Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Future Trends

Photo credit: Steve Miller

Climate change is expected to have significant impacts on critical infrastructure and natural and cultural resources in coastal New Hampshire over the next century and beyond.

This report is intended to help municipal and state decision-makers prepare for projected sea-level rise and other coastal hazards and minimize the risks those hazards pose to municipalities and state assets.

SEA-LEVEL RISE

Global sea levels have been rising and are expected to continue rising well beyond the end of the 21st century. Rising seas pose significant risks to our communities and ecosystems, cultural resources and other coastal property and infrastructure.

PROJECTIONS

Forecasting rates of global greenhouse gas emissions is challenging, but research shows that current greenhouse gas concentrations and current or accelerated emissions will continue to influence sea levels in the future.

PRECIPITATION

Mean annual precipitation in the northeastern United States increased by approximately 5 inches (more than 10%) between 1895 and 2011.

PROJECTIONS

Annual precipitation is expected to increase by as much as 20% between 2071 and 2099 compared to the late 20th century. Most of the precipitation increases will be in winter and spring in the form of rain or snow. Fall and summer will experience less of an increase.

SEA-LEVEL RISE SCENARIOS AT 2050 AND 2100

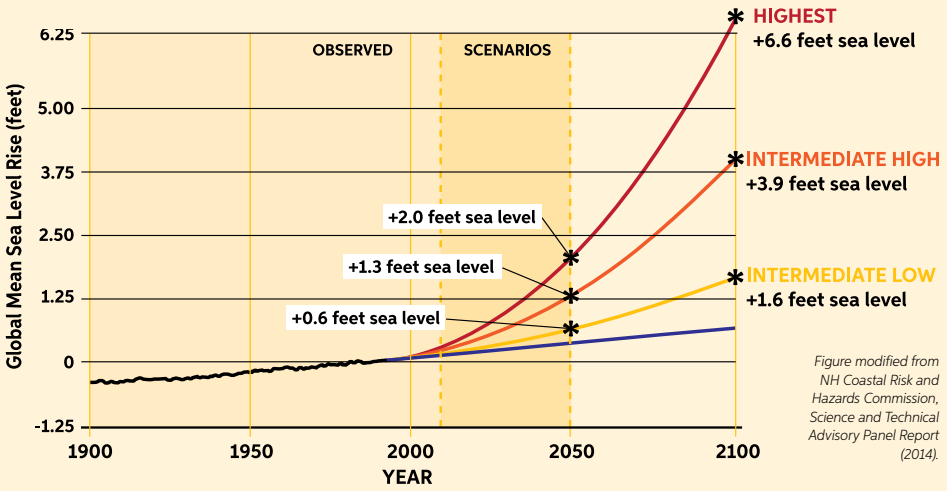
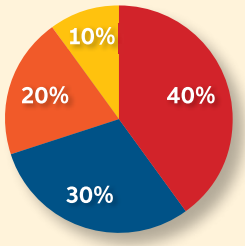


Figure modified from NH Coastal Risk and Hazards Commission, Science and Technical Advisory Panel Report (2014).

PROCESSES CAUSING SEA LEVELS TO RISE



- **40%** Ocean warming or thermal expansion
- **30%** Melting of land-based glaciers
- **20%** Melting of Antarctic and Greenland ice sheets
- **10%** Vertical land movements, shifts in Earth's gravity field and ocean dynamics

EXTREME PRECIPITATION

The Northeast experienced a 50% increase in total annual precipitation from storms classified as extreme events between 1901 and 2012. Here, "extreme" is defined as the number of times each year that the 24-hour rainfall amount exceeds the largest 1% of precipitation events in that year.

PROJECTIONS

Extreme precipitation 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.

STORM SURGE

Photo credit: Ron Sher

The New Hampshire coast is significantly impacted by both Nor'easters and hurricanes. Winds from these storms drive ocean water towards the land, resulting in the short-term rise in water levels called storm surge. The actual height of a flood is determined by factors such as storm intensity, forward speed, storm area size, coastline characteristics, and angle of approach to the coast, in addition to tide height. Nor'easters can impact the region for several days and produce a storm surge with or without the addition of inland runoff from heavy precipitation. Over the past ten years the largest storm surges observed in New Hampshire occurred during Nor'easters.

PROJECTIONS

Considering changes in water levels due to sea-level rise alone, today's extreme storm surge events (i.e. 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.

USING THIS REPORT:

How to Prepare for the Changing Climatic Conditions in Coastal New Hampshire

PREPARING FOR SEA-LEVEL RISE

For coastal locations where the need to protect existing coastal development, infrastructure or ecosystems is high, sea level estimates should be applied as follows:

1. **Determine the time period** over which the system is designed to serve (either in the range 2014–2050, or 2051–2100).
2. **If the design time period is 2014–2050,** commit to manage to 1.3 feet of sea-level rise, but be prepared to manage and adapt to 2 feet if necessary.
3. **If the design time period is 2051–2100,** commit to manage to 3.9 feet of sea-level rise, but be prepared to manage and adapt to 6.6 feet if necessary.
4. **Be aware that the projected sea-level rise ranges may change** and prepare to adjust design considerations if necessary. The choice of management strategies can include strategies to protect, accommodate, or retreat from the flood risk.

EXAMPLES OF PREPARING FOR SEA-LEVEL RISE

A building or facility with an anticipated lifespan beyond 2050 could be constructed today:

- **For the highest sea-level rise scenario of 6.6 feet** (the most protective approach).
  OR
- **For 2 feet of future sea-level rise** —but designed to allow modifications sometime in the future to protect against 3.9 or 6.6 feet of sea-level rise.

HISTORIC SEA LEVELS

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**.

FUTURE SEA LEVELS

Using 1992 sea levels as a baseline, New Hampshire sea levels are expected to rise **0.6 – 2.0 feet by 2050** and **1.6 – 6.6 feet by 2100**.

Photo credit: Tricia Miller

PREPARING FOR CHANGES IN PRECIPITATION

Consideration of historical increases in precipitation and projected future precipitation should be applied as follows:

- **If the design time period is 2014–2050**, buildings and infrastructure should be designed to withstand extreme precipitation intensities based on the most current precipitation data.
- **If the design time period is 2051–2100,** buildings and infrastructure should be designed to manage a 15 percent increase in the amount of precipitation produced during extreme precipitation events after 2050.

Photo credit: UNH Stormwater Center

PREPARING FOR CHANGES IN STORM SURGES

Coastal projects should be designed to consider future flood risks by adding projected sea-level rise heights to current storm surge heights, as measured by the 100-year and 500-year floods.

Photo credit: UNH Stormwater Center

ABOUT THIS REPORT AND THE NEW HAMPSHIRE COASTAL RISK AND HAZARDS COMMISSION

This Science and Technical Advisory Panel report is intended to guide the New Hampshire Coastal Risk and Hazards Commission in its development of recommendations to assist in planning and preparation for the changing climatic conditions in coastal areas of the state.

The New Hampshire Coastal Risk and Hazards Commission was established by the New Hampshire Legislature on July 2, 2013 by RSA 483E. The Commission is required to consider key scientific research on current and future coastal risks and hazards and is charged with recommending legislation, rules and other actions.

The Commission created a Science and Technical Advisory Panel to review available scientific information about coastal hazards and flood risks in New Hampshire.

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 a peer-reviewed report, which the Commission unanimously adopted in July 2014 and used to develop its final report and recommendations released in November 2016. The Panel suggests this assessment and report be updated at least every two years as new research and data become available.

To learn more about the New Hampshire Coastal Risk and Hazards Commission, go to **www.nhcrhc.org**.

For information or questions about the Commission, contact Cliff Sinnott, Commission Chair at **603-778-0885** or **csinnott@rpc-nh.org.**

To download the complete Science and Technical Advisory Panel report, go to www.nhcrhc.org.

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