Sea-Level Rise in New Jersey

Robert Kopp

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Association of New Jersey Environmental Commissions
May 10, 2023
The IPCC Sixth Assessment

- Most accurate and up-to-date global synthesis on climate science, impacts, adaptation and mitigation (assessment of research literature, not original research)

- Informs governments and other decision-makers about consequences of decisions (policy relevant, not policy prescriptive)

- Sixth Assessment Report: 721 scientists from 90 countries

- Working Group 1: 234 authors from 65 countries analysed 14,000 studies over 3 years

- Sea-level rise implications in WG1, WG2, SR1.5°C and SROCC
Recent changes in the climate are widespread, rapid, and intensifying, and unprecedented in thousands of years.
Global sea level has been rising at an accelerating rate since about 1970, and over the last century it’s risen more than in any century in at least 3000 years.
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1.5 inches/decade over 2006-2018
1.3 mm/yr (0.5 in/decade) over 1901-1971
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- 1.3 mm/yr (0.5 in/decade) over 1901-1971
- 1.9 mm/yr (0.7 in/decade) over 1971-2006

Graph showing the global mean sea level over time, with a trend line indicating an increase in sea level rise.
Global sea level has been rising at an accelerating rate since about 1970, and over the last century it’s risen more than in any century in at least 3000 years.

- 1.3 mm/yr (0.5 in/decade) over 1901-1971
- 1.9 mm/yr (0.7 in/decade) over 1971-2006
- 3.7 mm/yr (1.5 in/decade) over 2006-2018
Heating of the climate system has caused global mean sea level rise through ice loss on land and thermal expansion from ocean warming.

2.3 mm/yr (0.9 in/decade) over 1971-2018
Heating of the climate system has caused global mean sea level rise through ice loss on land and thermal expansion from ocean warming.

Human influence was very likely the main driver of global mean sea-level increases since at least 1971.
Sea level is rising even faster here in New Jersey than in the global average.

Since 1911, sea level in coastal New Jersey has risen by about 18 inches, compared to about 8 inches in the global average. The difference is largely due to natural land subsidence (about 7 inches), enhanced by groundwater withdrawal (about 3 inches).
The factors that affect sea level are more complex in specific places than in the global average.

Contributions over 2006–2018 out of 1.7 inches total globally

- Ice melt: 51%
- Thermal Expansion: 34%
- Land Water: 15%

Contributions over 2006–2018 out of 2.0 inches at Atlantic City

- Ice melt: 28%
- Thermal Expansion: 24%
- Winds, Currents, Land Water: 26%
- Sinking Land: 22%
Sea-level rise is making high-tide flooding more common.
The number of high-tide flooding days in Atlantic City has increased from less than 1/year in the 1950s to an average of 8/year over the last decade – a period over which sea level rose by about 9 inches.

Sea-level rise is making high-tide flooding more common.
Due to sea-level rise, 27,000 more NJ properties experience annual flooding than would have in the 1980s.

**FIGURE 3**

Change in New Jersey annual flood risk

Number of current properties at risk of annual flooding, by county, comparing sea levels in 1980 to sea levels today

<table>
<thead>
<tr>
<th>County</th>
<th>1980 Sea Levels</th>
<th>Current Sea Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumberland</td>
<td>964</td>
<td>1,118</td>
</tr>
<tr>
<td>Burlington</td>
<td>913</td>
<td>1,243</td>
</tr>
<tr>
<td>Camden</td>
<td>761</td>
<td>1,304</td>
</tr>
<tr>
<td>Gloucester</td>
<td>1,338</td>
<td>1,615</td>
</tr>
<tr>
<td>Salem</td>
<td>2,498</td>
<td>3,050</td>
</tr>
<tr>
<td>Monmouth</td>
<td>6,644</td>
<td>8,225</td>
</tr>
<tr>
<td>Atlantic</td>
<td>7,744</td>
<td>13,159</td>
</tr>
<tr>
<td>Cape May</td>
<td>16,221</td>
<td>21,572</td>
</tr>
<tr>
<td>Ocean</td>
<td>19,232</td>
<td>31,931</td>
</tr>
</tbody>
</table>

Source: Rhodium Group and First Street Foundation analysis
Sea-level rise is enhancing storm-driven flooding.
Human-caused sea-level rise was responsible for about 13% ($8 billion) of the property damage caused by Sandy in New York and New Jersey and exposed about 70 thousand people to Sandy’s flooding.

Sea-level rise is enhancing storm-driven flooding.
Due to sea-level rise and climate change, NJ’s average annual losses from hurricanes have increased about $1 billion since the 1980s.
There’s no going back from some changes in the climate system. However, some changes could be slowed and others could be stopped by limiting warming.
Sea level is going to continue to rise for many centuries to come, creating an escalating hazard for coastal communities.
Through the middle of the century, sea level projections exhibit limited sensitivity to emissions scenario.
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Extreme sea levels that occurred once per century in the recent past will occur about 20–30 times more frequently by 2050.
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- 0.55-0.90 m (1.8-3.0 ft) under the high emissions scenario (SSP3-7.0)
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by 2150:
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by 2150:
- 0.98-1.88 m (2.9-5.4 ft) under the high emissions scenario (SSP3-7.0)
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The more we limit our emissions, the lower the chance we trigger instabilities in the polar ice sheets that could substantially increase sea-level rise.
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Higher global mean sea level rise before 2100 could be caused by:

- Low likelihood, high-impact storyline, including ice sheet instability processes, under SSP5-8.5
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Higher global mean sea level rise before 2100 could be caused by:
- earlier-than-projected disintegration of marine ice shelves and the abrupt, widespread onset of marine ice sheet instability and/or marine ice cliff instability around Antarctica.
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Global mean sea level rise above the likely range – approaching 2 m (7 ft) by 2100 and 5 m (16 ft) by 2150 under a very high GHG emissions scenario (SSP5-8.5) – cannot be ruled out.
Through 2050, we are likely looking at 1-2 feet of rise in New Jersey, regardless of emissions.

Projected sea-level rise in New Jersey
Feet above year 2000 baseline

<table>
<thead>
<tr>
<th>Likely Range</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 83% chance</td>
<td>0.5</td>
<td>0.9</td>
</tr>
<tr>
<td>&lt;17% chance</td>
<td>1.1</td>
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</table>
Beyond 2050, projected rise is increasingly sensitive to level of emissions – especially for high-end risks.

Projected sea-level rise in New Jersey
Feet above year 2000 baseline

<table>
<thead>
<tr>
<th>Likely Range</th>
<th>2030</th>
<th>2050</th>
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<td>3.9</td>
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<table>
<thead>
<tr>
<th>Emissions</th>
<th>Low</th>
<th>Mod.</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1.7</td>
<td>2.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Mod.</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>High</td>
<td>1.1</td>
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Notes: All values are 1991-2010 (2001-2019) means of sea level measured with respect to a 1991-2009 baseline centered on the 2009 average. Observed = 0.2 ft.
Expected number of flood events increases significantly with sea-level rise.

Expected number of extreme sea level events at Atlantic City
Water level: Historic 10% probability extreme sea level events (3.3’ above high tide line)

Moderate emissions, likely rise (1.4’ by 2050, 3.3’ by 2100)

2000:
10% chance per year
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10% chance per year

2030:
Annual maximum high water

2055:
Minor tidal flooding level (~5-10 days/yr)
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- **2000:** 10% chance per year
- **2030:** Annual maximum high water
- **2055:** Minor tidal flooding level (~5-10 days/yr)
- **2100:** Permanent flooding
Projected sea-level rise translates into more frequent flooding.

Projected days/year of high tide flood at Atlantic City
Moderate emissions scenario

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<tr>
<td>2000</td>
<td>5 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>7 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>9 days</td>
<td>17 days</td>
<td>30 days</td>
</tr>
<tr>
<td>2030</td>
<td>17 days</td>
<td>35 days</td>
<td>75 days</td>
</tr>
<tr>
<td>2040</td>
<td>30 days</td>
<td>70 days</td>
<td>150 days</td>
</tr>
<tr>
<td>2050</td>
<td>45 days</td>
<td>120 days</td>
<td>255 days</td>
</tr>
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Even under moderate emissions, there is a good chance minor flooding will be close to daily by 2100.

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Moderate emissions scenario

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<td>190 days</td>
<td>315 days</td>
</tr>
<tr>
<td>2070</td>
<td>120 days</td>
<td>265 days</td>
<td>350 days</td>
</tr>
<tr>
<td>2080</td>
<td>165 days</td>
<td>320 days</td>
<td>**</td>
</tr>
<tr>
<td>2090</td>
<td>200 days</td>
<td>345 days</td>
<td>**</td>
</tr>
<tr>
<td>2100</td>
<td>240 days</td>
<td>355 days</td>
<td>**</td>
</tr>
</tbody>
</table>
More than 3,000 homes built in NJ from 2010-2017 will be in the annual flood zone by 2050.

Table 4: States with most new homes in annual risk zone, 2050

<table>
<thead>
<tr>
<th>State</th>
<th>Number of New Homes in Annual Risk Zone</th>
<th>Value of New Homes in Annual Risk Zone</th>
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</tr>
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<tbody>
<tr>
<td>1. New Jersey</td>
<td>3,087</td>
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<td>3.1</td>
</tr>
<tr>
<td>2. North Carolina</td>
<td>1,231</td>
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<td>388</td>
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<td>8. Maryland</td>
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</tr>
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<td>10. Louisiana</td>
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<td>0.7</td>
</tr>
</tbody>
</table>

Data reflect homes built from 2010 through 2016 (for Alabama, Florida, Mississippi, and New York) or through 2017 (for all other coastal states), and a risk zone defined by local ten-percent-annual-chance flood heights added on to median local sea level projections. Housing data source: Zillow (home locations and home values); Zillow and Microsoft (home locations); and ZTRAX (build years).
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</table>

Compare: between 2013 and 2021, NJ’s Blue Acres program had 830 families accept buyouts.

Source: NJ Spotlight, October 19, 2021
About 90,000 properties, worth about $80 billion, will enter into the 1-in-30 year hurricane flood plain by 2050.

FIGURE 10
Projected increase in current New Jersey homes facing hurricane flood risk by 2050

Increase in number of current buildings in the 1-in-30-year floodplain, by county, due to changes in sea level and expected hurricane activity between today and 2050. The range captures uncertainty in sea levels and hurricane activity under a high emissions scenario.

Source: Rhodium Group analysis
Adaptation capacity and governance to manage sea-level rise risks typically require decades to implement and institutionalize.

(a) Typical timescales of coastal risk management

- **Planned relocation**: *Typical intended lifetime of measures* ≈ 100 years
- **Protect barriers**: *Typical intended lifetime of measures* ≈ 100 years
- **Protect levees**: *Typical intended lifetime of measures* ≈ 50 years
- Elevating houses: *Typical intended lifetime of measures* ≈ 30 years
- Sediment-based protection: *Typical intended lifetime of measures* ≈ 15 years
- Ecosystem-based adaptation: *Typical intended lifetime of measures* ≈ 15 years

*Measures with long-living societal legacy*
The more we limit our emissions, the more time we have to adapt.

<table>
<thead>
<tr>
<th>Likely timing of exceedance at Atlantic City</th>
<th>Low Emissions (2°C)</th>
<th>High Emissions (5°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 ft.</td>
<td>2060-2100</td>
<td>2050-2090</td>
</tr>
<tr>
<td>4 ft.</td>
<td>2100 to after 2150</td>
<td>2080-2150</td>
</tr>
<tr>
<td>6 ft.</td>
<td>2140 to after 2150</td>
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</tr>
</tbody>
</table>

Kopp et al. (2019)
• Advance understanding of how coastal climate hazards, landforms, and human decisions interact to shape climate risk

• Facilitate flexible, equitable, and robust long-term planning to manage climate risk in the New York City-New Jersey-Philadelphia region

• Build an academic/stakeholder partnership model that provides insights for just, equitable, and inclusive climate action in diverse coastal, urban megaregions around the world

• Train the next generation of leaders in transdisciplinary climate research and engagement.
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RUTGERS
Institute of Earth, Ocean, and Atmospheric Sciences

High Water Line: Presenting the Science
April 13, 2022

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