

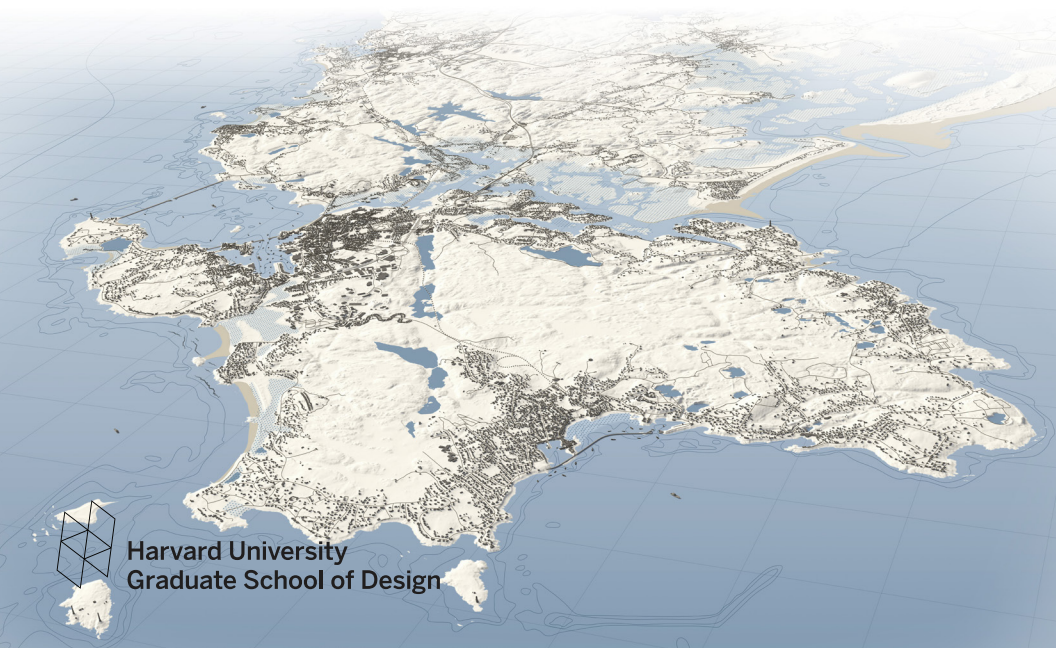
OFFICE FOR URBANIZATION

RESEARCH SUMMARY

COMPOUND VULNERABILITIES: The Case of Cape Ann and Climate Change

YEARS

2020—2022



Harvard University
Graduate School of Design

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Compound Vulnerabilities: The Case of Cape Ann is generously supported by the Cape Ann Climate Coalition, the Gloucester Meetinghouse Foundation, the City of Gloucester and the Town of Manchester-by-the-Sea. The project is further informed by collaborations with the Woods Hole Group, NOAA, HydroPredictions, LLC., and Limnotech.

Compound Vulnerabilities also benefits from Professor Gareth Doherty, Research Associates Sohun Kang and Ayaka Yamashita, and the Harvard University Graduate School of Design Critical Landscapes Design Laboratory.

TownGreen's mission is to act as a catalyst in assisting the greater Cape Ann region in becoming a vibrant and inclusive model of sustainability that is fossil fuel free and prepared for the impacts of climate change.

The Water Alliance aspires to be a lever for change, a space for conversation, and a collector of innovative ideas in water systems and management

The Harvard Graduate School of Design's Office for Urbanization draws upon the School's history of design innovation to address societal and cultural conditions associated with contemporary urbanization.

Cover Image: "Synoptic Rendering of Cape Ann,"
Compound Vulnerabilities: The Case of Cape Ann,
Harvard University Graduate School of Design
Office for Urbanization, 2022.

Climate Change on Cape Ann

The future of Cape Ann will be shaped, in large part, by the effects of climate change. These effects will reach well beyond sea level rise and increasing storm events. They will ultimately challenge and disrupt the cultural landscape, housing, transportation, public services, economic health, and diversity of the Cape Ann community. In light of these challenges, the Harvard University Graduate School of Design's (GSD) Office for Urbanization (OFU) partnered with local organizations on Cape Ann on a design research project from 2020 to 2022. *Compound Vulnerabilities: The Case of Cape Ann* focused on climate change mitigation, resilience, and adaptation across the Cape Ann region. The project included a range of scales of investigation: territorial, regional, municipal, and individual, and used a scenario planning methodology.

Methodology

Compound Vulnerabilities used a scenario planning methodology. Scenario planning is a method of long-term strategic planning that involves designing representations of different, plausible futures that decision makers can use in the present. OFU synthesized probabilistic scientific reports, engineering data, and information produced by other organizations to create rendered images and animations of potential futures. These scenarios were a stress test to reveal the biases and blind spots that people bring to complex, non-linear situations like climate change.

Cultural Landscapes

The collaboration between the Harvard University Graduate School of Design Office for Urbanization and Cape Ann organizations began in Summer 2020, when the team produced a *Cultural Landscapes Dossier*. The Office used historic maps, photographs, and images showing how Cape Ann has changed from before colonization to the present. The dossier described the existing conditions across six cultural landscapes on the Cape, and also included a map of the unique neighborhoods across the region, a calendar of events, and basic demographics that describe the region.

The dossier was a critical tool to understand Cape Ann, including its people's strong connection to the landscape and seascapes; the region's colonial, slave, and labor histories; the area's diverse and differing class distribution; its connection to the arts; and how Gloucester in particular is already experimenting with green infrastructure. In recognition that Cape Ann's interwoven ecologies, geographies, and economies transcend municipal boundaries, the scope of the project included the entire region: Gloucester, Rockport, Manchester-by-the-Sea, and Essex.

Scenario 0: The Great Storm of 2038

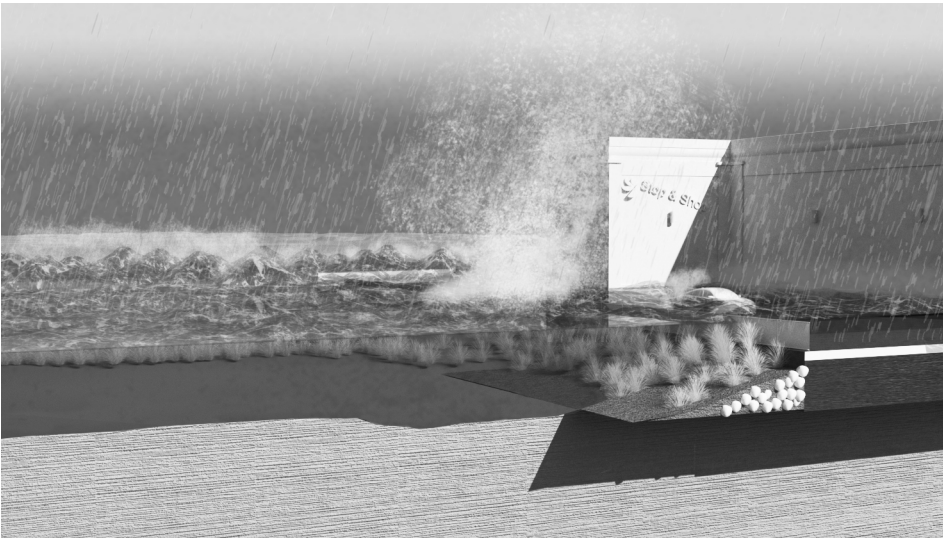
Scenario 0: The Great Storm of 2038 evaluated changes on Cape Ann that are already happening and projected a Category 3 hurricane that shows the potential costs of doing nothing.

Cape Ann's beaches, harbors, roads, reservoirs, and historic landscapes are already experiencing climate change. To describe these effects on the ground, twenty-seven places were selected, including critical roads, landscapes, institutions, and businesses. This was not a comprehensive list of all the places on Cape Ann that are vulnerable to climate change. Instead, these places provided a lens to understand the impacts of climate that are already happening and will continue to change on the beloved places across the region. The team then conducted a broad literature review of existing reports, photographs, and maps to better understand how people and organizations have documented climate change on the Cape.

To understand the history of storms on Cape Ann, OFU researchers looked at ten previous hurricanes and ten nor'easters that have struck coastal Massachusetts since the 1600s. One storm stood out. The Great New England Hurricane of 1938 tracked west through Massachusetts, sending fifty foot waves into Gloucester Harbor. The storm decimated the fishing fleet, and caused massive damages along the coast. The OFU team used the storm as inspiration for the fictional Great Storm of 2038, which lands in the near future over Labor Day in 2038.

In addition to historical storms, the team used engineering projections from the Woods Hole Group and NOAA to determine important details about the depth of coastal flooding, barometric pressure, storm surge, and wind speeds during the fictional storm. The team designed a series of animations that show the storm at increasingly detailed resolution, starting at the scale of the Atlantic Ocean, followed by Massachusetts, Cape Ann, and the downtown areas of Gloucester, Rockport, and Manchester-by-the-Sea, as well as Conomo Point in Essex.

A series of digital renderings show what the storm would look like at eye-level in fourteen places across Cape Ann. These immersive images were sequenced through a short story over thirty hours during the storm. While the storm may dissipate over a matter of hours, rebuilding Cape Ann will be a process that unfolds over many weeks and months to follow. By educating people about the effects of such a plausible storm, decision makers can adapt the region to better withstand and recover from a catastrophic event.



"Stop and Shop Plaza during the Great Storm of 2038," *Compound Vulnerabilities: The Case of Cape Ann*, Harvard University Graduate School of Design Office for Urbanization, 2022.

Scenario 1: Near Future Adaptations

Scenario 1: Near Future Adaptations evaluated the potential of a hybrid approach to adapting coastal development using hard and soft protection, as well as strategies for relocation and zoning reforms.

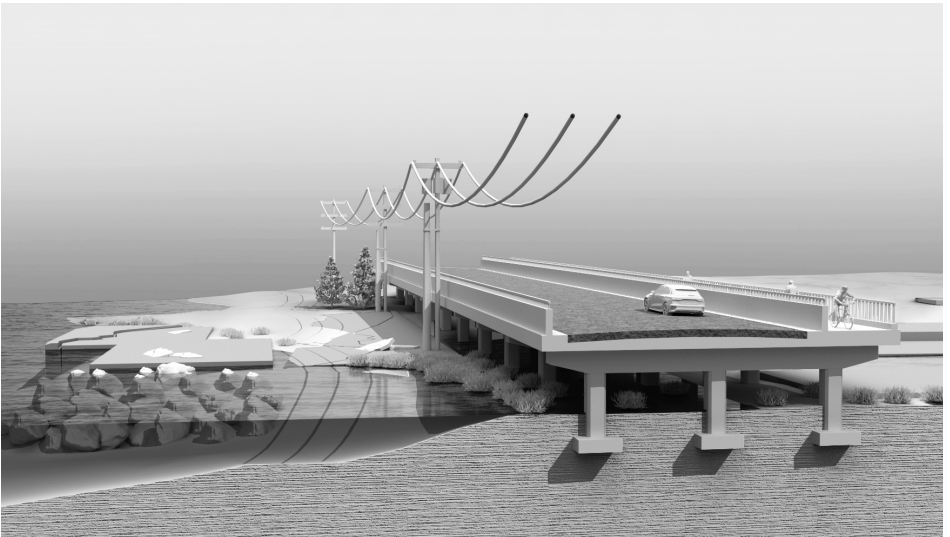
Scenario 1 adopted previous engineering and design solutions proposed for Cape Ann, as well as additional proposals put forth by OFU researchers. These proposals are not a comprehensive blueprint for action. Instead, they are suggestions for strategies that may be implemented and adopted by individuals, municipalities, organizations, and businesses over time. Ultimately, decision makers on Cape Ann must make choices that are best for these communities.

The Cape Ann community was built around the waterfront, making the region extremely vulnerable to flooding in the present day. Buildings, roads, and infrastructures that were constructed on historically filled lands and wetlands are likely to flood again in the immediate future. In addition to those historical risks, the Federal Emergency Management Agency (FEMA) has identified areas that have flooded in past storms and are likely to flood again, and the Woods Hole Group has mapped areas that are vulnerable to storm surge, as well as more gradual sea level rise.

The OFU team looked at this risk landscape to start shaping a series of comprehensive adaptation strategies organized around seven subscenarios: armor coastlines and communities; elevate and relocate supply systems; elevate and relocate transportation networks; elevate the public realm; accelerate natural adaptations; enhance individual agency to relocate; and develop local post-carbon economies. These subscenarios expanded adaptation measures from small, discrete sites to broader, framing questions that are a starting point for discussion. They also identified some of the most critical issues for adaptation on Cape Ann.

Scenario 1 also included an *Adaptation Strategies and Precedents Dossier*. This dossier is organized around five strategies for adaptation: communication, resistance, accommodation, avoidance,

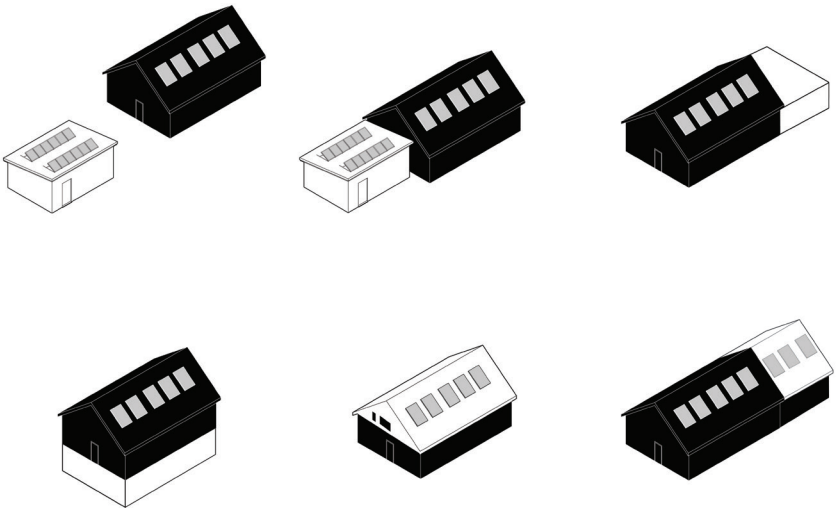
and capacity building. Each of these strategies includes precedents from around the globe that offer best practices to share information, construct nature-based and hard engineering solutions, prepare for intermittent flooding, build leadership, and find resources required to adapt to climate change. The dossier included observations around climate change on Cape Ann that are also relevant to other coastal communities in the United States. The *Adaptation Strategies and Precedents Dossier* suggested that Cape Ann can become a climate leader in the adaptation space by undertaking projects similar to those described in the dossier.



"Elevated Essex Causeway," *Compound Vulnerabilities: The Case of Cape Ann*, Harvard University Graduate School of Design Office for Urbanization, 2022.

Study 2: Net Zero Housing

As a region, Cape Ann faces significant demand for housing to increase social equity and accommodate the broad variety of lifestyle preferences of residents, including seniors, younger residents, families, artists, and workers. Study 2: Net Zero Housing projected a range of net-zero housing options across Cape Ann that are accessible to a wide range of residents, including passive orientation, renewable energy production, and innovative construction methods. The study included precedents for net zero building from across the globe, as well as an existing accessory dwelling unit (ADU) on Cape Ann that highlight how the region is already experimenting with green building.



"ADU Typologies," *Compound Vulnerabilities: The Case of Cape Ann*, Harvard University Graduate School of Design Office for Urbanization, 2022.

Study 3: Waste Recovery

The current solid waste disposal and wastewater treatment practices on Cape Ann are not sustainable. Study 3: Waste Recovery proposed to reduce greenhouse gas emissions generated by decomposing solid waste and envisioned a new strategy for regional wastewater treatment and waste collection. The study included precedents for waste recovery from around the globe, including cutting edge technologies and landscape strategies to better integrate waste management into each community.



"Existing Wastewater Treatment Plants," *Compound Vulnerabilities: The Case of Cape Ann*, Harvard University Graduate School of Design Office for Urbanization, 2022.

Cape Ann Fieldwork: Perceptions of Climate Change Among a Coastal Population

Cape Ann Fieldwork: Perceptions of Climate Change Among a Coastal Population is a regional effort between the GSD Critical Landscapes Design Lab, led by Professor Gareth Doherty, and the four Cape Ann municipalities of Gloucester, Rockport, Manchester-by-the-Sea, and Essex, with funding from the City of Gloucester and the Town of Manchester-by-the-Sea. Two Research Associates, Ayaka Yamashita and Sohun Kang, lived in downtown Gloucester for four months beginning on February 1, 2022. During their time on the Cape, the team conducted landscape fieldwork and cognitive map-making workshops. Their report is an invaluable record of the diverse voices on Cape Ann.

The landscape fieldwork included interviews, observations, and interpretations. By walking, biking, using public transport, and taking part in everyday life, Ayaka and Sohun explored and observed Cape Ann's landscapes. Participating and engaging in various community activities was also an indispensable part of talking with community members. By flattening social hierarchies, the research encompassed voices from various aspects of society, from the most vulnerable to well-known decision-makers.

The team conducted casual conversations with over one hundred people, and conducted appointment-based, semi-structured interviews with forty-four Cape Ann residents. The conversations shared a common list of questions, though these questions were posed in a variety of ways. The interview appointments were made through introductions from Cape Ann residents, from participating in community activities, and through social media such as Facebook and Instagram.

The team also hosted a workshop on cognitive mapping at the Grace Center. Nine participants, consisting of the homeless, group home residents, and volunteers, spent three hours in the afternoon drawing or writing maps of Cape Ann today, its probable futures, and the participant's preferred futures.

Cape Ann Fieldwork is shared in a report structured over four chapters. These chapters describe Cape Ann's geography, landscapes, and human ecology; interviews with six fictional characters that are composites of the interviews Ayaka and Sohun conducted; a summary of the various attitudes toward climate change on Cape Ann; and a series of concluding remarks.



"Landscapes of Cape Ann," *Cape Ann Fieldwork: Perceptions of Climate Change Among a Coastal Population*, Harvard University Graduate School of Design Critical Landscapes Laboratory, 2022.

Dissemination

Compound Vulnerabilities: The Case of Cape Ann has been disseminated in several formats, including an internally facing website, a long-form report, and several presentations and webinars.

The project can be accessed online at:

capeann.officeforurbanization.org

Username: capeanncoalition@officeforurbanization.org

Password: dogtowncommon

Reports

Office for Urbanization, *Cultural Landscapes* (Cambridge, MA: Harvard University Graduate School of Design, 2020).

Critical Landscapes Laboratory, *Cape Ann Fieldwork: Perceptions of Climate Change Among a Coastal Population* (Cambridge, MA: Harvard University Graduate School of Design, 2022).

Office for Urbanization, *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Harvard University Graduate School of Design, 2022).

Horsley Witten Group, *U.S. Environmental Protection Agency's Building Blocks Program Regional Resilience Toolkit: Cape Ann Summary Report* (Boston, MA: Horsley Witten Group, August 2022).

Events

Environmental Protection Agency and Horsley Witten, *Cape Ann/EPA Resilience Project Workshop #1* (webinar, EPA Building Blocks for Sustainable Communities, April 27, 2022), www.youtube.com/watch?v=JuKyDVRkg-E&t=5s.

Harvard University Graduate School of Design Office for Urbanization, *Scenario Planning for Climate Adaptation on Cape Ann* (webinar TownGreen2025, May 18, 2022), www.youtube.com/watch?v=297znKzKgs0.

Environmental Protection Agency and Horsley Witten, *Cape Ann/EPA Resilience Project Workshop #2* (webinar, EPA Building Blocks for Sustainable Communities, May 23, 2022), www.youtube.com/watch?v=dZYd_PSeZiM.

Office for Urbanization, *Compound Vulnerabilities: The Case of Cape Ann* (presentation, Harvard University Graduate School of Design Discovery Program, Cambridge, MA, June 5, 2022).

TownGreen2025, *Protecting and Preserving the Good Harbor Beach Ecosystem for Current and Future Generations: Climate Impacts on the Good Harbor Beach Ecosystem*, (webinar, TownGreen2025, October 26, 2022).

Gloucester Meetinghouse Foundation, *Planning for Reality Symposium on Climate Change and Downtown Gloucester* (presentation, Gloucester Meetinghouse Foundation, Gloucester, MA, November 18, 2022).

TownGreen2025, *Protecting and Preserving the Good Harbor Beach Ecosystem for Current and Future Generations: Adaptation: Is it Possible?* (webinar, TownGreen2025, November 30, 2022).



Creating a Carbon Neutral Community



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