NJ FRAMES

New Jersey Fostering Regional Adaptation through Municipal Economic Scenarios
Study area

EATONTOWN BOROUGH
FAIR HAVEN BOROUGH
HIGHLAND BOROUGH
LITTLE SILVER BOROUGH
OCEANPORT BOROUGH
RED BANK BOROUGH
RUMSON BOROUGH
SEA BRIGHT BOROUGH
SHREWSBURY BOROUGH
TINTON FALLS BOROUGH
MONMOUTH BEACH BOROUGH
WEST LONG BRANCH BOROUGH
LONG BRANCH CITY
MIDDLETOWN TOWNSHIP
OCEAN TOWNSHIP
Stakeholder-driven

- Remain informed on project updates from Mayors and Project Team at Key Milestones
- Encourage constituent and public support and input

Two Rivers Council of Mayors
Facilitator: D. Jenkins
Who: Mayors from the 15 Two Rivers Municipalities
- Is informed throughout process by liaison designated to Stakeholder Working Group
- Is formally briefed bi-annually by the project team

Local Two Rivers Municipal Governing Bodies
Informed by the Municipal Teams

Stakeholder Working Group
Facilitator: L. Auerbacher (JC NERR)
Who: (1) rep from each of the 15 Two Rivers Municipalities, Monmouth County reps, reps from the Constituency Advisory Group, and NJCMP
- Provide direction and guidance to project team on approach, methodology, progress, etc.
- Agree on (3) adaptation scenarios for Cost Benefit Analysis
- Agree upon the (1) adaptation scenario to be detailed in the RRAAP

Coordinating Agendas (Federal, Regional, State)
Facilitator: NJCMF
Who: DOT, FEMA, DCA, USACE, other NJ DEP Offices
- Consult/Concur on regulatory feasibility as needed

Constituency Advisory Group
Facilitator: M. Campo (Rutgers)
Who: Local Non-Profits, Community Leaders, Academic Institutions, Business Reps, Watershed Groups, etc.
- Provide comments to Stakeholder Working Group on project tasks and analysis outcomes
- Facilitate gathering information from representative/targeted constituent groups

Technical Advisory Group
Facilitator: Louis Berger
Who: (1) Municipal technical rep from each of the 15 Two River Municipalities, county reps, NUREP rep, APA rep, other technical practitioners
- Provide comments to Stakeholder Working Group on project tasks and analysis outcomes, based on their local and technical knowledge

Public Comment / Input
Facilitator: JC NERR/RU
Who: Public, full-time local residents, 2nd home owners/occasional residents, media
- Provide local input on community-based priorities, concerns and opportunities
- Web-based and in-person feedback opportunities
- Review project task outcomes and provide feedback on project options

NJ FOSTERING REGIONAL ADAPTATION THROUGH MUNICIPAL ECONOMIC SCENARIOS (NJ FRAMES)
The mean sea level trend is 4.05 millimeters/year with a 95% confidence interval of +/- 0.22 mm/yr based on monthly mean sea level data from 1932 to 2015 which is equivalent to a change of 1.33 feet in 100 years.
Regional planning

- Vulnerability Assessment
- Risk Analysis
- Adaptation Planning Scenarios
- Cost-Benefit Analysis
- Regional Resilience and Adaptation Action Plan (RRAAP)
# Summary of Water Levels for FRAMES

<table>
<thead>
<tr>
<th>Water Level</th>
<th>Permanent Inundation</th>
<th>Coastal Flooding</th>
<th>Coastal Storm Flooding</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 ft.</td>
<td>2030 Annual Flood - 1-in-20 chance HE – 2.7ft&lt;br&gt;2050 Annual Flood - LE/HE - 3.0ft&lt;br&gt;2100 Permanent Inundation – HE - 3.4ft</td>
<td></td>
<td></td>
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<tr>
<td>7 ft.</td>
<td>Current 100 Year Flood – 6.7ft&lt;br&gt;2100 10% Chance Flood – HE - 7.3ft&lt;br&gt;2100 Annual Flood - 1-in-20 chance HE – 6.9ft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 ft.</td>
<td>2100 1% Chance Flood - 1-in-20 chance HE – 12ft.&lt;br&gt;2100 Hurricane Sandy water level - HE – 11.7ft</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Science and Technical Advisory Panel

Update on Report and STAP Conclusions
1. What are the estimates of SLR and changing coastal storm hazards in New Jersey?

2. How probable are different levels of SLR and changes in coastal storm hazards?

3. How can stakeholders consider SLR and changes in coastal storms in light of different planning horizons, project types, and risk tolerances?

4. How can efforts to apply current science recognize scientific uncertainties and the ongoing nature of scientific learning, and how often should stakeholders reassess advances in scientific information for purposes of applying the latest science into practice?

5. Are there special considerations that stakeholders should address, including but not limited to uniquely vulnerable people, places, and assets when evaluating options for incorporating estimates for SLR and changes in coastal storms?

http://dx.doi.org/doi:10.7282/T3ZP48CF
Coastal Storms: No clear basis for NJ guidance to deviate from IPCC

• By increasing the baseline for flooding, higher sea levels will increase the impact of coastal storms on New Jersey.

• Changes in the frequency, intensity and tracks of coastal storms may also affect the impact of coastal storms in New Jersey. This is an area of active research.

• For now, planning and decision-making in New Jersey should be guided by the Intergovernmental Panel on Climate Change (IPCC)’s conclusions regarding changes in future storms, including:
  • The global frequency of tropical cyclones is not likely to increase, while maximum wind speeds are likely to increase;
  • Precipitation intensity during tropical cyclones is likely to increase; and
  • The global frequency of extratropical cyclones is not likely to change substantially.
# Sea Level Rise: Projected HEIGHT Estimates for NJ (ft.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Central Estimate</th>
<th>Likely Range</th>
<th>1-in-20 Chance</th>
<th>1-in-200 Chance</th>
<th>1-in-1000 Chance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030</td>
<td>0.8 ft</td>
<td>0.6 – 1.0 ft</td>
<td>1.1 ft</td>
<td>1.3 ft</td>
<td>1.5 ft</td>
</tr>
<tr>
<td>2050</td>
<td>1.4 ft</td>
<td>1.0 – 1.8 ft</td>
<td>2.0 ft</td>
<td>2.4 ft</td>
<td>2.8 ft</td>
</tr>
<tr>
<td>2100 Low emissions</td>
<td>2.3 ft</td>
<td>1.7 – 3.1 ft</td>
<td>3.8 ft</td>
<td>5.9 ft</td>
<td>8.3 ft</td>
</tr>
<tr>
<td>2100 High emissions</td>
<td>3.4 ft</td>
<td>2.4 – 4.5 ft</td>
<td>5.3 ft</td>
<td>7.2 ft</td>
<td>10 ft</td>
</tr>
</tbody>
</table>

Estimates are based on Kopp et al. (2014). Columns correspond to different projection probabilities. For example, the ‘Likely Range’ column corresponds to the range between the 17th and 83rd percentile; consistent with the terms used by the Intergovernmental Panel on Climate Change (Mastrandrea et al., 2010). All values are with respect to a 1991-2009 baseline. Note that these results represent a single way of estimating the probability of different levels of SLR; alternative methods may yield higher or lower estimates of the probability of high-end outcomes.

IPCC AR5 global projections for SLR: "For RCP8.5, the rise by 2100 is 0.52 m (1.7 ft) to 0.98 m (3.2 ft) with a rate during 2081–2100 of 8 to 16 mm yr".

Regional sea levels may reach values up to 30% (or higher) above the global mean sea level off of the Northeast coast. If you were add 30% to the GMSL, you would get a range from 2.2 - 4.2 feet.
Sea Level Rise: Projected RATE Estimates for NJ (ft.)

<table>
<thead>
<tr>
<th>Year</th>
<th>Likely Range</th>
<th>1-in-20 Chance</th>
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<tbody>
<tr>
<td>2030</td>
<td>0.2 to 0.4 in/yr</td>
<td>0.5 in/yr</td>
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<tr>
<td>2030 - 2050 Low Emissions</td>
<td>0.2 to 0.4 in/yr</td>
<td>0.5 in/yr</td>
</tr>
<tr>
<td>2030 - 2050 High Emissions</td>
<td>0.3 to 0.5 in/yr</td>
<td>0.6 in/yr</td>
</tr>
<tr>
<td>2050 - 2100 Low emissions</td>
<td>0.2 to 0.4 in/yr</td>
<td>0.5 in/yr</td>
</tr>
<tr>
<td>2050 - 2100 High emissions</td>
<td>0.3 to 0.7 in/yr</td>
<td>0.8 in/yr</td>
</tr>
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Estimates are based on Kopp et al. (2014). Twenty-year average rates of SLR. Columns correspond to different projection probabilities. For example, the ‘Likely Range’ column corresponds to the range between the 17th and 83rd percentile; consistent with the terms used by the Intergovernmental Panel on Climate Change (Mastrandrea et al., 2010). All values are with respect to a 1991-2009 baseline.
STAP compared with New Jersey/Federal Projections

Low Emissions [RCP 2.6] SLR Projections for New Jersey (Atlantic City) Compared to Federal SLR Projections
High Emissions Central Estimate SLR Projections For Flood Levels and Tidal Datums (Atlantic City, NJ)

- Representing the ‘Likely Range’
- Impacts from Coastal Storms
- Impacts from Annual Floods
- Daily High Tide Surpasses Nuisance Flood Threshold
When conducting assessments, practitioners should:

- Evaluate at least two SLR scenarios
  - 1 in ‘Likely Range’
  - 1 above ‘Likely Range’
- Two needed to consider exposures of people, places and assets that are particularly vulnerable to flooding, or for which the consequences of damage and failure have significant magnitude.

- Evaluate at least three flood conditions representing
  - Inundation
  - Tidal / Nuisance Flooding
  - Extreme Coastal Flooding (Storms)
- Three needed to represent conditions that occur with varying frequency and last for varying amounts of time
Water Levels
What Will Adaptation Cost?

• Evaluate **at least two SLR scenarios**
  • 1 in ‘Likely Range’
  • 1 above ‘Likely Range’

• Two needed to consider exposures of people, places and assets that are particularly vulnerable to flooding, or for which the consequences of damage and failure have significant magnitude.

• Evaluate **at least three flood conditions** representing
  • Inundation
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• Three needed to represent conditions that occur with varying frequency and last for varying amounts of time

How levels were chosen

Task 1: Select Appropriate Local Sea Level Rise Scenarios
- **Three SLR Scenarios**
  - Low Emissions Central Estimate - 2.3 Ft. SLR by 2100
  - High Emissions Central Estimate - 3.4 Ft. SLR by 2100
  - High Emissions 1-in-20 Chance Estimate - 5.3 Ft. SLR by 2100

Task 2: Develop High-Water-Level Event Scenarios
- **Three flood conditions**
  - Inundation
  - Tidal / Nuisance Flooding
  - Extreme Coastal Flooding (Storms)
  - Use NOAA Extreme Water Levels and Historic Storms
  - Add sea level rise to water levels for chosen years

Task 3: Choose Water Levels for Assessment
Select 3-4 water-levels that represent a low, medium, high, and perhaps catastrophic water-level. Project team consensus on 3 water levels based on group discussion and preliminary exposure assessment.
How levels were chosen

Task 1: Select Appropriate Local Sea Level Rise Scenarios

- **Three SLR Scenarios**
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# Projected Water Levels Relative to MHHW (ft.)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2030</th>
<th>2050</th>
<th>2100</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low Emissions Central Estimate - 2.3 Ft. SLR by 2100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane Sandy</td>
<td>8.3</td>
<td>9.1</td>
<td>9.7</td>
<td>10.6</td>
</tr>
<tr>
<td>1% Chance Flood (100-year flood)</td>
<td>6.7</td>
<td>7.5</td>
<td>8.1</td>
<td>9</td>
</tr>
<tr>
<td>10% Chance Flood (10-year flood)</td>
<td>3.9</td>
<td>4.7</td>
<td>5.3</td>
<td>6.2</td>
</tr>
<tr>
<td>99% Chance Flood (Annual flood)</td>
<td>1.6</td>
<td>2.4</td>
<td>3</td>
<td>3.9</td>
</tr>
<tr>
<td>Permanent Inundation (MHHW)</td>
<td>0</td>
<td>0.8</td>
<td>1.4</td>
<td>2.3</td>
</tr>
<tr>
<td><strong>High Emissions Central Estimate - 3.4 Ft. SLR by 2100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane Sandy</td>
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<td>9.7</td>
<td>11.7</td>
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<td>5</td>
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<td>Permanent Inundation (MHHW)</td>
<td>0</td>
<td>0.8</td>
<td>1.4</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>High Emissions 1-in-20 Chance Estimate - 5.3 Ft. SLR by 2100</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hurricane Sandy</td>
<td>8.3</td>
<td>9.4</td>
<td>10.3</td>
<td>13.6</td>
</tr>
<tr>
<td>1% Chance Flood (100-year flood)</td>
<td>6.7</td>
<td>7.8</td>
<td>8.7</td>
<td>12</td>
</tr>
<tr>
<td>10% Chance Flood (10-year flood)</td>
<td>3.9</td>
<td>5</td>
<td>5.9</td>
<td>9.2</td>
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<td>3.6</td>
<td>6.9</td>
</tr>
<tr>
<td>Permanent Inundation (MHHW)</td>
<td>0</td>
<td>1.1</td>
<td>2</td>
<td>5.3</td>
</tr>
</tbody>
</table>
# Summary of Water Levels for FRAMES

<table>
<thead>
<tr>
<th>Rounded Water Level</th>
<th>What High Water Level Condition Does This Height Represent?</th>
</tr>
</thead>
</table>
| **Permanent Inundation** | 3 ft. | - 2030 Annual Flood - 1-in-20 chance HE – 2.7ft  
- 2050 Annual Flood - LE/HE - 3.0ft  
- 2100 Permanent Inundation – HE - 3.4ft |
| **Coastal Flooding** | 7 ft. | - Current 100 Year Flood – 6.7ft  
- 2100 10% Chance Flood – HE - 7.3ft  
- 2100 Annual Flood - 1-in-20 chance HE – 6.9ft |
| **Coastal Storm Flooding** | 12 ft. | - 2100 1% Chance Flood - 1-in-20 chance HE – 12ft.  
- 2100 Hurricane Sandy water level - HE – 11.7ft |
3 foot inundation

- 2030 Annual Flood (99% Chance) & SLR Scenario (1-in-20 chance) – 2.7ft
- 2050 Annual Flood (99% Chance) & SLR Scenario (LE/HE) - 3.0ft
- 2100 Permanent Inundation (MHHW) & SLR Scenario (HE) - 3.4ft
7 foot inundation

- Current 100 Year Flood (1% Chance) – 6.7ft
- 2100 10 Year Flood (10% Chance) & SLR Scenario (HE) - 7.3ft
- 2100 Annual Flood (99% Chance) & SLR Scenario (1-in-20 chance HE) – 6.9ft
12 foot inundation

- 2100 100 Year Flood (1% Chance) & SLR Scenario (1-in-20 chance HE) – 12ft

- 2100 Hurricane Sandy & SLR Scenario (HE) – 11.7ft
## How will this information be used?

<table>
<thead>
<tr>
<th>Vulnerability Assessment</th>
<th>What critical and community assets are impacted by these water levels?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk Assessment</td>
<td>What is the risk to the critical and community assets?</td>
</tr>
<tr>
<td>No Action Scenarios</td>
<td>These water levels are the No Action Scenarios.</td>
</tr>
<tr>
<td>Planning Scenarios</td>
<td>How does the community want to plan for/respond to these water levels?</td>
</tr>
<tr>
<td>Cost Benefit Analysis</td>
<td>What is the net benefit of the community’s planning response compared to action?</td>
</tr>
</tbody>
</table>
Stakeholder and Community Engagement

**Local Two Rivers Municipal Governing Bodies**
- Informed by the Municipal Reps

**Two Rivers Council of Mayors**
- Facilitator: D. Jenkins
- Who: Mayors from the 15 Two Rivers Municipalities

**Stakeholder Working Group**
- Facilitator: L. Auermüller (JC NERR)
- Who: 2 reps from each of the 15 Two Rivers Municipalities, Monmouth County reps, Reps from the Constituency Advisory Group, and NJCMP

**Constituency Advisory Group**
- Facilitator: M. Campo (Ruggles)
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**Technical Advisory Group**
- Facilitator: Louis Berger
- Who: 1 Municipal technical rep from each of the 15 Two River Municipalities, county reps, NJAREM, rep, APA rep., other technical practitioners

**Public Comment / Input**
- Facilitator: JC NERR/RU
- Who: Public, full-time local residents, 2nd home owners/occasional residents, media

**Coordinating Agendas (Federal, Regional, State)**
- Facilitator: NJDEP
- Who: DOT, FEMA, DCA, USACE, other NJ DEP Offices

Key Points:
- **Overall Engagement**: Coordination
- **Public Comment**: Input throughout process

- **Remain informed on project updates from Mayors and Project Team at Key Milestones**
- **Encourage constituent and public support and input**
- **Provide direction and guidance to project team on approach, methodology, progress, etc.**
- **Agree on (3) adaptation scenarios for Cost Benefit Analysis**
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- **Provide comments to Stakeholder Working Group on project tasks and analysis outcomes**
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**NJ FOSTERING REGIONAL ADAPTATION THROUGH MUNICIPAL ECONOMIC SCENARIOS (NJ FRAMES)**
Thank you!

Your Advisory Group leader will be in touch about next steps and future meetings.

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Nick.Angarone@dep.nj.gov

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auermull@marine.rutgers.edu

Bethany Bearmore  
bbearmore@louisberger.com

Matt Campo  
mcampo@ejb.rutgers.edu