Supplementary Information
Indicator E: Climate Change
State of Casco Bay 6th Edition

References

No references cited in this chapter.

Further Reading

Maine Climate Council. Maine Won't Wait, a Four-Year Plan for Climate Action. December 2020. https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/MaineWontWait_December2020.pdf

This comprehensive climate action plan was prepared with goals to decrease greenhouse gas emissions and achieve carbon neutrality. It also details how climate change will impact Maine specifically.

USGCRP, 2018: Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II [Reidmiller, D.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, K.L.M. Lewis, T.K. Maycock, and B.C. Stewart (eds.)]. U.S. Global Change Research Program, Washington, DC, USA, 1515 pp. Chapter 18: Northeast. doi: 10.7930/NCA4.2018. https://nca2018.globalchange.gov/chapter/18/#key-message-1

A large, detailed report, covering many aspects of climate change and its impact on the U.S. The Summary of Findings, and Chapter on the Northeast Region are the most relevant summaries for our region, but topic-specific chapters also address regionally important impacts, from human health to effects on forests, agriculture and marine resources.

Ivan Fernandez, Robert Marvinney, Cassaundra Rose, Susie Arnold, Linda Bacon, Andrew Barton, Brian Beal, Sean Birkel, Russell Black, Alix Contosta, Amanda Cross, Adam Daigneault, Thomas Danielson, Stephen Dickson, Jeanne DiFranco, Susan Elias, Glenn Hodgkins, Brian Hubbell, Joe Kelley, Rick Kersbergen, Glen Koehler, Rebecca Lincoln, William Livingston2, Pamela Lombard, Bradfield Lyon, Andrew Pershing, Nichole Price, Jonathan Rubin, Joseph Salisbury, Erin Simons-Legaard, Peter Slovinsky, Robert Steneck, Sally Stockwell, Richard Wahle, Jay Wason, Aaron Weiskittel, and Carl Wilson. 2020. Scientific Assessment of Climate Change and Its Effects in Maine: A Report By The Scientific And Technical Subcommittee Of The Maine Climate Council. https://www.maine.gov/future/sites/maine.gov.future/files/inline-files/GOPIF_STS_REPORT_092320.pdf

A readable technical summary of climate change in Maine.

Methods and Data Sources

Weather and precipitation data for the Portland Jetport was retrieved from NOAA's National Centers for Environmental Information Climate Data Online APIs., specifically via API v2. Information on this API is available here: <https://www.ncdc.noaa.gov/cdo-web/webservices/v2>. Documentation on specific datasets is available at: <https://www.ncdc.noaa.gov/cdo-web/datasets>. The data can also be accessed through the “Climate Data Online” data portal.

National Centers for Environmental Information (NCEI). (n.d.). *Climate Data Online: Dataset Discovery*. Datasets | Climate Data Online (CDO) | National Climatic Data Center (NCDC). Retrieved from https://www.ncdc.noaa.gov/cdo-web/datasets.

Global historical weather and climate data. The longest continuous dataset for our region is the Portland Jetport data, which started in the 1940s. Our analyses are based principally on daily data or annual summaries. See the GitHub repositories for specific data sets, access methods, and analyses.

Trend analyses and graphics are based on linear regression models (for measurements like temperature or amount of rainfall) or generalized linear models for count data (like number of days with rainfall or exceeding temperature thresholds). Trendlines shown in graphics are statistically significant at $p < 0.05$. For further details, including data, model specifications, alternative models, and checks used to ensure models were appropriate to the data, see the data analysis archive at https://github.com/CBEP-SoCB/CDO-Portland-Jetport_sum.

Sea level rise data for the graphic depicting long-term trends in sea level were downloaded from the NOAA Tides and Currents page for the Portland tide gage at https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8418150 . The data was downloaded directly using the "Export to CSV" button found here: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?id=8418150. Those data are not raw data, as NOAA pre-processed them to remove some seasonal patterns.

Our other analyses of sea level trends relied on hourly observed water level and hourly predicted water level records downloaded from a NOAA API using python scripts. Details on the API are available from the NOAA webpage: <https://tidesandcurrents.noaa.gov/api/>. The python code we used is available via the GitHub archive: https://github.com/CBEP-SoCB-Details/Portland_SLR_sum.

The trendline in the sea level trend graphic is based on a generalized least squares linear model with an autoregressive error structure (*AR(1)*). Results match the slope and standard error reported by NOAA to within rounding error.

The trendline on the graphic showing annual frequency of flooding is based on a generalized linear model (a binomial model with logit link).

One reviewer requested that we highlight that the rate of sea level rise is increasing. We conducted analysis to evaluate whether the Portland data supported that conclusion. Ultimately, we decided it did not. Other periods in the nearly 100-year historic record (notably beginning in the 1920s) show rates of sea level rise similar to rates observed over the last couple of decades.

The claim (in a figure legend) that another foot of sea level rise would lead to about an eightfold increase in frequency of tidal flooding derives from two different approaches to modelling the impact of sea level rise on flood frequency. The first uses a “bathtub model” that adds a fixed amount of sea level rise onto recent water levels, and simply counts up the number of flood events that suggests would happen if sea levels were higher. That approach is similar to (but not identical with) a method used by Maine Geological Survey (MGS) to highlight risk of future flooding. To complement the MGS approach, we developed a novel approach to simulating future flood frequency. We simulated future deviations between predicted and observed water levels using ARIMA models. By adding predicted tidal height from the recent past, a fixed value for a sea level rise scenario (here, one foot), and simulated time series showing deviations between predicted and observed water levels, we were able to estimate not only the expected number of future flooding events annually, but also estimate uncertainty in those estimates. Results of both methods were broadly similar, highlighting significant increases in frequency of tidal flooding.

Many details of our sea level rise analyses have been built into a draft R package. The draft package is available at https://github.com/ccb60/SLRSIM.

Access to data and summary of data analysis can be found at https://github.com/CBEP-SoCB. For a full archive of data and all analyses steps head to https://github.com/CBEP-SoCB-Details.