

3. Understanding What We Are Facing

While New Hampshire has been very fortunate to have avoided the most extreme impacts of recent events like Tropical Storm Irene in 2011 and Superstorm Sandy in 2012, the state has experienced other significant weather events in the coastal region. We have seen intense Nor'easters like Winter Storms Juno in 2015 and Nemo in 2013, the October 2011 Snowstorm, and others that have had large and lasting impacts on our communities. These types of storms will have even greater impacts with projected sea level rise and an increase in the frequency and severity of extreme rain events will lead to more floods. While some additional climate change related impacts are now unavoidable due to past emissions of heat-trapping greenhouse gases (and the long lifetime of these gases in the atmosphere), the amount of future climate change and the extent of damaging impacts will depend on the amount of greenhouse gases that continue to accumulate in the atmosphere. As a result, efforts to reduce emissions or remove carbon dioxide from the atmosphere will not only reduce the amount and speed of climate change, but will also reduce the amount of adaptation needed. Although the Commission's mission and report are focused on adaptation, we recognize that efforts to reduce greenhouse gas emissions and adaptation are intrinsically linked, and therefore support continued action to reduce the drivers of climate change in New Hampshire, including implementation of the New Hampshire Climate Action Plan.³³ The Commission also recognizes that we must continue to track the evolving science regarding atmospheric concentrations of greenhouse gases and associated projected impacts. Understanding the best science behind projected risks and hazards is essential to enabling our coastal communities to be as prepared as possible to avoid costly impacts and the potential loss of life.

3.1 Science and Technical Advisory Panel

The Commission created a Science and Technical Advisory Panel (STAP) to review available scientific information about coastal hazards and flood risks in New Hampshire. Comprised of scientists and experts in the fields of meteorology, engineering, climate, hydrology, and other related sciences, the Panel's charge was to:

1. Ensure the Commission is aware of and is using the best available and relevant scientific and technical information to inform its recommendations; and
2. Assist the Commission in interpreting and reconciling conflicting projections, scenarios and probabilities about future conditions.

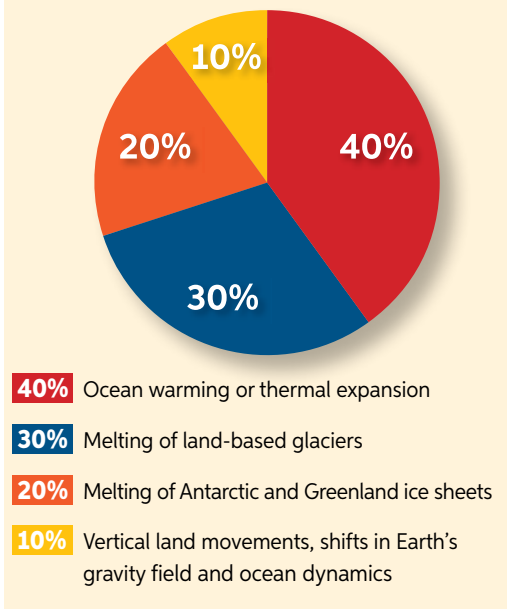
The Panel analyzed the latest published data on historic trends and projections for the years 2050 and 2100 for sea-level rise, coastal storms, and extreme precipitation. These findings were summarized in an externally-reviewed STAP report entitled, *Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Future Trends*,³⁴ which the Commission unanimously adopted after careful and deliberate discussion in July 2014 and used to develop its recommendations to assist in planning and preparation for the changing climatic conditions in coastal areas of the state. The Panel recommends the STAP report be updated regularly as new research and data become available.

While a changing climate, melting ice sheets, and warmer ocean temperatures are enhancing coastal storms and extreme precipitation hazards, and are contributing to sea-level rise, it is important to note that our current and historical development patterns also contribute to the coastal risks and hazards we are facing. We have historically developed along rivers and shorelands. We continue to encroach on natural buffers with development that is, as a result, at risk from flooding. The increases in pavement and other impervious surfaces associated with development cause an increase in runoff and flooding due to the inability of these surfaces to absorb rain and snow melt. These development patterns exacerbate the climatic impacts and contribute to changing floodplains.

3.2 Science and Technical Advisory Panel Report

The following section is a summary of the information presented in the STAP report. A condensed two-page summary of the STAP report is provided in [Appendix D](#). It is important to note that while projections for storm surge, sea-level rise, and extreme precipitation are described independently below, they are not mutually exclusive. In fact, the combined occurrence of heavy rainfall and storm surge, together with sea-level rise, will likely increase flooding in coastal regions. Additionally, present-day storm surge already poses an immediate threat to our coastal region during Nor'easters and tropical storms. Both episodic and unpredictable in nature, storm surge presents a hazard we must remain vigilant about and must continue to plan for carefully. Finally, mapping efforts conducted by the Rockingham Planning Commission and the New Hampshire Geographically Referenced Analysis and Information Transfer System (NH GRANIT) show that projected sea-level rise is largely contained within the current 100-year floodplain.³⁵ As a result, communities that adopt and enforce floodplain management activities within the current 100-year floodplain will also be preparing for and building resilience against projected sea-level rise related impacts in the long term.

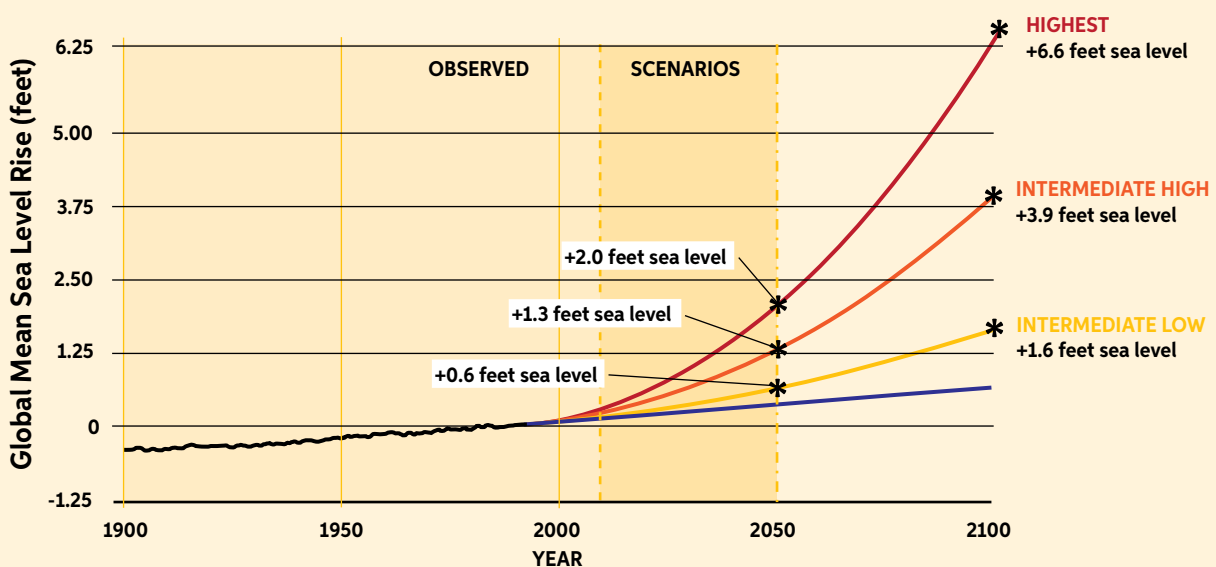
FIGURE 1. Processes causing sea levels to rise from 1990-2012. Source: NHCRHC STAP (2014).



Sea-Level Rise

Forecasting rates of global greenhouse gas emissions is challenging, but research shows that current greenhouse gas concentrations and current or accelerated emissions rates will continue to influence sea levels in the future. Planning for a 100-year flood now can also prepare us for mid-century sea-level rise. Figure 1 illustrates the processes contributing to sea-level rise and their proportions over the period from 1990-2012. Figure 2 shows the projected sea-level rise for the years 2050 and 2100 under different greenhouse gas emissions scenarios as reported in the National Climate Assessment published in 2014. These scenarios assume intermediate-low greenhouse gas emissions, intermediate-high emissions, and the highest emissions conceivable.

FIGURE 2. Sea-level rise scenarios under different emission levels in 2050 and 2100. Source: Adapted from NHCRHC STAP (2014).



Based on local tide gauge data, sea levels in New Hampshire have been rising by an average of 0.7 inches per decade since 1900. The rate of sea-level rise has increased to approximately 1.3 inches per decade since 1993. Using 1992 sea levels as a baseline, New Hampshire sea levels are expected to rise between 0.6 and 2.0 feet by 2050 and between 1.6 and 6.6 feet by 2100.

Storm Surge

Considering changes in water levels due to sea-level rise alone, today's extreme storm surge events (i.e. 1-percent-annual-chance flood /100-year flood) will have a greater inundation extent and occur more frequently over time. Due to increased coastal development, there has been a significant increase in impacts from hurricanes nationwide over the 20th Century. However, there is some uncertainty in the projection of trends in hurricane frequency and intensity in any given region, and no research consistently finds a trend in the frequency and intensity of Nor'easters.



Photo credit: Ron Sher

Annual and Extreme Precipitation

Annual precipitation is expected to increase by as much as 20 percent by the end of the 21st century compared to the late 20th century. Most of the precipitation increases are expected to be in winter and spring in the form of rain or snow. Fall and summer are expected to experience less of an increase.

Extreme precipitationⁱⁱⁱ events are projected to increase in frequency and in the amount of precipitation produced. In particular, the rainfall amount produced by hurricanes is projected to increase. However, current climate models and analyses are not as good at projecting future changes in the frequency or magnitude of extreme precipitation events.

Other Hazards and Risks

The Commission recognizes that New Hampshire's coastal communities face additional coastal risks and hazards that were not explicitly summarized by the Science and Technical Advisory Panel or by the Commission's recommendations. The Commission limited its focus based on the legislative mandate, available information, and resources, however additional coastal hazards pose serious risks and should be studied further and acted upon, where deemed necessary. Some of these hazards include increases in average temperatures; drought; snowfall; seasonal shifts; potential air quality issues; saltwater intrusion and rising groundwater tables from sea-level rise; ocean acidification and the impacts on habitats and fisheries; and other impacts to well-being and quality of life, including the health of New Hampshire coastal residents. [Appendix E](#) highlights some of the additional hazards that should be studied in future iterations of the STAP report and discussed in future Commission efforts. These hazards have significant and increasing health implications as they are exacerbated by climate change, and though efforts have begun in the State to better understand health impacts, this needs to be a continuing focus of study.

Based on this summary of the science, the STAP offered planning guidance for adapting to storm surge, sea-level rise, and changes in annual and extreme precipitation. This guidance is summarized in Section 5.2.

ⁱⁱⁱ For the purposes of this report, "extreme precipitation" is defined as the largest one percent of daily events in a year. This definition comes from the 2014 National Climate Assessment, however many other valid definitions of the term "extreme precipitation" exist.