Assessing the Effects of Storm Surge Barriers on the Hudson River Estuary

Project Location

Hudson River estuary, NY

Project Duration

October 2018 to February 2020

Project Lead

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Project Type

Catalyst – Targeted investment for advancing collaborative science

Project Partners

- Consensus Building Institute
- Cornell University Water Resources Institute
- Hudson River Estuary Program
- Hudson River National Estuarine Research Reserve
- New York State Department of Environmental Conservation

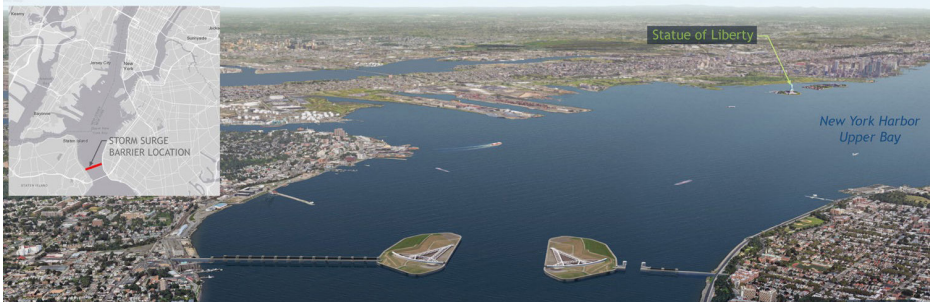
Project Webpage

nerrssciencecollaborative.org/project/Orton18

Overview

Coastal cities around the world are exploring engineered approaches to defend against extreme storms and the resulting surges of ocean water that cause massive flooding. Storm surge barriers are one option to minimize flooding and protect people and property. They typically span the opening to a harbor or river mouth and include gates that are closed only when storm surge is expected. However, even when gates are open, these structures reduce water flow and tidal exchange, affecting water quality and ecological processes in estuaries. These environmental effects of large surge barriers are poorly understood.

When this project began, an initiative was underway to consider the construction of a gated storm surge barrier to protect the New York metropolitan area. The U.S. Army Corps of Engineers, states of New York and New Jersey, and New York City partnered to conduct the Harbor and Tributaries focus area feasibility study to evaluate this and other options to manage coastal storm risks. To more fully explore the advantages and disadvantages of large surge barriers, this project modeled and analyzed the physical influences of surge barriers and hosted a series of workshops to synthesize and share results. The project amplified existing collaborative science, gave scientists and community stakeholders a more robust understanding of surge barrier effects on the Hudson River and its wetlands, and identified priorities for future research. Project results informed the government's feasibility study and established a foundation for collaboration among people involved in the topic here in the New York metropolitan area and around the world.



This artist rendering shows a proposed surge barrier near the Verrazano Narrows Bridge, between Staten Island and Brooklyn. U.S. Army Corps of Engineers.

Project Approach

The project was designed to foster close collaboration and information-sharing among scientists and community stakeholders in order to integrate perspectives across a diverse set of organizations. At the outset, the Consensus Building Institute conducted a series of one-on-one conversations with eight critical project partners to ensure results would be valid and credible. A Project Advisory Committee, composed of 14 organizations representing federal, state, and city agencies, non-governmental organizations, and research institutes, met regularly to ensure the projects goals, methods, and products met the needs of end users including the regional feasibility study partners and Hudson River estuary stakeholders.

The project team then conducted a series of three workshops for researchers, federal, state, and city agencies, and community stakeholders to assess the potential effects of surge barriers. An initial scoping session established the current state of knowledge and collaboratively developed a research agenda. A scientific workshop then invited experts on estuaries and surge barriers to address specific knowledge gaps and areas of uncertainty, and learn from past surge barrier projects. At the end of the project, a final workshop was held to review project results and identify future research priorities.

In response to priorities identified during the initial workshop, the project team conducted statistical analyses and computational modelling of surge barriers' physical estuary effects. These analyses helped address the effects of sea level rise on the frequency and duration of surge barrier closures to prevent flooding, as well as the resulting effects on salinity, stratification, and rain-driven flooding in the Hudson River estuary.

Results

A full discussion of the project's scientific findings, modeling results, and future research priorities is provided in a series of workshop reports and a pending manuscript. A few key takeaways are provided here.

- Examples from several existing surge barrier systems show that it is possible to mitigate some negative physical and ecological effects by minimizing the obstruction of tidal flows, for example by creating large openings in the barrier and limiting how often and how long gates are closed across those openings. Unfortunately, there is very little ecological data from before and after barriers have been constructed.
- Project analyses demonstrate that gate closure frequency and duration both strongly influence the potential effects of a surge barrier on the Hudson River estuary. Project findings show that as sea levels rise, gate closures will become more common and longer lasting, increasing the barrier's impact on the estuary's ecology. If management agencies adjust the water level that triggers gate closure in response to rising seas, the surge barrier could still protect communities from storms but would leave coastal infrastructure vulnerable to elevated sea levels.
- Even with a gated surge barrier system in the New York-New Jersey harbor estuary, significant expenditures will still be required in future decades for adaptive management of sea level rise, for example by raising costly seawalls or other modifications of the shoreline.
- More research is needed into the region's estuarine and tidal river sedimentary systems and to identify the types of events that are important to sediment deposition in tidal marshes.

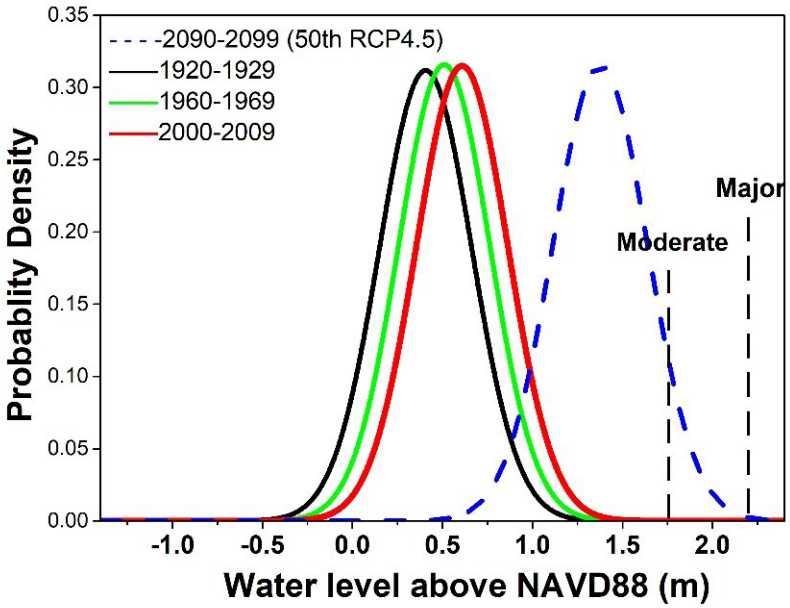


Illustration of how the probability of water levels exceeding National Weather Service flood thresholds (moderate and major) increases with sea level rise. This could lead to an exponential increase in surge barrier closures. Probability density functions are based on historical water level data from The Battery, NYC, with the 50th percentile regional sea level rise projections to 2090-2099 for a moderate emissions pathway (RCP 4.5) (Chen et al., submitted 2020).

Products

- Scoping session workshop report and scope of work – Summarizes the project's initial scoping session workshop, planned project activities, and final research topics and methodologies.
- Surge Barrier Environmental Effects science workshop report – Synthesis of scientific understanding regarding surge barrier effects on tidal wetlands and migrating organisms, highlighting areas of consensus and divergence, and recommendations for future research.
- Final workshop report and future scope of work – Summarizes research results on surge barrier effects and the Hudson River estuary and gives an agenda for future research.
- Webinar presenting the project's research findings
- Data and code for surge barrier closure modeling and analysis
- Two scientific publications

Benefits

This project enhanced engagement and exchange among the research community to expand scientific understanding of storm surge barriers, and created a robust foundation for future collaboration. In the case of the New York-New Jersey harbor estuary, the project increased coordination and understanding between researchers and key stakeholders in the New York metropolitan area.

The project contributed greater scientific input to the barrier feasibility study, helping the U.S. Army Corps of Engineers and its partners to consider a range of costs and benefits of surge barriers. Modeling and analysis for the New York-New Jersey harbor estuary showed that surge barriers do not fully solve the problem of sea level rise. This evidence enabled stakeholders to advocate for the U.S. Army Corps of Engineers to address this problem in their feasibility study.

What's Next

The regional feasibility study has been paused due to a funding gap at 4.5 years into a 7-year process. Even if the process is not fully completed, it is likely that the U.S. Army Corps of Engineers will at some point complete a Tentatively Selected Plan, in which case there may be continued momentum on the scientific assessment started under this project. There continues to be considerable interest in research on surge barrier effects on estuaries worldwide. Locally, there is strong interest in conducting a survey of organisms in the harbor region, a research need identified by this project that is relevant whether or not a surge barrier project moves forward.

About the Science Collaborative

The National Estuarine Research Reserve System's Science Collaborative supports collaborative research that addresses coastal management problems important to the reserves. The Science Collaborative is managed by the University of Michigan's Water Center through a cooperative agreement with the National Oceanic and Atmospheric Administration (NOAA). Funding for the research reserves and this program comes from NOAA. Learn more at nerrssciencecollaborative.org or coast.noaa.gov/nerrs.