Department of Environmental Protection
Report to the Interagency Council on Climate Resilience

Anticipated Sea-Level Rise Based on the 2019 Report of the Rutgers University Science and Technical Advisory Panel

December 12, 2019

Introduction

By issuing Executive Order 89 (EO 89) on October 29, 2019, Governor Murphy made clear that climate change resilience is a high priority for the State of New Jersey. The Executive Order recognizes the scientific community's consensus that climate change is occurring globally and nationally and that New Jersey, as a coastal state, is particularly vulnerable to climate change impacts. EO 89 sets forth the Governor's vision and direction for state government agencies to work together to protect public health and safety, and to maintain the physical, economic and social vitality and resilience of New Jersey's communities under the current and anticipated impacts of climate change.

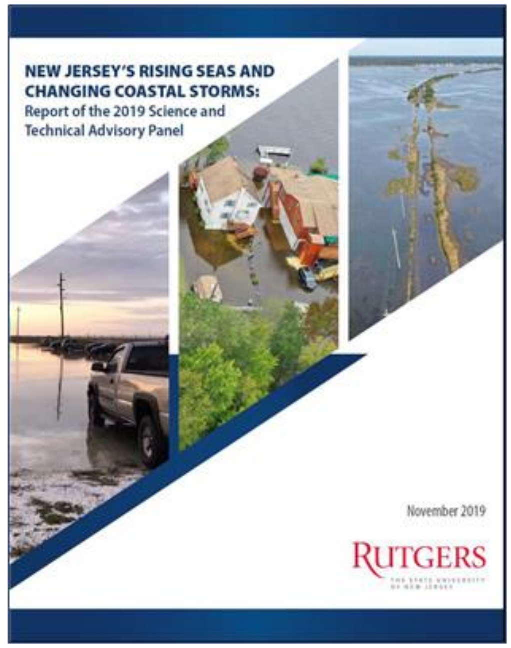
In Executive Order 89, Governor Murphy directs all state agencies to take action to address the urgent need to coordinate and integrate climate change considerations into planning and decision-making at all levels of government. EO 89 establishes the Interagency Council on Climate Change and directs state agencies, under the leadership of the state's Chief Resilience Officer and with support from the Department of Environmental Protection (DEP), to develop a Statewide Climate Change Resilience Strategy by September 1, 2020.

Recognizing that the first step to building resilience is to understand what we are up against, Executive Order 89 further directs the Chief Resilience Officer and the DEP to provide the scientific foundation for the Statewide Climate Change Resilience Strategy, by presenting an initial assessment to the Interagency Council at its first meeting and developing a more detailed Scientific Report on Climate Change within 180 days (by June 1, 2020).

DEP already has taken the first step to provide the scientific information needed to plan for climate change resilience, by commissioning Rutgers University to reconvene a Science and Technical Advisory Panel to provide an updated report on the latest science regarding current and anticipated future sea level rise and storm impacts along New Jersey's coast. The panel is a group of scientists and practitioners that was first brought together by Rutgers in 2015 to evaluate the most current science on sea level rise projections and changing coastal storms. The updated 2019 panel report is summarized below.

Rutgers University Science and Technical Advisory Panel

The first report of the Science and Technical Advisory Panel was published in 2016. Since that time, new research has been published that allows scientists to better quantify climate impacts, such as sea-level rise. For example, more detailed research into melting ice sheets has been published since the last report that influences some of the previous conclusions.



In 2019, DEP charged STAP to evaluate new information on sea-level rise and changing coastal storms. Specifically, their research focused on estimating how much sea-level rise we can expect in each decade through 2150, and how coastal storms might change in that time.

Sea-Level Rise: What and Why?

Sea levels change for many reasons, both as a result of human-caused climate change and natural processes. As humans emit greenhouse gases, they act to warm both the atmosphere and the oceans. Sea-level rise is caused by three primary functions: 1) most substantially through the melting of glaciers and ice sheets on land which flows into the ocean; 2) as water temperature rises, the actual water molecules themselves expand, much like wood expands in the summer, and; 3) much of New Jersey is subsiding, or sinking, due to long-term geologic changes. When this happens across the world, we see a steady increase in sea-level.

The degree to which the climate changes—and thus how extreme its impacts are—is primarily driven by how much greenhouse gas humans emit into the atmosphere. In other words, with higher levels of emissions, temperatures and sea levels will rise more than they would with lower emissions. We are currently emitting greenhouse gases at high levels. If we continue to emit at present levels (or increase our emissions), we will see higher amounts of sea-level rise than if we dramatically reduce our emissions. Although there has been some progress in slowing global greenhouse gas emissions through greenhouse gas mitigation measures, such as renewable energy and efficient vehicles, the future remains largely uncertain.

The Science Behind STAP Report

To prepare updated estimates of sea-level rise in the coming decades, STAP scientists examined leading studies of sea-level rise. They also compiled historical data from tide gauges to understand how much change we have already seen. As discussed earlier, the magnitude of climate change impacts, including sea-level rise, depends on emissions levels.

As a basis for future global greenhouse gas emissions, STAP analyzed three possible futures or "scenarios" of high, moderate, and low emissions. For reference, the low emissions scenario is consistent with limiting temperature rise to 2℃ (3.6°F), as is called for in the Paris Climate Agreement and which requires a dramatic cut in the current amount of greenhouse gases that are emitted. Moderate emissions are interpolated as the midpoint between the high- and low emissions scenarios and approximately correspond to the warming expected under current global policies. The high scenario corresponds to a continued growth in global emissions leading to a 5℃ (9°F) increase. With that information, they projected the magnitude and rate of sea-level rise for New Jersey under each of these three emissions scenarios.

Potential changes in sunny-day (tidal) flooding were also evaluated using the results of the sea-level rise projections. Changes to coastal storms were evaluated by reviewing the current scientific literature.

STAP Conclusions & Results

Sea-level Rise

STAP concluded that sea-level in New Jersey rose 1.5 feet from 1911-2019, more than twice as much as the global average. The rate of sea-level rise in New Jersey is also twice as high as the global average between 1979 and 2019 (0.2 inches per year versus 0.1 inches). **Table 1** displays the increases in sea levels projected by STAP to 2150. Additionally, **Figure 1** displays the same information in graph format.

Table 1. New Jersey Sea-Level Rise above year 2000 baseline* in feet. Adapted from STAP

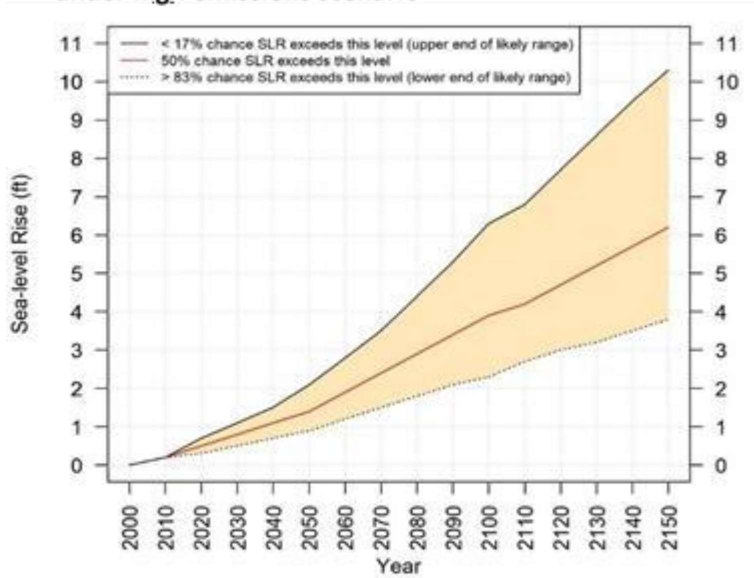
<table>
<tr><th colspan="6">Likely Range</th></tr>
<tr><th>2030</th><th>2050</th><th>Emissions</th><th>2070</th><th>2100</th><th>2150</th></tr>
<tr><td rowspan="3">0.5–1.1</td><td rowspan="3">0.9–2.1</td><td>Low</td><td>1.3–2.7</td><td>1.7–3.9</td><td>2.4–6.3</td></tr>
<tr><td>Mod.</td><td>1.4–3.1</td><td>2.0–5.1</td><td>3.1–8.3</td></tr>
<tr><td>High</td><td>1.5–3.5</td><td>2.3–6.3</td><td>3.8–10.3</td></tr>
</table>

Sea-level rise projections for New Jersey from 2000 to 2150 under the low, moderate, and high emissions scenarios. The likely range represents the range of projections between which there is a 66% chance that sea-level rise will occur. This figure is adopted from values presented in Table ES-1 of the STAP Report. (Kopp et al. 2019).

There will always be some degree of uncertainty when trying to predict dynamic processes 100 years into the future. That is why we see a range of likely values for sea-level rise. Here, “likely” is used to explain the level of confidence that scientists have in those values. Specifically, “likely” means that there is at least a 66% chance that the sea-level rise amount we will observe in those years will be between the values listed. While having a range of possibilities under multiple emissions scenarios may appear confusing at first glance, it simply represents flexibility in how we can use this information to plan for the future. For example, if an engineer designs a major bridge, they might use a more conservative (upper end) value than they would if planning a living shoreline project.

Importantly, the data show that different levels of emissions only produce a difference in sea-level rise beyond 2050. From 2030-2050 the difference in results from the three emissions scenarios was almost negligible. This is, in part, because we don’t observe the effects of emissions immediately after they happen. The increases in sea level we will see between now and 2050 are the result of the emissions that have already occurred. However, it also means that sea-level rise through 2050 cannot be changed through our actions.

Figure 1. Diagram of sea-level rise projections curve under high emissions scenario



Sea-level rise projections for New Jersey from 2000 to 2150 under the high emissions scenario. The likely range (colored area) represents the range of projections between which there is a 66% chance that SLR will occur. This figure is adopted from values presented in Table 1. (Kopp et al., 2019).

In addition to projecting an increase in sea level, STAP expects increasing rates at which the sea will rise. The rate of sea-level rise is important because, for example it plays a role in the ability of marsh systems to adapt to increased water levels and salinity. Many of these ecosystems are already stressed, suggesting that faster rates of sea-level rise in the future may be too much for them to cope with.

Coastal Storms

STAP also considered current science on tropical cyclones – hurricanes and tropical storms – and nor’easters. After reviewing the relevant literature, STAP found no consensus that the frequency of tropical cyclones will change in the next century. However, there is evidence that suggests wind speeds and rainfall rates will increase when future tropical cyclones do happen. Similarly, STAP found no consensus to suggest changes in the frequency, wind speed, or rainfall rates of future nor’easters. That remains an active field of research.

Despite there being no anticipated increase in the frequency of tropical cyclones, the combination of higher sea levels, faster wind speeds, and faster rates of rainfall could dramatically increase the flooding impacts and storm surge associated with the events that do occur.

Tidal Flooding

Tidal, high-tide, or sunny-day flooding also occurs in the absence of storms. STAP projects that tidal flooding – water levels of 2-feet above high-tide – will increase as sea levels rise, increasing the frequency of flooding events. For example, in the 1950s, Atlantic City saw high-tide flooding less than one (1) time every year. More recently, Atlantic City saw an average of eight (8) high- tide floods every year between 2007-2016.

As early as 2030, Atlantic City could experience 35 days of high-tide flooding each year, and 120 days in 2050. **Table 2** displays the number of high- tide flooding days in Atlantic City projected by STAP out to 2150. STAP provides similar information for other tide gauges around New Jersey.

Table 2. Atlantic City Flood Days under a High Emissions Scenario

	Likely Range		
Year	**>83% Chance**	**~50% Chance**	**<17% Chance**
2020	9 days	17 days	30 days
2030	17 days	35 days	75 days
2050	45 days	120 days	255 days
2070	145 days	300 days	360 days
2100	290 days	every day	every day
2150	every day	every day	every day

Tidal flooding projections and frequencies based on sea-level rise projections for New Jersey under the high emissions scenario. This table is adapted from values presented in Table B3 of STAP Report. (Kopp et al., 2019).

STAP drew conclusions about the extent of high-tide flooding in addition to the frequency at which flooding would occur. Under the moderate emissions scenario, in 2050 sunny-day flooding that occurs at high-tide could be equivalent to what is currently considered a 10-year flood event. More detailed results and methodologies are available in the full 2019 STAP report[1].

Acknowledgements

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[1] Kopp, R.E., *et al.* New Jersey's Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel. Rutgers, The State University of New Jersey. Prepared for the New Jersey Department of Environmental Protection. Trenton, New Jersey.