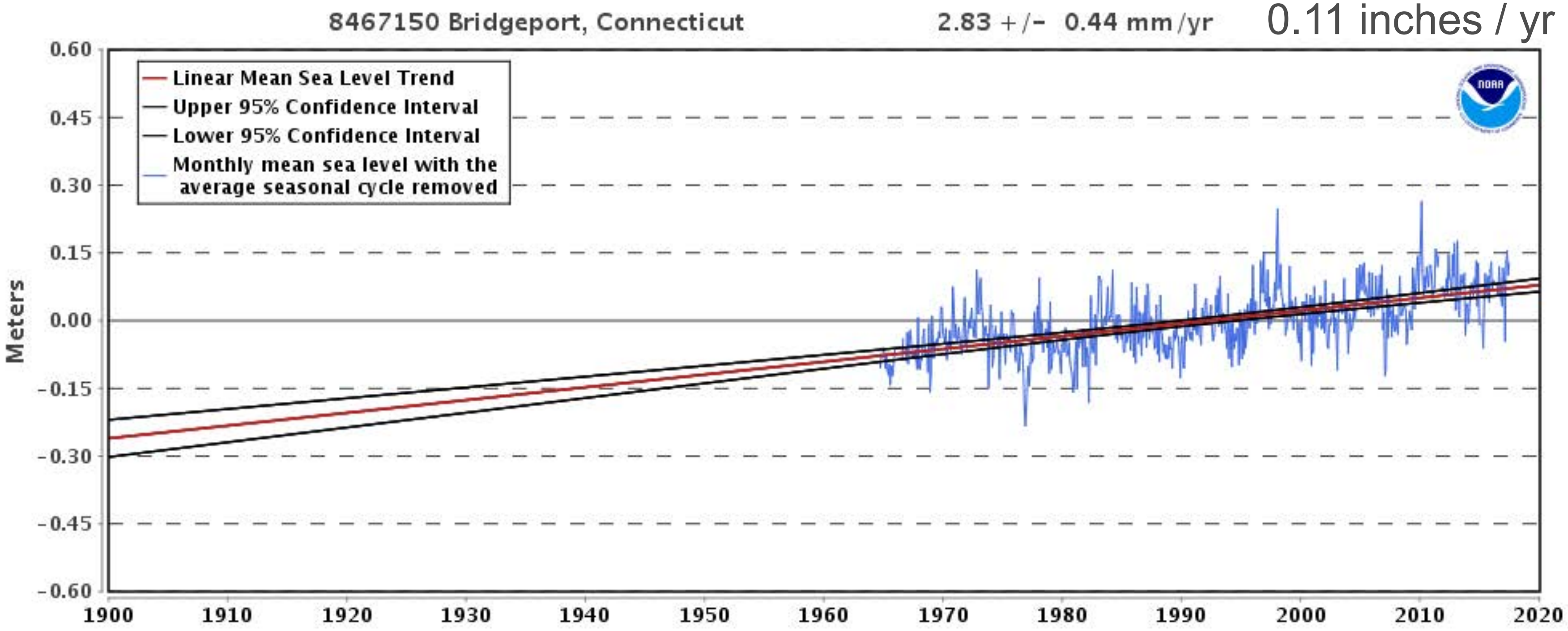
NOAA

FUSS & O'NEILL

Observed Climate Changes

Sea Level Rise - CT

0.11 inches / yr



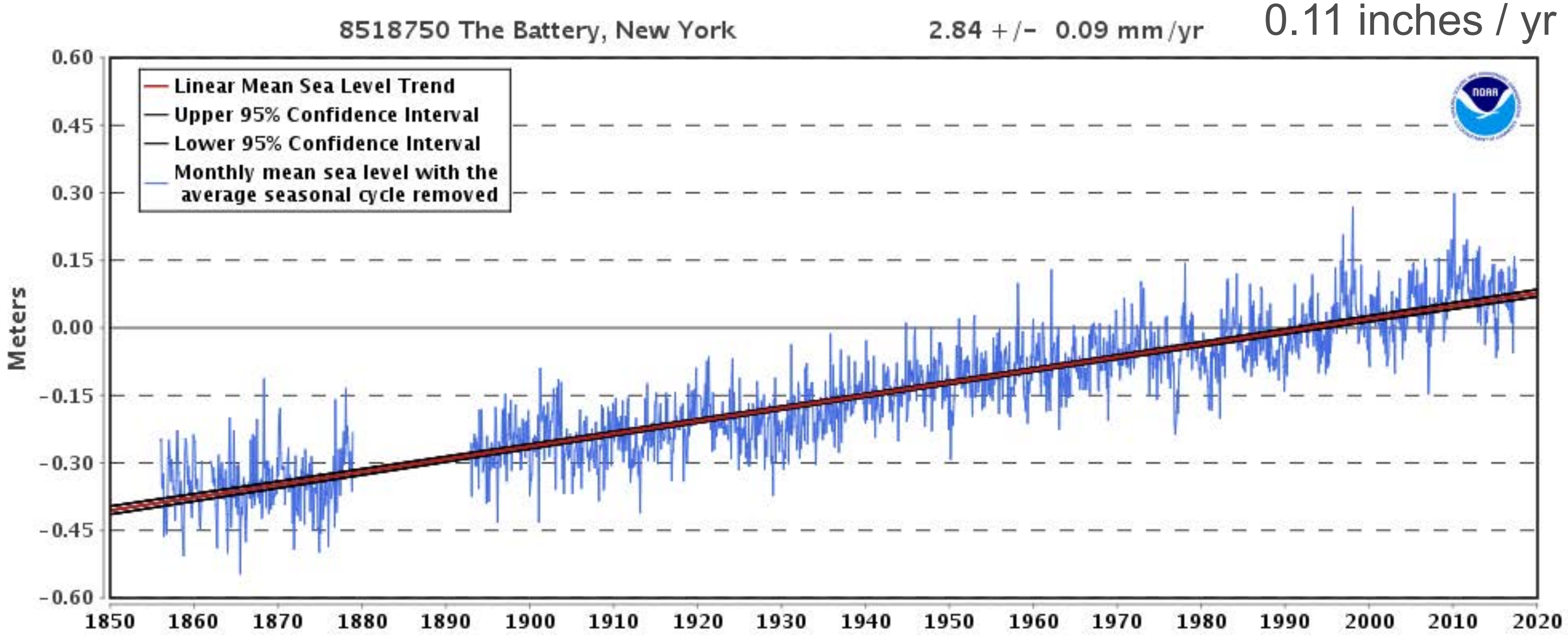
NOAA

FUSS & O'NEILL

Observed Climate Changes

Sea Level Rise - NY

0.11 inches / yr



NOAA

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Recent Climate Predictions

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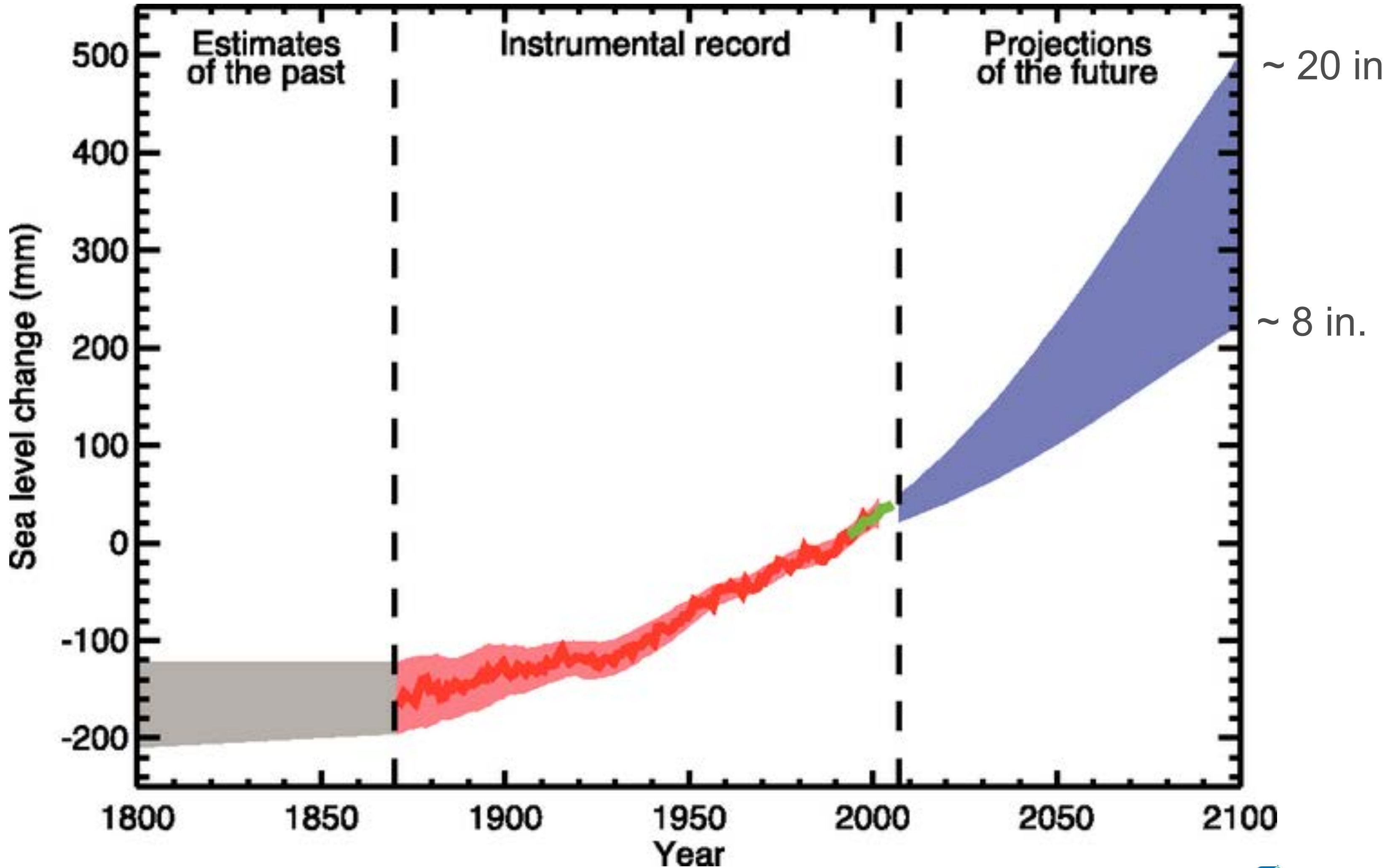
Recent Climate Predictions

Global Sea Level Rise (IPCC, 2001)



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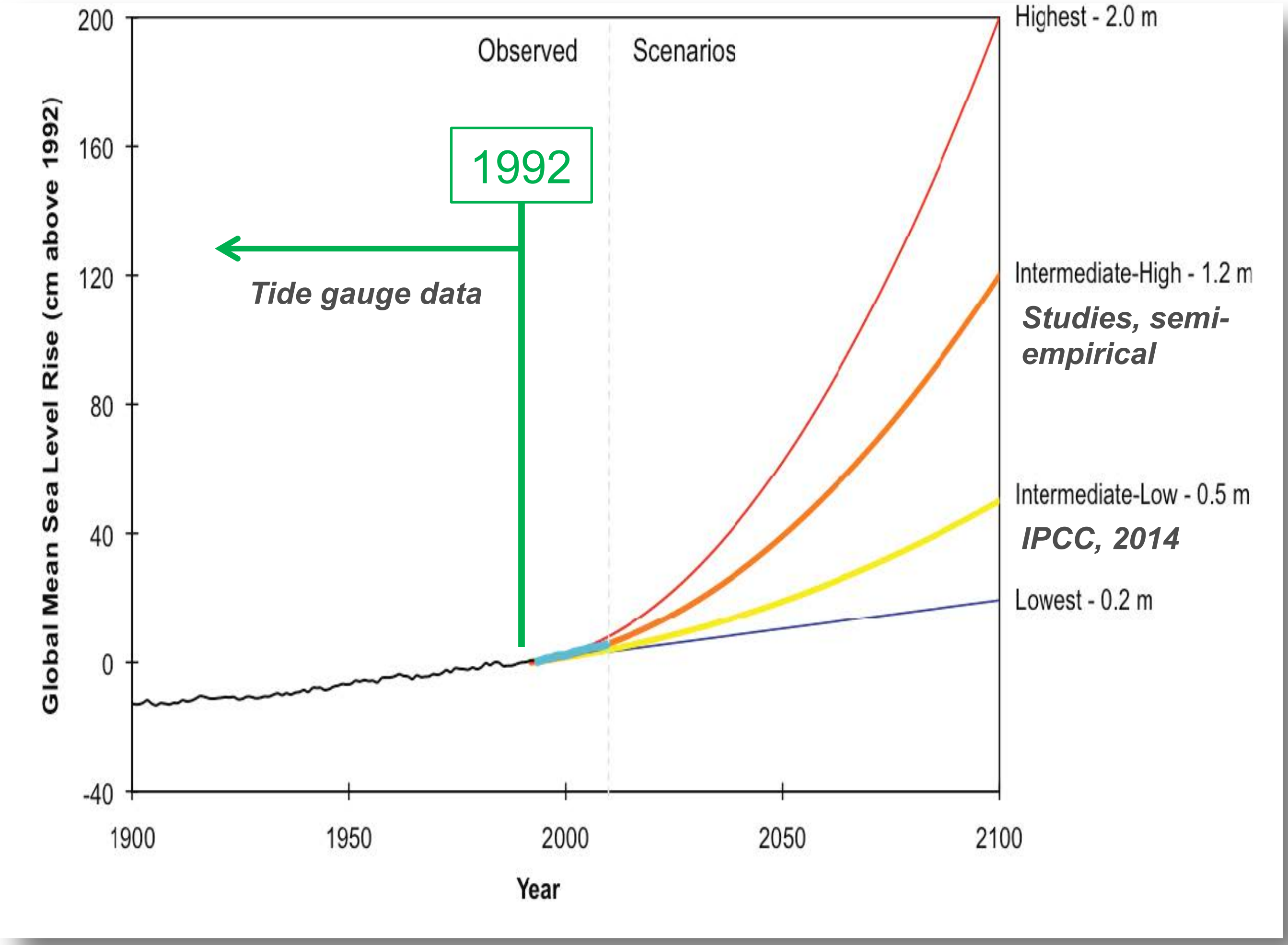
Recent Climate Predictions

United States Sea Level Rise (NOAA, 2012)



~ 78 in.

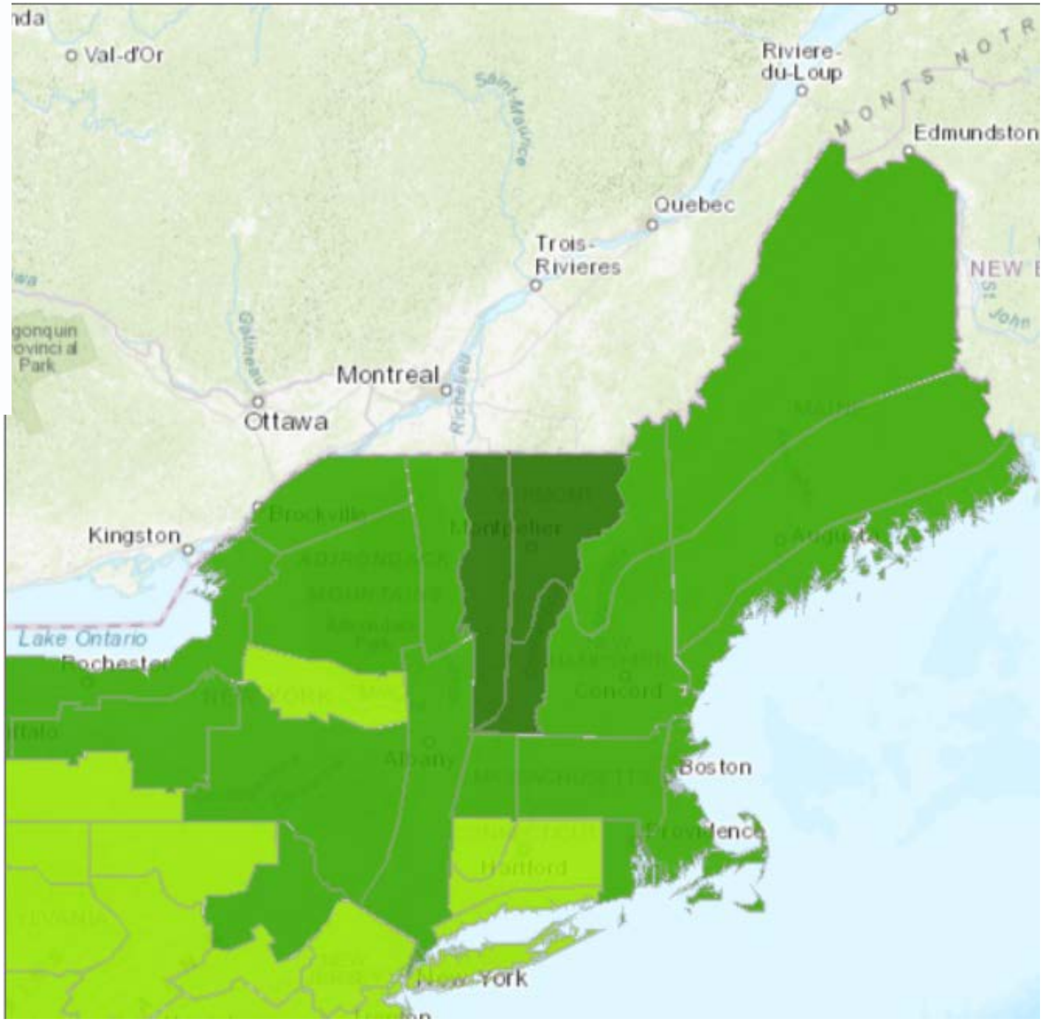
~ 47 in.

~ 8 in.

Recent Climate Predictions

Change in total precipitation

- Increased precipitation across Northeast
- >10-20% in majority of the region
- > 2-10% CT & Long Island
- >20-30% in NH



NCA, 2014

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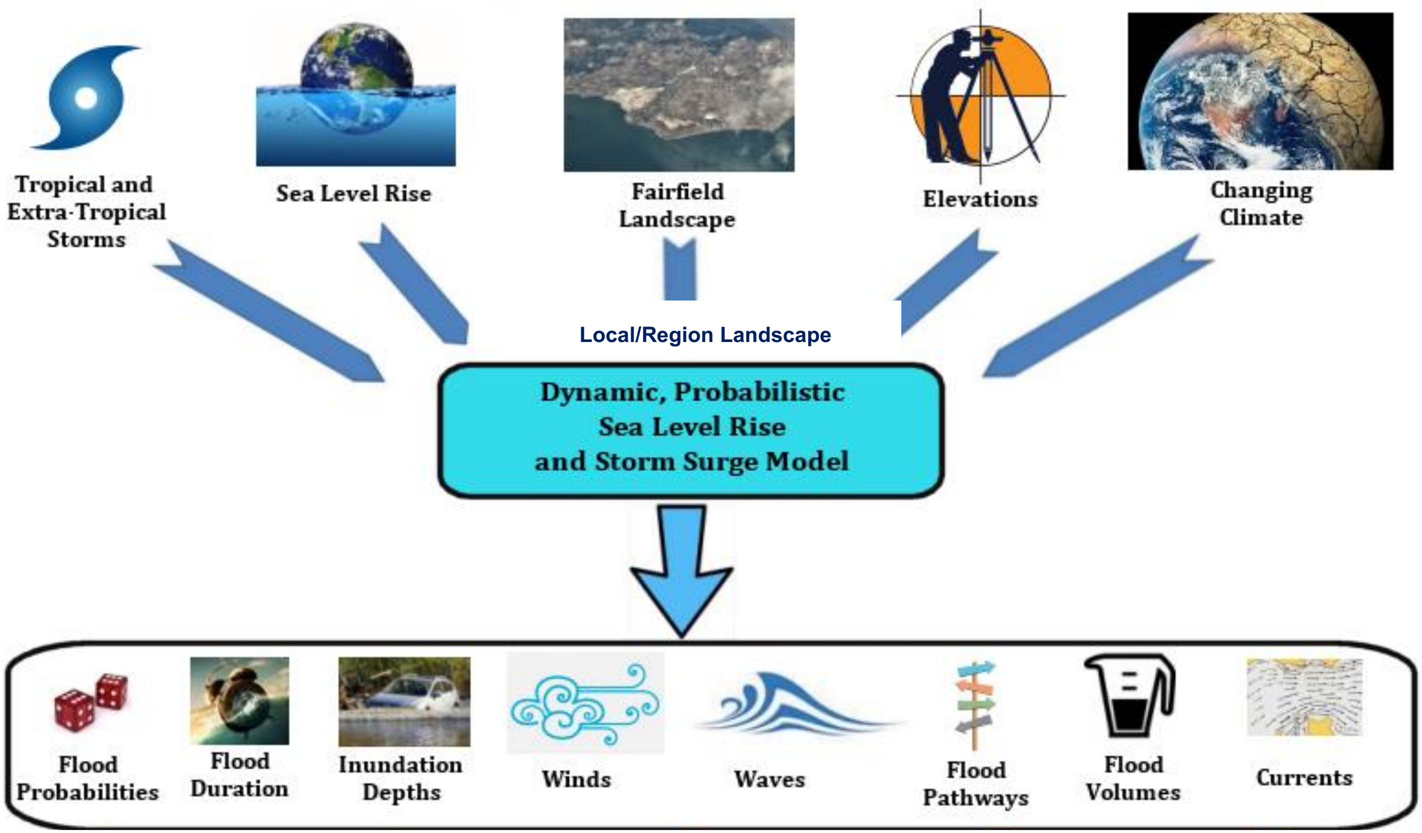
Modeling Approaches & Considerations

Bathtub Model

- Increases the waste surface elevation values and compares the new water elevation with the topographic elevations of the land.
- Does not accurately represent what may actually happen.
- Unable to represent the dynamic nature of storms.
- Does not determine the volumetric flux of water that may flood low-lying areas or how long the flooding may last.
- Does not account for waves and winds.
- Predicts /over-predicts inundation where flooding won’t occur.
- Misidentifies dry areas that would actually be inundated.
- Areas with critical infrastructure and/or complex landscapes require dynamic modeling.

Modeling Approaches & Considerations

Dynamic, Probabilistic Model



Bathtub Model

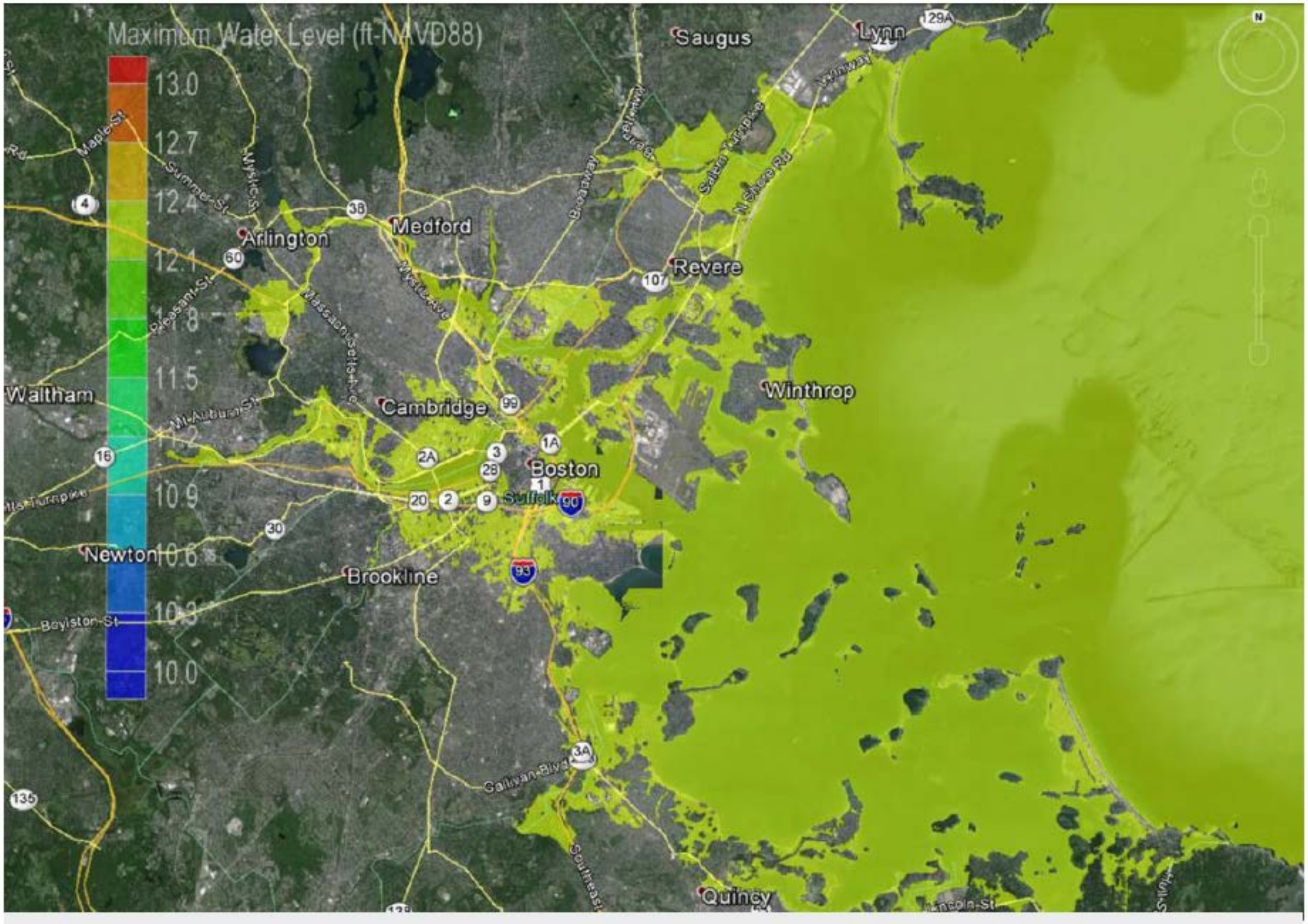


Figure 1. Bathtub model results for Boston Harbor area showing a maximum water surface elevation of 12 feet NAVD88.

Dynamic, Probabilistic Model

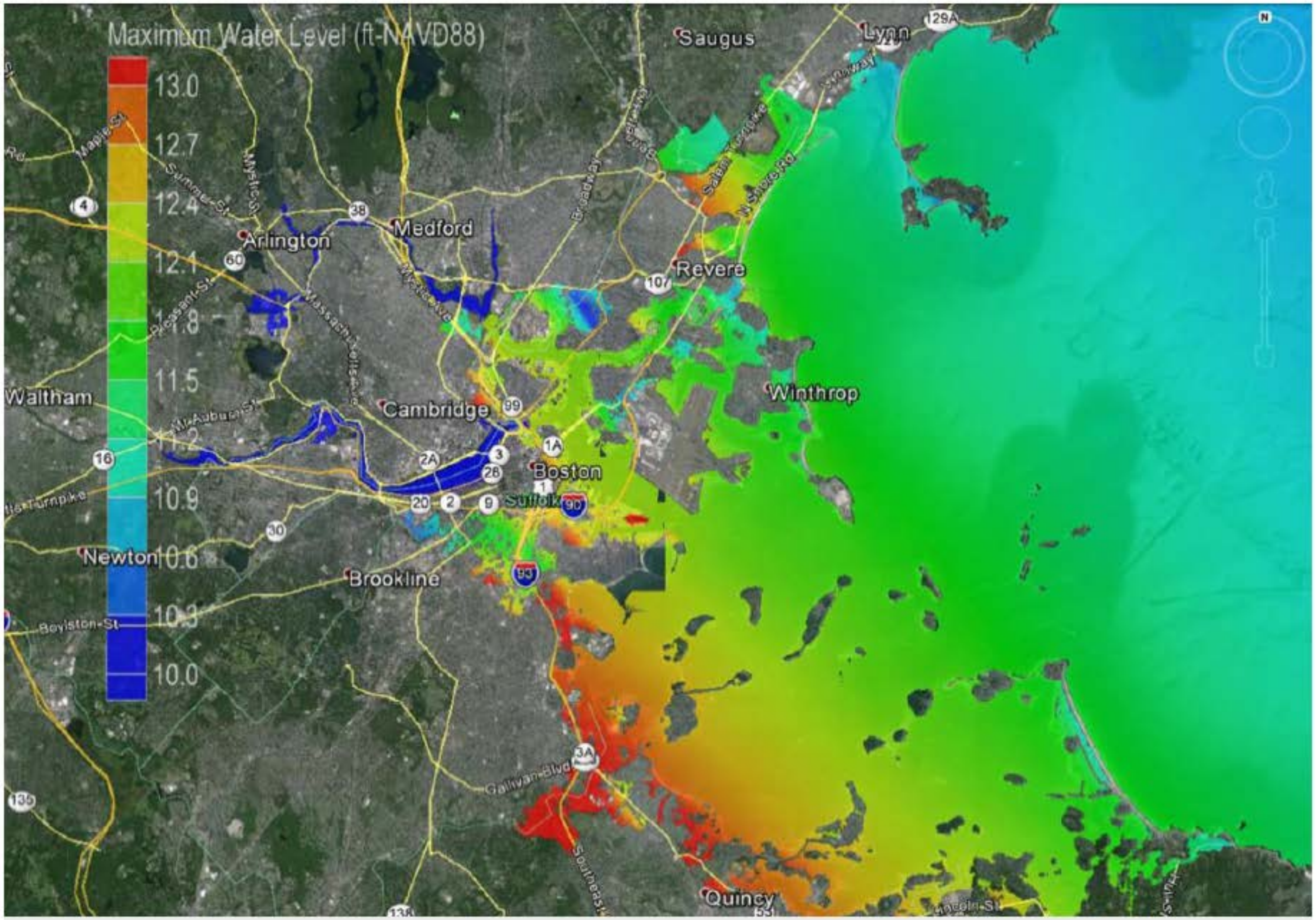
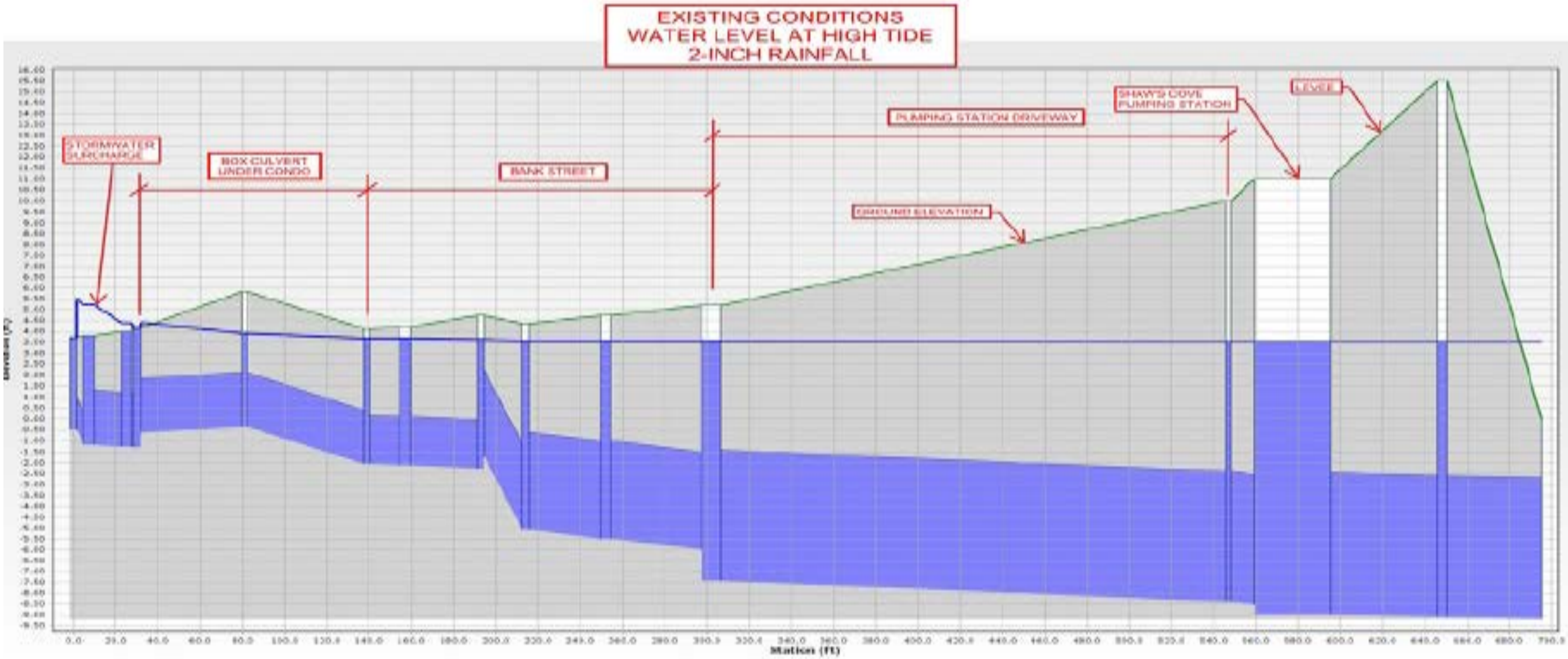
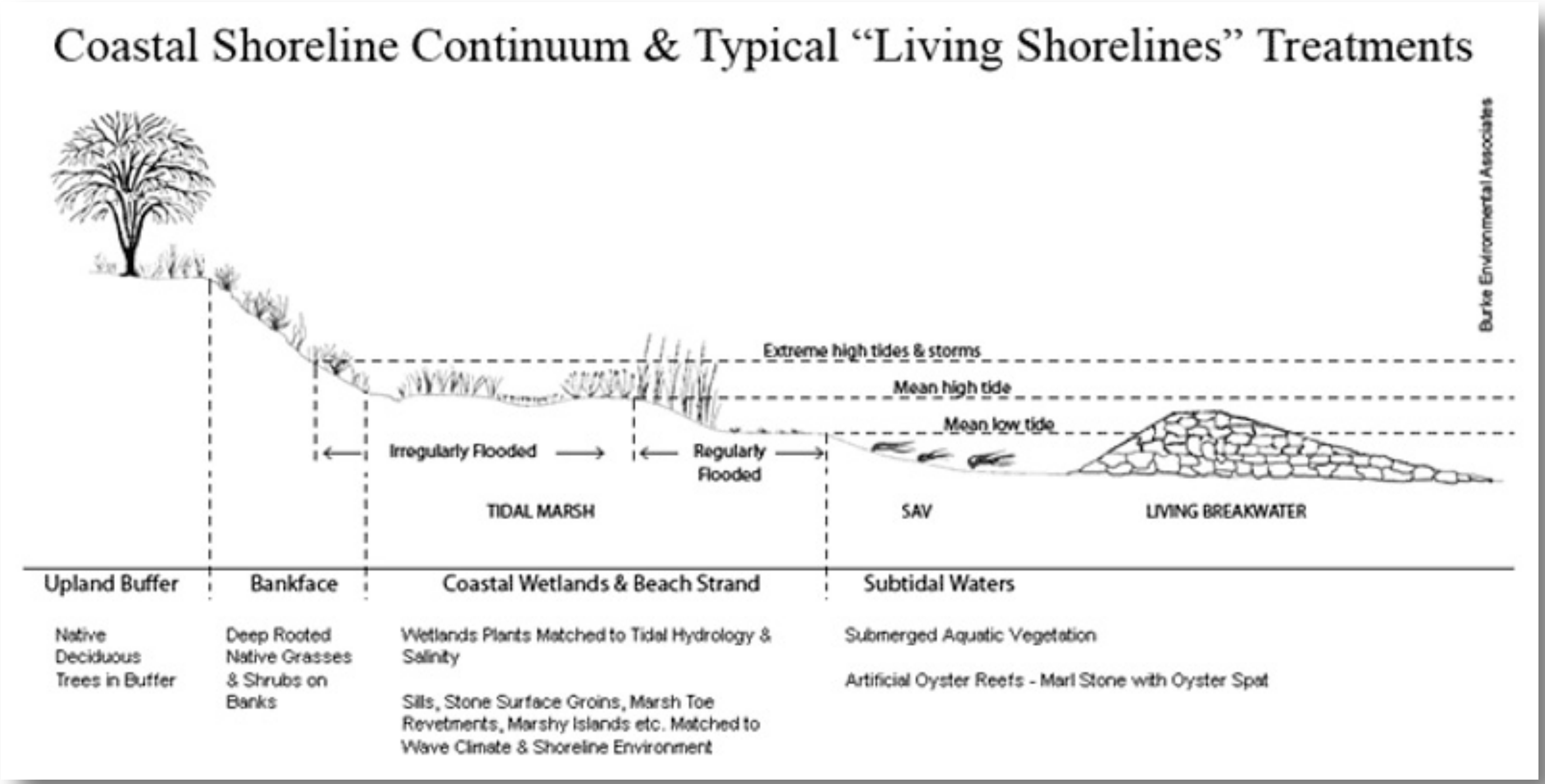


Figure 2: Dynamic numerical model results for Boston Harbor area showing a storm that peaks at 12 feet NAVD88.

Impacts on Infrastructure



Sustainable Design



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Other Solutions . . .

Warwick Sewer Authority

Maine coastal WWTFs

Mitigating hazards at sewage pump stations

Beneficial wastewater reuse