PRESERVATION IN A CHANGING CLIMATE:

ADAPTATION TO SEA LEVEL RISE IN HISTORIC COASTAL CITIES,

A CASE STUDY OF SALEM, MA

A Thesis

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ABSTRACT

In this new era of climate change, human civilization faces unprecedented challenges in adapting to its impacts, one of which is sea level rise. Rising seas have profound and long-term repercussions in coastal regions, particularly in the U.S. along the East Coast and the Gulf of Mexico. In the past decade, Hurricane Sandy and other major storm events have had disastrous effects in low-lying coastal regions.

This thesis investigates the existing preservation planning framework at the federal, state, and local levels to determine policy and program actions that aid the integration of adaptation planning strategies in preservation legislation. With a focus on the historic cities that face severe physical, economic, and political implications of sea level rise and related coastal hazards, the City of Salem, Massachusetts, is examined to review ongoing adaptation efforts on designated sites and their approaches to preserving the significance, setting, and integrity of the historic resources.

The research methodology combines qualitative and quantitative data collection and analysis. A comprehensive literature review lays the theoretical groundwork, drawing insights from journals, reports, case studies, and policy documents. It further analyzes the current practices in adaptation planning of historic resources to identify the opportunities and challenges faced in preservation due to adaptation efforts. Salem's current policy, planning, and legislative framework are reviewed in detail, incorporating site visits, stakeholder interviews, and GIS Mapping. The study, thus, argues the need to establish adaptation planning as a preservation priority rather than the reverse and concludes with recommendations for policy and operation strategies for the adaptation of historic resources in this community that have broader applicability in local governments.

BIOGRAPHICAL SKETCH

Angela Fernandes is a trained architect and preservationist from Mumbai, India. Having graduated with a bachelor's degree in architecture from the University of Mumbai in 2018, she has over four years of experience in design and preservation. Her interest in historic preservation stems from her academic and practical experiences working on various design and urban planning projects in historical contexts. Through her work, Angela gained valuable insights into the crucial role that heritage architecture plays in shaping a sustainable contemporary built environment and the challenges posed by the existing dichotomy between preservation and development. It motivated her to pursue a master's in the field to broaden her understanding of historic buildings, preservation, and the associated legislation, which she believes, contributes to better design for a sustainable future.

Angela started her career as an architect with a city-based architectural firm in Mumbai. She continued to pursue several preservation projects of diverse scopes that provided extensive experience in the field, from research and documentation to advocacy and outreach. At Cornell, her coursework has equipped her with expertise in preservation law, economics, and building materials which play an integral role while designing within historical contexts. Angela also opted for the NYC semester at Cornell's Gensler Family AAP Center last fall, which allowed her to apply her preservation knowledge and architecture background to practical design and planning projects, collaborating with city agencies and design firms. In the past year, she also worked as a Preservation Intern at Robert A.M. Stern Architects, preparing historic structure reports and cultural significance studies.

To Mom, Dad & Elton

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I am indebted to the participants of my study from the City of Salem, House of Seven Gables, Cape Cod Commission, and Union Studio, whose willingness to share their time and insights has made this research possible. Special thanks to the Newport Restoration Foundation and Keeping History Above Water Conference for the wealth of information that they have documented over the years, motivating and supporting further research into this pressing subject. Many thanks to the Cornell AAP NYC Studio staff and faculty for all their support through my semester in New York, especially Robert Balder, who I have been so fortunate to have known and worked with. A special thank you to Christopher Hinman for his patience in answering all my doubts.

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LIST OF ABBREVIATIONS

AMOC	Atlantic Meridional Overturning Circulation
CCRP	Climate Change Response Program
CRCC	Cultural Resource Climate Change
CRHMP	Cultural Resource Hazard Mitigation Plan
COSTEP	Coordinated Statewide Emergency Preparedness
CROD	Climate Resilience Overlay District
CZM	Coastal Zone Management
DOI	Department of the Interior
DPCD	Department of Planning and Community Development
DSR	Department of Sustainability and Resiliency
EOEEA	Executive Office of Energy and Environmental Affairs
EOPSS	Executive Office of Public Safety and Security
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FHOD	Flood Hazard Overlay District
FIRM	Flood Insurance Rate Map
GHG	Greenhouse Gas
GIS	Geographic Information System
GMP	General Management Plan
GMSL	Global Mean Sea Level
GRD	Gravitational, Rotational, and Deformational
HABS	Historic American Building Survey
HAER	Historic American Engineering Record
HALS	Historic American Landscape Survey
HMP	Hazard Mitigation Plan
IPCC	Intergovernmental Panel on Climate Change
MACRIS	Massachusetts Cultural Resource Information System
MA/HL	Massachusetts Historic Landmark

MEMA	Massachusetts Emergency Management Agency
MGL	Massachusetts General Laws
MHC	Massachusetts Historical Commission
MVP	Municipal Vulnerability Preparedness
NCA	National Climate Assessment
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRHP	National Register of Historic Places
NRSS	National Resource Stewardship and Science Directorate
OCLP	Olmstead Center for Landscape Preservation
PM	Policy Memorandum
RMAT	Resilient Massachusetts Action Team
SERC	Sustainability, Energy, Resiliency Committee
SHC	Salem Historical Commission
SHMCAP	State Hazard Mitigation and Climate Adaptation Plan
SHPO	State Historic Preservation Officer
SLR	Sea Level Rise
SRC	Salem Rebuilding Commission
STAPLEE	Social Technical Administrative Political Legal Economic Environmental
THPO	Tribal Historic Preservation Officer
UCS	Union of Concerned Scientists
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

INTRODUCTION

Thesis Statement

The foundational concept of historic preservation is protecting significant historic and cultural resources from potential threats of destruction, alteration, or neglect. The primary goal of the nation's enduring historic preservation laws is to identify, evaluate, and safeguard resources that hold historical significance. However, in the face of escalating climate change impacts, sea-level rise is one of the most critical threats to preservation that is not given due priority.

Changes impacts were realized after the devastating Superstorm Sandy in 2012, which stands as one of the costliest storms in U.S. history. Record-level storm surge, precipitation, and flooding propagated efforts to increase adaptation of the natural and built environment to climate change and build resiliency in metropolitan areas such as New York and Boston. While these larger cities continue to undertake large-scale efforts to fortify the cities against shifting shorelines, smaller historic coastal communities are challenged by the fundamentals of adaptation planning that intersect with historic preservation concerns. Of the many such at-risk cities in the Northeast, Salem, MA, presents an excellent case study of a city at a crucial phase of planning with efforts to manage historic resources across the federal, state, regional, and local levels. This thesis, thus, aims to investigate the research question: How can preservation planning effectively integrate climate change adaptation practices within the existing legislative framework dictated by the NHPA of 1966 to address the impacts of sea-level rise on historic and cultural resources?

Rising sea levels present unprecedented challenges that call for innovative and adaptive strategies within the realm of preservation planning to safeguard our invaluable heritage for future generations. By delving into the complex interplay between climate change adaptation and historic preservation, the study seeks to identify practical approaches and policy recommendations to foster the resilience of our cultural heritage amidst the changing climate landscape. This requires synthesizing various aspects of historic preservation planning, including history, economics, climate science, and public policy. Through a comprehensive analysis of current practices, case studies, and stakeholder perspectives, this research endeavors to contribute to a more sustainable and adaptive preservation planning paradigm that ensures the sustained preservation and continuity of our shared heritage in the face of sea-level rise.

Methodology

The research methodology was designed to provide a comprehensive understanding of how preservation planning and climate change adaptation practices address the impacts of sea-level rise. To achieve this objective, an approach combining qualitative and quantitative data collection and analysis was employed.

The first step involved conducting a thorough literature review to gather existing knowledge and insights on climate change adaptation, historic preservation planning, and the impacts of sea-level rise on cultural heritage. This review drew from academic journals, reports, policy documents, case studies, and relevant publications to establish a robust theoretical foundation for the research. Subsequently, a selection of case studies of historic coastal sites facing sea-level rise impacts was undertaken to provide empirical evidence and real-world examples of adaptation strategies. These case studies were limited to the

geographic extent of the U.S. Atlantic Coast and Gulf Coast which has historically experienced the highest sea level rise scenarios.

Among the shortlisted historic coastal cities, the City of Salem, Massachusetts, was chosen as the case study to undertake detailed research on the ongoing preservation practices and adaptation efforts. Data was collected through site visits, stakeholder interviews, archival records, and existing reports on adaptation measures. Semi-structured interviews with the city agency staff, Patricia Kelleher, City Preservation Planner, Department of Planning and Community Development, and Neal Duffy, Director of the Department of Sustainability and Resiliency, were conducted to gain insights into the perceptions and attitudes of preservation practitioners, and policymakers. Other relevant stakeholders, including Susan Baker, Collections Manager, House of Seven Gables, and Kara Babcock, Associate at Union Studio, the architectural consultancy firm working on ongoing adaptation assessments, were also interviewed. These conservations helped gain an in-depth understanding of their experiences, challenges, and strategies for integrating climate change adaptation within preservation planning. Sarah Korjeff, Planner and Historic Preservation Specialist at the Cape Cod Commission provided further insights on the local-level preservation challenges at a regional scale. The discussions and presentations on the Keeping History Above Water Conference forum in Trinidad & Tobago (March 2023) and Portsmouth, New Hampshire (May 2023), along with the Annual Conference by the Salem Historic Preservation Partners were also essential sources providing insights into existing practices in sea level rise adaptation.

The research methodology also included a comprehensive GIS-based exposure analysis, with the primary objective of comprehending the existing climate and sea level rise

data and evaluating their relevance to historical resources. The GIS analysis was employed to identify at-risk historical resources and ascertain the specific nature of the associated risks. The study enabled an assessment of the extent to which current policies integrate adaptation measures for safeguarding historic and cultural resources while identifying potential gaps or areas that require improvement.

In conclusion, this research will synthesize the findings from the literature review, case studies, interviews, and the exposure analysis to develop comprehensive recommendations for effectively incorporating climate change adaptation practices within preservation planning. Drawing upon best practices, stakeholder perspectives, and insights into identified challenges, these recommendations will serve as a valuable guide for policymakers, practitioners, and communities, empowering them to proactively preserve and protect historic and cultural resources from the potential impacts of sea-level rise.

Chapter Summaries

Chapter 1 explores the impacts of sea level rise on historic and cultural resources in coastal regions, particularly along the Atlantic Coast. It emphasizes the unprecedented challenges posed by climate change, with rising sea levels having profound and long-term repercussions in densely populated coastal cities. Many of these cities are already experiencing "hot spots" of higher-than-average local sea level rise. The chapter delves into the study of current sea level rise scenarios, potential hazards, risks to historic communities, and implications for the preservation of cultural heritage. It highlights the physical, economic, and socio-cultural consequences of climate change and coastal hazards on historic resources, emphasizing the importance of proactive adaptation planning to protect cultural heritage continuity, economic vitality, and community identity. The chapter

concludes by stressing the need for site-specific assessments, stakeholder engagement, flexibility, compliance with local regulations, and timely responses to ensure the preservation of historic resources for future generations and the sustainable development of coastal communities.

The second chapter focuses on the significance of adaptation planning in addressing the challenges brought about by climate change impacts on cultural resources. It offers insights into the process of vulnerability assessment, risk analysis, goal setting, stakeholder engagement, implementation, and continuous monitoring. The chapter examines current practices at the federal level, particularly the role of the National Park Service (NPS) and the Federal Emergency Management Agency (FEMA) in protecting cultural resources from climate change impacts. It also presents two case studies from Florida and Annapolis, Maryland, showcasing adaptation planning efforts at the state and local levels. By identifying existing gaps and achievements in adaptation planning, this chapter underscores the importance of collaboration and adaptive management to preserve and protect historic resources effectively.

The third chapter focuses on a specific case study, Salem, Massachusetts, a historically significant city facing climate change impacts. This chapter delves into Salem's rich maritime and cultural heritage and its vulnerability to sea level rise and extreme weather events. Through an exploration of existing preservation legislation and climate adaptation planning in Massachusetts, the chapter highlights the challenges and opportunities for integrating climate change adaptation within preservation efforts. The case study reviews ongoing adaptation planning efforts in Salem, including the rehabilitation of the Salem Maritime National Historic Site, the "Resilient Together: The Point" initiative, and the

ongoing climate change assessment at the House of Seven Gables. By analyzing Salem's preservation and adaptation strategies, this chapter seeks to identify practical approaches for effectively integrating climate change adaptation within historic preservation planning.

The fourth and final chapter synthesizes the findings of the research and provides recommendations for incorporating climate change adaptation methods into historic preservation planning. Applying the insights gained from the Salem case study and analysis of current practices, this chapter proposes actionable strategies to enhance preservation legislation, prioritize adaptation measures, and foster collaboration among stakeholders. It emphasizes the importance of considering socio-economic factors, environmental justice, and equity in adaptation planning and outlines the need for regional and localized solutions. By offering specific guidance on documenting and assessing at-risk historic resources and promoting preservation-sensitive adaptation methods in the context of the case study city, this chapter aims to contribute to the sustainable preservation of historic and cultural resources in the face of climate change impacts.

CHAPTER I

IMPACTS OF SEA LEVEL RISE ON HISTORIC RESOURCES

Introduction

In this new era of climate change, human civilization faces unprecedented challenges in adapting to its impacts, including sea level rise. Global sea levels rising at an accelerating rate have proven to have profound and long-term repercussions in coastal regions worldwide, including the United States. The global average rise has been about eight inches since the Industrial Revolution. However, a 2014 study by the Union of Concerned Scientists shows that many U.S. cities along the East Coast and the Gulf of Mexico have seen much higher increases in local sea levels in only the past 50 years, making them "hot spots" facing higher-than-average local sea level rise. These low-lying regions along the Atlantic coast are some of the most densely populated cities, home to tourist destinations, fisheries, natural landscapes, military bases, financial centers, and beaches and boardwalks.[1] From Maine to Miami, coastal shorelines and communities that have historically played a very integral part in the developmental history are now increasingly at a high risk from sea-level rise and its hazards, which may lead to catastrophic losses of land and life.

Chapter 1, thus, delves into a study of the current sea level rise scenario, specifically along the Atlantic Coast, with an aim to understand the nature of potential hazards, the risks they pose to historic coastal communities and the direct and indirect implications on the historic resources and their preservation.

[1] Union of Concerned Scientists, *Causes of Sea Level Rise: What the Science Tells Us* (April 2013), 1, https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/Causes-of-Sea-Level-Rise.pdf.

Climate Change and Sea Level Rise on the Atlantic Coast

Global sea level rise is caused by two major factors: the melting glaciers and ice sheets of Greenland and Antarctica that are losing mass at an accelerating rate and the increasing volume of seawater as it expands due to rising temperatures. These factors are attributed to an exponential rise in temperatures over the past 100 years caused by greenhouse gas (GHG) emissions. While the thermal expansion of ocean water was the main driver of global sea level rise since the start of the Industrial Revolution, recent studies have suggested the melting ice contributed to more than 75 percent of the sea level rise between 2003 and 2007 and continues to take over as the dominant contributor.[2]

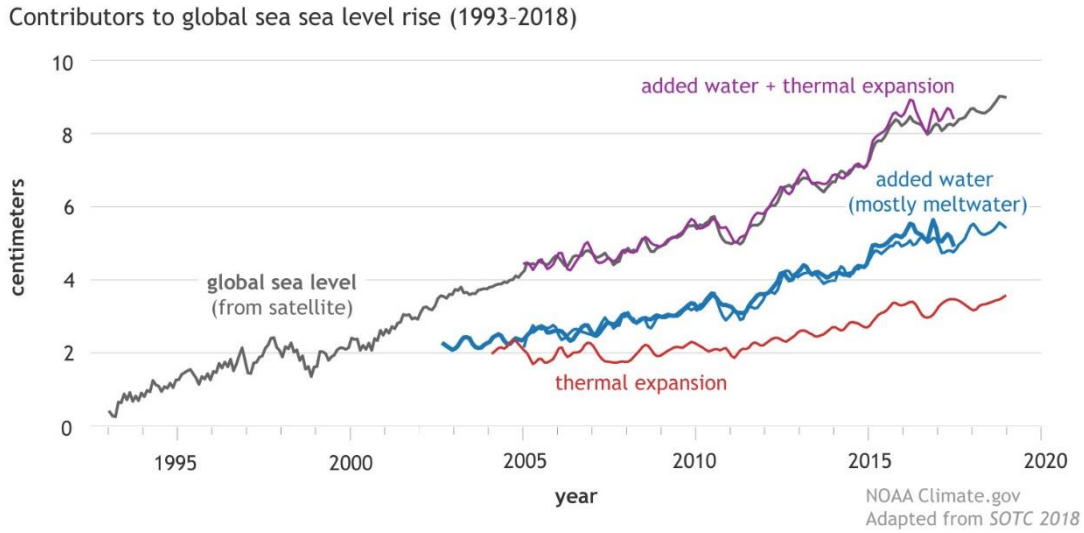

Figure 1: Observed Sea level rise since 1993 in black line, along with estimates of the two different contributions to sea level rise: thermal expansion (red) and added water due to glacier melt (blue) cumulatively represented in purple.
Source: NOAA.gov (2022)

The Global Mean Sea Level (GMSL) rose by 0.14 inches (3.6 millimeters) per year from 2006-2015, which was 2.5 times the average rate of 0.06 inches (1.4 millimeters) per year throughout most of the twentieth century. In 2021, the GMSL was 3.8 inches (0.09

[2] Union of Concerned Scientists, *Causes of Sea Level Rise*, 2; "NASA Finds Polar Ice Adding More To Rising Seas," NASA, March 8, 2011, http://www.nasa.gov/topics/earth/features/earth20110308.html.

meters) above 1993 levels and was expected to rise at least 12 inches (0.30 meters) above the 2000 levels by the end of the century, even if greenhouse gas emissions follow a relatively low trajectory in the coming decades. [3]

While the rising GMSL serves as an important indicator of climate change, the local and regional sea level rise is of the most importance to coastal communities worldwide. Measured through a global network of tide gauges and satellites, regional and local sea levels are not uniform and are influenced by many factors, including land subsidence, ocean currents, geologic factors, groundwater flow, drilling, dredging, and construction. Regional or relative sea level rise can result from three main drivers: stereo dynamic sea level change, *vertical land motion*, and changes in land ice and Earth, *gravitational, rotational, and deformational changes.*[4]

Stereodynamic sea level change refers to ocean circulation, currents, temperature, and salinity. Variations in trade winds and currents can cause water levels to rise or fall in various areas. The freshwater influx from ice sheets and glaciers melting can change the water's density, temperature, and salinity, affecting ocean circulation patterns in different regions. A further contributor to the variations in regional sea levels is vertical land motion or "either subsidence or uplift that occurs in coastal regions and can lead to the change in the height of sea level relative to land." [5] This phenomenon can result from geologic processes

[3] "Climate Change: Global Sea Level," NOAA Climate.gov, accessed June 18, 2023, http://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.

[4] National Oceanic and Atmospheric Administration, *2022: Global and Regional Sea Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines*, by W.V. Sweet et.al., NOAA Technical Report (Silver Spring, MD, February 2022), 1, https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf.

[5] NOAA, *2022: Global and Regional Sea Level Rise Scenarios for United States,* 7.

and human activities like groundwater extraction or fossil fuel extraction, which can cause land subsidence, as well as naturally occurring sediment compaction and settling over time.

Additionally, changes in land ice and the Earth's characteristics – gravitational, *rotational, and deformational (GRD)* changes – can affect regional sea levels. Freshwater is added to the oceans when ice sheets and glaciers melt or lose mass. This alters the gravity, deformation, and rotation of the Earth, leading to higher sea level rise in regions farther away from the source of ice melting compared to nearby areas. These distinct patterns of sea level rise, often referred to as "fingerprints," explain why the loss of ice mass from distant Antarctica has a more significant impact on the U.S. coastline than the loss of ice mass from Greenland.[6]

The most updated global, regional, and local level scenarios for all U.S. States and territories are provided in the 2022 NOAA Technical report "Global and Regional Seal Level Rise Scenarios for the United States: Updated Mean Projections and Extreme Water Level Probabilities Along U.S. Coastlines" produced by the Sea Level Rise Interagency Taskforce. SLR Projections in the report range up to 2150, along with focused observation-based trajectories, which serve as a near-term period (2020-2050) comparison of the scenarios. The report incorporates a set of five sea level rise scenarios, i.e., Low, Intermediate-Low, Intermediate, Intermediate-High, and High, developed from a suite of climate-modeled projections. It also includes observed extrapolations of SLR for eight coastal regions in the United States based on tide-gauge record data, namely, the Northeast (Maine to Virginia), the Southeast (North Carolina to the east coast of Florida), the Eastern Gulf (west coast of Florida to Mississippi), the Western Gulf (Louisiana to Texas), the

[6] NOAA, *2022: Global and Regional Sea Level Rise Scenarios for United States,* 6-7.

Southwest (California), the Northwest (Oregon to Washington), the Hawaiian Islands, and the Caribbean.[7] As per the report, sea level along the U.S. coastline is projected to rise, on average, 10-12 inches (0.25-0.30 meters) by 2050, which will be as much as the rise measured over the last 100 years, i.e., 1920-2020. Further, local sea level rise will continue to vary regionally along U.S. coasts because of changes in both land and ocean height, with highest levels of 14-18 inches (0.35-0.45 meters) along the Gulf Coast and 10-14 inches (0.25-0.35 meters) along the East Coast.[8] Areas along the Atlantic coast thus face sea level rise that is higher than the average, leading to the formation of local "hotspots."[9]

Recent studies have reported a major "hot spot" along the U.S. Atlantic Coast north of Cape Hatteras. Since 1950, SLR rates in this Northeast hot spot have been approximately three to four times higher than the global level caused by was caused by stereodynamic changes and mass redistributions associated with a possible weakening of the Atlantic Meridional Overturning Circulation (AMOC).[10] The AMOC is one of the global ocean's primary circulation systems of ocean currents that circulates water within the Atlantic Ocean, bringing warm water northwards at the surface and cold water southwards to the bottom of the ocean.[11] The slowing down of AMOC is already witnessed in the Gulf of Maine and Northeast Shelf, which has warmed 99 percent faster than the global ocean over

[7] NOAA, *2022: Global and Regional Sea Level Rise Scenarios for United States,* 13.

[8] Ibid., 60.

[9] Asbury H. Sallenger, Kara S. Doran, and Peter A. Howd, "Hotspot of Accelerated Sea-Level Rise on the Atlantic Coast of North America," *Nature Climate Change* 2, no. 12 (December 2012): 884, https://doi.org/10.1038/nclimate1597.

[10] W. R. Gehrels et al., "A Preindustrial Sea-Level Rise Hotspot Along the Atlantic Coast of North America," *Geophysical Research Letters* 47, no. 4 (2020): 1, https://doi.org/10.1029/2019GL085814.

[11] Niklas Boers, "Observation-Based Early-Warning Signals for a Collapse of the Atlantic Meridional Overturning Circulation," *Nature Climate Change* 11, no. 8 (August 2021): 680–88, https://doi.org/10.1038/s41558-021-01097-4.

the past ten years.[12] If the AMOC continues to slow down, it will lead to sea water piling up the Northeast Coast contributing to a higher rate of sea level rise by nearly an additional eight inches to current projections.[13]

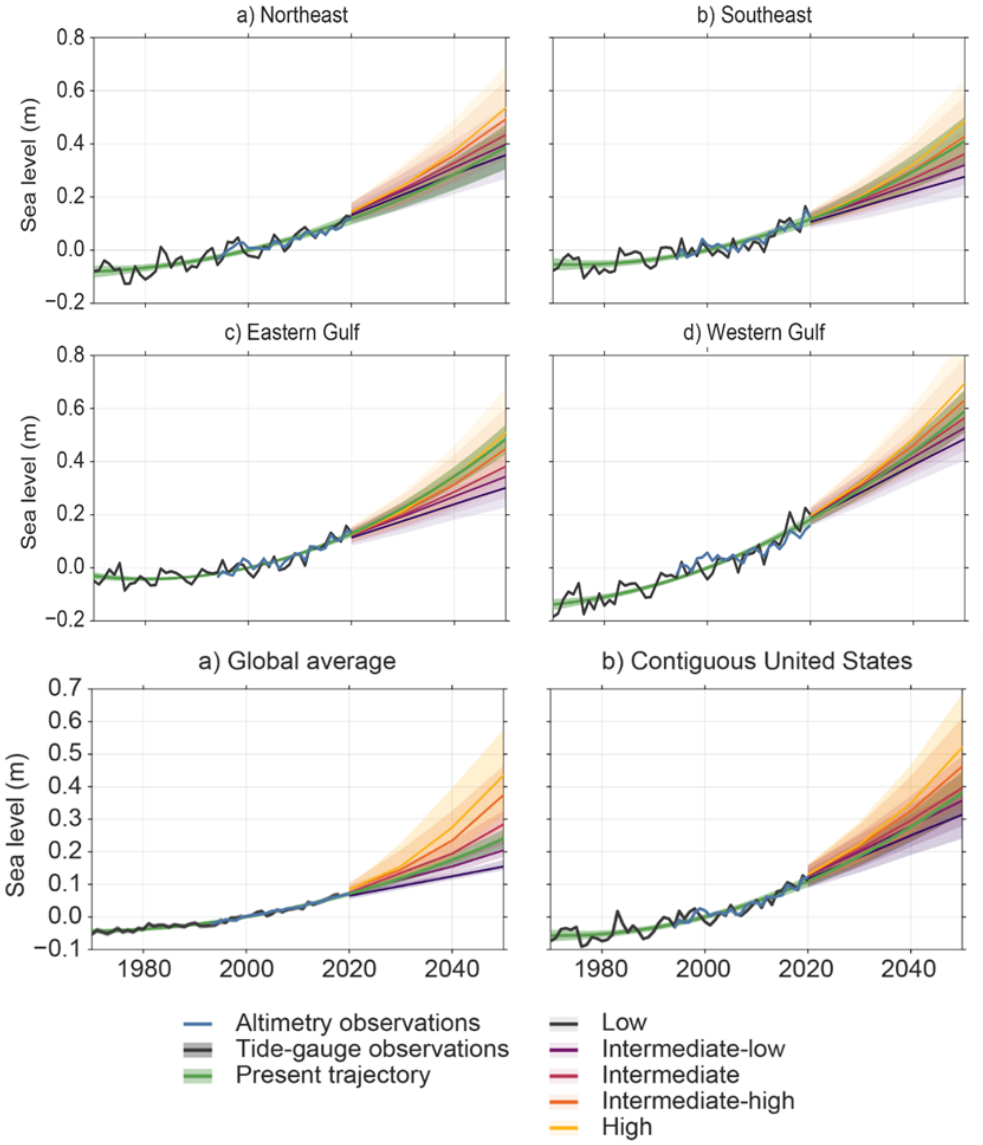

Figure 2: Observation-based extrapolations using tide-gauge data and five Scenarios, in meters, for a) global mean sea level and b) relative sea levels for the contiguous United States and the four regional scenarios on the U.S. Atlantic Coast from 2020 to 2050 relative to a baseline of 2000.
Source: 2022 NOAA Technical Report.

[12] "Reconstruction of Major North Atlantic Circulation System Shows Weakening," NOAA Fisheries, NOAA, June 29, 2022, New England/Mid-Atlantic, https://www.fisheries.noaa.gov/feature-story/reconstruction-major-north-atlantic-circulation-system-shows-weakening.

[13]

Climate Hazards to Historic Coastal Communities

While sea level rise is one of the primary indicators of the changing climate causing permanent inundation, it is not the sole risk. The combination of rising sea levels with land subsidence, and various other coastal factors like storm surge, wave effects, rising coastal water tables, river flows, and rainfall, is leading to a higher severity and frequency of coastal hazards, especially on the East Coast. These hazards are further impacted by other climate-related changes, resulting in increased exposure and vulnerability of coastal populations and their resources. Although storms, floods, and erosion have always been risks, they threaten the continued viability of coastal communities that depend on coastal water, land, and other resources for economic health and cultural integrity.[14] Thus, sea level rise is changing essential systems and the dynamics at play along coasts. In this section, chief coastal hazards amplified by sea level rise that pose potential risks to historic coastal communities are described in detail.

High-Tide Flooding

High tide flooding, also known as "sunny-day or nuisance flooding," refers to the temporary flooding of coastal areas during high tide events. It happens when water levels reach or exceed the identified threshold height for flooding, resulting in the inundation of streets, sidewalks, and other low-lying areas. High-tide flooding can occur even on sunny days without storms or heavy rainfall. As the average global sea level rises due to climate change, the baseline water level during high tides increases, making it easier to exceed normal thresholds and flood coastal areas more frequently and extensively. Additionally, sea

[14] Elizabeth Fleming et al., *Chapter 8: Coastal Effects. Impacts, Risks, and Adaptation in the United States: The Fourth National Climate Assessment, Volume II* (U.S. Global Change Research Program, 2018), 324, https://doi.org/10.7930/NCA4.2018.CH8.

level rise can lead to increased infiltration of tidal water into coastal groundwater systems, further contributing to high tide flooding in some areas. The occasional king tides –causing extreme high tide events – pose an even greater risk.[15] [16]

`According to a 2018 NOAA analysis, high-tide flooding in the United States doubled between 2000 and 2015, going from an average of three days per year to six in the Northeast Atlantic. It is most prevalent on the East and Gulf Coasts, where its frequency has increased by about 200% during the previous two decades. However, in coastal towns such as Annapolis, MD, the statistics are far more dramatic, directly impacting historic resources. According to NOAA's stated flooding standards for the city, Annapolis had a record-breaking 18 days of high-tide flooding from May 2019 to April 2020. The previous record was 12 days in 2018, an increase from seven days in 2015.[17]

Storm Surge

Storm surge refers to the "abnormally high water levels pushed ahead of tropical storms or hurricanes that can surge onto land. The pulse of seawater delivered onto the coast can result in extreme coastal and inland floods."[18] Due to sea level rise, storm surge occurs over an elevated sea level and may extend further inland. This means that a storm today could cause more extensive flooding than a storm of the same size did in 1900.[19] Such storm surges have the potential to seriously damage infrastructure, including roads, trains, bridges,

[15] "High-Tide Flooding," U.S. Climate Resilience Toolkit, June 2, 2023, https://toolkit.climate.gov/topics/coastal/storm-surge#footnote1_sqzzujf.

[16] "What Is High Tide Flooding?," National Oceanic and Atmospheric Administration, accessed July 5, 2023, https://oceanservice.noaa.gov/facts/high-tide-flooding.html.

[17] Ellen Gray, "Beating Back the Tides," NASA, October 16, 2020, http://www.nasa.gov/feature/esnt/2020/beating-back-the-tides.

[18] "Storm Surge," U.S. Climate Resilience Toolkit, March 25, 2020, https://toolkit.climate.gov/topics/coastal/storm-surge#footnote1_sqzzujf.

[19] Union of Concerned Scientist, *Causes of Sea Level Rise*, 5.

buildings, and pipelines, as well as cause beach erosion, habitat degradation, and considerable property loss.

When Hurricane Irma hit 20 miles to the north of Florida's Key West 20 miles in 2017, it was a Category 4 storm with winds of 130 mph and a storm surge of 5 to 8 feet. Coastal Georgia and South Carolina experienced high tides and storm surges of up to three feet as the storm moved up the west coast of Florida. Even though the winds gradually decreased to tropical storm status, several coastal communities in Florida, Georgia, North and South Carolina, and Virginia suffered significant wind and storm surge damage.[20]

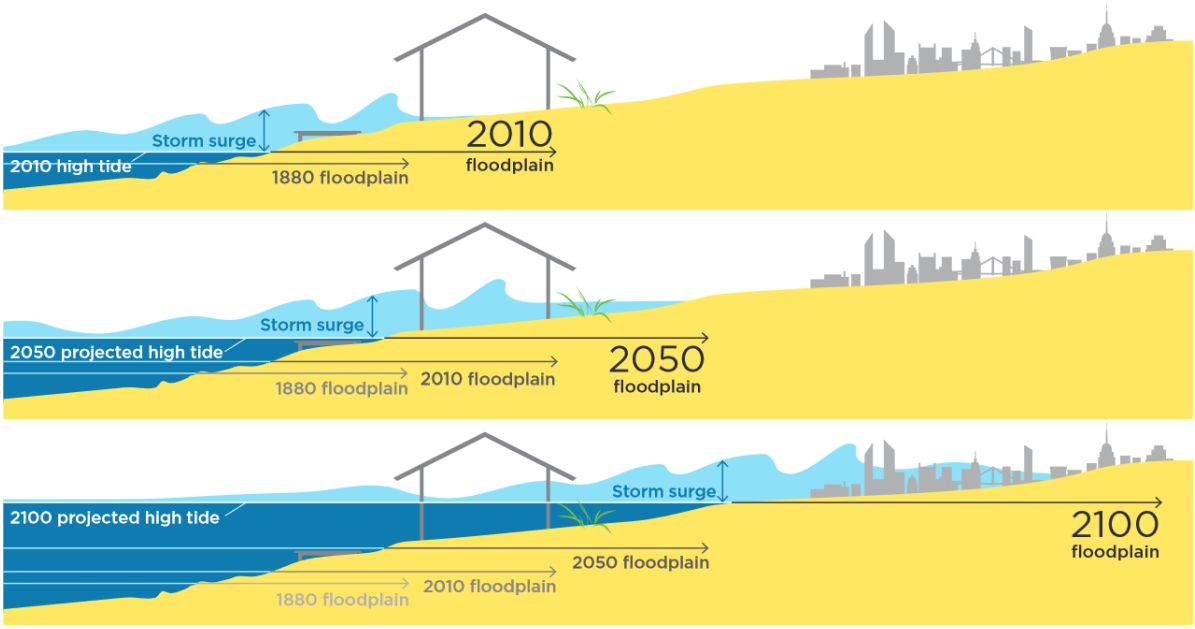

Figure 3: Illustration showing the effects of sea level rise on higher storm surges.
Source: Union of Concerned Scientists (2013).

[20] "Storm Surge," U.S. Climate Resilience Toolkit.

Coastal Erosion and Degradation

"Coastal erosion is the process by which local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and sands along the coast."[21] It occurs due to the combined effects of the waves, currents, tides, wind, and other natural forces acting on coastal regions and continuously modifying the shoreline over time. Sea level rise amplifies the probabilities of erosion by allowing waves to reach further inland despite calm conditions. The natural coastal defenses have already been weakened by erosion and urbanization in many areas of the United States, leaving them more susceptible to storm events. However, a future increase in storm frequency and intensity will, in turn, result in more coastline erosion.

This phenomenon is highly local, with average coastline recession rates of 25 feet per year recorded on some barrier islands in the Southeast. These high rates of coastal erosion are unlikely to be a primary concern in undeveloped areas, but in densely populated areas, one or two feet of erosion may be devastating.[22] Along the Atlantic Coast, one of the historic cities at high risk is the island of Nantucket, Massachusetts. The town has always been susceptible to coastal erosion because it is composed of glacially deposited and compacted sandy soils. However, sea level rise and the potential for more frequent and intense storms are expected to increase the erosion rate further. Portions of its shoreline, particularly along the South Shore, have eroded more than one hundred feet inland in the past decade.[23]

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[21] "Coastal Erosion," U.S. Climate Resilience Toolkit, April 1, 2021, https://toolkit.climate.gov/topics/coastal/storm-surge#footnote1_sqzzujf.

[22] Ibid.

[23] Coastal Resiliency Advisory Committee, *Nantucket Coastal Resilience Plan-Final Report* (Nantucket, Massachusetts, November 2021), 67, https://www.nantucketma.gov/DocumentCenter/View/40278/Nantucket-Coastal-Resilience-Plan-PDF.

Groundwater Table Rise

Sea level rise is a driving factor behind the hazard of groundwater table rise in coastal areas. As global sea levels continue to rise, the pressure on coastal aquifers increases, causing the groundwater table to elevate further. In low-lying coastal areas with shallow depths, this can lead to the water table eventually reaching above the land surface. Seasonal floods can be especially severe when high tide coincides with significant rainfall events. Consequently, even areas not directly connected to the shoreline may experience flooding and inundation. Depending on the geography and the climatic conditions in a given area, there can be several impacts, including the cause of the formation and spread of wetlands, changes in surface drainage patterns, increased soil saturation, and land inundation. The elevated groundwater table poses challenges for subsurface utilities and infrastructure. Groundwater infiltration into underground utility systems can lead to corrosion, damage, and operational difficulties. Additionally, the stability and integrity of building foundations can be compromised, requiring costly repairs and maintenance efforts.[24]

Implications of Sea Level Rise on Cultural Heritage

The U.S. coasts contain some of the country's most dynamic environments and economically vibrant cities and towns that hold approximately 42% of the nation's population.[25] They serve as hubs of commerce and are home to diverse ecosystems that have historically developed into thriving communities due to a combination of factors, including their strategic location, access to natural resources, trade opportunities, and the rise of tourism. The Fourth National Climate Assessment (NCA), in its chapter on *Coastal Effects,*

[24] Coastal Resiliency Advisory Committee, *Nantucket Coastal Resilience Plan-Final Report*, 62.
[25] Fleming et al., "Chapter 8," 324.

has identified that the "Coastal Economies and Properties are already at Risk," "Coastal environments are at Risk," and that the resultant "Social Challenges are intensified."[26] However, it fails to identify the common thread that spans the three vulnerable sectors – cultural resources. Essential for the sustainability, vitality, and resilience of historic coastal communities, they preserve heritage, reinforce cultural identity, drive economic growth, provide educational opportunities, foster social cohesion, and contribute to the promotion of the community. Throughout history, environmental forces have influenced cultural treasures. However, climate change poses a significant threat to cultural resources by altering and intensifying these processes, resulting in a broader range of impacts with greater severity.[27]

The National Park Service's Cultural Resource Climate Strategy outlines the direct impacts that pose considerable risks to cultural resources. While not specific to only coastal resources, it encompasses a broader range of resource types in its analysis, including archaeological resources, cultural landscapes, ethnographic resources, museum collections, and historic buildings and structures. Relevant impacts caused by hazards related to sea level rise and climate change are presented in Table 1. Based on these impacts, this section further focuses on its implications for preserving cultural resources.

[26] Ibid., 323-324.

[27] National Park Service, Climate Change Response Program, *Climate Change Response Strategy*, (Fort Collins, Colorado, 2010), 18, https://www.nps.gov/subjects/climatechange/culturalresourcesstrategy.htm.

Table 1: Climate Change and Sea Level Rise related impacts to Cultural Resources.

	Impact on Cultural Resources
Inundation and Increased Flooding Events	<u>During Flood:</u> - Submersion of coastal sites - Increase in nuisance flooding leading to problems of access and higher likelihood of range of flood damage. - Damage to or overwhelming drainage systems, leading to associated building damage. - Increase risk of mold on museum collections.
	<u>Post- Flood:</u> - Deterioration/corrosion of infrastructure not designed for inundation or saltwater exposure. - Increased cracking due to associated ground heave and subsidence. - Crystallization of salts introduced to buildings by seawater. - Disassociation of historic districts, settings due to increased pressure to relocate or elevate structures or surrounding structures. - Loss of access leading to loss of use.
Increased Frequency and/or Severity of Storm Surges	<u>During Surge:</u> - Structural damage or collapse from moving force of storm surge. - Immediate alteration/ destruction of historic landscape. - Increased risk of inundation of homes and towns, esp. during unpredictable and extreme weather. - Changes to surrounding landforms or vegetation, which may affect future drainage. - Damage to utilities, generators, and electrical systems. - Damage to [archival] items and disassociation of materials and records during emergency evacuations. - Increase risk of rot, fungal/insect attack, mold and mildew.
	<u>Post-Surge:</u> - Cracks in building and associated destabilization of buildings and pipes due to ground heave and subsidence/shrink-swell soils. - Erosion of supporting ground around structure. - Changes to surrounding landforms, which may affect future drainage. - Increased pressure to relocate or elevate structures, and/or surrounding structures (may also be pre-flood).
Increased Coastal Erosion	- Loss or compromise of structure. - Increased pressure to relocate or elevate structures, and/or surrounding structures. - Increased rusting, corrosion, and salt deposits due to increased salt in the environment as the coastline encroaches. - Exposure of new and known archeological sites
Higher Water Table	- Rising damp, often marked by efflorescence/ salt deposits. - Rot of subsurface components from higher water table. - Flooding damage in basements and other below grade features. - Structural damage due to buoyant forces. - Increased risk of rising damp/rot; Potential for higher relative humidity levels in collections storage areas.

Source: National Park Service, "Cultural Resources Climate Change Strategy" (2016).

Physical Implications

As sea levels rise, coastal regions, including historical sites and cultural landmarks, face an increasing risk of inundation and erosion. Historic buildings, monuments, and archaeological sites situated along the shoreline become vulnerable to flooding, undermining their structural integrity and risking irreversible damage. Additionally, sea level rise can accelerate the deterioration of building materials, particularly for older structures not designed to withstand prolonged exposure to saltwater. Coastal erosion threatens to erode the foundations of historic buildings and monuments, leading to their potential collapse. Moreover, critical infrastructure, like roads and utilities, may suffer significant damage or become submerged, affecting the functionality of historic properties and infrastructure.

Coastal hazards and climate change impacts can lead to landscape modifications, as iconic coastal vistas, beaches, and traditional coastal practices are at risk of disappearing or being drastically altered. Protecting and adapting these historic and cultural resources in the face of sea level rise demands urgent attention and integrated planning to safeguard the rich heritage and identity tied to coastal regions. Erosion and land loss along the coastline also alter the physical environment, including beaches, dunes, and wetlands. These changes impact the aesthetic appeal of the coastal area and disrupt natural habitats and ecosystems, potentially leading to a loss of biodiversity and ecological balance.

Economic Implications

Coastal hazards can destroy or damage historic buildings and infrastructure, leading to substantial economic losses. Minor flooding may only require clean-up. However, major damage to the building structure requires demolition and removal of the damaged building fabric. The cost of repairing, restoring, or rebuilding these assets can be significant,

especially considering the specialized expertise often required for historic preservation. Additionally, repeated flood events will mean recurring and additional expenses.

Due to their increased susceptibility to coastal hazards, historic properties in coastal areas can additionally incur higher insurance premiums. When evaluating coverage, insurers could take into account the risks of erosion, storm damage, and floods, which could result in increased insurance premiums for property owners. Property owners will continue to incur out-of-pocket losses as a result of rising self-insurance costs. This can also have a detrimental effect on a building's value, both as an asset to the owner and for its market value, as prospective buyers might not be able to secure flood insurance for a property and, as a result, be denied financing.

Historic resources play a vital role in attracting tourists and generating revenue for coastal cities. Tourism may decline when these resources are compromised or lost due to coastal hazards, such as flooding or erosion. This, in turn, can have a cascading effect on local businesses, including hotels, restaurants, shops, and tour operators, leading to revenue loss and potential job cuts.

Socio-cultural Implications

Historic resources hold cultural and historical significance, representing the identity and heritage of communities. When these resources are compromised or lost due to coastal hazards, it can result in a profound loss of cultural heritage that extends beyond physical damage to structures. It can impact the sense of place, community pride, and the ability to transmit traditions and historical narratives to future generations.

Coastal hazards may necessitate the relocation or abandonment of coastal communities within floodplains, including those with significant historic value. This

displacement can disrupt social networks, fragment communities, and weaken community bonds. Losing historic neighborhoods can also sever the connections between residents and their shared heritage. Migration to new areas may also result in challenges in preserving intangible cultural heritage and traditional knowledge that has been intricately linked to specific geographical locations.

Furthermore, the degradation or loss of historic resources can erode the cultural fabric of a community. Historic buildings often embody architectural styles, craftsmanship, and traditional building techniques that reflect the unique character of a place. When these resources are lost, it becomes challenging to maintain the authenticity and distinctiveness of a community, potentially leading to the dilution of cultural identity.

Conclusion

The alarming rise in sea levels and the related hazards on the Atlantic Coast pose severe threats to the areas within the local "hotspots" of higher-than-average sea level rise. While larger cities, including New York, Boston, and Washington D.C., continue to undertake large-scale efforts to fortify the cities against shifting shorelines, smaller historic coastal cities continue to struggle with the fundamentals of adaptation planning that intersect with historic preservation concerns.

Adaptation planning for historic resources is crucial due to their unique vulnerabilities and irreplaceable cultural value. These resources represent a community's identity, history, and traditions, making their preservation essential for cultural heritage continuity. The limited replicability of these resources underscores the need for proactive adaptation planning to protect their historical authenticity and cultural value. Moreover, historic coastal cities heavily rely on them for economic growth, as major tourist attractions

contributing significantly to local economies. By safeguarding these landmarks and sites, adaptation planning maintains economic vitality and sustainable development. In addition to economic importance, historic resources foster social cohesion and community identity. Preserving them reinforces community resilience amidst environmental challenges.

While the challenges of safeguarding historic and cultural resources from sea level rise are common to most historic cities across the nation and the Atlantic Coast, the issues call for localized solutions that deal with regional variations and contextual vulnerabilities. Each historic resource and coastal landscape is unique, with varying vulnerabilities, making site-specific assessments crucial. Moreover, engaging local stakeholders, including residents, businesses, and cultural heritage experts, ensures that adaptation strategies align with community values and concerns, fostering consensus and ownership of the plans. It also allows for quicker decision-making and implementation of priority adaptation measures, offering better protection for historic resources from immediate risks posed by rising sea levels. Thus, through site-specific assessments, stakeholder engagement, flexibility, compliance with local regulations, and timely responses, local adaptation planning ensures the preservation of historic resources for future generations and the sustainable development of coastal communities.

CHAPTER II

ADAPTATION PLANNING IN PRESERVATION – CURRENT PRACTICES

Introduction

Adaptation planning refers to the process of identifying and implementing strategies to proactively address the risks and challenges posed by current and future climate change impacts. It involves developing and implementing measures to enhance the resilience and ability of communities, ecosystems, and infrastructure to withstand the changing climate conditions. The planning process commonly involves some key steps and components, namely, vulnerability assessment, risk analysis, goal setting and strategy development, stakeholder engagement, implementation followed by continuous monitoring and adaptive management.

The increasing evident impacts of climate change and sea level rise has led to the transition of climate change adaptation from a phase of awareness to planning and implementation of actual strategies. Efforts by a broad range of international, governmental, and local organizations, scientific groups, academic studies, and climate activists combined have contributed to a broadened understanding of the significance of climate change adaptation, encouraging an increase in the number of adaptation responses and guidance for implementation. This has, in turn, led to an increasing awareness for the need to incorporate preservation consideration within adaptation planning to safeguard historic and cultural resources that are at risk, especially in low-lying coastal communities. However, there continues to be very limited guidance on specific strategies and responses for historic resources, especially in the preservation community.

At the federal level, the government and agencies have now assumed a coordinating role in adaptation planning and implementation, including the dissemination of information, the development of legal frameworks, and, most importantly, the provision of financial support to other levels of government. State, regional, and local organizations, on the other hand, are at the forefront of adaptation planning as they deal with challenges presented by the lack of guiding data on local vulnerabilities and potential hazards and a multitude of adaptation options to implement targeted and contextually relevant adaptation strategies. An understanding of the available guidance and existing adaptation responses for cultural resources is essential in understanding the nature of the challenges posed in the case study. This chapter, therefore, delves into current adaptation planning practices across the different levels of governance that have proven to be critical tools in guiding local coastal communities in dealing with the sea level rise adaptation to historic resources.

The chapter first evaluates the strategies and planning guidance documents at the federal level by the National Park Service (NPS). As the lead preservation agency that administers the NHPA, NPS stands at the front line of safeguarding over 400 significant sites from the impacts of climate change. This section provides an overview of NPS policies and practices highlighting principal guiding documents and concepts in adaptation planning. While these guidance documents cater only to the needs of NPS-owned sites, they provide valuable insights into the integration of cultural resource considerations with wider applicability. Next, the chapter focuses on The Federal Emergency Management Agency's (FEMA) guidance on integrating cultural and historic properties into hazard mitigation planning. The document published in 2005 has served as a primary tool for local governments and preservation organizations focused on cultural resource adaptation. FEMA,

the federal agency responsible for coordinating and providing assistance in response to disasters and emergencies, manages the federal flood insurance program, which is also a crucial tool in the adaptation of historic resources.

Lastly, the chapter reviews the application of the adaptation concepts and more specifically, the FEMA guide at the state and local levels. The first study presented is of the State of Florida that utilizes the FEMA guidance to develop a planning document that specifically addresses the threats of sea level rise. The second study analyzes the case of Annapolis, Maryland, which has led local efforts in hazard mitigation planning to include cultural resource considerations as per FEMA's guidelines. The section thus summarizes key takeaways from the review of these existing planning documents that can be applied within the local context of the case study city and concludes with observations on the role of the different levels of government within the existing framework.

National Park Service: Guidance on Cultural Resource Considerations

The National Park Service (NPS) is a bureau of the U.S. Department of the Interior responsible for preserving and protecting natural and cultural resources across the country. Over 400 national parks, monuments, historic sites, and other protected areas are managed by the National Park Service, established in 1916 by the "National Park Service Organic Act" of Congress.[28] The NPS did not focus much on historic preservation in its early years. This changed in the 1930s when the agency started acquiring forts, cemeteries, and historic houses and assisting property owners. The Historic American Buildings Survey (HABS)

[28] "Quick History of the National Park Service," National Park Service, last update August 24, 2022, https://www.nps.gov/articles/quick-nps-history.htm

was one of the first explicit historic preservation initiatives launched by the NPS in 1935, designed to document historic structures and engineering works across the country.[29]

In addition to overseeing national parks and other protected areas that are a part of the National Park system, the NPS is in charge of carrying out the National Historic Preservation Act (NHPA) of 1966 and is the principal federal agency in charge of the care and management of cultural resources. In conformance with the NHPA, the NPS collaborates with federal, state and local governments and private businesses and individuals to identify and safeguard historic properties. The NPS is in charge of designating significant properties to the National Register. A historic property must first be nominated for the National Register, after which the National Park Service will assess the nomination. The Keeper of the National Register of Historic Places is a National Park Service employee who makes the ultimate determination. The agency reviews federal projects that may impact historic properties and works with other federal agencies to ensure compliance with the NHPA.[30] It also provides technical assistance and financial support to state and local governments, tribes, and private organizations through programs such as the Federal Historic Preservation Tax Incentives, Technical Preservation Services, and the National Center for Preservation Technology and Training to help them preserve historic properties. Other cultural resource programs include the National Heritage Areas, American Battlefield Protection Program, National Scenic and National Historic Trails, certification of local governments, and partnerships—including collaborations through the Landscape

[29] *Historic American Buildings Survey*, (Washington, D.C.: National Park Service, n.d.)

[30] Sara C. Bronin and Ryan Rowberry, *Historic Preservation Law in a Nutshell*, Second Edition, Nutshell Series (St. Paul, MN: West Academic Publishing, 2018), 51; "National Historic Preservation Act," Historic Preservation, National Park Service, last updated December 1, 2022, https://www.nps.gov/subjects/historicpreservation/national-historic-preservation-act.htm

Conservation Cooperatives and with Tribal governments, other Federal agencies, States, universities, and non-governmental partners—help the NPS in shaping the national framework for historic preservation inside parks and around the country.[31]

Now, over 100 years since the founding of the NPS, the agency finds itself forced to develop new ways to protect the natural and cultural resources in its care from the impacts of a changing climate. A decade ago, an NPS analysis had already identified that 96 percent of its land is in areas of observed global warming over the past century. At least 85 sites have already recorded changes attributable to climate change. Another study by NPS scientists has determined that over one-quarter of the units of the National Park System, i.e., more than 100 national parks, are situated along ocean coastlines and, thus, are vulnerable to the combined impacts of sea-level rise and storm surges.[32] They pose considerable risks to infrastructure, archeological sites, lighthouses, forts, and other historic structures in coastal units of the national park system.[33] Along the Atlantic Coast, the Southeast region is projected to experience the highest storm surges based on historical data and NOAA storm surge models. However, several NPS sites in the Northeast region also are projected to have relatively high SLR rates in 2030, 2050, and 2100,[34] including two of the nation's newest national monuments–sites commemorating Harriett Tubman in Maryland and Fort Monroe in Virginia–that already face an imminent threat from sea level rise.[35]

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[31] "What is Historic Preservation," Historic Preservation, National Park Service, last updated February 22, 2023, https://www.nps.gov/subjects/historicpreservation/what-is-historic-preservation.htm.

[32] Debra Holtz et al., *National Landmarks at Risk: How Rising Seas, Floods, and Wildfires Are Threatening the United States' Most Cherished Historic Sites* (Union of Concerned Scientists, May 2014), 2, https://www.ucsusa.org/sites/default/files/2019-09/National-Landmarks-at-Risk-Full-Report.pdf.

[33] National Park Service, Natural Resource Stewardship and Science, *Sea Level Rise and Storm Surge Projections for the National Park Service*, by Maria A. Caffrey, Rebecca L. Beavers, and Cat Hawkins Hoffman, NPS/NRSS/NRR—2018/1648, (Fort Collins, Colorado, 2018), viii.

[34] National Park Service, *Sea Level Rise and Storm Surge Projections,* 17.

[35] Holtz et al., *National Landmarks at Risk*, 2.

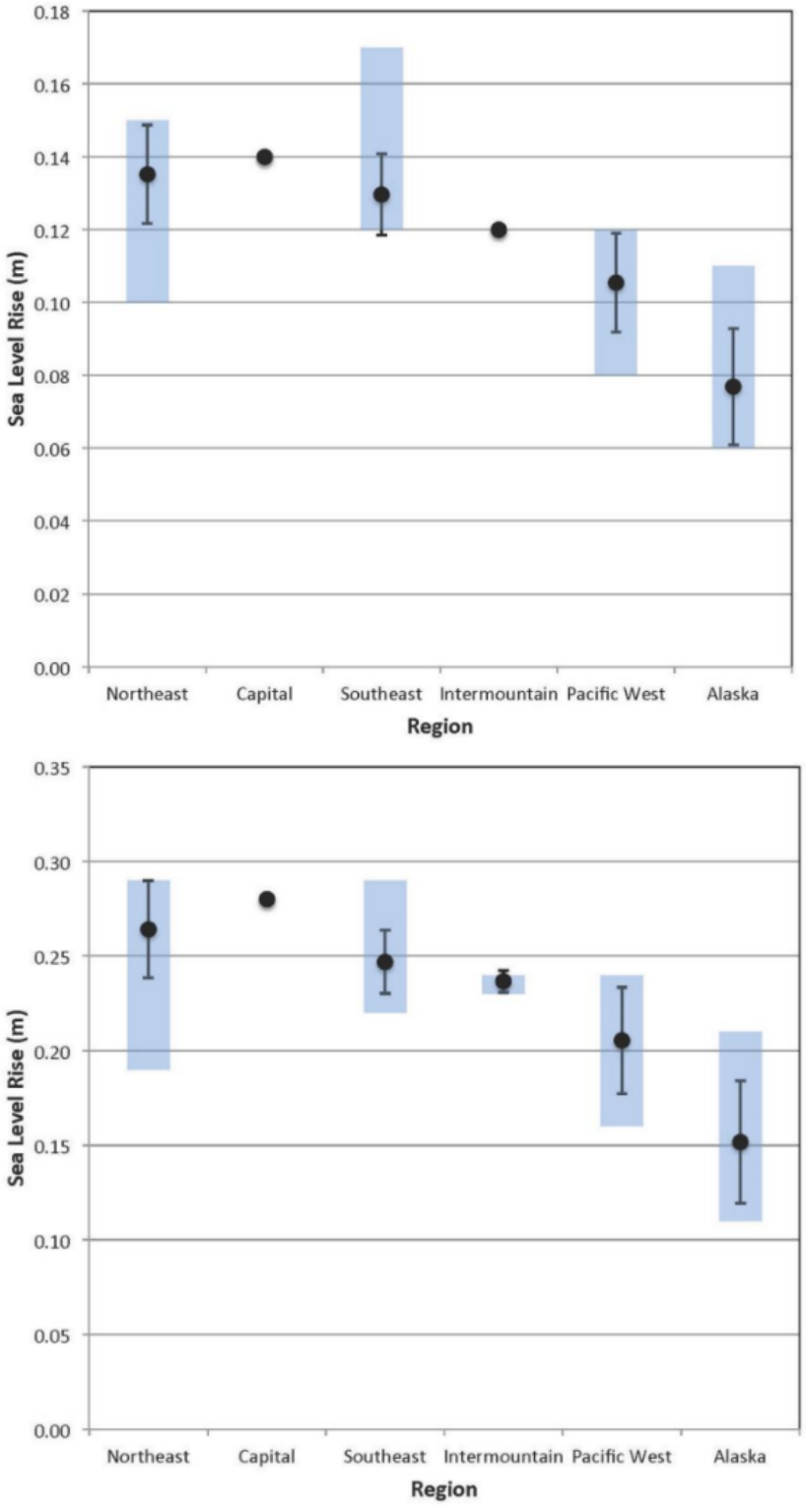

Figure 4: Graph showing projected future sea level rise for the six NPS regions for 2030 (above) and 2050 (below)under RCP8.5. Black dots indicate the average sea level rise in meters. Black bars represent the standard deviation of each mean, and the blue bars mark the full range of sea level estimates. *Source: National Park Service (2018)*

Hurricane Sandy in 2012 and, more recently, Hurricanes Harvey, Irma, and Maria in 2017 have already demonstrated the extensive damage that can be caused by sea level rise and storm surge. On October 29, 2012, Sandy was at hurricane strength when it landed near Atlantic City, New Jersey, south of Fire Island National Seashore and Gateway National Recreation Area. While the NPS expected flooding at 40 coastal park sites, it was most significant in New York City.[36]

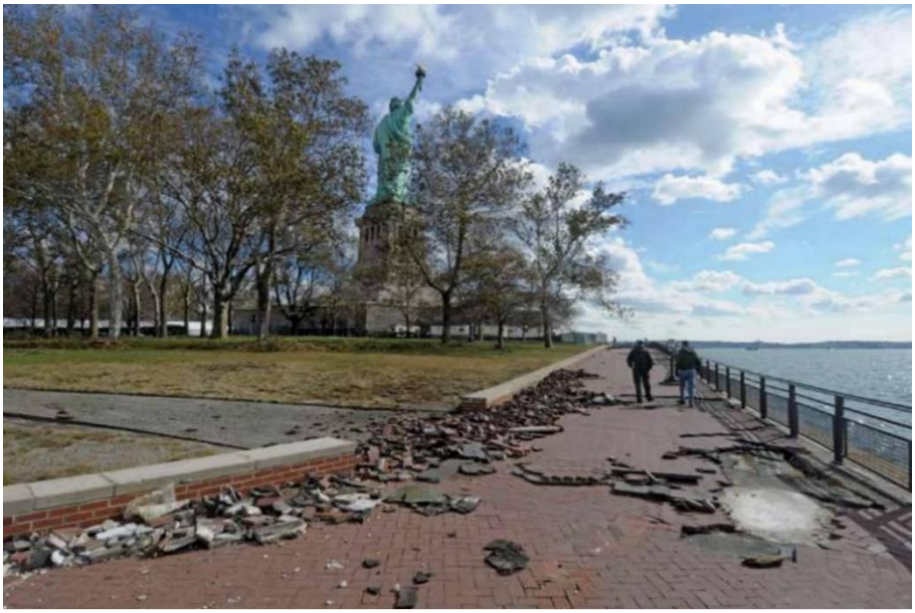

Figure 5: The aftermath of Hurricane Sandy on Liberty Island. The massive storm surge destroyed most of the Liberty and Ellis Islands' radio equipment, electrical infrastructure, and security systems.
Source: National Park Service (2013)

The storm surge submerged three-quarters of Liberty Island and almost all of Ellis Island, destroying critical infrastructure with an estimated $77 million in damage. Recovery efforts took several months, with Liberty Island and Ellis Island re-opening after almost a year. Even then, architectural repairs continued to be carried out on Ellis Island, with sections of the main historic building and museum, including most of their exhibits,

[36] Maria Caffrey and Rebecca Beavers, "Planning for the impact of sea-level rise on U.S. national parks," *Park Science* 30, no.1 (Summer 2013): 10-11

remaining closed till 2017. The event, thus, not only hampered operations that affected the interpretation of the historic site but also marked the close of a 200-year-old tradition of housing the Park's superintendent on site when the NPS decided not to rebuild the small brick house located on the lowest part of the island due to the risk of flooding. This experience, however, helped the National Park Service to develop adaptation strategies and decision frameworks that will assist other coastal national parks that must respond to and recover from a future storm. [37]

Recognizing this challenge posed by global climate change, the NPS established the *Climate Change Response Program* (CCRP) in 2007 under the Natural Resource Stewardship and Science (NRSS) Directorate. It was implemented as a response initiative to guide management actions and collaboration at national, regional, and park levels. After securing the base funding, they developed and published the *Climate Change Response Strategy* in September 2010. This document was formulated as an integrated blueprint that would guide the agency's efforts to address climate change at all levels based on goals and objectives listed under four fundamental "pillars" or components: Science, Adaptation, Mitigation, and Communication. Anchored in agency policy and Congressional law, this approach is consistent with Secretarial Order 3289 and complements strategies proposed by other DOI bureaus and other agencies.[38]

[37] Caffery and Beavers, "Planning for the impact of sea-level rise on U.S. national parks," 10.

[38] National Park Service, Climate Change Response Program, *Climate Change Response Strategy*, (Fort Collins, Colorado, 2010), 1-6.

Cultural Resources Climate Change Strategy (2016)

By 2012, the year of Hurricane Sandy, the NPS had subsequently released several policy and guidance documents that coordinated climate change response which included the Call to Action (Action Item 21: Revisit Leopold 2011), Revisiting Leopold: Resource Stewardship in the National Parks (2012), Green Parks Plan (2012), Climate Change Action Plan (2012). The then-NPS Director Jon Jarvis issued a policy memorandum entitled, *Applying NPS Management Policies in the Context of Climate Change,* which addressed the implications of climate change on the guiding principles of impairment and natural conditions of NPS resource management (PM 12-02).[39] However, these efforts failed to address the cultural resources within parks at high risk and outline a framework to base priority actions and decisions relating to protecting and adapting cultural resources. This led to an ensuing policy memorandum titled '*Climate Change and Stewardship of Cultural Resources'* issued to address the effectiveness of NPS stewardship of cultural resources (PM 14-02). The memoranda posed "three essential questions with respect to NPS cultural resources and climate change: (1) what is climate change adaptation for cultural resources; (2) how should we make decisions related to cultural resources in light of climate change; and (3) how do we communicate regarding climate change science and impacts."[40] Building on the foundation of this memorandum, the NPS published the *Cultural Resources Climate Change Strategy* (CRCC) in 2016. Intended primarily as a companion document to the Climate Change Response Strategy (2010), it expands upon the roles of cultural resources in climate change science, adaptation, mitigation, and communication. The CCRC Strategy

[39] National Park Service, "Policy Memorandum 12-02: Applying NPS Management Policies in the Context of Climate Change" (2012), https://www.nps.gov/subjects/policy/upload/PM_12-02_3-6-2012.pdf.

[40] National Park Service, "Policy Memorandum 14-02: Climate Change and Stewardship of Cultural Resources" (2014), https://www.nps.gov/subjects/policy/upload/PM_14-02.pdf.

sets out four overarching goals for cultural resources as listed below, guiding how to recognize and respond to a wide range of environmental changes:[41]

1. Connect Impacts and Information: Set the broad scope of cultural resources and climate change response by connecting the concepts of impacts and information with the four pillars of climate change response: science, adaptation, mitigation, and communication.
2. Understand the Scope: Coordinate science, management, and communication to identify and improve understanding of the effects of climate change on cultural resources.
3. Integrate Practice: Incorporate climate change into ongoing research, planning, and stewardship of cultural resources.
4. Learn and Share: Collaborate with partners to grow and use the body of knowledge and practice for cultural resources and climate change.

The CRCC Strategy, therefore, attempts to provide direction in implementing climate change policies establishes by laying out the fundamental concept framework for cultural resources based on the four components of the Climate Change Response Strategy, further identifying the broad range of climate impacts to the different type of cultural resources by climate change hazards. One of the climate change trends addressed in this section of the CCRC is sea-level rise, which categorizes the impacts on cultural resources under four sub-categories of major observable phenomena: flooding events, storm surges, coastal erosion, and higher water table (See Table 1). At the time of its publication, such a

[41] National Park Service, Cultural Resources, Partnerships, and Science and Climate Change Response Program, *Cultural Resources Climate Change Strategy,* by Marcy Rockman, Marissa Morgan, Sonya Ziaja, George Hambrecht, and Alison Meadow (Washington, D.C., 2016), 4-5.

structured list of climate change impacts would guide NPS managers and have widespread applications on heritage at risk of climate change globally.

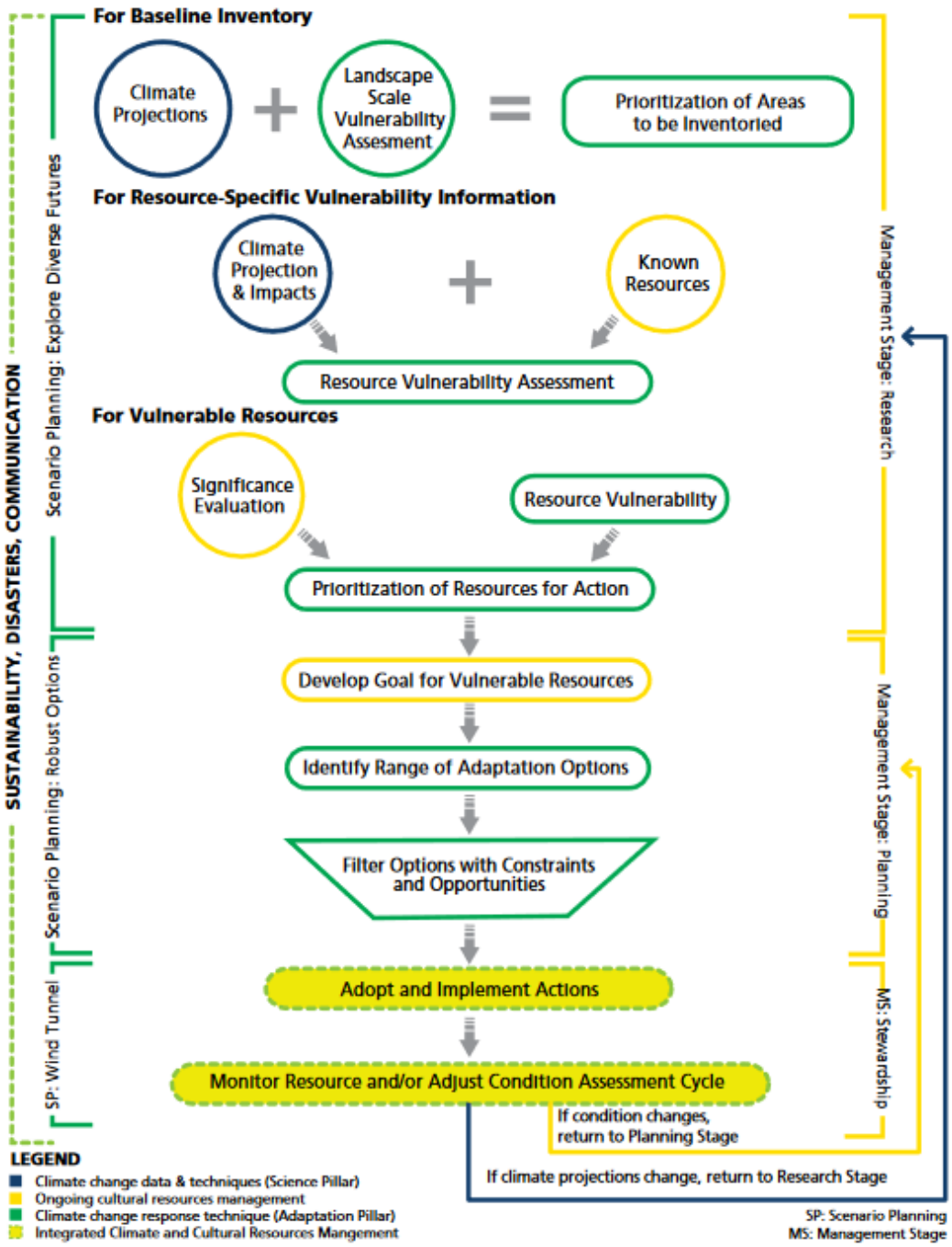

Figure 6: Cultural Resources Management- Climate Change Integration Flow Chart. The chart outlines major touchpoints between climate change and research, planning, and stewardship stages of cultural resources management.
Source: National Park Service (2016)

With regard to cultural resources adaptation planning, however, one of the most crucial aspects of the Strategy are the goals and methods outlined to integrate climate change into the existing NPS management framework. Drawing out from the points set out in the policy memorandum (PM 14-02) on "Cultural Resources Decision-Making in an era of Climate Change," the strategy identifies multiple action points that employ new and existing climate data, projections, and risk-evaluation techniques into cultural resource management, while also integrating cultural resources with major climate change approaches. Figure 6 illustrates the schematic chart outlining major touchpoints between climate change actions and the various stages of NPS management policies for cultural resources.[42] Thus, in recognizing their leadership role within the historic preservation framework of the country, the NPS took the first step in prioritizing, sharing adopted techniques, and helping guide collective actions towards the climate change adaptation of cultural resources with the CCRC Strategy.

At the same time, the NPS developed the *Coastal Adaptation Strategies Handbook* (2016) that outlined response strategies specific to parks in estuarine and coastal areas, including the Great Lakes, addressing the impacts associated with storm surges and sea level rise. A section focuses on cultural resources, categorizing them into five types: archaeological resources, cultural landscapes, ethnographic resources, museum collections, and historic and prehistoric buildings and structures. Describing the threats due to higher water levels, the document identifies policies, processes, and strategies that assist in adaptation planning based on the Cultural Resources Response Strategy.[43] The Handbook is

[42] National Park Service, *Cultural Resources Climate Change Strategy,* 26-27.

[43] National Park Service, *Coastal Adaptation Strategies Handbook 2016,* by Rebecca Beavers, Amanda Babson, and Courtney Schupp, NPS 999/134090 (Washington, D.C., 2016).

supplemented with the *Coastal Adaptation Strategies: Case Studies* (2015), which provides a compilation of 24 case studies of national park units in various settings along the coast that have successfully tackled climate change issues, mainly threats due to sea level rise.[44] Along with the focused guidance provided by the NPS in adapting various resource types to climate change, it also promotes specific adaptation planning processes such as "Scenario Planning" and the "RAD Adaptation framework" that are now employed across most National Parks.

Scenario Planning

The uncertainty related to the future of climate change, as well as the regional and local variations in sea level change, has prompted many resources management and climate research organizations, including the IPCC and U.S. Global Change Research Program (USGCRP), to employ scenario planning, "a vehicle for developing multivariate climate change responses and strategies, and test decisions in a context of uncontrollable and uncertain environmental, social, political, economic, or technical factors."[45] A longstanding military and private sector tool, the NPS began exploring this approach in 2007 and has now adopted scenario planning as a long-range planning tool in a variety of park management process and documents, including General Management Plans and Resource Stewardship Strategies.[46] The NPS focused on developing multivariate, local-level impact scenarios to address the climate change concerns of park managers. Scenario development can be carried out by either a highly participatory, workshop-based approach, engaging Park mangers in

[44] National Park Service, Natural Resource Stewardship and Science, *Coastal Adaptation Strategies: Case studies*, by Courtney Schupp, Rebecca Beavers, and Maria Caffrey, NPS 999/129700 (Fort Collins, Colorado, 2015).

[45] National Park Service, *Cultural Resources Climate Change Strategy*, 29.

[46] National Park Service, Climate Change Response Program, *Using Scenarios to Explore Climate Change: A Handbook for Practitioners* (Fort Collins, Colorado, 2013), 1-2.

"scenario thinking exercises" that leverage the expertise of resource managers and other subject-matter experts, or a technical approach in which scientists link climate projections to quantitative models, or even a combination of both, depending on the level of park planning. In 2013, the Park Service published *Using Scenarios to Explore Climate Change: A Handbook for Practitioners*,' which outlines a five-step process for developing climate change scenarios: Orientation, Exploration, Synthesis, Application, and Monitoring. [47]

In 2021, the National Park Service published *Planning for a Changing Climate*, a guidebook that integrated scenario planning within a general adaptation planning framework. The framework was based on an existing planning approach described in *Climate-Smart Conservation*, the product of an interagency and nongovernmental organization partnership led by the National Wildlife Federation (NWF). The guide thus streamlines the scenario planning process within the framework flexibly with a wide range of NPS planning and management needs. The process consists of six iterative steps that build on each other continuously, rather than one with an endpoint, which requires constant monitoring, evaluation, and refinement, an approach supported by the Department of Interior and the NPS's commitment to adaptive management. Thus, the goal is to implement strategies that achieve the park's climate-informed goals while monitoring and adapting to changing environmental conditions.[48]

[47] National Park Service, Climate Change Response Program, *Using Scenarios to Explore Climate Change*, 10.

[48] National Park Service, Climate Change Response Program, *Planning for a Changing Climate: Climate-Smart Planning and Management in the National Park Service* (Fort Collins, Colorado, 2021), 11.

Resist-Accept-Direct Framework

The National Park Service has also developed the Resist-Accept-Direct (RAD) Adaptation framework to assist in evaluating potential adaptation strategies based on their goals and objectives. Each of the three basic strategies represents a different approach to responding to climate change. Resisting suggests that NPS managers may focus on maintaining the persistence of resources and facilities by implementing strategies that resist change. When resisting change is not viable (e.g., the cost of resistance is exorbitant or the magnitude of potential change overwhelms the technical ability to preserve resources in their current state), managers will need to move to accepting change. This may require modifying or changing management practices to accommodate changing climatic conditions. Lastly, for living resources, with multiple potential trajectories of change, managers may also actively direct the trajectory of change to a new desired condition.[49] The framework, therefore, helps develop a broader range of climate change adaptation strategies, particularly for natural resources having multiple, plausible trajectories of potential change but may also prompt broader thinking for cultural resources, facilities, and visitor experience.

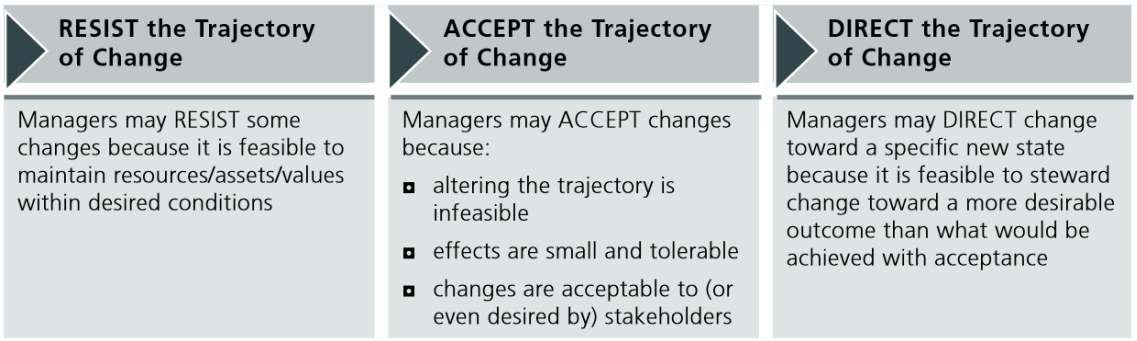

Figure 7: The RAD framework.
Source: National Park Service (2021).

[49] "Resist-Accept-Direct," Climate Change, National Park Service, last updated August 19, 2022, https://www.nps.gov/subjects/climatechange/resistacceptdirect.htm; National Park Service, Climate Change Response Program, *Planning for a Changing Climate*, 9-10.

Federal Emergency Management Agency: The National Flood Insurance Program and Hazard Mitigation Planning for Cultural Resources

The Federal Emergency Management Agency (FEMA) is a federal agency that operates under the U.S. Department of Homeland Security. While FEMA is not directly involved in either climate change adaptation efforts or in historic preservation, it is the agency in charge of administering the National Flood Insurance Program (NFIP) as a part of its federal role in "leading the Nation's efforts to prepare for, protect and mitigate against, respond to, and recover from the impacts of natural disasters."[50] Created by an act of Congress in 1968, the NFIP allows property owners, renters, and businesses from 23,000 participating communities across the country to gain access to flood insurance coverage from the federal government.[51] The communities are required to adopt minimum building and development regulations within Special Flood Hazard Areas (SFHA) to enforce new and "substantially improved" or "substantially damaged" residential buildings be elevated with the lowest floor at or above the Base Flood Elevation (BFE) determined for the site.[52] Thus, FEMA is also responsible for developing floodplain management and regulations and providing the current flood hazard data through Flood Insurance Rate Maps (FIRMs) and the National Flood Hazard Layer geodatabase.

[50] Federal Emergency Management Agency, *FEMA Strategic Plan: Fiscal Years 2008-2013*: *The Nation's Preeminent Emergency Management and Preparedness Agency*, FEMA P-422 (Washington, D.C., 2008), 1, https://www.fema.gov/pdf/about/fy08_fema_sp_bookmarked.pdf.

[51] "Flood Insurance," FEMA.gov, accessed July 5, 2023, https://www.fema.gov/flood-insurance.

[52] Federal Emergency Management Agency, National Flood Insurance Program, *Floodplain Management Bulletin: Historic Structures*, FEMA P-467-2 (Washington, D.C., 2008), 3, https://www.nj.gov/dep/hpo/Index_HomePage_images_links/FEMA/FEMA%20historic_structures.pdf.

National Flood Insurance Program Considerations for Historic Resources

Recognizing the unique value of cultural resources, the NFIP in 1989 made two particular considerations for historic buildings, landmarks, and sites to incentivize the NFIP to historic property owners. Firstly, they did not need to meet the floodplain management requirements for new construction of the NFIP as long as they maintained their historic designation, i.e., they were provided an exemption from the "substantial improvements" and "substantial damage" provisions of the Program. Secondly, they could avail of subsidized flood insurance rates, i.e., the rates that applied to Pre-FIRM buildings, even if it has been substantially improved or substantially damaged so long as the building retained its historic designation.[53] For this purpose, the NFIP defines "historic structure" in its 2008 *Floodplain Management Bulletin: Historic Structures (FEMA-P-467-2)* as buildings that are:[54]

1. Listed individually in the National Register of Historic Places or determined to be eligible for listing by the Secretary of the Interior.
2. Contributing structures to the historic significance to a National Register historic district or a historic district determined to be eligible for listing as by the Secretary of the Interior.
3. Listed on a state inventory, in states with historic preservation programs appointed by the Secretary of the Interior, or
4. Listed on a local inventory, in states with historic preservation programs appointed by the Secretary of the Interior.

[53] Federal Emergency Management Agency, National Flood Insurance Program, *Floodplain Management Bulletin: Historic Structures*, 3-4.

[54] Ibid., 4.

The definition provided above itself serves as the minimum criteria of eligibility to avail of the federal insurance coverage, and thus not only insures the structures from flood damage without any major alterations to the historic fabric but also serves as an incentive for historic property owners to seek historic designation and maintain the historic character, promoting continued preservation. That said, historic buildings still require to be protected from physical flood damage so that it does not face catastrophic loss in the event of a disaster.

As FEMA is a federal law, the provisions allow local municipalities and communities to enforce more stringent interpretations if necessary. Communities can therefore adopt an ordinance that requires variances for "substantial improvements" to "historic structures" or alternatively include the "historic structures" exemption as part of their "substantial improvement" definition. Local level variances can therefore establish conditions that could make the historic buildings more flood resistant and minimize flood damage. Conversely, any attempts of reconstruction, rehabilitation, or other improvements proposed of designated historic structures would be directly regulated by local governments and preservation commissions and reviewed closely for potential effects on historic character and integrity.[55] The document also suggests seeking guidance from your State Historic Preservation Officer or Tribal Historic Preservation Officer to evaluate best practices in mitigation measures with minimal impact on the character-defining design features of the historic structure to avoid loss of designation.[56]

[55] Federal Emergency Management Agency, National Flood Insurance Program, *Floodplain Management Bulletin: Historic Structures*, 5.

[56] Ibid., 8.

Apart from its role in managing the National Flood Insurance Program, FEMA has also developed a range of tools and guidance documents, of which some resources focus on mitigation actions specifically for cultural resources. The FIRMs produced by FEMA and the National Flood Hazard Layer geodatabase are important tools for understanding flood risks to cultural resources, conducting detailed flood risk assessments, and determining the vulnerability of cultural resources to flooding. The data and information provided by FEMA's flood hazard mapping efforts can help communities understand their flood risk, develop effective mitigation strategies, and support funding applications for hazard mitigation projects, especially from federal and state sources. Additionally, FEMA publishes Technical Bulletins that provide guidance on various aspects of hazard mitigation. While not specific to cultural resources, several bulletins address flood-related mitigation measures that can be applied to protect these assets.

Integrating Historic Property and Cultural Resources

An important resource focusing on the mitigation and management of cultural resources is the state and local mitigation how-to guide titled *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning.* The document developed by FEMA is part of a series of mitigation planning "how-to" guides for the purpose of assisting communities, States, and Tribes in developing an effective hazard mitigation plan. This particular resource is developed specifically to address historic properties and cultural resources considerations and serves as a supplementary guide to the

"core four" that provide an overview of the key elements: organizing resources, assessing risks, developing a mitigation plan, and implementing the plan and monitoring progress.[57]

FEMA defines hazard mitigation planning as "the process of determining how to reduce or eliminate the loss of life and property damage resulting from natural and manmade hazards."[58] Thus, while hazard mitigation aims to minimize or eradicate the risks, adaptation planning aims at building resilience for each asset. Though the strategies employed would principally differ in both approaches, the planning considerations and methodologies involved are the same. Moreover, the application of the guide to develop a FEMA-approved hazard mitigation plan by state, tribes, and local communities is required qualification for FEMA-approved grant programs, including the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation Competitive Grant Program (PDM-C).[59]

FEMA guidance breaks down the planning process into four phases corresponding to the key elements listed above. The guide thus helps both large and small communities with varying levels of resources, expertise, and funding by outlining specific steps in each of the four phases of the hazard mitigation planning process to integrate historic preservation planning considerations. Table 2 summarizes the stepwise process outlined in the guide with key takeaways for cultural resource management proposed in each phase.

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[57] Federal Emergency Management Agency, *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning*: *State and Local Mitigation Planning How-To Guide*, FEMA 386-6 (Washington, D.C., 2005), vii.

[58] Federal Emergency Management Agency, *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning*.

[59] Ibid., ii.

Table 2: Phasing Process of Integrating Cultural Resources in Hazard Mitigation Planning.

Phases of Plan	*Stepwise Cultural Resource Considerations*
Phase One: Organize Resources	Step 1: Assess community support. - Assessing community awareness of historic properties and cultural resources and support for protection from hazards. - Resources available for hazard mitigation related to historic properties and cultural resources. Step 2: Build the planning team. - Identifying and recruiting historic preservation and cultural resource experts to join the planning team should such expertise not already be represented by the core planning team members. Step 3: Engage the public. - Public meetings, questionnaires and visual definition surveys. - Held in conjunction with open gatherings of historical societies and historic preservation groups, neighborhood social or ethnic organizations, planning advisory groups, local governments.
Phase Two: Assess Risks	Step 1: Identify the Hazards - Identify hazards that affect the community. Step 2: Profile the hazards to determine hazard-prone areas and magnitude of each hazard. - Review the identified hazards within the planning areas and their profile. Step 3: Inventory Historic Properties and Cultural Resources - Determine and proportion the value of historic property and cultural resource assets in your community located in hazard-prone areas. - Establish preservation priorities. Step 4: Estimate Losses - Determine the extent of damages to historic properties and cultural resources. - Calculate the Total loss of historic properties by each hazard.
Phase Three: Develop a Mitigation Plan	Step 1: Develop Mitigation goals and Objectives for your preservation hierarchy. - Review and analyze the findings from your risk assessment of historic properties. Formulate Goals and determine objectives. - Gather public input on whether historic properties and cultural resources fit into the hazard mitigation plan. Step 2: Identify, evaluate, and prioritize actions. - Identify alternative mitigation actions. - Identify and analyze State and Local mitigation plans. - Evaluate, select, and prioritize mitigation actions appropriate for historic and cultural resources based on one of three methods: preservation hierarchy, STAPLEE criteria, or Benefit-Cost Analysis.

Source: Federal Emergency Management Agency (2005)

Table 2: continued

Phases of Plan	*Stepwise Cultural Resource Considerations*
Phase Three: Develop a Mitigation Plan	Step 3: Prepare an implementation strategy. - Identify how mitigation actions will be implemented. - Document the implementation strategies. - Obtain the consensus of the Planning Team, more specifically the preservation partners, SHPO/THPO, etc. Step 4: Incorporate Historic Property and Cultural Resource Protection efforts into the Hazard Mitigation Plan.
Phase Four: Implement the Plan and Monitor Progress	Consideration 1: Sensitivity of Information - Precautions while handling sensitive information such as disclosing specific locations of archaeological sites, or details about certain cultural practices and traditions, etc. Consideration 2: Required regulatory review - Activities fulfilling requirement of compliance with Section 106 of the NHPA, by official communication with SHPO/THPO. Consideration 3: Interagency Coordination/Agreements - Continuous coordination with interagency preservation partners including SHPO/THPO, local or regional planning entities, local building officials, etc. - Prepare an interagency agreement between or among involved agencies, that provides a formal framework to streamline regulatory review process. Consideration 4: Evaluating and Updating your Plan - Evaluate implementation actions to identify new information about historic and cultural resources. - Reformulate specific actions, objectives or even goals based on new observations and priorities. Consideration 5: Updating your Inventory Data - Develop a strategy for revising and updating your inventory data based on evaluation results. - Update every 3 years for State Plans and 5 years for local plans.

FEMA's role in protecting cultural resources from flooding hazards is part of a broader framework that involves multiple federal, state, tribal, and local agencies working together to safeguard these valuable assets. By leveraging FEMA's guidance and tools, stakeholders can develop comprehensive and effective hazard mitigation plans that account for the preservation of cultural resources, helping to ensure their long-term sustainability and resilience in the face of flooding hazards.

Florida: Adaptation Planning for Historic Resources at the State Level

In recent years, the state of Florida has experienced a concerning escalation in sea level rise, which has become a significant environmental and economic challenge. The effects of rising sea levels have been particularly pronounced due to Florida's extensive coastline, low-lying geography, porous limestone bedrock, and vulnerability to tropical storms and hurricanes. Coastal cities, including Miami, Fort Lauderdale, and Tampa, have been at the forefront of experiencing the impacts of sea level rise. These cities, known for their vibrant tourism, thriving economies, and cultural resources, are now grappling with frequent and more severe flooding events and increased vulnerability to storm surges.

The frequency of "sunny day" flooding, where high tides cause inundation, has significantly risen. Historic structures and sites along the coastal areas face increasing threats of erosion and submergence with a risk of being permanently damaged or washed away. Saltwater intrusion is another significant impact on historic structures built of the porous limestone bedrock that are causing major damage to building materials. Inland communities near rivers and estuaries are also susceptible to increased flooding and drainage issues as rising seas affect water levels and hydrological patterns. Additionally, the ecological balance of the Everglades, a unique and fragile ecosystem, is being disrupted as saltwater encroaches on freshwater habitats.

Recognizing the urgency of the situation, state and local governments, scientific institutions, and community organizations have taken measures to address sea level rise. Initiatives include the development of resilience plans, investments in infrastructure improvements, such as sea walls and stormwater management systems, and the promotion of sustainable practices and adaptation strategies. However, the magnitude of the challenge

calls for continued research, collaboration, and coordinated efforts to safeguard Florida's coastal areas and preserve its rich natural and cultural heritage for future generations.

With a focus on the adaptation planning processes, the Florida Department of Economic Opportunity (DEO) launched the Community Resiliency Initiative (CRI) in response to the growing interest from Florida communities in adapting to rising sea levels. The five-year initiative, funded by NOAA through the Florida Coastal Office of the Florida Department of Environmental Planning, focused on coordinating planning efforts throughout different regions of the state with an attempt to incorporate sea level rise adaptation into existing local comprehensive plans, hazard mitigation plans, and disaster redevelopment plans. The initiative analyzed current adaptation planning practices, collected relevant data and information, and developed guidance for agencies and communities to consider when implementing adaptation strategies.[60] In 2015, it published a guidebook titled *Adaptation Planning for Historic Properties*, providing valuable guidance to local municipalities regarding viable planning approaches for the adaptation of historic resources within the current legal framework.

Based on the FEMA guidance, the guidebook outlines four main components of an Adaptation Plan, which further categorizes the action steps that support the planning process. These include: [61]

1. Context: This refers to the "preparatory activities taken by the planning team and the community to increase their understanding of the relevant planning issue and to unite and fortify their efforts to address the issue." This includes building the team that

[60] Department of Economic Opportunity, Community Resiliency Initiative, *Adaptation Planning for Historic Properties*, by Julie A. Dennis and Daniel Fitz-Patrick (Florida, 2015), ii, https://floridadep.gov/sites/default/files/Adaptation-Historic-Properties_0.pdf.

[61] Department of Economic Opportunity, *Adaptation Planning for Historic Properties*, 16.

will steer the planning effort, drafting goals and objectives to guide the process, and surveying existing conditions and resources.

2. Vulnerability Assessment: The second step involves the survey, documentation, and evaluation of the hazards, the resources exposed to these hazards, and the extent of the impact. The Vulnerability Assessment mainly focuses on three types of analysis: Exposure Analysis, Impact Analysis, and Adaptive Capacity.
3. Adaptation Strategies: This step refers to the development of a "toolkit of responses from which communities can choose to adapt to sea level rise" as a response to the analysis and findings from the vulnerability assessments. The adaptation strategies are often categorized as Protection, Accommodation, and/or retreat based on the nature of the action and its effect on the resource.
4. Implementation Strategies: Similar to the FEMA guide, this step involves the team preparing for activities and tasks that support the successful implementation of the prioritized strategies, including applying for potential funding options, crafting a timeline and schedule for the execution of the identified actions, and monitoring and evaluating the progress.

While these components set up the conceptual framework for the general adaptation planning process, the document identifies two primary approaches to this process that communities can adopt when it comes to planning for the adaptation of historic resources in the face of sea level rise, which is, ss an integration within the larger adaptation planning framework, or as a standalone planning process. [62]

[62] Department of Economic Opportunity, *Adaptation Planning for Historic Properties*, 15.

Table 3: Summary of Components and sub-components of the Adaptation Planning Process for Historic Resources.

Adaptation planning component	Adaptation planning subcomponent	Novel elements of adaption planning for historic resources
Context	Assemble a Steering Committee	Include historic preservation professionals on the steering committee or as part of a focus group (Local historians, preservation architects, engineers, policymakers, non-profits and organizations, Main Street Program coordinators, etc.)
	Identify Opportunities for Community Participation	Identify discussion opportunities to ensure the inclusion of historic preservation professionals, property owners, and all relevant stakeholders in discussions.
	Set Guiding Principles and Motivations	Include goals specific to adapting historic resources and maintaining historic significance.
	Describe the Planning Context	Gather relevant data, which can include creating an inventory and map of current historic and cultural resources in the planning area.
Vulnerability Assessments	Conduct an Exposure Analysis	Overlay the exposure map with the map of the historic properties inventory. Determine which historic properties are in the area exposed to the chosen sea level rise scenario.
	Conduct an Impact Analysis	Evaluate the economic value of historic properties at risk in the sea level rise scenario, including potential direct damage costs and the potential loss of functional economic potential.
	Assess Adaptive Capacities	Determine the ability of the community and the innate ability of these vulnerable historic resources to adapt to and accommodate potential sea level rise.
Adaptation Strategies	Assign Focus Areas	Determine the community value of vulnerable historic properties and combine this information with the results of the vulnerability assessment.
	Identify Adaptation Strategies	Identify adaptation strategies categorized by protection, accommodation, or retreat. Consider strategies that can be implemented at different scales
	Prioritize Adaptation Needs	Use a STAPLEE or similar analysis to determine adaptation strategies for each focus area. The major consideration will be the impact of potential adaptation strategies on historic integrity.

Source: Excerpted from Florida Department of Economic Opportunity, "Adaptation Planning for Historic Resources," (2015).

Table 3: Continued

Adaptation planning component	*Adaptation planning subcomponent*	*Novel elements of adaption planning for historic resources*
Implementation Strategies	Survey Funding Options	In addition to resilience and hazard mitigation grants, there may be extra funding options applicable to historic preservation that can be used to adapt these properties.
	Integrate into Existing Plans	Pass a resolution and/or incorporate aspects of adaptation planning for historic properties in the comprehensive plan. Identify plans in the community that address historic preservation and consider incorporating aspects of adaptation planning in these plans.
	Create a Schedule of Activities	Determine who is responsible for each action and when the action might occur. Include considerations of the role of the historic property owner if the building is privately owned.
	Monitor and evaluate	Monitor the implementation process in addition to reassessing vulnerability in future years. Keep historic resource inventory up to date if changes are made to properties.

Communities may, thus, opt to develop a comprehensive adaptation plan for the entire jurisdiction, encompassing various types of resources, including historic properties. In such communities, adapting historical resources to mitigate the effects of sea level rise becomes part of the broader adaptation planning framework. These communities will likely seek to understand the integration of historic resources within their overall adaptation strategy. Alternatively, communities may prioritize the protection of historic resources as their primary focus in adaptation planning. In this case, specific guidance regarding the adaptation of historic resources will be necessary.[63] The historic and cultural resource considerations within each component and sub-component of the adaptation planning process are summarized in Table 3.

[63] Department of Economic Opportunity, *Adaptation Planning for Historic Properties*, 22.

Annapolis, Maryland: A Community-Based Approach at the Local Level

Annapolis is a historic city nestled along the shores of Chesapeake Bay, and Maryland's capital, with the only remaining wooden capitol building in the country. It, too, faces significant threats from sea level rise, endangering its invaluable historic resources. Located on the mid-Atlantic coast, the community faces some of the highest rates of sea level rise globally. It is highly vulnerable to other impacts, including storm surges and flooding during extreme weather events. Coastal flooding poses significant threats due to the low-lying topography combined with rising sea levels and land subsidence. The average number of nuisance flooding days increased from 3.8 days in 1957-1963 to 39.3 days between 2007-2013.[64] The city's proximity to the Chesapeake Bay and its numerous waterways increases its vulnerability, particularly of the historic buildings and structures, as prolonged exposure to floodwaters can lead to structural deterioration, erosion, and the loss of irreplaceable cultural heritage. The recurring nature of coastal flooding poses significant challenges to the city's resilience and long-term sustainability, necessitating adaptive measures to protect Annapolis and its historic resources from the adverse impacts of these flood events.

The Governor's Commission on Climate Change issued the Maryland Climate Action Plan in 2008, promoting state and local level legislative and policy actions to protect the built environment.[65] However, in the case of this historic city with a collection of 18th-, 19th-and 20th-century buildings that are a crucial socio-economic driver, it was imperative

[64] Lisa M. Craig and Leslee F. Keys, "A Tale of Two Cities: Annapolis and St. Augustine Balancing Preservation and Community Values in an Era of Rising Seas.," *Park Stewardship Forum* 36, no. 1 (January 2020): 64.

[65] Maryland Commission on Climate Change, *Climate Action Plan*, by Martin O'Malley, (Maryland, 2008).

to integrate cultural resources within the planning. Recognizing this need, the City of Annapolis began its efforts to update the city-wide Hazard Mitigation Plan to incorporate cultural resources by launching a coalition called "Weather it Together,"

The City of Annapolis undertook the effort with the help of funding from the National Trust for Historic Preservation, Preservation Maryland, the Maryland Historical Trust, and the Maryland Department of Natural Resources. While work on the plan began in 2013, it was completed in 2018. It incorporated an addendum to the Annapolis Natural Hazard Mitigation Plan (HMP) as Weather it Together: A Cultural Resource Hazard Mitigation Plan (CRHMP).[66] Based on the approach recommended by the Federal Emergency Management Agency's (FEMA) "how-to-guide," *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning (2005)* discussed earlier in this chapter, the CRHMP was the first city nationwide to successfully publish the first comprehensive cultural resource plan to address the threat of flooding to a historic coastal city. The document thus serves as a model community-based planning process for other historic coastal communities that are also threatened by the effects of Sea level rise and climate change. Within each phase prescribed by the FEMA guidance, the Planning Team undertook additional tasks to ensure community stakeholder engagement, as detailed below:

- Phase One- Organize Resources: In recognizing the limitations of resources, the Weather It Together Planning Team (the Team) focused all its efforts within the first phase on organizing resources and establishing partnerships to build a strong core team of experts and community stakeholders. By the end of this phase, the Team had

[66] City of Annapolis, *Weather it Together: A Cultural Resource Hazard Mitigation Plan (Annapolis, Maryland, 2018),* 41.

secured 45+ partners representing over 29 different organizations, including city and government agencies, historic preservation partners, sea level scientists, non-profit organizations, and businesses.[67] Representatives of the core team organizations would meet every month "to share best practices in hazard mitigation, provide essential data on sea level rise, review impact on natural and cultural resources, and explain the financial implications of flooding related to financing mitigation projects, flood insurance, and property valuation." [68] Along with exposure and engagement, the partnerships established also benefitted the program in securing funding and in-kind technical support. Some of the "Weather it Together" Core team organizations included the Office of Emergency Management, City Departments of Planning and Zoning, Public Works, Environmental Policy, Harbormaster, the National Trust for Historic Preservation, the Maryland Historical Trust, National Park Service, US/ICOMOS, the Union of Concerned Scientist, U.S. Army Corps of Engineers, the state departments of Environment, and Natural Resources, the Urban Land Institute, and several others.

- Phase Two- Assess Risks: With flooding in the study area already identified as the primary hazard for the mitigation plan, the Team discovered that the FEMA model could work for both short-term (flooding) and long-term (sea level rise) hazard planning when it comes to assessing properties for vulnerability. Thus, in this phase of the process, the focus was more on developing the inventory for historic properties and cultural resources assets. While technical, financial, and human resources were being mobilized in Phase 1, the Team already began undertaking

[67] City of Annapolis, *Weather it Together*, 48.
[68] Ibid.

surveys of structures within the study area that had not been intensively surveyed earlier. To complete the Historic Survey Inventory, the Planning team employed survey methods that combined the FEMA Worksheets and the Maryland Historic Property Inventory as well as the National Register of Historic Places format. This ensured an intensive level survey was completed on all pending properties, thus using the risk assessment analysis as an opportunity to update the local and state inventory.

The Team additionally collaborated with the core team partners and stakeholders to further carry out a more detailed survey, evaluation, and assessment using the available expertise. The U.S. Army Corps of Engineers Cultural Resources and Flood Management Teams conducted a Flood Elevation Survey, which is not a part of the FEMA "how-to" process. Having inspected every structure in the study area for flooding potential and exposure, they also developed a report that described model mitigation strategies for 16 prototype buildings within the study area, analyzing the pros and cons, including factors such as cost-benefit analysis, insurance rates, tax credits, etc.

Based on all the survey data and risk assessments, a geodatabase was developed that helped in identifying preservation priorities within the study area. With the lack of technical expertise within the Planning team, the GIS Mapping was carried out with the technical assistance of the City's Management and Information Technology Division. As a result of this exercise, 47 properties were identified as preservation priorities with a high community value.

- Phase Three- Develop a Mitigation Plan: In drafting the Mitigation Plan, The Planning Team ensured that priorities identified throughout the planning process were consistent with existing community planning documents, more specifically, the Annapolis Comprehensive Plan (2009). Following FEMA guidance, the Team crafted a list of problem statements based on the risk assessment findings under the five mitigation categories: prevention, property and resource protection, structural diversions, public education and awareness, and natural resource protection for historic landscape features and archaeological sites. Five goal statements were then developed for the CRHMP, drafted about formative policy and planning documents, including the Maryland Commission of Climate Change 2016 Annual Report, the 2016 Maryland Hazard Mitigation Plan, and the "Build Back Better" report by the United Nations Office for Disaster Risk Reduction:

    1) Implement a public awareness and engagement program.
    2) Lead building resilience efforts in flood adaptation and mitigation.
    3) Develop a disaster response and recovery plan to "build back better."
    4) Align land use, economic development, environmental and regulatory activities to protect the City's historic character and cultural and natural assets while promoting economic vitality.
    5) Fund public improvements and incentivize private investment for flooding adaptation.

  Based on these five goals, the Team drafted fifteen objectives to respond to each goal statement. It sought input from community members and public and private stakeholders to develop 48 action items for consideration by the Core Team. Those

action items were refined and categorized into nine project areas for implementation under the five goals and fifteen objectives. These served as the foundation for a series of 48 possible mitigation and adaptation actions, which were assessed against the 'Weather it Together' preservation hierarchy and the FEMA STAPLEE criteria. Draft amendments to the City's comprehensive plan, historic preservation ordinance, and the development of design guidelines for historic structures were also considered in this phase.

- Phase Four- Implement the Plan and Monitor Progress: While the City of Annapolis is finalizing the CRHMP, the implementation process has already begun. Following community participation events, private building owners in Annapolis began engaging with the historic preservation office to establish the best mitigation methods for their structures. The City of Annapolis' Department of Public Works and the United States Naval Academy have begun discussions with the United States Army Corps of Engineers on joint stormwater infrastructure replacement work, and the National Trust and the Maryland Historical Trust have brought the City of Annapolis into discussions with other communities to share the hazard mitigation planning methodology. It was also determined the Maryland Historical Trust, as the State Historic Preservation Office, would serve as the ultimate review authority for the CRHMP.

Conclusion

In conclusion, adaptation planning is a crucial process in proactively addressing the risks and challenges posed by climate change impacts. The increasing awareness of climate change and its evident impacts, including sea level rise, has led to a transition from awareness to planning and implementing actual adaptation strategies. Various international, governmental, and local organizations, along with scientific studies and climate activists, have contributed to a broadened understanding of climate change adaptation, resulting in an increase in adaptation responses and guidance for implementation. In the context of historic and cultural resources, the need to incorporate preservation considerations within adaptation planning have become increasingly apparent, especially in low-lying coastal communities. The Federal Emergency Management Agency (FEMA) and National Park Service (NPS) have played critical roles in providing guidance and tools for integrating cultural resource considerations into hazard mitigation and adaptation planning. FEMA's National Flood Insurance Program (NFIP) has also incentivized historic property owners by providing exemptions and subsidized flood insurance rates.

Case studies in Florida and Annapolis, Maryland showcase efforts to incorporate cultural resource considerations into adaptation planning at the state and local levels. Both locations have taken proactive steps to assess risks, develop mitigation plans, and engage with stakeholders to protect historic resources from the impacts of sea level rise and coastal flooding. Despite the progress, there is still limited guidance on specific adaptation strategies for historic resources. However, by studying and applying the existing planning documents and integrating historic preservation planning into broader adaptation

frameworks, local coastal communities can develop comprehensive plans to safeguard their cultural heritage and enhance their resilience to climate change.

The efforts by governments, agencies, and local communities in adaptation planning for historic resources are critical in ensuring the long-term sustainability and protection of cultural heritage in the face of climate change. As the impacts of climate change continue to evolve, ongoing research, collaboration, and adaptive management will be essential to effectively preserve and protect historic resources for future generations.

CHAPTER III

SALEM, MASSACHUSETTS

Introduction

The City of Salem, one of the oldest settlements along the northeastern Atlantic coast, is located in Essex County, Massachusetts, some sixteen miles north of Boston. With 11.2 miles of coastal frontage, three coastal rivers—North, South and Forest Rivers—define its territory, which settlers have continually manipulated to create more land area. Famous for the Salem witch trials and for its role in the maritime trade, Salem's unique identity and character are intricately tied to its historic resources that contribute directly to fostering tourism and generating economic benefits for a population of over 40,000. However, extreme precipitation events and severe storm surges have increased recently due to the impacts of climate change and sea level rise, with nor'easters, blizzards, hurricanes, thunderstorms, and tornadoes occurring more often. These hazards threaten the significant historic resources and with them the identity and livelihood of Salem. Having laid the basis for understanding sea level rise hazards and the current adopted adaptation practices for preservation in Chapters 1 and 2, this chapter focusses on Salem, Massachusetts to understand the current dynamics at play between historic preservation and climate adaptation planning and to identify opportunities to integrate both approaches.

The chapter first sets the context with a brief historical overview of the city, summarizing the developmental history along Salem's changing shoreline. Understanding the coastal evolution will serve as a crucial foundation for assessing the vulnerability of historic resources to contemporary climate-related hazards. It further reviews the current preservation legislation and designation framework, examining the laws, regulations, and

guidelines set forth to protect the city's historic and cultural resources. It also evaluates the existing adaptation planning and policies implemented in Salem. By understanding the city's current approaches to address climate change impacts, we can identify potential opportunities for integration with historic preservation initiatives.

Based on an exposure analysis conducted by the author, the chapter further pinpoints vulnerable areas and structures, noting the significance of each resource and the extent of plausible threats. Lastly, it delves further into the ongoing adaptation efforts by some of these historic sites at risk, which demonstrate promising collaboration between preservation and adaptation practices. Studying these initiatives provides valuable lessons and best practices for developing a holistic and collaborative approach. The chapter concludes with a review of the gaps within the existing preservation and policy planning framework in Salem, assessing their effectiveness in addressing climate hazards and their consideration of historic preservation, in context of the ongoing initiatives.

Historical Background

Salem traces its origins back to 1626 with the arrival of Roger Conant and a group of settlers who established a settlement on the Peninsula. Known initially as Naumkeag, derived from the Native American term for "fishing place," the earliest town founded in the Massachusetts Bay Colony was renamed Salem, derived from the Hebrew word for "peace." Capitalizing on its proximity to the sea, the community at Salem grew rather quickly into one of the leading maritime centers in the New World. By the early 1800s, Salem had become one of the critical mercantile ports in North America, trading across Europe, Asia, and the Far East. After the decline of trade in the mid-nineteenth century, the community in Salem transitioned into an industrial economy. It continued to diversify the local economic base by including manufacturing and retail. These developments, in turn, brought on major physical and social reforms in Salem. The disastrous fire of 1914 caused significant destruction to life and property; however, Salem was sustained as the region's major hub for "industry, business, education, law, and county government."[69]

The Salem peninsula is located at the southern base of Cape Ann, extending into the northern perimeter of Massachusetts Bay. The original landform, only two miles long and less than half a mile wide, was bound on the northwest and southeast by two wide tidal rivers and on the east by a deep harbor and sound. The North and South Rivers were wide coastal estuaries with extensive shallows and marsh, much of which was exposed at low tide and inundated at high tide. A muddy cove, today known as Collins Cove, divided the tip of the Peninsula. One prong extended northeast, and the other, the Salem Neck, extended

[69] Bryant Franklin Tolles, *Architecture in Salem: An Illustrated Guide* (Salem, Massachusetts.: Essex Institute, 1983), xv.

eastward into the harbor.[70] The Pawtucket tribe of Native Americans, often called the Naumkeags, were presumably the first inhabitants concentrated on the northeastern tip of the Peninsula. The mouths of the North and South Rivers and other coastal locations and areas adjacent to Salem's interior wetlands would likely have been locations for villages and habitations, agricultural fields, seasonal hunting, fishing, food gathering activities, and human burials.[71]

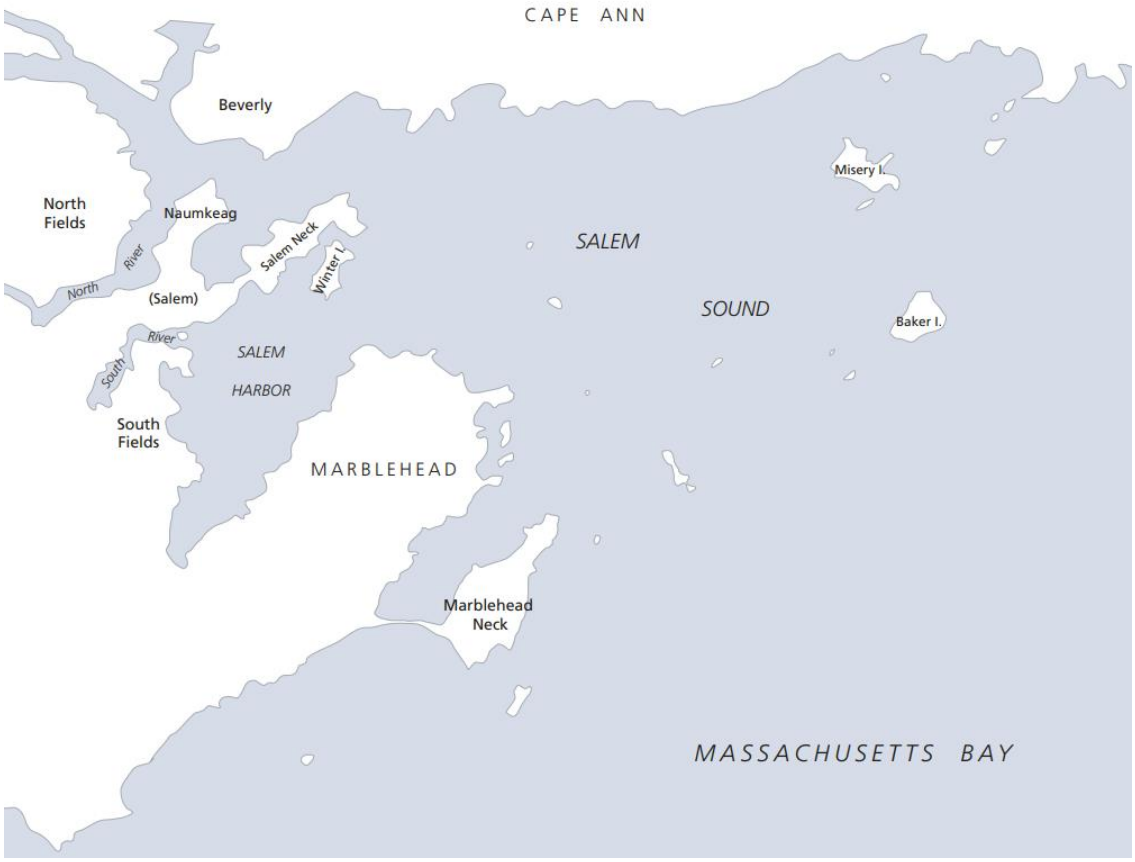

Figure 8: Map showing geographical names associated with the European Settlement in 1626. *Source: Olmstead Center for Landscape Preservation (2017).*

[70] Olmstead Center for Landscape Preservation, *Cultural Landscape Report for Salem Maritime National Historic Site: Salem, Massachusetts*, by John W. Hammond et al. (Boston, 2017), 10.

[71] Department of Planning and Community Development, *City of Salem Historic Preservation Plan Update*, by Communities Opportunities Group, Inc., (Salem, Massachusetts, 2015), 18, https://www.cityofmadison.com/dpced/planning/documents/Salem.pdf.

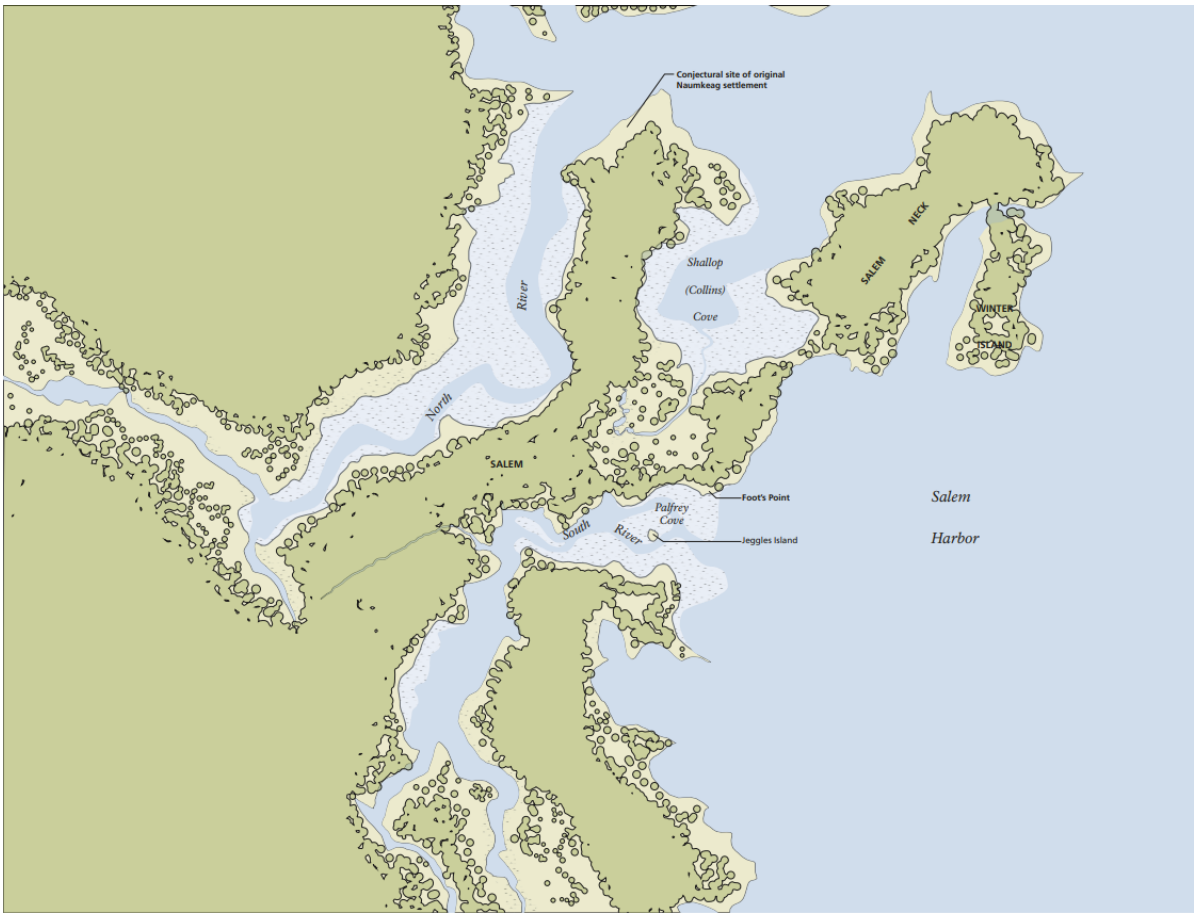

Figure 9: Plan conjecturing the 1626 period conditions within the regional context of Salem. *Source: Olmstead Center for Landscape Preservation (2017).*

In 1626, the first Europeans arrived in Salem when Roger Conant and his associates from England's Dorchester Company established a settlement at the mouth of the Naumkeag River. Two years later, a second party of European settlers from the Massachusetts Bay Colony under the command of Captain John Endecott arrived. During that time, the colony of Salem covered most of the land area now known as the North Shore. The settlements were concentrated along the waterfront and Salem Village, now part of Danvers.[72] With much of the population engaged in farming, fishing, and various maritime trades, the town's central core developed along Townhouse Street (now Washington Street) and Main Street

[72] T. F. Hunt and H. M. Batchelder, *Visitors' Guide to Salem*, 69Th Thousand (Salem, Massachusetts: The Essex Institute, 1937), 5–7; Department of Planning and Community Development, *Historic Preservation Plan Update*, 18.

(now Essex Street). Townhouse Street spanned the shortest distance between the North and South Rivers, housing the important civic buildings. At the same time, Main Street ran across the length of the peninsula up to Salem Neck, with the mansions of all the wealthy residents lined on either side.[73]

Figure 10: Image showing the site of the Old Planters Settlement in 1626.
Source: The History of Salem, Volume 1, 1626-1637

During the Colonial period, the town began dividing portions of its common lands while reserving some land for perpetual use, such as the military training grounds of the Salem Common and the fishing grounds of Winter Island.[74] "For many years, Salem's waterfront areas remained largely undeveloped, as the near-shore waters of the peninsula were too shallow for large ships to dock." [75] Within the town, the center of maritime activity was a small stretch of waterfront on the South River at the south end of the town center. "By the turn of the eighteenth century, this area became the principal waterfront, with buttresses built to bank the steep end of the peninsula and create small wharves." [76] Salem's important

[73] Olmstead Center for Landscape Preservation, *Cultural Landscape Report*, 32.
[74] Department of Planning and Community Development, *Historic Preservation Plan Update*, 19.
[75] Olmstead Center for Landscape Preservation, *Cultural Landscape Report*, 33.
[76] Olmstead Center for Landscape Preservation, *Cultural Landscape Report*, 33.

role in the Atlantic trade network fueled the rise of a wealthy merchant class and the development of Salem's waterfront, where wharves, warehouses, and residences were constructed. By the mid-1700s, wharves started extending from the shoreline along this concentrated stretch that emerged as Salem's central waterfront called Wharf Street or Front Street.[77]

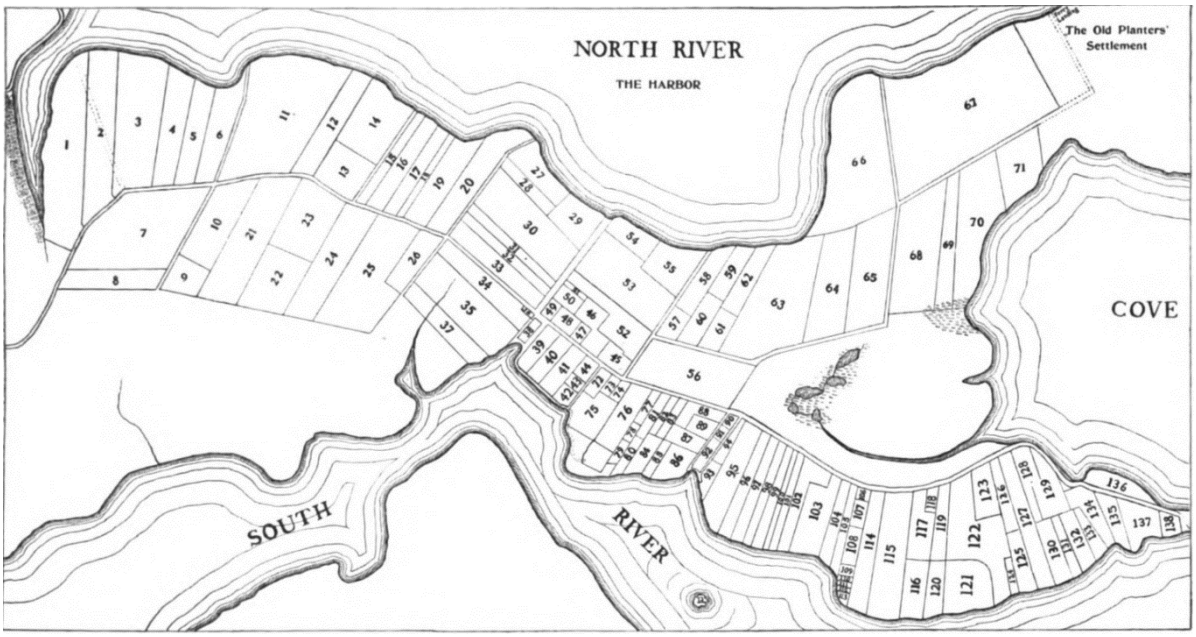

Figure 11: Parcel Map of Salem Town Settlement in 1660 depicted by Historian Sidney Perley.
Source: The History of Salem, Volume 1, 1626-1637.

Salem gained prominence during the 18th century, eventually cementing its position as the nation's principal port during the Revolutionary War. Salem remained open when the British closed the larger ports of Boston and New York during the Revolutionary War, and local ship owners converted their fleets into privateering ships that ultimately brought in enormous profits. Following the war, Salem's merchants started to broaden their international trade with countries including Europe, the West Indies, Africa, Russia, and

[77] Ibid., 51.

China. This led to such immense wealth and success that Salem surpassed other communities in terms of per capita wealth in the newly founded United States of America.

This prosperity led to substantial development of infrastructure, including new homes, civic, religious, and industrial structures, as well as new roads and bridges connecting the north and south parts of the town, which allowed for the expansion of residential construction outside of the core area. Along Chestnut Street and the newly constructed Common, Salem's affluent merchants built houses in the fashionable neo-classical architectural style of the Federal era. The most prominent architect and woodworker in Salem during the period, Samuel McIntire, designed many of the largest Federal-style homes in the neighborhood.

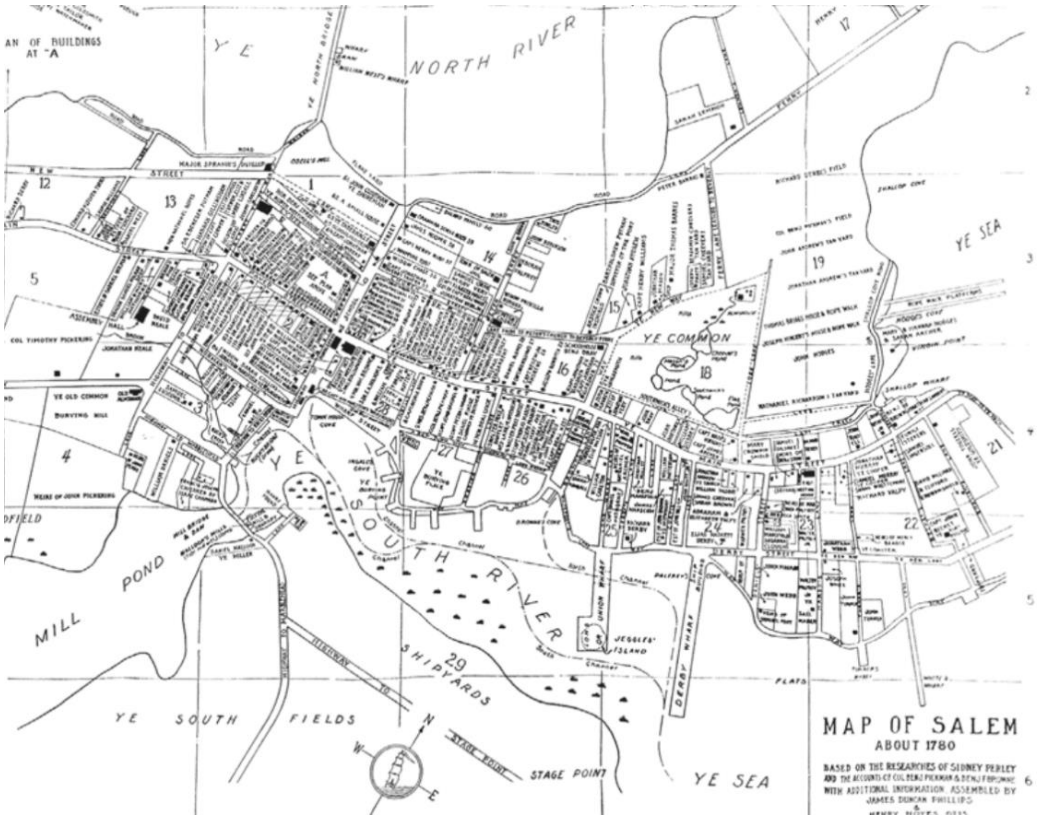

Figure 12: Portion of the Map of the City of Salem about 1780 by Henry Noyes Otis.
Source: Olmstead Center for Landscape Preservation (2017).

Figure 13: Illustrations depicting early examples of Salem's domestic architecture: top left, Roger Williams House (1634); right, Simon Bradstreet House (c.a.1650); bottom left, Pickman House (1750); right, Elias Derby Hasket House (1799).
Source: An Historical Sketch of Salem, 1879

Salem continued to develop as a leading maritime center in the New World, with fishing, commerce, and related trades dominating the community's economic base. Consequently, it became one of the chief shipbuilding areas in the colonies, with most of its population directly or indirectly employed in the industry. There were a few small shipbuilding and repair yards near the wharves, but most shipbuilders needed a larger space and were situated along the North River and on the peninsula toward Salem Neck. To finish

and outfit the ships, numerous skilled craftspeople were required, and they established their workshops along the waterfront near the shipbuilding yards or on the central waterfront. [78]

After the Revolutionary War, however, the modest infrastructure of the shipbuilding sector had developed into vital waterfront areas teeming with businesses that kept it afloat. From the mill dam to the mouth of the South River, the shoreline was congested with wharves and warehouses. While the larger wharves were large enough to accommodate warehouses on the wharves themselves, the smaller wharves were across the street from the warehouses on the central waterfront. "Counting houses, banks, offices, stores, inns and other businesses that service the commerce of trade, as well as the residences of ship owners, captains, and mariners were clustered near the waterfront area between Main Street and the South River."[79] The South River's curve retained deep water near the coast and made it possible to build short, broad wharves. These shorter wharves stretched into Browne Cove and around Burial Point. Beyond it was a new kind of wharf that reached several hundred feet into the river to access the deeper waters and hold more ships simultaneously. The length of Union Wharf from the bottom of Union Street to Jeggles Island was roughly 600 feet. By this time, Derby Wharf, which was 800 feet long, was constructed to the east of Union Wharf.[80]

By the mid-1800s, the economic engine of Salem had already shown signs of a dramatic shift from maritime trade to industry that left the waterfront area as a shadow of its former self. The development of the railroad system reduced the demand for coastal maritime trade even more. The area's expanding industry needed raw resources. So, instead

[78] Olmstead Center for Landscape Preservation, *Cultural Landscape Report*, 51.
[79] Ibid., 53.
[80] Ibid.

of storing exotic commodities, waterfront warehouses began stockpiling stone, coal, timber, and other inexpensive, high-bulk materials.

Figure 14: The South River portion of the Map of the City of Salem by Henry McIntyre, 1851.
Source: Norman B. Leventhal Map Center, Boston Public Library.

As manufacturing rose in New England towns, Salem's first factories produced textiles, shoes, and leather. Maritime merchants founded the Naumkeag Steam Cotton Company, built at Stage Point, south of the South River and west of the southern end of Derby Wharf. As Salem's industrial development continued to expand, significant numbers of immigrants came to Salem seeking factory employment. Most immigrants were Irish Roman Catholics; other immigrant groups included French Canadians, English, Swedish, Scottish immigrants, and others from Eastern Europe. Soon, high-density ethnic neighborhoods dominated the waterfront areas previously occupied by maritime life and trade, including Stage Point and Derby Street. Former agricultural and summer estate areas were also converted into year-round residential neighborhoods.

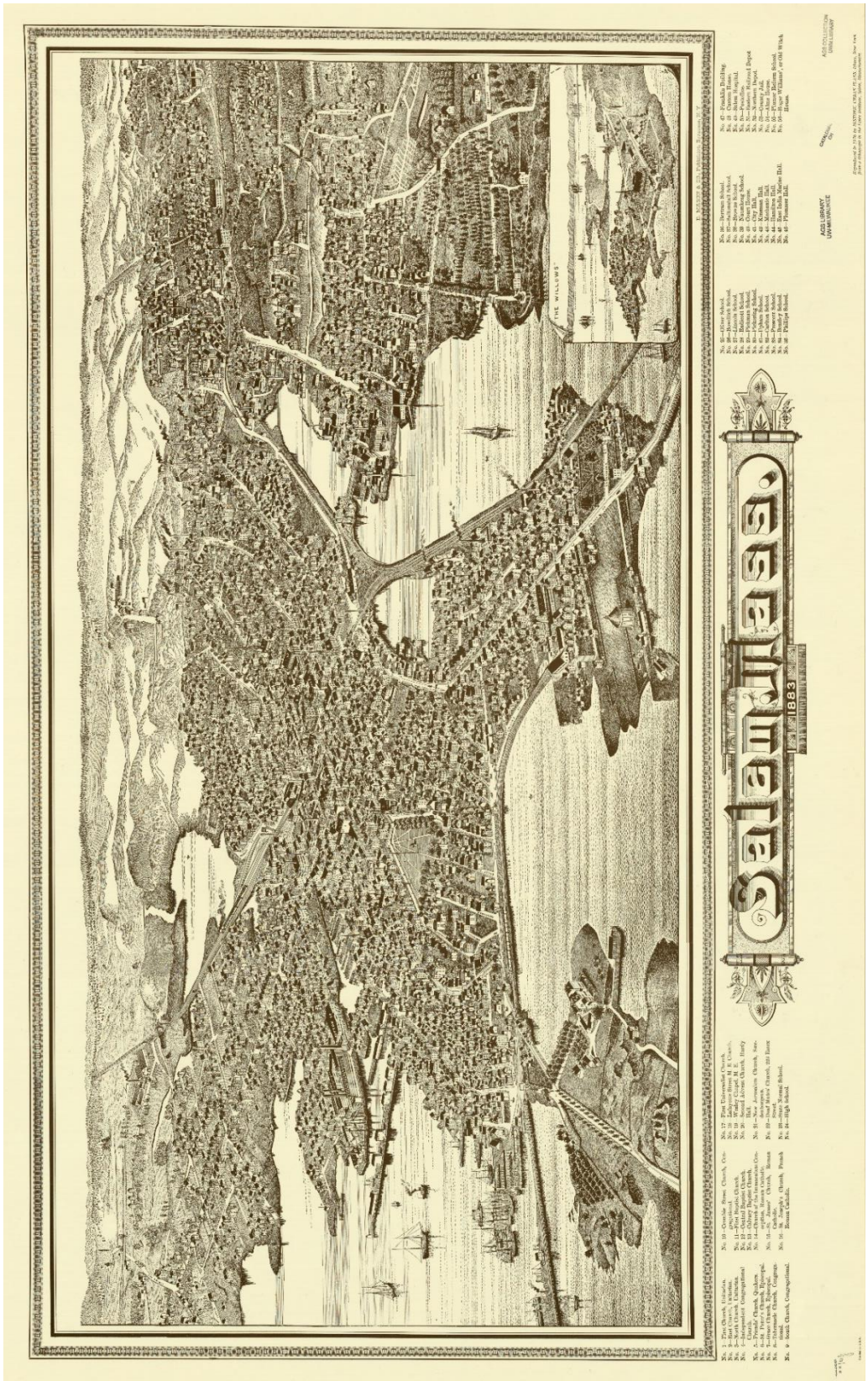

Figure 15: 1883 Bird's Eye View map of Salem, Massachusetts by J. Lyth.
Source: State Library of Massachusetts

There was perhaps no event with a more significant impact on the landscape of Salem than the Great Fire of 1914. Salem was devastated by a fire that swept through the city, destroying much of the city's waterfront area, including the Naumkeag Mills and other factory facilities on Stage Point. While the fire spared Derby Wharf and the U.S. Customs House, it reached Central Wharf, burning down over two hundred fifty-six acres of the city, 1,800 buildings, homes, and factories and leaving over 15,000 people homeless.[81]

Figure 16: Image showing an aerial view of Stage point after the Salem Fire of 1914.
Source: Leslie Jones Collection, Boston Public Library.

[81] *Historic Preservation Plan Update*, 22.

The Salem Rebuilding Commission (SRC) was appointed and given significant authority to supervise public building and roadway construction, take land by eminent domain, grant building permits, and create new building regulations. A set of building construction regulations based on building size and usage was developed by the SRC in its "Regulations for the Erection of Buildings within the Burned District of the City of Salem" document. By 1917, more than 65% of the destroyed neighborhood had been rebuilt, and the new structures were thought to be much better built than the old ones.[82] Brick apartment buildings gained prominence around this time, especially in the Point Neighborhood, which today contains the city's most impressive Classical Revival-style brick apartment buildings.

The destruction caused by the fire and rebuilding efforts further provoked conversations on the preservation of Salem's buildings of the Age of Sail, with organizations such as the Peabody Museum of Salem and The Essex Historical Society that gathered literary, historical, and scientific information and artifacts of Salem's maritime history. Many other preservation organizations also emerged at the beginning of the twentieth century, which sought to restore the exemplary example of Colonial and Federal houses. In 1938, Derby Wharf and the surrounding area were designated the nation's first National Historic Site.[83]

Preservation Legislation and Planning Framework

Under the provisions of the NHPA of 1966, the City of Salem has a total of 1848 historic resources in Salem listed on the National Register of Historic Places – the official federal registry of historical and cultural resources administered by the National Park

[82] *Historic Preservation Plan Update*, 22.
[83] Olmstead Center for Landscape Preservation, *Cultural Landscape Report*, 84–85.

Service.[84] The designation process for the National Register calls for a historic resource to be any of the five types, i.e., building, structure, object, site, or district. The resource should meet certain criteria and undergo a formal nomination and evaluation process to be listed on the National Register. Further, under Section 106 of the NHPA, federal agencies are required to review the impacts of their undertakings on the resources listed. Salem, to date, has 88 individual properties and 23 districts listed on the National Register. Additionally, the City has ten properties with 46 resources designated National Historic Landmarks (NHL) by the Secretary of the Interior.[85] NHL is a special designation assigned to nationally significant historic places with exceptional value or quality in interpreting national history over a particular state or locality. Fewer than 2,500 historic places in the United States have been honored with this designation.[86]

The Massachusetts Historical Commission (MHC) serves as the office of the State Historic Preservation Officer (SHPO) and is thus responsible for the administration of the National Register of Historic Places in Massachusetts, federal and state regulatory review, the federal and state historic tax credits and the certified local government program. The MHC also maintains the Inventory of Historic and Archaeological Assets of the Commonwealth, a comprehensive record of over 2000 historic properties designated under federal or local legislation. These include the individual properties and districts listed on the National Register, those determined to be eligible for designation, National Historic Landmarks, local historic districts, and those protected by preservation restrictions. The list,

[84] "MACRIS: Massachusetts Cultural Resource Information System," Massachusetts Historical Commission, accessed June 25, 2023, https://mhc-macris.net/.

[85] "MACRIS."

[86] Sara C. Bronin and Ryan Rowberry, *Historic Preservation Law in a Nutshell*, Second Edition, Nutshell Series (St. Paul, MN: West Academic Publishing, 2018), 40.

published annually by the MHC, protects properties from potentially adverse State actions. Any project seeking funding, licenses, or permits from a state agency is subject to review in compliance with M.G.L. ch.9, §§ 26-27 C as amended by 254 Stat. 1988, ch.254. The MHC also established the Massachusetts Historic Landmarks (MA/HL) as a voluntary program that engaged historic property owners to protect their significant properties as certified State landmarks. Property owners with MA/HL-certified historic properties follow the established Standards for Care and Management "under which they are required to maintain the historically significant architectural features of their property and to seek the prior review and approval of the Massachusetts Historical Commission before undertaking any major alterations." All MA/HL certified are also included in the State Register. The MACRIS database lists 46 historic properties in Salem as certified Massachusetts Historic Landmarks.

State law also identifies preservation restrictions as an additional layer of protection for historic resources. Like a conservation restriction, preservation restrictions consist of a recorded legal agreement between the property owner and a qualified non-profit or governmental organization to maintain identified architectural features of a historic building or structure. The organization that holds the restriction is responsible for monitoring the property and approving any proposed changes to the portions of the building included in the restriction. As per the MACRIS database, 45 properties in Salem are currently protected by preservation restrictions under M.G.L. ch.184, §§ 31-33.

Massachusetts State Historic Preservation Plan (2018-2022)

As the State Historic Preservation Office, the MHC takes the lead in preparing the five-year state historic preservation plan. While a draft for the 2023-2031 Plan has been recently released for public input, the state currently follows the Massachusetts State

Historic Preservation Plan 2018-2022.[87] The current plan thus gives an overview of the MHC and its partner organizations, reviews earlier plans, and includes a timeline of significant historical events in the Commonwealth. It also discusses opportunities and issues unique to Massachusetts in the field of historic preservation such as the insufficient survey, documentation, and updates at the local level of legislation, limited funding opportunities, lack of preservation education for homeowners, and the threats posed by climate change and sea-level rise. The Plan also lists several goals, each with corresponding objectives –one of which directly pertains to the protection of "historic resources from climate change, natural disasters, and human-made disasters" with the following: [88]

1. Encourage vulnerability modeling, planning, policies, infrastructure, and regulations that will help protect significant historic resources from climate change, natural disasters, and human made disasters.
2. Encourage owners of historic and archaeological resources to engage in disaster preparedness planning.
3. Promote coordination and communication regarding disaster-planning best practices between cultural resources stewards and emergency-management agencies.

[87] "MHC Seeking Public Input for the State Historic Preservation Plan 2023-2031," Massachusetts Historical Commission, accessed July 15, 2023, https://www.sec.state.ma.us/mhc/mhcpublicinput/publicinputidx.htm.

[88] Massachusetts Historical Commission (MHC), *Massachusetts State Historic Preservation Plan 2018-2022*, by Christopher C. Kelly, (Boston, 2018), 4-5.

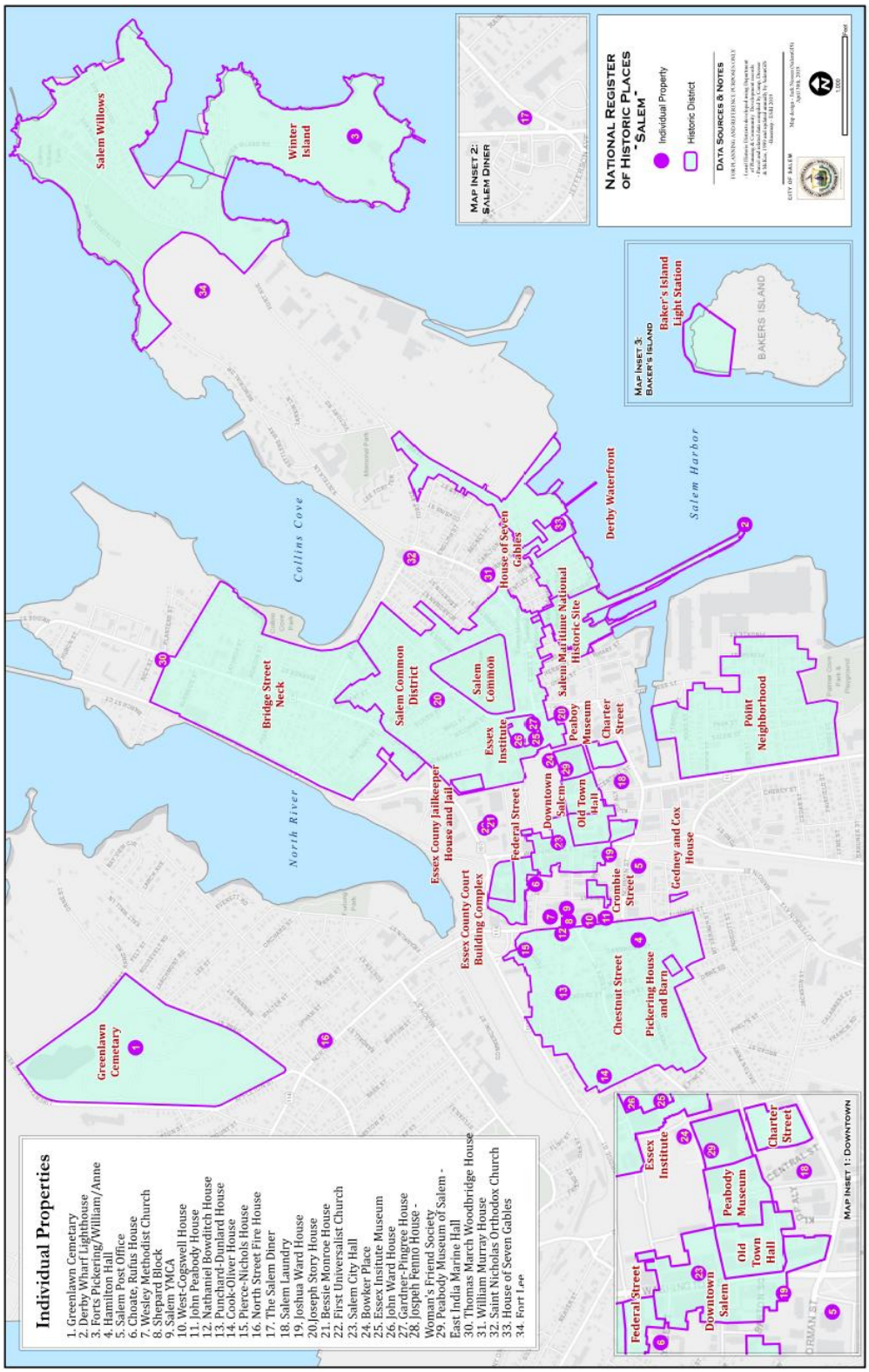

Figure 17: Map showing individual properties and districts listed on the National Register of Historic Places.
Source: City of Salem (2019).

At the local level, the City of Salem adopted the Historical Commission and Historic Districts Ordinance in 1971 under M.G.L Chapter 40C through a local City Ordinance 19-63, Article IV – *Historical Commission and Historic Districts,* known as the Historic Districts Act. This enabled the designation of the first local historic district in Salem. As of today, The City of Salem has over 650 resources designated within four local historic districts including the Derby Street Historic District, Lafayette Street Historic District, McIntire Historic District and the Washington Square Historic District.[89] From waterfront homes built by maritime workers, and the domestic architecture from the 18th and 19th centuries, to the eclectic mash-up of revival styles that parallel national trends, these local historic districts showcase a range of historic resources that have been part of Salem's development. "Buildings within a district may lack individual distinction yet contribute to a district's collective significance."[90]

Under the Ordinance, the Salem Historical Commission (SHC) is appointed with authority to regulate changes to buildings and structures located within a local historic district, visible from the public right-of-way through a public design review and approval process. The SHC currently has a board of 10 appointed commissioners and is supported by a Preservation Planner who serves full-time as staff in the Department of Planning and Community Development (DPCD). Administered by the DPCD, every project proposing alterations, additions, or new construction to a building within a historic district, visible from the public right-of-way, must obtain approval through the issuance of a Certificate of Non-Applicability, Certificate of Appropriateness, or Certificate of Hardship. Undertaking

[89] "MACRIS: Massachusetts Cultural Resource Information System."

[90] Salem Historical Commission, *Salem Historical Commission Guidelines Notebook*, by Lisa Easton, (Salem, Massachusetts, 2022), 33.

work without approval can result in project delays and possible violations.[91] The Ordinance is supported by the adopted local Historic Preservation Plan and the design review guidelines in its Guidelines Notebook to achieve the City's preservation goals.

City of Salem Historic Preservation Plan Update (2015)

The 2015 Plan *Update* to the 1991 Historic Preservation Plan serves as an educational tool and guidance document to inform preservation efforts undertaken by the City and private owners. The Plan is created as a guide that compiles all information about preservation practices in the City of Salem that would inform public and private efforts. It thus includes an overview of the City's history, preservation timeline, existing legislation and policy framework, historic resources inventory, and preservation partners.[92] Additionally, it lists the opportunities and issues affecting Salem's historic resources and community character. It drafts an Action Plan that identifies priority recommendations, implementation responsibility, and timelines for each. This section of the Plan also highlights the challenge of planning for natural disasters and climate change impacts and makes the following recommendations to meet the City's preservation goals: [93]

- Implement recommendations set forth in the City's 2015 Climate Change Report.
- Work with preservation partners to identify historic resources at risk from climate change, including City-owned resources and resources at Bakers Island, the Salem Maritime Site, and the House of Seven Gables.
- Commission a planning study focusing specifically on Salem's historic resources most at risk from rising sea levels.

[91] Historic Districts Act, *Massachusetts General Laws,* Chapter 40 C.
[92] *Historic Preservation Plan Update*, 1.
[93] *Historic Preservation Plan Update*, 130.

- Continue to participate in COSTEP MA and support efforts of the Local Cultural Triage Officer to prepare and respond to emergencies. DPCD/SHC staff should work with Local Officer to coordinate City staff involvement in COSTEP.
- Review recent emergency responses to identify needed changes in protocol.
- Include a discussion of natural disaster planning at the preservation partner's meeting and consider hosting a regional forum on climate change and natural disaster planning for historic resources.

Salem Historical Commission Guidelines Notebook (2022)[94]

Most recently, the City of Salem released the Salem Historical Commission Guidelines Notebook, which guides preservation treatments for historic buildings based on the Secretary of Interior's Standards for Treatment of Historic Properties. It serves as a principal resource to the SHC, property owners, and other municipal review boards undertaking additions, alterations, rehabilitation, or reconstruction of buildings and structures within the local historic districts. With the help of diagrams, maps, and photos, the updated notebook clearly illustrates Salem's most common architectural styles and the appropriate design principles and best practices in preserving each architectural element.

The 2022 guidelines provide recommendations on sustainable building practices in preservation, including sustainable alternative materials and reusing historic materials. However, this update does not include adaptation and flood-proofing strategies that can be adopted to protect historic buildings.

[94] Salem Historical Commission, *Salem Historical Commission Guidelines Notebook*.

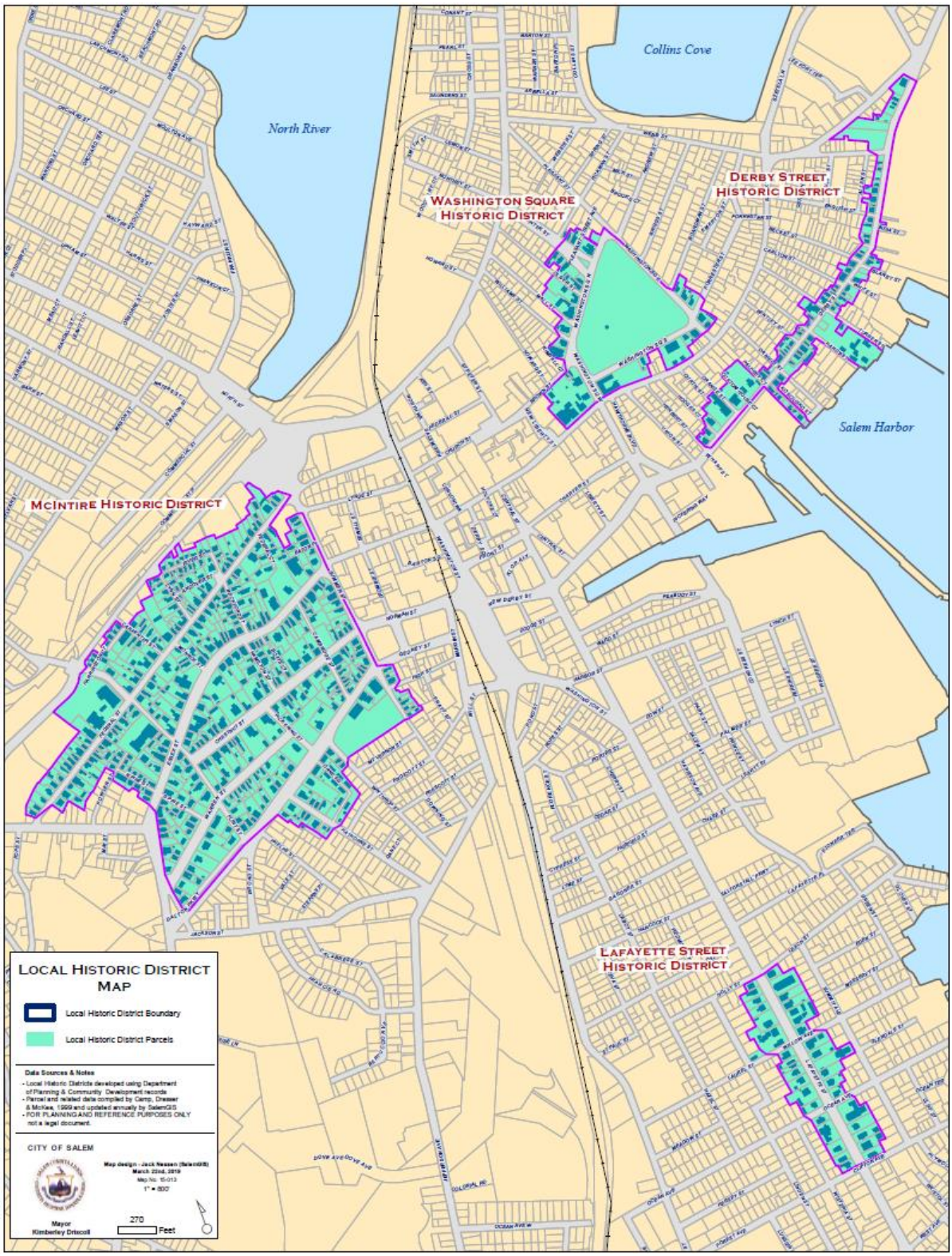

Figure 18: Map showing Salem's local historic districts.
Source: City of Salem (2019).

The City of Salem also adopted a *Demolition Delay Ordinance* in 1986 that allows the Commission to review demolition applications for a "significant building" to determine at a public hearing if it is to be "preferably preserved." Salem's demolition delay regulations are included within Article IX – Public Property under Section 2 -1572, "Review Process for granting demolition permits for historic buildings or structures," and were most recently updated in 2021. Under the ordinance, a "significant building" qualifying for an SHC review should be 50 years or older and should be determined to satisfy any one of the criteria prescribed by the ordinance. If the Commission determines that the building should be "preferably preserved" in a review, a delay period of 12 months (for buildings 50- 99 years of age) or 18 months (for buildings 100+ years old) from the closing date of the public hearing is imposed. During this period, no demolition or building permit may be issued without the Commission's approval. Therefore, the ordinance's purpose is not to permanently prevent demolition but to ensure that all preservation solutions for properties threatened with demolition have been explored.[95]

Existing Climate Adaptation Planning and Policies

Massachusetts has supported risk reduction efforts from natural and man-made hazards since the first FEMA-approved statewide Hazard Mitigation Plan in 1986. Mitigation efforts have endorsed the development and integration of state laws, policies, and programs and the support of non-government, private, and non-profit organizations. Building on previous mitigation efforts, Governor Charlie Baker signed Executive Order 569, Establishing an Integrated Climate Change Strategy for the Commonwealth, in

[95] Salem Historical Commission, *Salem Historical Commission Guidelines Notebook*, 15.

September 2016. The Executive order lays out comprehensive approaches to reduce greenhouse gases, assess vulnerability to climate change impacts, and adopt strategies to build resiliency and integrate climate change adaptation into state and local legislation. It directs the Executive Office of Energy and Environmental Affairs (EOEEA) and the Executive Office of Public Safety and Security (EOPSS) to develop, publish and implement a Climate Change Adaptation Plan that serves as the framework for assessing vulnerability, building resiliency, and mitigating climate change. Additionally, it stated that every Executive Office would designate a Climate Change Coordinator to undertake vulnerability assessments for each office and assist with implementing adaptation efforts across the State government.

State Hazard Mitigation and Climate Adaptation Plan (2018)

Following the Executive Order's framework, the Commonwealth published the 2018 State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) in an effort managed by the EOEEA, EOPSS, and the Massachusetts Emergency Management Agency (MEMA). A first-of-its-kind, the statewide Plan integrated climate adaptation into the existing hazard mitigation plan. It expanded upon the previous Plan of the 2011 Massachusetts Climate Change Adaptation Report while serving as an update to the Commonwealth's 2013 State Hazard Mitigation Plan. The development of the SHMCAP was also a requirement for eligibility to receive the non-emergency Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) assistance and Federal Emergency Management Agency

(FEMA) mitigation grants, including the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM) Grant, and the Flood Mitigation Assistance (FMA).[96]

A project team of technical specialists from several key state agencies assembled to prepare the Plan based on an integrated strategy that would "identify climate change impacts, describe the effect climate change is anticipated to have on natural hazards, and prepare an integrated strategy to understand and mitigate risks."[97] The SHMCAP is structured around four climate change impacts, namely, changes in precipitation, sea level rise, rising temperatures, and extreme weather, which are further linked to 14 natural hazards. These include inland flooding, coastal flooding, drought, landslide, coastal erosion, tsunami, average and extreme temperatures, wildfire, invasive species, hurricanes and tropical storms, severe winter storms/ nor'easters, tornadoes, severe weather, and earthquakes. The mission is to "reduce the statewide loss of life and protect natural resources, property, infrastructure, public health, and the economy from natural hazards and climate change impacts through the development of a comprehensive and integrated hazard mitigation and climate adaptation program."[98] The SCHMAP process is guided by five main goals:[99]

1. Integrate Programs and build institutional capacity.
2. Develop forward-looking policies, plans, and regulations.
3. Develop risk reduction strategies for current and future conditions.
4. Invest in performance-based solutions.
5. Increase education, awareness, and incentives to act.

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[96] Executive Office of Energy and Environmental Affairs (EOEEA), Executive Office of Public Safety and Security (EOPSS), Massachusetts Emergency Management Agency (MEMA), *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, (Boston, 2018), 1.2-1.4.

[97] *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, 1–7.

[98] *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, 13.

[99] *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, 7–2.

The SHMCAP further enlists a series of prioritized climate adaptation and mitigation actions developed by the Executive Offices and agencies of the Commonwealth as part of the planning process. A significant focus of the Plan was the analysis of the state's capability and adaptive capacity, which placed additional emphasis on integrating the Commonwealth's past and current efforts into the updated Plan. However, in assessing the risks based on its effects on five main sectors – populations, government, built environment, natural resources, and environment and economy, the Plan fails to prioritize the vulnerabilities of historic and cultural resources to prescribe specific actions involving the Massachusetts Historical Commission or other statewide cultural resource management agencies. The Plan only identifies the risk of coastal flooding due to sea level rise to cultural resources at a high-level stating –

> Historical and archeological sites within current and future coastal flood zones are vulnerable to sea level rise. Colonial and Native American cemeteries located on the Boston Harbor Islands are already impacted by erosion. Revolutionary War and other historic sites in Boston, such as the Charleston Navy Yard and Faneuil Hall, are vulnerable to flooding.[100]

Massachusetts Climate Change Assessment (2022)

The first five-year update of the SHMCAP is anticipated to be released in the Fall of 2023. As a part of this effort, the *Massachusetts Climate Change Assessment* was published in 2022 and will serve as a core component of the 2023 update as the detailed hazard risk assessment. The 2022 Climate Assessment aligns with the methodology of the 2018 SHMCAP in evaluating climate impacts for five primary sectors: Human, Infrastructure, Natural Environment, Governance, and Economy. However, 37 climate "impacts" were identified and prioritized for this assessment based on the most recent climate data,

[100] *Massachusetts State Hazard Mitigation and Climate Adaptation Plan*, 4–108.

projections, and stakeholder input.[101] Broadening the scope of the assessment, the 2022 MA Climate Change Assessment aims to answer the following questions for each impact:

- How big of a climate effect will this have?
- Will populations living in environmental justice areas be disproportionally affected?
- Are we currently doing enough to adapt to this impact?

Accordingly, each impact is assigned an "urgency score" at a state and regional level to guide decision-making related to adaptation actions.

The assessment results are summarized statewide and for seven different "Climate Assessment regions" grouped by identifying existing jurisdictions and planning regions facing similar climate change challenges. The city of Salem falls under the "North and South Shores" region, in which "Damage to Coastal Buildings and Ports from sea level rise and storm surge, coastal erosion, and high winds" is identified as one of the "high priority" impacts under the infrastructure sector. Additionally, "tourism related to vulnerable historical landmarks" is also identified as an impact with "medium priority" under the Economy sector. While the assessment addresses the physical implications of sea level rise to historic and cultural resources, it fails to recognize the cultural value of the assets as historic designated structures that are most impacted.[102]

[101] Executive Office of Energy and Environmental Affairs (EOEEA), Executive Office of Public Safety and Security (EOPSS), *2022 Massachusetts Climate Change Assessment: Volume I- Executive Summary*, (Boston, 2022), ES1.

[102] Executive Office of Energy and Environmental Affairs (EOEEA), Executive Office of Public Safety and Security (EOPSS), *2022 Massachusetts Climate Change Assessment: Volume III- Regional Reports*, (Boston, 2022), RS72.

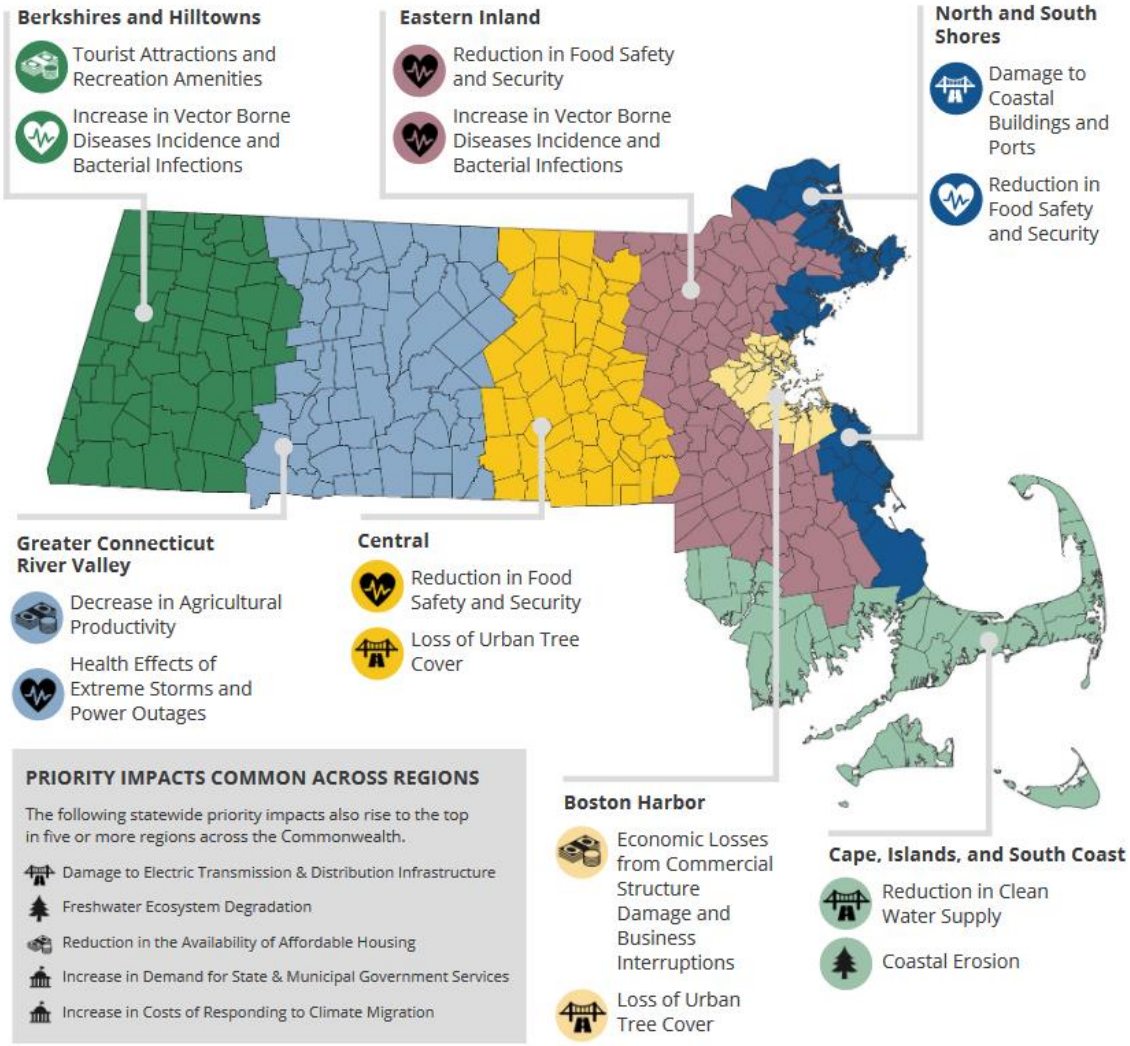

Figure 19: The seven regions identified in the 2022 Massachusetts Climate Assessment highlighting the selected unique impact within every region.
Source: Massachusetts Climate Assessment, Volume III (2022)

2030	2050	2070	2090
NEAR TERM	MID-CENTURY	MID-LATE CENTURY	END OF CENTURY
The summer mean temperature could increase by 3.6°F from the historical period (1950-2013), causing impacts to local agriculture.	Area affected by a 5 percent annual chance of a foot or more of coastal flooding increases by nearly two times compared to current area.	Sea surface temperatures could increase by 5°F, reducing marine fish catch and increasing risks from harmful bacterial infections.	Tropical cyclone frequency in the coastal New England region could increase by nearly 50 percent, leading to damage from storm surge, heavy rainfall, and high winds.

Figure 20: Key findings of the climate change projections that may be important for the North and South shore region over the 21st century.
Source: 2022 Massachusetts Climate Change Assessment Report.

Other state programs that tackle climate adaptation and hazard mitigation include the Municipal Vulnerability Preparedness (MVP). In support of Executive Order 569, the MVP was also launched in 2017 to assist local governments in the Commonwealth with funding to carry out vulnerability assessments and develop action plans to improve resiliency to climate change. Communities that complete the MVP Planning Grant process are listed as MVP Communities and are eligible for MVP Action Grant money to carry out the prioritized activities specified during the planning phase. In the first year, more than $1 million in MVP planning grants were awarded to 71 towns and cities across the state. The Commonwealth also established the Resilient Massachusetts Action Team (RMAT), which includes representatives from each Secretariat and key state agencies tasked with specific responsibilities to implement the SHMCAP and maintain the planning progress. ResileintMA.org, the Massachusetts climate change clearinghouse, has also been set up and maintained by the EOEEA, which provides local planners and decision-makers access to climate data projections, risk maps, featured websites, design tools, and documents relevant to climate change adaptation and mitigation across the state. Additionally, several other state-vide initiatives – the Silver Jackets Program, Floodplain Management Initiatives, National Flood Insurance Program, and more – establish key federal-state partnerships to support state and local climate change and hazard mitigation efforts.

The Commonwealth's Coastal Zone Management (CZM), the lead policy, planning, and technical assistance agency on coastal issues in EOEEA, also assists state, regional, and local climate adaptation actions. As a part of the agency's mission and program, the CZM has several grants, including the StormSmart Coasts Program and the Coastal Resilience Grant Program, to fund community-driven efforts that address the risks of coastal erosion,

storm damage, flooding, and related issues. The CZM also provides several tools and guidance to guide local planning efforts, including the online map viewer to help coastal communities assess local vulnerabilities and risks from climate hazards and several other guidance documents, such as the Increasing Resilience through Application of Nature-Based Infrastructure document.

At the local level, The City of Salem is in the process of implementing several policies and projects that contribute to adapting Salem to the impacts of climate change and build resiliency. This includes policy amendments such as the Wetlands Ordinance which was recently enacted into the local ordinance as well as infrastructural updates and studies carried out along the waterfront in areas such as Collins Cove, Salem Willows, Palmers Cove and Harmony Grove. The efforts are spearheaded by the Department of Sustainability and Resiliency (DSR) who are either involved directly managing programs and projects or coordinating with other Departments and local organizations. The City has also established a Sustainability, Energy and Resiliency Committee (SERC) that provides guidance and review on resiliency initiatives by municipal operations.

Ready for Tomorrow: The City of Salem Climate Change Assessment and Adaptation Plan (2014)

The City of Salem produced its first adaptation plan, *Ready for Tomorrow* in 2014. The Department of Planning and Community Development directed the collaborative effort to include several other city agencies along with an Advisory Working Group with representatives from MA Coastal Zone Management, Salem Sound Coastwatch, and Salem State University –three key organizations already involved with adaptation efforts in Salem. Intending to identify immediate, actionable adaptation actions, the Plan targeted four key climate change impacts, i.e., extreme heat, extreme precipitation, sea level rise, and storm

surge. It investigated the resulting stresses vulnerabilities on the components of six different sectors, including critical building infrastructure, water, energy, stormwater, transportation, and vulnerable populations. Within these sectors, "historical and culturally significant buildings and areas" are covered under the first sector of critical building infrastructure.

Of 104 vulnerable, stressed components identified, a total of 17 prioritized vulnerabilities were listed based on the results of a risk assessment methodology devised for this purpose. Furthermore, the Plan enlists 43 adaptation strategies to address each prioritized vulnerability, designed to be incorporated into existing and future city projects.[103] The 2014 Climate Adaptation Plan successfully recognizes the City's designated historic and cultural resources as a prioritized vulnerability under "O: Property Damage or Loss of Historic Properties," stating:

> Flooding currently occurs in the historic areas of Willows near Fort Lee, Emerton and Forester Streets, Derby Wharf/ Maritime Historic Site, and Bridge Street. Flooding from storm surges may flood these areas more severely and frequently and may flood additional historically or culturally significant properties. These are essential assets for economic development and tourism.[104]

Accordingly, the following seven adaptation strategies were identified to address this vulnerability:[105]

- Evaluation of buildings for floodproofing opportunities.
- Re-siting existing facilities outside future flooding levels.
- Elevating a building.
- Elevating a building's critical uses.

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[103] Department of Planning and Community Development, *Ready for Tomorrow: The City of Salem Climate Change Vulnerability and Assessment Plan*, by CDM Smith (Salem, Massachusetts, December 2014), 21-24.

[104] *Ready for Tomorrow: The City of Salem Climate Change Vulnerability and Assessment Plan*, 44.

[105] Ibid., 44–46.

- Floodproof Buildings.
- Limiting or restricting development in future flooding areas.
- Improving land use planning and regulations.

The *Ready for Tomorrow Plan* is accompanied by four additional documents as Appendices that provides the detailed study and documentation of the assessment matrices and priority vulnerabilities, adaptation strategies, and GIS mapping of all components within the six sectors.

City of Salem Community Resiliency Building Workshop (2019) [106]

Salem was designated a Municipal Vulnerability Preparedness (MVP) community in 2017 because of the Climate Change Assessment and Adaptation Plan. Subsequently, Salem received multiple MVP grants, including Salem Sanitary Sewer Trunk Line Relocation Assessment and the Green Infrastructure for Stormwater Management in City Projects. In 2019, the city conducted a Community Resiliency Building (CRB) Workshop through the MVP program that identified 130 specific actions for future planning and implementation to protect the City's assets and critical infrastructure through a more resilient and cohesive approach. The workshop findings identify "historic resources: districts and museums" enlisted as "societal" category assets to be highly vulnerable to all four priority hazards – extreme heat events, extreme precipitation events, sea level rise, and storm surge, with the following recommended adaptation actions:

[106] Salem Sound Coastwatch, *Community Resilience Building Workshop: Summary of Findings*, by Barbara Warren, (Salem, Massachusetts, 2020), https://www.salemsound.org/PDF/SALEM-MVP-Report-RiskMatrix.pdf.

- Conduct risk study and hold meetings with historic building managers and staff to discuss resiliency.
- Conduct community education on climate risks and encourage relocation of assets within buildings.
- Have Historic Commission conduct an environmental checklist to determine what is being done regarding resiliency.

City Of Salem: Hazard Mitigation Plan (2020 Update)

Building primarily on the findings of the 2014 Ready for Tomorrow Plan and the MVP Workshop findings, the 2020 Hazard Mitigation Plan published in 2020 serves as an update to the original 2012 Hazard Mitigation Plan, in compliance with the Federal Disaster Mitigation Act of 2000 that "requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five-year intervals."[107] The Plan follows a six-step process centered around public input based on the FEMA guidance for local muti-hazard mitigation planning. The Salem Local Hazard Mitigation Planning Team reviewed and modified the 2012 Hazard Mitigation Plan goals for the City of Salem to reflect a more inclusive and streamlined approach for this plan update. These include:[108]

1. Prevent and reduce the loss of life, injury, public health impacts, and property damage resulting from all identified natural hazards.

[107] Metropolitan Area Planning Council (MAPC), *Hazard Mitigation Plan 2020 Update* (Salem, Massachusetts, 2021), 1.

[108] Metropolitan Area Planning Council (MAPC), *Hazard Mitigation Plan Update 2020*, 87.

2. Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services.
3. Increase cooperation and coordination among private entities, City officials and Boards, State agencies, and Federal agencies.
4. Increase awareness of the benefits of hazard mitigation through outreach and education.

Consequently, the Plan identifies mitigation measures based on the risk assessments of 180 critical infrastructure facilities and a review of existing measures to specify mitigation strategies for each. However, unlike the Massachusetts SHMCAP, this plan doesn't integrate actions for Climate adaptation and also leaves out considerations for historic resources.

Historic Resources at Risk: Exposure Analysis (2023)

To identify the historic resources in Salem at high risk from the impacts of sea level rise, the author carried out an exposure analysis predominantly as a Geographic Information Software (GIS) exercise. The analysis lays the groundwork for a comprehensive climate change vulnerability assessment that employs a methodology derived from the National Park Service's Coastal Hazards & Sea-level Rise Vulnerability Assessment Protocol published in 2022. To conduct the analysis, three key exposure indicators were identified based on the climate change stressors prioritized in the region's Hazard Mitigation Plan. These include flooding potential, sea rise inundation, and extreme-level flooding. Based on the exposure of the historic and cultural resources to the key indicators, an exposure index score was assigned for each resource. Appendix A documents the methodology, data sources, mapping, and analysis in full detail. Based on the results of the exposure analysis, four of the

11 inventory areas in the City of Salem were found to have the largest number of historic designated resources at the highest risk. These areas are:

1. Stage Point: Point Neighborhood Historic District.
2. Derby Street: Salem Maritime National Historic Site, House of Seven Gables Historic District.
3. Bridge Street: Bridge Street Neck Historic District.
4. Salem Willows: Salem Willows Historic District.

Derby Waterfront Historic District: National Register Historic District

The Derby Waterfront District is the focal point of Salem's maritime activities. It was one of the most pivotal seaports in the United States during the 18th century. The well-preserved merchants' mansions, shops, residences, and wharves within this district serve as a testament to Salem's glory as a former sea trading center and the coastal community that flourished during the Federal Era. Moreover, many existing buildings hold direct associations with individuals, families, trades, and services that emerged due to the bustling commercial activities that took place in the area between 1760 and 1820.[109]

Designated as a historic district on the National Register of Historic Places in 1975, the Derby Waterfront Historic District spans along Derby Street between Herbert Street and Block House Square. The 25-acre site of the National register historic district is determined to be significant under Criterion A in the areas of commerce and Criterion C in the areas of architecture. The boundaries of the historic district differ from but encompass the Salem Maritime National Historic Site, a national historic landmark and NPS park, the House of

[109] National Park Service, *National Register of Historic Places Inventory - Nomination Form: Derby Waterfront District,* by Judy D. Dobbs, (Boston, 1975).

Seven Gables Historic District, which is also a national landmark, and the extent of Derby Street local historic district.[110] While most buildings along the spinal Derby Street fall in the low exposure zone, the cluster of federal-style dwellings along Kosciusko and Daniels Street are at a high exposure risk of inundation. Of the 130 buildings within the district, 24 have a high and moderate exposure score, excluding those within the Salem Maritime National Historic Site and the House of Seven Gables.

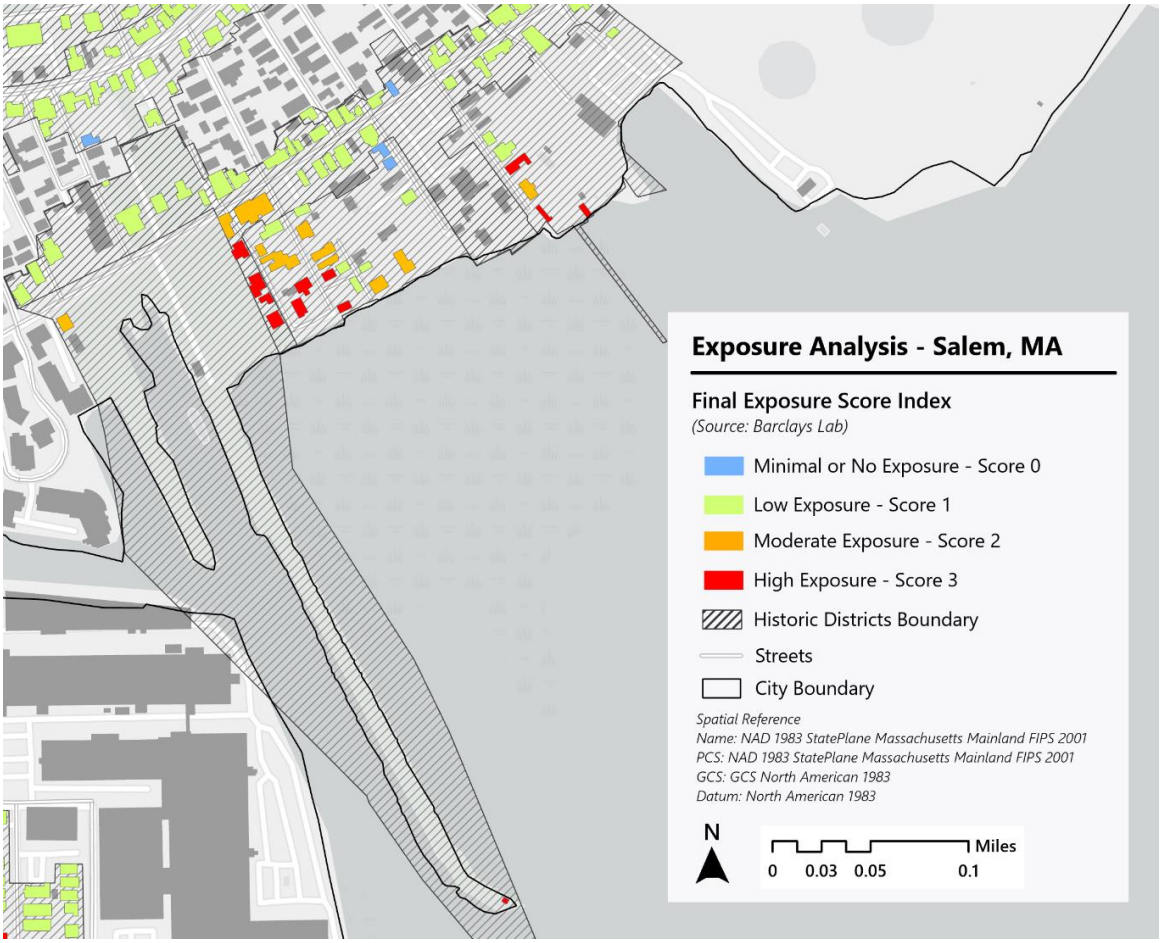

Figure 21: Map showing the Exposure Analysis results of Derby Waterfront Historic District. *Source: Author*

[110] *National Register of Historic Places Inventory- Nomination Form: Derby Waterfront District*.

Figure 22: Examples of the federal-style domestic architecture within Derby Waterfront Historic District that have a high-exposure score. Left, 18-20 Kosciusko St; right, 12 Kosciusko St.
Source: MACRIS

Salem Maritime National Historic Site:

National Landmark, National Register Historic District, Local Historic District

The Salem Maritime National Historic Site served as a center of seaport activity in Salem since the Colonial Period. Initially involved in the Atlantic Trade to the West Indies, it ventured into pioneering post-Revolutionary War initiatives in global trade, particularly with the Far East. Recognizing the site's immense importance to the nation's customs, banking, insurance, and market systems, it was distinguished as the first National Historic Site under the Historic Sites Act of 1935. In 1966, with the enactment of the National Historic Preservation Act (NHPA), it was formally listed on the National Register as a historically significant unit within the National Park Service.

Documentation for the Salem Maritime National Historic Site was updated in 2014, which identified 24 contributing resources, including ten buildings, nine sites, and five structures overlapping with other historic designations and resource types. These include the Custom House, Narbonne House, Derby House, West India Goods Store, Hawkes House,

and Scales House. The site, however, is centered around the three wharves stretching into the ocean from Derby Street: Central, Hatch, and Derby Wharf. Derby Wharf served as Salem's longest and busiest Wharf for many years –with over 14 warehouses standing on the Wharf once upon a time. The Derby Wharf Light Station, which stands right at the end of the Wharf in the middle of the sea, is also listed in the National Register as a part of the Lighthouses of Massachusetts Thematic Resource Nomination.

Arguably the city's most significant and valuable historic resource, the Salem National Maritime Historic Site, is also the most vulnerable to inundation due to its location on the coast. The exposure analysis determines only one of three exposure indicators affects the buildings along Derby Street, which suggests the buildings within the district are at low exposure risks. However, the wharves and the Light Station are at risk of complete inundation in the near future. The effects of climate change and sea level rise stressors have already between witnessed along the Wharf during significant storms. The storms, however, are also frequently increasing, making the inundation of the wharf and light station a very common sight.

Figure 23: Image showing Derby Wharf during low tide. The Wharf extends 2045 feet into the Salem Harbor with the Light Station at its tip.
Source: National Park Service [111]

[111] "Derby Wharf: Salem Maritime National Historic Site," National Park Service, last updated November 7, 2021, https://www.nps.gov/places/derby-wharf.htm

House of Seven Gables:

National Historic Landmark, National Register Historic District, Local Historic District

In contrast to the Salem Maritime National Historic Site and the Derby Waterfront Historic District, which recognize the significance of the area's maritime history, the House of Seven Gables Historic District designation outlines the literary significance of the preservation efforts of the House of Seven Gables Settlement Association under a plan by Chandler and Caroline O. Emmerton. The small complex of settlement houses represents an early effort in preservation "that combined use as a museum site and adaptive reuse for specific purposes, in this case, both as a settlement house and as a money maker to support the work at the settlement house." [112] The district consists of the 1668 House of the Seven Gables, the Colonial Revival Garden, and the eight other buildings that serve the House of the Seven Gables Settlement.

In 2007, the district was designated as a National Historic Landmark under Criterion A and Criterion C in the areas of architecture, education, and social history between 1668-1742 and 1870-1958. The site also satisfies the National Historic Landmark criterion (1) "Properties that are associated with events that have made a significant contribution to, and are identified with, or that outstandingly represent, the broad national patterns of United States history and from which an understanding and appreciation of those patterns may be gained.," and Criterion (4) "Properties that embody the distinguishing characteristics of an architectural type specimen exceptionally valuable for a study of a period, style, or method of construction, or that represent a significant, distinctive and exceptional entity whose components may lack individual distinction," with the NHL exception (2) "Buildings or

[112] National Park Service, *National Historic Landmark Nomination: House of Seven Gables Historic District*, by Anne Andrus Grady (Washington D.C., 2005), 4.

structures that have been moved from their original historic location." The designation, therefore, recognizes seven of the nine buildings as contributing resources along with one site, i.e., the colonial revival garden. The buildings include the Turner House, more commonly known as the House of Seven Gables, the Retire Beckett House, Hooper-Hathway House, Nathaniel Hawthorne's Birthplace, and the Counting House.[113]

The exposure analysis determines only the House of Seven Gables as an individual building with a high exposure index. However, in noting the significance of the property, the exposure of the site as a whole to inundation due to sea level rise and, more specifically, in the event of a Category 3 Storm would have the most devastating effects. The impact is then not limited to the material and physical structure of the building; the landscape and setting of the settlement are also at risk.

Figure 24: Image showing the rear portion of the House of Seven Gables Historic District site that borders Salem Harbor.
Source: The House of Seven Gables

[113] *National Historic Landmark Nomination: House of Seven Gables Historic District*, 16; National Park Service, "National Register Bulletin: How to Apply the National Register Criteria for Evaluation" (National Park Service, n.d.), 50.

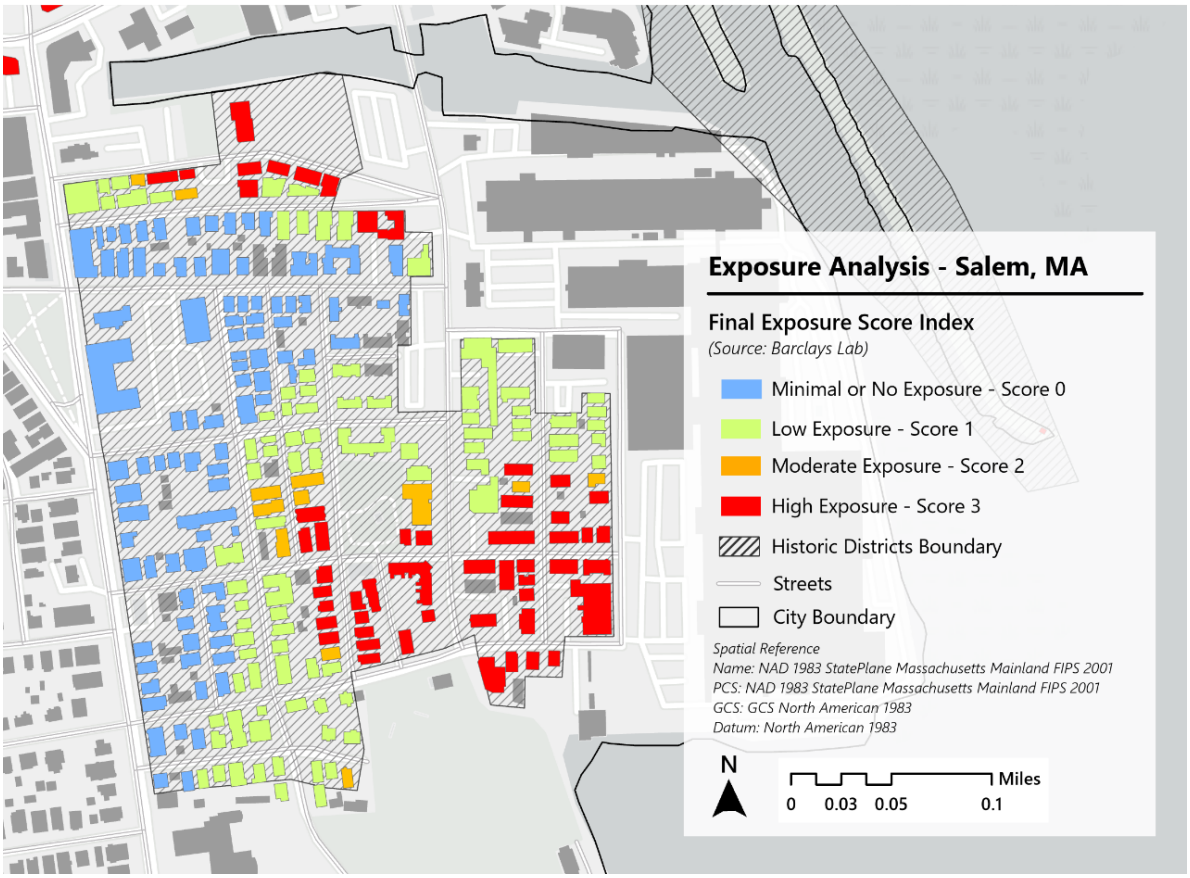

Figure 25: Map showing the Exposure Analysis results of Point Neighborhood Historic District.
Source: Author

The Point Neighborhood Historic District is a densely populated area in Salem that emerged after the Great Salem Fire of 1914. Located in South Salem, bounded by the South River, the former Naumkeag Steam Cotton Factory Mill, Lafayette Street, and Palmer's Cove, this neighborhood is characterized by its visually cohesive collection of residential buildings from the early 20th century, reflecting popular architectural styles of that time such as Colonial Revival, Classical Revival, and Renaissance Revival.[114]

[114] National Park Service, *National Register of Historic Places Registration Form: Point Neighborhood Historic Distric*t, by Patricia Kelleher and Maureen Cavanaugh (Maynard, Massachusetts, 2014), sec. 7, 4, https://mhc-macris.net/Documents/NR/14000972.pdf.

During the 1870s, the Point Neighborhood began to emerge and was primarily occupied by the immigrant workers who arrived to work in the local shoe, leather, and cotton industries. Multi-family buildings built during this time to accommodate the influx of immigrants were predominantly wooden structures with three or four floors, which many residents considered lower quality. Tragedy struck in 1914 with the devastating Great Salem Fire, which engulfed over 256 acres of the city, virtually wiping out the entire Point Neighborhood. In the aftermath of the fire, the Salem Rebuilding Commission, a city-appointed body, took charge of the reconstruction efforts. They established comprehensive guidelines dictating the size, placement, and materials used in the new construction and the required spacing between buildings. Following the guidelines set by the Salem Rebuilding Commission after the fire, the structures in the Point Neighborhood were constructed using fireproof materials, mainly brick masonry.[115]

Apart from the occasional demolitions and a few instances of material changes, the Point district still maintains its original integrity in terms of its location, setting, design, craftsmanship, and materials. It was, thus, listed on the National Register of Historic Places as a local historic district in 2014, under designation criteria A and C, due to its historical significance and association with local community planning and development and architecture. The designation currently includes a total of 278 contributing resources within the historic district boundaries that showcase architectural styles such as the Late Victorian (Queen Anne, Panel Brick, Renaissance Revival), Late 19th and early 20th century Colonial/Classic Revival, and American Movements, and the Modern Movement.[116]

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[115] *Historic Preservation Plan Update*, 39.

[116] *National Register of Historic Places Registration Form: Point Neighborhood Historic Distric*t, sec. 8, 16-19.

Figure 26: Examples of the Colonial Revival, Classical Revival and Neo-Classical brick buildings withing the Point Neighborhood Historic District that have a high exposure score. Top, left, 37 Ward St, right, 105 Congress St are typical examples of multi-dwelling apartment buildings. Middle, Salem Electric Light Company is the only pre-1914 building in the historic district. Below, J.E. Dube Bakery Building, an example of commercial building in the district. *Photographs by Brian Graves (2014) Source: MACRIS*

Of the total 240 buildings within the district analyzed in this study, 51 structures fall in the high exposure risk category, and 12 fall under moderate exposure risk. These include some exceptional examples of significant architectural styles, mainly Colonial Revival and Classical Revival, contributing to the historic district. 75 Palmer St, or 117 Congress St, are examples of the three- or four-story, multi-family, and apartment building types showcasing the Neoclassical style in brick construction. There are also examples of commercial buildings, such as the J.E. Dube Bakery Building and the Leavitt St Autobody Repair shop, which fall under high exposure risk. The Salem Electric Light Company, one of the only pre-1914 buildings constructed entirely of masonry and steel, is also at risk. Only four of the 51 high-risk exposure buildings are non-contributing resources.

Bridge Street Neck Historic District: National Register Historic District

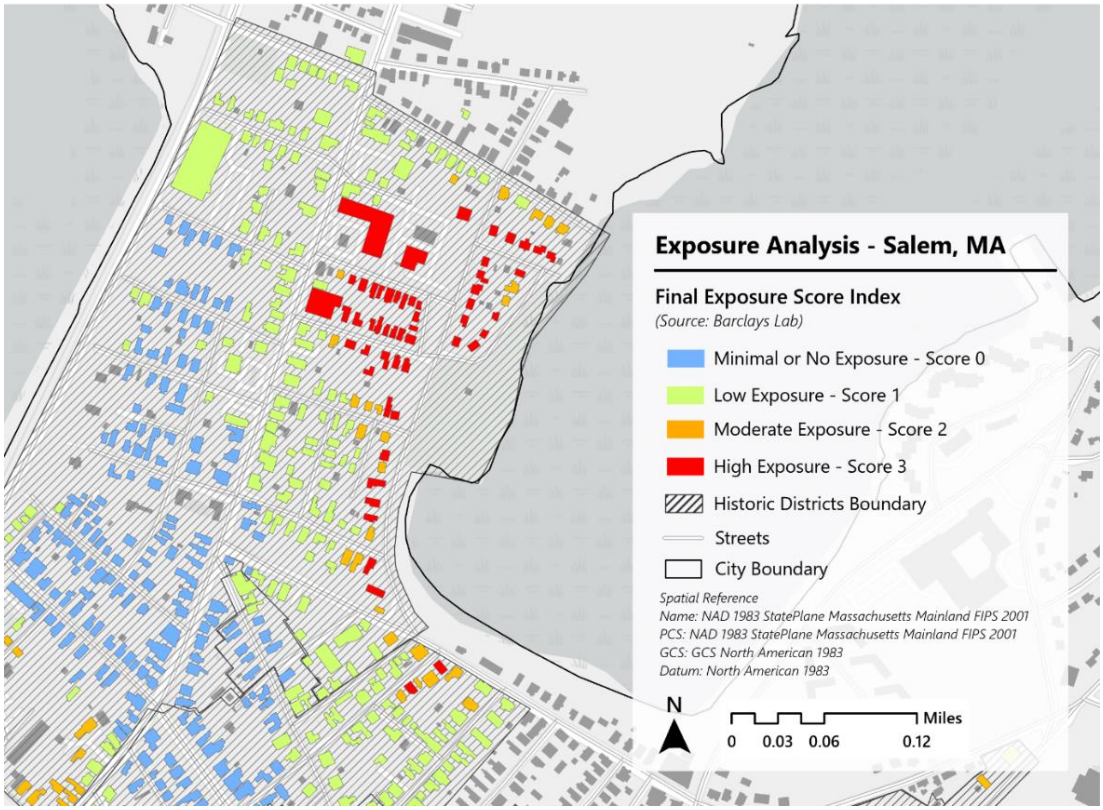

Figure 27: Map showing the Exposure Analysis results of Bridge Street Neck Historic District.
Source: Author

Situated on the peninsula of land between the North River and Collins Cove, it is one of the earliest areas to be settled in Salem. The neighborhood developed along Bridge Street, the northeast-southwest axis, serving as a vital link between Salem's downtown area and its outlying communities to the North. It is characterized by its well-preserved collection of structures that showcase various architectural styles from the late 18th to the early 20th century, including s variations on the Georgian/Federal, Greek Revival, Gothic Revival, Italianate, Second Empire, and Queen Anne. A predominantly residential district, it once housed sea captains, merchants, and the dwellings of the working classes who found employment in the neighborhood's maritime-related businesses and nearby factories and car shops. Bridge Street has continued to develop as a main commercial corridor connecting Salem to Beverly, with a diverse collection of historic commercial buildings and converted residences.[117]

Bridge Street Neck was listed on the National Register of Historic Places as a historic district in 2002. The listing designated 383 resources, including all single- and multi-family dwellings, commercial establishments, schools, religious facilities, and a park. Like the Point Neighborhood, Bridge Street Neck historic district is considered significant under Criterion A and C due to its historical significance and association with local community planning and development and architecture between 1780-1952.[118]

The historic district is most affected along the northeastern coast fronts of Collins Cove, with the entire stretch of buildings along the edge at high or moderate exposure risk. Of the 356 buildings analyzed, 52 have high exposure to sea level rise stressors, while 33

[117] National Park Service, *National Register Historic Places Registration Form: Bridge Street Neck Historic District*, by Lisa Mausolf and Betsy Friedberg (Boston, 2002), sec. 7, 1-3.
[118] Ibid.

have moderate risk. The 52 high-exposure buildings include residential buildings with Cape Cod, Italianate, Georgian, and Queen Anne seen as the most prominent styles. The bulk of Cape Cod and Ranch-style dwellings along Conners and East Collins Road, representing the last of all concentrated construction periods between 1949-50, falls directly in the High exposure zone. Only two of these affected buildings are non-contributing resources.

Figure 28: Examples of single- and multi-family dwellings within the Bridge Street Neck Historic District that have a high exposure score. Top, left, 13-15 Collins St (Queen Anne), right, 5 Collins St (Victorian Eclectic); bottom, 19 East Collins St (Cape Cod Ranch Style).
Source: MACRIS.

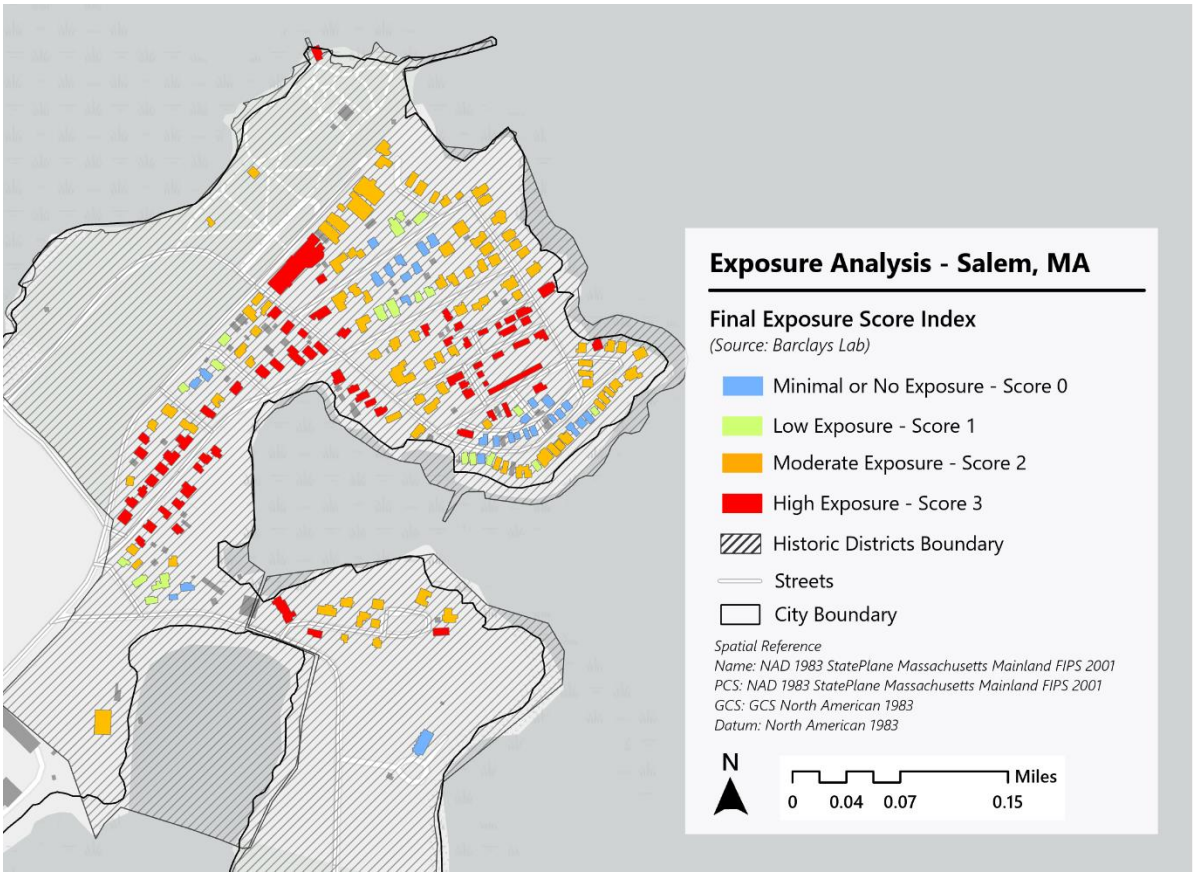

Figure 29: Map showing the Exposure Analysis results of Salem Willows Historic District. *Source: Author*

Situated at the northeastern edge of Salem Neck, a peninsula distinct from Bridge Street Neck, the Salem Willows Historic District is historically significant as a coastal summer resort community from the late 19th century. The district encompasses residential zones featuring quaint summer cottages on compact plots nestled along narrow roads. Additionally, it includes Salem Willows Park, along with various structures and buildings that facilitate its amusement and recreational activities. Around one-third of the district comprises parkland, characterized by undulating hills adorned with fully-grown trees, waterfront paths, stretches of beach and rugged coastline, and picturesque vistas overlooking the town of Beverly. The district showcases a diverse range of late 19th and early 20th-century architectural styles with various vernacular interpretations. These include Queen

Anne, Colonial Revival, Shingle, and the general category of Victorian Eclectic. While the 19th-century structures were constructed as summer residences, those constructed in the 20th century were intently built as year-round residences.[119]

Listed on the National Register of Historic Places in 1994, the Salem Willows historic district includes over 280 resources within approximately 100 acres of land, of which 226 resources contribute to the district's significance. The buildings are predominantly residential and typically stand at heights of 1.5 to 2 stories and are adorned with shingles, clapboards, or a combination of both as external cladding. The roofs of most buildings adopt gabled designs, sometimes oriented towards the street, occasionally incorporating cross gables or more intricate plans. The district retains the integrity of location, design, setting, materials, workmanship, feeling, and association and meets Criteria A and C of the National Register of Historic Places at the local level.[120]

With its location on the peninsula surrounded by the ocean on all three sides, more than 75% of the built heritage within the district is at risk of inundation, some of the largest numbers identified within the City of Salem. Of the 201 buildings within the district, 65 buildings indicate a high exposure score, and 87 indicate a moderate exposure score, endangering an entire neighborhood during a flooding event. The Colonial Revival and Eclectic Victorian residences along Beach, Bayview, and Columbus Avenues are relatively the most affected due to their location bordering the coast.

[119] National Park Service, *National Register Historic Places Registration Form: Salem Willows Historic District*, by Kim Withers Brengle and Betsy Friedberg (Boston, 1994), sec.7, 2.

[120] Ibid., sec. 7, 1-2.

Figure 30: 48 Bayview Ave showcases a typical example of the Victorian eclectic style commonly seen in the Salem Willows Historic District. The property elevated to the Base Flood Elevation in 2018, setting a precedent for other at-risk structures in the neighborhood.[121]
Source: Google (2019).

[121] Laurence Spang, "Rising to the Challenge – How to Adapt to the New Standards," Preservation in a Changing Climate 2022, Peabody Essex Museum, September 12, 2022, video of lecture, https://www.youtube.com/watch?v=9si06DSqxYg&t=5627s.

Ongoing Adaptation Planning Efforts

Derby Wharf - Resiliency on Salem's Maritime Waterfront (2021)

The Salem Maritime National Historic Site was established in 1938 and was the first such designation in the United States. Today, its 8.93 acres site houses a collection of 10 historic buildings, nine archeological sites, four historic wharves, and a light station, all of which span from 1675 to 1944. Additionally, the park oversees the management of the Salem Regional Visitor Center, located in downtown Salem at the Salem Armory, in support of the National Park Service's mission to promote the Essex National Heritage Area. The park's significance lies in its association with Salem's pivotal role in developing international maritime trade from the late 17th century through the 19th century. As the very first property designated as a national historic site in 1938, it also stands as an essential local representation of the Colonial Revival movement of the early 20th century and the work by NPS landscape architect Norman T. Newton from 1938 to 1944.[122]

However, with its location along the waterfront of Salem Harbor, the Salem Maritime National Historic Site is most vulnerable to the impacts of climate change. Impacts of the rising sea levels and inundation caused due to storm surges and king tides have already been encountered more frequently in the past decade. The wharves and the resources directly on the waterfront are most vulnerable to coastal impacts. Derby Wharf, for instance, exhibits visible signs of deterioration in its stone bulkheads, which have suffered from the repeated battering of waves and tides, leading to dislodged and missing stones. The surface of the wharf regularly experiences significant erosion as a consequence of over-washing,

[122] National Park Service, *Salem Maritime National Historic Site Foundation Document*, (Salem, Massachusetts, 2019), 3-10, https://www.nps.gov/sama/learn/management/upload/SAMA_FD_2019_508x.pdf.

leading to damage to the walking trail. Other areas, including Hatch's Wharf and the Derby Beach area, have also witnessed impacts from erosion, compaction, and saltwater intrusion. Increased flooding has also caused damage to the historic structures on site, affecting exterior surfaces and internal structural systems. At the Customs House, the potential of increased flooding has prompted park staff to move offices, storage, and sensitive collections from basement areas to upper floors; however, these measures do not completely eliminate the risk. These consequences and the potential for severe storm damage present substantial threats to the long-term preservation of the site's resources.[123]

The latest Foundation Document for the Salem Maritime National Historic Site, published in 2019, outlines these threats from climate change posed to the historic structures, archives, and collections, the viewshed, the waterfront, and the NPS-developed cultural landscape. It further lists some essential sustainability and resiliency actions as high-priority planning and data needs that the Park management should focus on in the near future. The suggested actions based on priority levels are summarized in Table 4.

Based on the recommendations of the foundation document, under the leadership of NPS Superintendent Paul DePrey, the Park Management conducted a condition assessment of the seawall bordering the wharves and proposed a plan to rehabilitate the wharf system of all three wharves: Derby Wharf, Hatch's Wharf, and Central Wharf. The process that the Salem Maritime Park Management has adopted since the 1930s requires dredging of the wharf to excavate the earth at the top and the sides of the bulkhead so as the realign the

[123] Paul DePrey, "Derby Wharf - Resiliency on Salem's Maritime Waterfront," Salem Sound Coastwatch, September 9, 2021, video of presentation, https://vimeo.com/601973967; *Salem Maritime National Historic Site Foundation Document,* 36-38.

bulkhead stone blocks and backfill the wharf with materials that are coarse, angular and less likely to erode by continuous wave action.[124]

Table 4: Climate Change Adaptation Planning and Data Needs for Salem Maritime National Historic Site as per 2018 Foundation Document.

#	Planning and Data Needs	Priority	Notes
1	Salem Waterfront Resiliency Plan	High	This plan would seek to minimize erosion from sea level rise and to reduce overtopping the 18th-century wharves (Derby, Hatch's, and Central Wharf) Increased erosion is threatening the integrity of these resources
2	Climate Change Adaptation Plan	High	This plan would identify management actions necessary to increase the resilience of high-value at-risk resources as identified in the climate change vulnerability assessment
3	Cultural landscape rehabilitation and preservation maintenance plan	High	This plan would be the National Environmental Policy Act compliance document for implementing the cultural landscape report treatment recommendations
4	Historic structure reports for Narbonne House and Derby Wharf Light Station	High	This plan would provide background information and guidance for rehabilitating park structures
5	Climate Change Vulnerability Assessment	High	Study will identify park resources at risk from sea level rise and increasing storm frequency
6	Data on sea level rise and storm intensity	High	Data needed to inform the climate change vulnerability assessment and climate change adaptation plan
7	Monitor sea level rise and salt inundation and their impacts on vegetation, structures, soils, and circulation surfaces	Moderate	Data needed to inform the climate change vulnerability assessment and climate change adaptation plan
8	Data and/or GIS mapping related to sea level rise and climate change-related risk	Moderate	Needed especially related to the wharves

Source: National Park Service (2018).[125]

[124] Paul DePrey, "Derby Wharf - Resiliency on Salem's Maritime Waterfront."
[125] *Salem Maritime National Historic Site Foundation Document,* 39-42.

With a current bulkhead height between 10.5 feet to 12 feet from the Mean Lower Low Water (MLLW) level, the proposed rehabilitation of Derby Wharf would raise it to a height of 14 feet, with the trail path 2 feet above the bulkhead, i.e., at 16 feet. While the raised elevation addresses daily high tide levels, it may not withstand storm surge conditions in Categories 2 or 4 storms. However, the proposed elevation corresponds to the lowest level of drainage on Derby Street that runs across the three wharves, which avoid interruption of the existing stormwater drainage system. The plan proposes a phased process to carry out repair works of sections based on the nature of construction, which would also avoid the closure of the entire waterfront for the project's duration. The rehabilitation of each section would first require the repair of the existing wharf, followed by raising the bulkhead to the proposed height. Methods employed include cribbing and pining, and differ based on the construction material, i.e., granite, piling, or sheet-piling.[126]

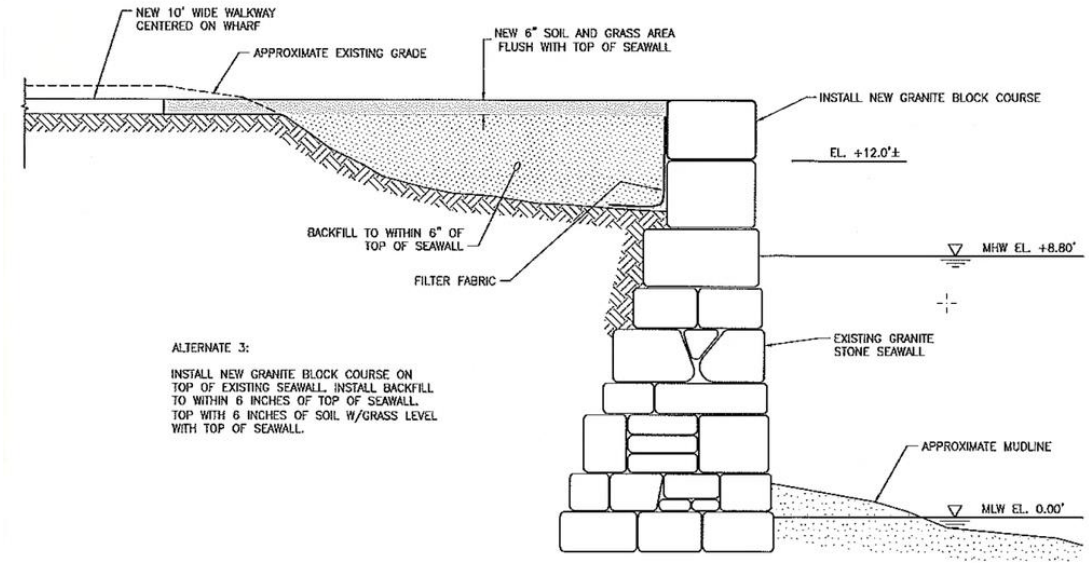

Figure 31: Working drawing of the proposed rehabilitation of Derby Wharf by backfilling and raising the masonry.
Source: National Park Service (2021).

[126] Paul DePrey, "Derby Wharf - Resiliency on Salem's Maritime Waterfront."

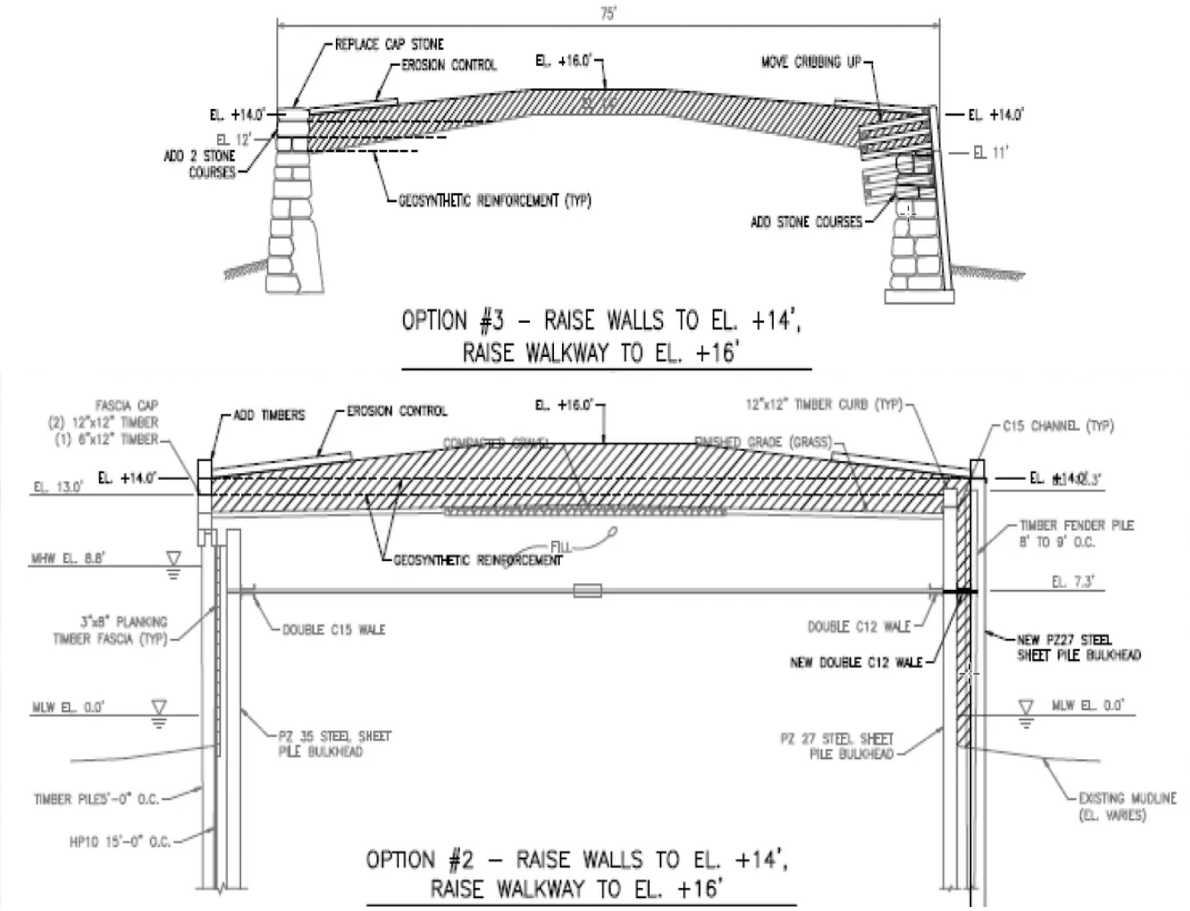

Figure 32: Working drawings of proposed rehabilitation of Derby Wharf using the cribbing method and sheet piling.
Source: National Park Service (2021).

The study, which was completed in 2021, was also presented to other stakeholders from the city. However, due to a lack of funding resources, the rehabilitation of the Derby Wharf system has still not advanced from the conception phase. As of today, the new Superintendent of the Salem Maritime National Historic Site and the Saugus Iron Works National Historic Site is Jennifer Hardin, who was appointed in 2022. The most recent project progressing on the site is the Custom House repair and preservation that will be ongoing until December 2023.[127]

[127] "Custom House Repair and Preservation Project Commences - Salem Maritime National Historic Site (U.S. National Park Service)," accessed July 1, 2023, https://www.nps.gov/sama/learn/news/custom-house-preservation.htm.

Resilient Together: The Point (2021-2024)

In 2020, the cities of Beverly and Salem, Massachusetts, partnered on a collective Climate Action and Resilience Plan titled *Resilient Together.*[128] The effort aimed to limit climate change to 1.5 degrees Celsius and reduce greenhouse gas emissions by proposing short- and long-term solutions that build resilience in the neighboring cities. The Plan was prepared with funding support from the Massachusetts Executive Office of Energy and Environmental Affairs MVP Program and concluded with the document's publication in June 2021. As the "next step" to this collective effort, *Resilient Together: The Point* was launched in December 2021 to focus on neighborhood-specific dealing with the climate crisis.

While the Point neighborhood is a National Register-designated historic district, with many contributing historic resources representing its significance and association in the local developmental history, it is also identified as one of the most socio-economically and physically vulnerable neighborhoods, especially in the wake of present and future climate risks. The community persistently faces challenges of high unemployment, poor infrastructure, housing quality, and gentrification, rooted in a history of social injustice. Consequently, the Point has been designated as an Environmental Justice Community by the Commonwealth of Massachusetts.[129]

Thus, for the City's first neighborhood-level climate adaptation planning effort, highest priority was given to Point neighborhood with the following project objectives: [130]

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[128] City of Salem, Massachusetts and City of Beverly, *Beverly & Salem Resilient Together: Climate Action and Resilience Plan*, by Kim Lundgren Associates, Inc., Nitsch Engineering, Inc. $ Utile, (Salem, Massachusetts, 2021).

[129] City of Salem, Massachusetts, *Creating a Vision, Strengthening a Community: A Vision and Action Plan for the Point Neighborhood in Salem 2013 – 2020*, by Jennifer Erickson (Salem, Massachusetts, 2013)

[130] City of Salem, *Resilient Together: The Point*, (Salem, Massachusetts, 2022), 3.

1. Provide a multi-lingual community outreach, education, and engagement process.
2. Map predictions of future flooding from sea level rise, storm surge, and rain.
3. Assess how climate change impacts will affect vulnerable populations and community assets.
4. Develop recommendations to make the community more resilient to future flooding and extreme heat.

Phase One marked the project's initial stage, considered the 'planning' phase. Funded by a grant from the Massachusetts Office of Coastal Zone Management (CZM), the City of Salem engaged a team of consultants to create a comprehensive representation of existing and future climate-related risks and proposed strategies for the local area to adapt to and mitigate these risks. The Plan thus focused on vulnerabilities to four climate change stressors, including extreme heat, inland flooding, coastal flooding due to storm surge, and sea level rise.[131] The planning process involved a five-step approach: Community outreach, education, and management, understanding existing conditions, modeling future flooding & assessing vulnerabilities, developing strategies and priorities, and preparing the Plan. The Community Outreach Campaign played a crucial role in the process, which aimed at gaining insights into the social and physical vulnerabilities experienced by residents in The Point neighborhood. Accordingly, the Plan progresses to identify several adaptation strategies based on community feedback that would incur public and private investment to improve climate change resilience in The Point.

[131] "Resilient Together: The Point" accessed July 1, 2023, https://publicinput.com/thepoint#0.

Figure 33: Resilience approaches and strategies identified through Phase One of the initiative. Source: Resilient Together: The Point, (2022).

The Phase One report finally outlines a series of recommendations to be pursued to implement the strategies identified within the four distinct categories:[132]

1. Social Strategies
    - Resilience Hub Feasibility Study.
    - Workforce Development Grant Program
2. Policy Strategies
    - Affordable Housing and Historic Building Adaptation Fund
    - Building and Infrastructure Regulations
3. Operational Strategies
    - Community Preparedness and Communication
4. Physical Strategies
    - Heat Mitigation and Relief
    - Stormwater Management Alternatives Analysis and Capital Plan
    - Palmer Cove Resilience Project
    - South River Coastal Resilience Project.
    - Shetland Park Redevelopment

[132] City of Salem, *Resilient Together: The Point*, 69-79.

Addressing the historic building stock, the recommendation for an "Affordable Housing and Historic Building Adaptation fund" proposes to establish a funding initiative aimed at assisting property owners in The Point in accessing financial resources and other forms of support to enhance the resilience of their homes and businesses against flooding and extreme heat. It thus promotes renovation and retrofitting of existing buildings over demolition to floodproof and build resiliency for private properties. Potential funding resources identified include the Community Preservation Act but do not consider historic tax credits that can now benefit the community since its designation as a historic district.[133]

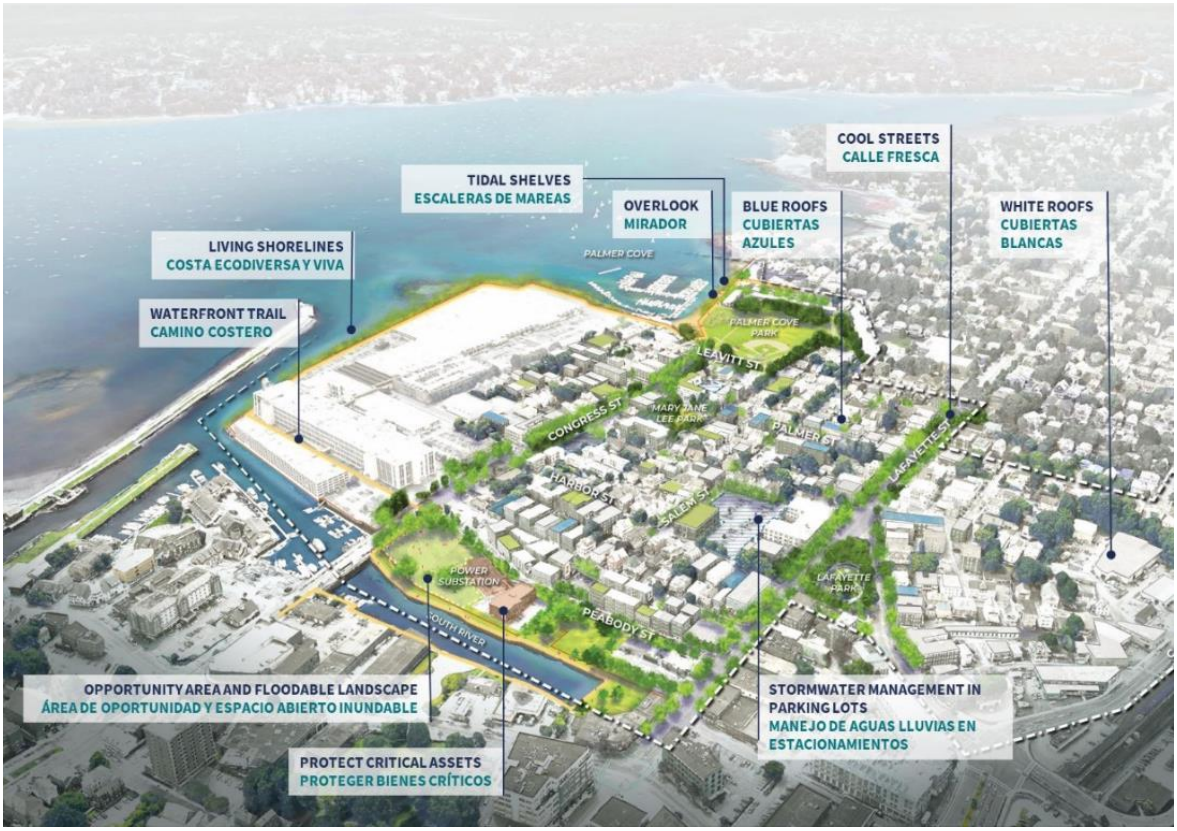

Figure 34: Illustration depicting proposed resilience and adaptation strategies for the Point Neighborhood as a part of the Resilient Together: The Point Plan.
Source: SCAPE Landscape Architecture, (2022).

[133] City of Salem, *Resilient Together: The Point*, 71.

With Phase One concluding in July 2022, the City is now undertaking Phase Two, which focuses on implementing some of the resulting community-based recommendations. These include short-term mitigation efforts to deal with present-day issues of flooding in the neighborhood, as well as long-term actions focusing mainly on potential improvements to The Palmer Cove seawall and revetment for protection from the severe storm surge and sea level rise impacts. Major considerations have also been given to community input in designing and analyzing long-term measures. Additionally, The City, in collaboration with consultant partners and community members, will actively involve the neighborhood to enhance awareness of climate change, its associated risks, and the potential impacts on The Point neighborhood. This will entail various community engagement forms, such as workshops, events, projects, surveys, and meetings. Additionally, informational materials and toolkits will be supplied to support these efforts. The Final report summarizing all findings, lessons learned, and community feedback will be published in June 2024.[134]

Preserving History: Assessments and Climate Adaptations at the House of Seven Gables (2022-2024)

A National Register historic district that also houses a national landmark, the House of Seven Gables Settlement Association, presently functions as a 501(c)(3) charitable organization that maintains the historic settlement as an open-air museum. Carrying forward the vision of their founder Caroline Emmerton, the organization continues to work towards the preservation of all the structures on site, including the Retire Becket House (c. 1687), the Hooper-Hathaway House (c. 1682), Nathaniel Hawthorne's Birthplace (c. 1750); the Phippen House (c. 1782); and the Counting House (c.1830). Additionally, the organization

[134] "Resilient Together."

offers public programs in language education, social and recreational activities, skills training, and citizenship classes.[135]

Thus, in continuing their mission and vision of education through preserving the 355-year-old historic site, the House of Seven Gables has determined the timely need for a thorough reevaluation of the site concerning the threats posed by climate change and its impacts. The awareness of climate-change-related preservation issues was led by the growing occurrences of sinkholes in the rear garden that sits directly on Salem Harbor. This was caused due to the over-stressed and over-washed granite-block seawall, part of which was arguably built as early as the 1700s. This further led to significant cuts in funding, which is essential for the organization's operations, as the lawn area was a major space utilized for revenue generation. Simultaneously, the long-term health of the valuable collections held by the organization, both in storage and on exhibition, was also in peril due to the changing environmental conditions related to the presence of water, temperature, humidity and light levels, pest activity, dust and pollution levels, and housing issues. Basement flooding during extreme precipitation also damaged many of the organization's archives. The increased rain, heat, and humidity are also significantly affecting the historic structural elements of the buildings, including the unique foundation system of the Turner-Ingersoll House.[136]

To investigate and monitor the issues caused by climate change impacts on the historic district site, the House of Seven Gables Settlement Association launched Preserving History: Assessments and Climate Adaptations at the House of Seven Gables, a two-year-

[135] "Organization History," The House of the Seven Gables, accessed July 6, 2023, https://7gables.org/organization-history/.

[136] Susan Baker, online interview by author, March 24, 2023.

long climate change and adaptation study that led to the recommendation of significant short-term site improvements and long-term adaptation goals and strategies.[137] The project scope thus explorers the following areas:

- Monitoring the hydrology of our site to understand how stormwater flows and how best to protect our historic resources.
- Making our seawall resilient enough to handle rising sea levels.
- Investigating how to protect our utilities and critical infrastructure from future water inundation.[138]

Having begun in the Fall of 2022, the first year of the initiative has focused on on-site data gathering, building and site analysis, adaptation planning, short-term maintenance planning, and both peer-to-peer and public outreach, which will be summarized in the progress report published September 2023. Further, the second year would involve continued reporting on-site analysis, detailed planning for permitting, construction-ready planning, drawings, and documentation for near-term modifications and longer-term adaptation recommendations. There will be continued peer-to-peer and public outreach and, also, delivery of the final adaptation plan report.[139]

The vulnerability assessment was made possible by the funding grant award of a $509,919 grant received from the Massachusetts Office of Coastal Zone Management (CZM) as a part of the state's Coastal Resilience Grant program. The CZM's Coastal

[137] "State Grant Enables Major Short- and Long-Term Climate Change Study and Planning at The House of the Seven Gables," The House of the Seven Gables, September 26, 2022, https://7gables.org/2022/09/26/state-grant-enables-major-short-and-long-term-climate-change-study-and-planning-at-the-house-of-the-seven-gables/.

[138] "Coastal Resilience Grant Program - Featured Projects | Mass.Gov," accessed July 1, 2023, https://www.mass.gov/service-details/coastal-resilience-grant-program-featured-projects.

[139] "State Grant Enables Major Short- and Long-Term Climate Change Study and Planning at The House of the Seven Gables."

Resilience Grant Program offers financial support and technical guidance to local governments and nonprofit organizations in order to promote creative local initiatives in addressing the challenges posed by coastal flooding, erosion, and sea level rise. This includes facilitating communication and public outreach efforts, conducting vulnerability assessments, engaging in planning activities, implementing engineering projects, and implementing natural storm damage protection measures.[140]

The grant, which will be collaboratively managed by The Gables and its project partner, Salem Sound Coastwatch, represents a pioneering achievement as it is the first to be awarded to a nonprofit museum. Other consultants on the project include Union Studios, Collins Engineers, and Horsley Witten Group, who are responsible for carrying out the technical investigations and reporting on-site. As a part of the peer-to-peer review and public outreach, the House of Seven Gables has also involved the City departments, the preservation planner, along with community groups, including the Historic Derby Street Neighborhood Association and the Peabody Essex Museum, thus exploring the possibility of creating an adaptation plan that could reach beyond the Gables and Derby Street historic district, to create a procedural model for other similar institutions in the region.

Conclusion

Nearly a decade after the publication of Salem's first climate adaptation plan, *Ready for Tomorrow*,[141] the city has undertaken multiple initiatives to address the impacts of climate change. These efforts, however, have not effectively recognized the economic and community value of the City's historic resources, nor have they integrated preservation

[140] "Coastal Resilience Grant Program - Featured Projects | Mass.Gov."
[141] *Ready for Tomorrow: The City of Salem Climate Change Vulnerability and Assessment Plan*.

considerations into adaptation planning. In evaluating the current legislation and policy framework relevant to both preservation and resiliency, in addition to ongoing initiatives, various observations may be made about the strategies employed by the City, particularly from a preservation standpoint.

At the policy level, the City of Salem recognizes the importance of policy strategies through the various planning studies conducted over the years, to facilitate and streamline the climate adaptation processes. However, the necessary policy actions have yet to be enacted, and the current focus lies only on zoning ordinances, neglecting the incorporation of climate adaptation and resiliency requirements into building codes and performance standards. While the Wetland Protection Ordinance, implemented in 2022, concentrates on ecological considerations, there is promise in the ongoing Coastal Resilience Overlay District (CROD), which aims to amend the existing flood hazard overlay district (FHOD) regulations. However, the zoning regulations lack consideration for the historic and cultural resources located within the floodplain. Preservation regulations, too, are not effective in providing any protection or review of the resources at risk. Of the four locally designated historic districts, only the Derby Street Historic District is impacted by sea-level rise. Areas such as the Point Neighborhood, Salem Willows, and the Bridge Street Neck historic district, primarily comprising privately owned properties, are vulnerable to potential risks, however, they are not protected by local level legislation. They increasingly face the risk of historically inappropriate construction, elevation, or even demolition undertaken to mitigate the effects of flooding, leading to the loss of significance, setting and integrity. The only policy that allows for the SHC to review any structural or non-structural adaptation being carried out by a historic property owner in these areas is the Demolition Delay Ordinance,

which was recently amended to increase review timeframe in favor of preservation efforts. Beyond these specific challenges, it is evident that a lack of interagency coordination, personnel, and resources within the city agencies is hindering a more integrated approach that encompasses preservation considerations. A more collaborative effort is required, especially given the presence of federal agencies such as the Salem Maritime National Historic Site, necessitating effective communication and cooperation between different levels of government.

On the other hand, Salem's climate change assessments and adaptation plans have not kept pace with regional and state-level planning priorities. Notably, the City's Hazard Mitigation Plan 2020 Update fails to incorporate climate change adaptation within the hazard mitigation framework, thus focusing primarily on near-term hazards rather than addressing long-term impacts. To align better with comprehensive and forward-thinking strategies, it is crucial for Salem's plans to be updated in accordance with State Executive Order 569 and the Massachusetts State Hazard Mitigation and Climate Adaptation Plan (SHMCAP). These state-level initiatives can provide valuable guidance and direction to local governance in their pursuit of effective climate adaptation. To enhance the city's approach further, consideration should be given to FEMA's guidance, as explored in Chapter 2. This guidance offers additional tools and methods to integrate cultural resources into a preservation-sensitive approach for hazard mitigation and adaptation planning.

Cultural resource vulnerability assessments can serve as a vital starting point for the climate adaptation process. Presently, the City of Salem employs the statewide probabilistic coastal flooding model assessment prepared by the Woods Hole Group, which is widely accepted across the state. While this model offers a standard dataset for evaluation of flood

hazards, it falls short in specifically identifying historic resources at risk or assessing their level of exposure. As a result, the City's current focus on larger-scale structural adaptation strategies, such as those in Collins Cove, North River, and Palmer Cove, is crucial for protecting significant areas of the population. However, these efforts overlook the potential risks faced by historic resources.

The absence of vulnerability assessments for historic resources also prohibits the determination of preservation priorities within the broader Climate Change agenda. Additionally, both the State and local Historic Preservation Plans emphasize the importance of maintaining and updating historic resource inventories through continuous survey documentation and assessments. To address this gap, it is possible to combine evaluation and assessment efforts to gather a more extensive and comprehensive dataset and tools for adaptation, which can be utilized by decision-makers and stakeholders to make informed choices. Additionally, this integrated approach can act as an effective communication tool, enabling groups like Salem Preservation Partners to grasp the economic and communal value of these resources and determine preservation priorities.

The ongoing adaptation efforts within the city reveal a lack of local legislation and planning to adequately support adaptation and preservation programs through collaboration, funding, guidance, and review. There is a pressing need for a cohesive approach that harmonizes preservation and adaptation, streamlining permitting processes and securing funding opportunities to facilitate smoother project implementation. Despite these challenges, the efforts operating within distinct sectors are setting important precedents for collaborative adaptation practices involving multiple stakeholders.

The House of Seven Gables, was successful in establishing partnerships with other preservation organizations to collectively make a case and tap into State-level funding sources, creating new avenues to access the substantial capital necessary for preservation and adaptation efforts. The project thus sets precedent for projects that intend to accomplish such detailed assessments of historic sites. The assessment itself is expected to establish a standard framework within the local context that can encourage the City to take on such assessments of historic resources at risk.

These efforts also emphasize the efficacy of neighborhood-scale strategies within the context of Salem. By focusing on community-level interventions, these initiatives address the specific needs of targeted demographics with limited built resources. This context-specific approach promotes collaborative decision-making and facilitates the implementation of actions within shorter timeframes, making it highly effective in addressing climate hazards and their escalating threats. The *Resilient Together: The Point* initiative successfully proves these claims with strategies that specifically integrate climate adaptation with solutions to the communities more pressing issues, including affordable housing, unemployment, and economic redevelopment. Presumably, such neighborhood scale plans could more effectively integrate the local historic resources and its significance to the community, tailoring adaptation and mitigation recommendations that maintain the historic character, integrity and setting of the resource.

To enhance Salem's climate adaptation strategies and preservation efforts, a comprehensive approach is essential. This includes the enactment of necessary policy measures, integrating climate adaptation and resiliency requirements into building codes and performance standards, and most importantly, extending protection to historic and cultural

resources within vulnerable areas. Furthermore, fostering interagency collaboration and resource allocation will foster a more integrative and effective planning process for the benefit of the city and its valuable heritage. Adopting a more holistic perspective that aligns with regional and state priorities and incorporates cultural preservation considerations, Salem can ensure a more resilient and sustainable path forward in combating the challenges posed by climate change.

By establishing a supportive framework that fosters collaboration, provides adequate funding, offers guidance, and ensures thorough review processes, Salem can strengthen its adaptation and preservation programs. This comprehensive approach will enable the city to effectively respond to climate challenges while safeguarding its distinct identity and character.

CHAPTER IV:

FINDINGS AND RECOMMENDATIONS

Introduction

Adaptation planning of historic resources in vulnerable coastal areas is now a critical part of historic preservation, as it threatens the historic significance, integrity of the property as well as the very existence of the resource. The decision-making frameworks for the historic resources, however, differ from the corresponding frameworks for non-historic properties, as they have unique needs with respect to the preservation of their significance and context. Thus, supplemental policies, legislation and actions are required to support the adaptation efforts.

The final chapter summarizes the findings of this thesis's research on current adaptation practices for historic resources and the planning framework of the case study site, identifying relevant aspects of the existing preservation legislation that require reforms for the effective integration with adaptation planning considerations. These findings present the opportunities and constraints within the existing framework, making recommendations for actions that can holistically promote adaptation of historic resources. It further applies these recommendations to the case of the City of Salem that, based on the research in Chapter 3, determines four targeted strategies for implementation to safeguard the historic resources at risk within the city.

Policy and Planning Reforms

Current adaptation planning guidance and recommend various actions to exercise strategies within the existing hazard mitigation and resiliency planning efforts. However,

there are limited planning policies within existing city legislation to support the implementation of these actions. While several cities have established laws to address sea level rise issues faced by structures in the floodplain zone, including building code elevation requirements, zoning district overlays, site design review, they rarely include cultural resource considerations to support and incentivize the adaptation of historic resources. More importantly, the preservation laws do not recognize climate change impacts as a potential threat to historic resources they ought to protect.

Integrating adaptation planning within existing preservation legislation requires a comprehensive set of planning policy reforms to address the unique challenges posed by historic resources in the face of climate change. Strengthening existing land-use and zoning policies through building codes, zoning codes and regulations, and performance standards that recognize historic resource considerations and encourage appropriate rehabilitation and rebuilding especially after a hazard event is essential. Additionally, the legislation governing preservation needs to be amended in order to explicitly acknowledge the effects of climate change and the pressing need for adaptive measures to safeguard historical sites.

To achieve a comprehensive approach, it is first imperative to promote collaboration among relevant stakeholders, such as governmental institutions, preservation organizations, and local communities. This means putting in place procedures for effective communication and engagement, providing every stakeholder an opportunity to have their opinion. Incentives for private property owners to make investments in resilient solutions for historic properties may be included, as well as clauses that give funding for adaptation initiatives top priority. In order to effectively inform decision-making processes, policy reforms should promote the integration of climate research and historic preservation expertise.

Strengthening monitoring and data collection mechanisms will also be critical for assessing the vulnerabilities of historic resources to climate-related threats and identifying appropriate adaptation strategies. Ultimately, the goal should be to strike a balance between safeguarding the unique cultural heritage of historic sites while ensuring their long-term viability in the face of changing climatic conditions.

Socio-Economic Considerations

Integrating adaptation planning of historic resources within existing preservation legislation should take into consideration various socio-economic considerations to ensure that the preservation efforts are equitable, sustainable, and beneficial for all stakeholders involved. Climate or environmental justice is a crucial aspect that must be taken into account while integrating adaptation planning for historic resources within existing preservation legislation. Historically marginalized and disadvantaged communities often bear the brunt of climate change's adverse effects due to various factors such as socio-economic disparities, limited access to resources, and unequal political power. These communities may be more likely to reside in areas with higher exposure to climate-related risks, including coastal regions prone to flooding, low-lying areas susceptible to sea-level rise, or regions facing extreme weather events. When formulating adaptation plans, decision-makers must prioritize efforts in areas with a high concentration of vulnerable populations and empower these communities to become active stakeholders. Vulnerability assessments should consider socio-economic factors, demographic characteristics, and historical injustices to determine the extent of vulnerability.

Policymakers require to be aware of the potential impact of adaptation measures on local communities within historic districts. Displacement or gentrification that may result

from adaptive actions, could disproportionately affect vulnerable populations. Preservation efforts should thus prioritize equitable access to historic sites and their benefits for all members of the community. Engaging with communities during the planning process and incorporating their perspectives and needs will foster a sense of ownership and commitment to the preservation efforts. Involving local communities in the adaptation planning process is crucial. Their traditional knowledge, cultural values, and lived experiences can provide valuable insights into the significance of historic resources and potential climate threats.

Adaptation measures can come with costs, and these expenses may place a burden on property owners and communities. Adaptation actions, therefore, should consider providing financial assistance or incentives to support the implementation of climate-resilient measures, particularly for low-income property owners and historic sites of public interest.

Local-Level Legislation

Regional variations in sea level rise scenarios affecting relative sea level rise trends, demand localized solutions that cater to the contextual vulnerabilities. Within the preservation planning framework, however, historic resources are provided with the highest level of protection at the local level of legislation. Essential reforms to the existing local preservation ordinance warrant the most pragmatic and context-sensitive approach to integrate adaptation planning within existing preservation frameworks. It thus presents an opportunity to create a robust framework that combines climate science, preservation expertise, legal regulations, community engagement, and adaptive strategies.

The first step to this approach would require the designation of resources at risk as local landmarks and historic districts that provides an overlay of historic resource protection. It is also imperative to have an exhaustive inventory of the locally designated historic

resources that is duly updated from time to time. The inventory provides the foundation for conducting comprehensive climate impact assessments tailored to historic sites. These assessments identify the specific climate-related risks and vulnerabilities faced by these sites, such as flooding, sea-level rise, storm surge. Collaborating with climate scientists, preservation experts, and local communities ensures a holistic understanding of the challenges and opportunities for preserving cultural heritage in the face of climate change.

Local preservation legislation must be updated to explicitly address the challenges of climate change and the importance of adaptation planning for historic resources. By revising preservation regulations and guidelines, local authorities can incorporate provisions that prioritize climate resilience in all restoration or development projects affecting historic sites. These updated regulations may mandate the use of climate-resilient materials, construction techniques, and design principles that ensure the long-term protection and sustainability of historic structures. The integration of climate considerations into preservation regulations enhances the legal framework for preserving cultural heritage in the context of a changing climate.

To ensure a cohesive and systematic approach, local preservation plans must integrate climate adaptation goals and strategies. By incorporating climate resilience as a central consideration in preservation plans, local authorities can ensure that preservation efforts align with adaptation objectives. This involves setting clear targets for preserving historic resources in the face of climate change, outlining specific measures to enhance resilience, and allocating necessary resources for implementation. Integrating adaptation into preservation plans reinforces the commitment of local communities to safeguard their cultural heritage and strengthens their preparedness for climate-related challenges.

Role of State and Federal Governments

At the local level, the integration of adaptation planning for historic resources within existing preservation legislation is greatly bolstered by the crucial support of federal and state governments. Their involvement plays a pivotal role in enhancing the effectiveness and success of adaptation initiatives aimed at safeguarding cultural heritage in the face of climate change. Several key roles undertaken by federal and state governments contribute significantly to this collaborative effort.

Firstly, federal and state governments provide vital funding and resources to support local adaptation planning endeavors. Financial assistance in the form of grants, subsidies, or low-interest loans eases the financial burden on local communities, enabling them to implement climate-resilient preservation projects effectively. By allocating resources to conduct comprehensive climate impact assessments, research, and data collection, higher-level authorities facilitate the identification of climate-related risks and vulnerabilities of historic resources. These critical funds and resources empower local communities to take proactive steps in preserving their cultural heritage amidst the challenges of a changing climate.

Secondly, federal and state agencies offer invaluable technical assistance and expertise to support local adaptation planning efforts. Collaborating with local authorities and preservation experts, higher-level entities provide specialized knowledge in climate science, preservation practices, and adaptation strategies. By guiding local stakeholders in conducting robust climate impact assessments, federal and state governments ensure that the assessment process is scientifically grounded and able to identify potential climate-related

threats accurately. This technical assistance empowers local communities to make informed decisions and implement climate-resilient measures effectively.

Supporting capacity building and training programs is another important contribution played by federal and state governments in promoting adaptation planning at the local level. By organizing workshops, seminars, and educational initiatives, higher-level authorities equip local stakeholders with the skills and knowledge necessary to integrate adaptation strategies into preservation planning. These capacity-building efforts may include training sessions on climate-sensitive restoration techniques, disaster preparedness, and sustainable practices. By empowering local communities with expertise, federal and state governments foster a sense of ownership and commitment to climate-resilient preservation efforts.

In addition to providing technical assistance, federal and state governments play a pivotal role in facilitating coordination and collaboration among various stakeholders involved in adaptation planning. As intermediaries, they connect local communities with relevant resources, expertise, and networks to foster a cohesive and integrated approach. Government agencies facilitate partnerships between preservation organizations, climate scientists, non-profit groups, and local authorities. Such collaborations enhance the exchange of knowledge, best practices, and lessons learned, creating a more robust and comprehensive adaptation strategy.

Moreover, federal and state governments should extend critical policy and legislative support to integration efforts. By incorporating adaptation requirements into preservation laws and policies, higher-level authorities create a strong legal framework that guides and incentivizes local authorities in their climate-resilient preservation endeavors. These supportive policies may include tax incentives for property owners implementing adaptive

measures or regulations that prioritize climate resilience in restoration projects affecting historic resources. Clear and enforceable policies reinforce the commitment to preserving cultural heritage in the face of climate change.

Federal and state governments possess valuable climate data and research findings that can benefit local communities in their adaptation planning. They establish databases and platforms where climate data and research are accessible to local stakeholders. By sharing relevant information, higher-level entities empower local authorities to make informed decisions based on the latest climate projections and trends. Research sharing also enables local communities to learn from successful adaptation initiatives implemented elsewhere, fostering innovation and effective strategies.

Recommended Adaptation Strategies – Salem, MA

Strategy #1: Intensive-level survey documentation and assessment of historic resources in the flood risk area.

Documentation and assessment of the historic and cultural resources at risk should help establish preservation priorities based on the historic significance, on-ground conditions and potential vulnerability to hazards, community value of the resources and the cost of their loss, replacement, or repair due to a hazard event. The survey should thus go beyond the local level historic survey forms, to include physical, economic, and social conditions by undertaking the following actions:

Action #1: Complete and update the intensive level survey documentation for historic properties in the flood risk area.

Action #2: Conduct a non-structural mitigation assessment at the property level to identify the vulnerability of individual resources and suggest mitigation approaches.

Action #3: Determine the overall community and economic value through district-wide assessments of historic resources at risk.

Action #4: Develop a GIS map and general inventory recording the outcomes of the assessments to ensure accessibility to citizens, private property owners, business owners, government officials and other stakeholders.

The exposure analysis determining the federal and locally designated historic resources at risk of the three exposure indicators, flooding, storm surge, and sea level rise, can serve as a starting point to the above actions. It is crucial to include all the prioritized hazards, rather than focusing on only on a single hazard for each survey. The data sources and methodology should also be standardized across the city, to create a coherent compilation of information, that decision-makers and stakeholders can utilize to establish preservation priorities. FEMA's guidance on assessing risks, recommends, at the minimum, collecting the following information on historic resources:

1. Name and Address/Location of Asset Subject to Hazard.
2. Date of Construction/Creation.
3. Type of Property/Type of Resource.
4. Square Footage.
5. Structural System.
6. Primary Material(s) of Property/Primary Materials of Resource.
7. Current Function (for Properties).
8. Current Condition; and

9. Building Characteristics (for Properties) (Building Type/Type of Foundation, Roof Materials, Roof Construction, Vegetation, Topography, Distance from the Hazard Zone).

Goals & Objectives Addressed:

- Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services. (HMP Update 2020)
- Lead a vulnerability assessment of historic neighborhoods. (BD-8, Beverly & Salem: Resilient Together Action Plan, 2021)
- Evaluation of Buildings for Floodproofing Opportunities (34-O, Ready for Tomorrow, 2014)
- Work with preservation partners to identify historic resources at risk from climate change, including City-owned resources and resources at Bakers Island, the Salem Maritime Site and House of Seven Gables. (Salem Preservation Plan Update 2015)
- Commission a planning study that focuses specifically on Salem's historic resources most at risk from rising sea level. (Salem Preservation Plan Update 2015)

Resources and Precedents:

- In Annapolis, Maryland the USACE prepared the *Nonstructural Mitigation Assessment for the City of Annapolis Historic District* in 2014 of 16 prototypical properties in the study area in conjunction of their elevation analysis of 147 structures. These buildings include both frame and masonry construction, detached and party-wall buildings, and residential and commercial uses.

- The National Nonstructural Committee (NNC) at the USACE also provides how-to guidance on conducting assessments along with survey form formats through their *Field Guide fir Conducting Nonstructural Assessments (May 2019)* and the *Nonstructural Flood Risk Management Matrix User Guide (May 2019).*
- FEMA's *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning (2005)* provides complete guidance on conducting community and economic value analysis for historic resources at risk. *Worksheet #2 Determine Extent and Value of Historic Properties, Worksheet #3 Inventory Historic Property and Cultural Resource Assets* and *Worksheet #4 Determine Community Value for Historic Property and Cultural Resource Assets* in the guidebook provides a set format to conduct a successful assessment.
- In 2017, Portsmouth, New Hampshire developed a Historic Resource Valuation and Risk Assessment Map by integrating quantitative data (e.g., flood elevation, topography, structure-type, and economic value) with the qualitative data (e.g., historic survey forms, National Park Service designations). Supported by funding from the National Park Service (NPS) under the Hurricane Sandy Pre-Disaster Mitigation grant program the State of New Hampshire Division of Historic Resources, the mapping was also published as a GIS database making it accessible to the community.

Strategy #2: Historic District Design Guidelines with Preservation Sensitive Flood Adaptation Methods

The Salem Historical Commission Guidelines Notebook published in 2022, provides the most updated standards and guidelines on preservation of historic resources within local

historic districts, based on established preservation practice and philosophy in the Secretary of the Interior's Standards for the treatment of Historic Properties. The updated guidelines incorporate sustainable building practices including energy retrofits and alternative materials; however, it does not address adaptation methods within historic buildings.

Mitigation adaptation measures employed in historic buildings must be sensitive to the character and context of the resources. Thus, it is imperative to develop specific guidelines that cater to the basic property and resource protection for historic resources at risk. This includes retrofitting, rehabilitation, wet and dry floodproofing, elevating the structure or relocation. The following actions should therefore be performed to ensure that adaptation measures undertaken are historically appropriate and pro preservation:

Action #1: Develop design guidelines for preservation-sensitive flood adaptation of historic properties and archaeological resources in Salem, accepted by FEMA as compliant with the floodplain management regulations and the Secretary of the Interior's Standards for Rehabilitation.

Action #2: Update the Historical Commission Guidelines Notebook to incorporate adaptation techniques identified in action #1 and other best practices in SLR adaptation and mitigation.

Action #3: Review and evaluate preservation-sensitive methods for flood adaptation, and revise City's building code to require such methods for flood-proofing designated historic properties in the flood risk area.

While the design guidelines focus on treatments to individual properties, it is also crucial to document recommendations on hard and soft adaptation methods that affect the neighborhood's significance and character. Contributing features such as landscaping,

outbuildings, alleyways, orientation, and setback historic buildings often shared between historic buildings often help to distinguish the scale and character of the historic district. Adaptation and mitigation actions should thus be sensitive to the historic context, as well, and should be addressed within historic district guidelines.

Goals & Objectives Addressed:

- Prevent and reduce the loss of life, injury, public health impacts and property damage resulting from all identified natural hazards. (HMP Update 2020)
- Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services. (HMP Update 2020)
- Adopt and enforce updated building codes. (37-O, Ready for Tomorrow, 2014)
- Implement energy efficiency upgrades, renewables, and resilience improvements in all municipal properties. (BD-7, Beverly & Salem: Resilient Together Action Plan, 2021)

Resources and Precedents:

- In 2021, the National Park Service released the illustrated version of *The Secretary of The Interior's Standards for Rehabilitation & Guidelines on Flood Adaptation For Rehabilitating Historic Buildings,* that is the only guidance provided at the federal level dealing with the adaptation of historic buildings. The document should be a required source in the establishment of any adaptation related design guidelines.
- At the regional level, Miami-Dade County released *Resilient Rehab: A Guide for Historic Buildings in Miami-Dade County,* which serves as the design guidebook for

historic buildings within the region, with an additional chapter on resiliency methods and strategies.

- Boston's *Resilient, Historic Buildings Design Guide* provides an excellent example of the formulation and representation of local level design guidelines. Published in 2018, the document focuses only on resiliency and provides a complete how-to guide on identifying risks and the appropriate adaptation strategies from within the guide.

Strategy #3: Update to local historic districts and Climate Resiliency Overlay District

Overlay zoning is an efficient tool to target particular properties or locations that meet the criteria, such as flooding susceptibility; mainly because the effects of storm surge and flooding often do not affect the entire jurisdiction. In Salem, historic resources are currently protected by the Historic Districts Overlay in compliance with MGL Chapter 40C. This Overlay district, however, does not incorporate the federally designated cultural resources at risk located along the shoreline and most vulnerable to the effects of sea level rise. Additionally, the Flood Hazard Overlay District (FHOD) which is currently in the process of being amended to the Climate Resiliency Overlay district (C-ROD). It is built from recent resiliency related initiatives including the *Beverly & Salem Resilient Together Climate Action & Resilience Plan*, the *Resilient Together: The Point* initiative, and the wetlands protection ordinance update. The amendment considers waivers from the provisions of the ordinance through a special permit process for historic buildings. It also recommends inputs from The SHC in the approval process for historic buildings within the overlay district. However, the process still doesn't ensure the conformation of adaptation strategies to preservation standards, especially for the majority of resources at risk that are not locally designated.

The thesis therefore proposes updating the current local preservation ordinance in order to designate more local historic districts based on the resources at risk from climate change. Climate Resiliency Overlay Districts that include the locally designated historic and cultural resources at risk from all climate hazards would thus fall directly under the purview of the Salem Historical Commission. The SHC Review is therefore imperative to determine if proposed adaptation methods for buildings within the Overlay District are in compliance with the design guidelines or is employing the best methods possible in weighing preservation priorities and the protection of the resource. Furthermore, the Overlay district can implement other zoning approaches within the district including:

1. Downzoning: Limit the type of new development or requiring that more intense users obtain special use permits.
2. Increased setbacks: apply erosion based or tiered setbacks for waterfront properties.
3. Increased freeboard: require additional freeboard consistent with estimates for projected SLR.
4. Limits to building size and density allowances: requires smaller, or less dense development that would be allowed by the base zoning.

The following actions should be undertaken to administer the "Climate Resiliency Overlay District" in historic districts:

Action #1: Amend the Historic Preservation Ordinance and HPC Rules of Procedure to designate a higher number of local historic districts including Point Neighborhood, Salem Willows, and Bridge Street Neck, including all significant properties at risk. Risks should

not only be analyzed based on the FEMA Flood Insurance Rate Maps, but also accounts for other flooding hazards, such as storm surge and permanent inundation.

Action #2: Update the Zoning ordinance to encourage and incentivize hazard mitigation and flood adaptation techniques and provide historic tax credits for adaptation and mitigation actions.

Action #3: Develop a process for expedited review and amend HPC & related zoning review procedures and rules for post-disaster recovery from declared disaster events.

Goals & Objectives Addressed:

- Prevent and reduce the loss of life, injury, public health impacts and property damage resulting from all identified natural hazards. (HMP Update 2020)
- Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services. (HMP Update 2020)
- Increase cooperation and coordination among private entities, City officials and Boards, State agencies and Federal agencies. (HMP Update 2020)
- Encourage and incentivize property owner participation in deep energy retrofits. (BD-1, Beverly & Salem: Resilient Together Action Plan, 2021)
- Establish overlay zoning district(s) that establish minimum flood resilience design standards for new construction and existing buildings. (BD-6, Beverly & Salem: Resilient Together Action Plan, 2021)
- Limit or restrict development in future flooding areas. (40-O, Ready for Tomorrow, 2014)
- Improve land use planning and regulations. (41-O, Ready for Tomorrow, 2014)

Resources and Precedents:

- Although there are no direct precedents to Flood Hazard Overlay Districts catering specifically to Cultural resource, the City of Boston's Article 25A Coastal Flood Resilience Overlay District (CFROD), adopted into the Zoning Code in October 2021, serves as an important resource.
- The Annapolis Case study presented in Chapter 2 of this thesis also mentions the *Model Sea-Level Rise Overlay Zone: For Maryland Local Governments* outlines two sub-districts for areas subject to frequent flooding and storm surge that could have some applicability in Annapolis, namely the "Floodplain Conservation District" (FCD) for highly vulnerable areas with sensitive natural resources would limit and restrict redevelopment. The second sub-district, the "Floodplain Accommodation District" (FAD), would be designed to allow for continued development while "requiring that structures be sited and built to be more resilient to impacts.

Strategy #4: City-wide Demonstration Projects

Based on the preservation priorities established by the intensive-level survey documentation and assessment, the SHC should identify structures and group of structures considered to be of high value both economically and culturally in defining the historic context of Salem. These structures should then be the locus of demonstration projects in collaboration with city agencies and preservation partners in an attempt to exhibit model design of preservation-sensitive adaptation and mitigation methods. The projects, in turn, would comply with the necessary zoning codes, and design guidelines, and be documented through every stage, to set a local precedent for successful mitigation. Whilst demonstration

projects are rather successful on a property scale as the targeted scope of work is relatively smaller within a practical time frame, passive neighborhood-scale resilience strategies can also be undertaken within the context of a historic district. Accordingly, the following actions should be exercised to pursue demonstration projects:

Action #1: Identify potential historic resources to serve as demonstration projects and discuss findings with community and other stakeholders through workshops that provide public input in decision making.

Action #2: Owners of these significant historic structures that have been identified as having high community value, are to be solicited to volunteer to take part in demonstration projects.

Action #3: Explore sources of planning and Capital funding or alternate tax credit cost mitigation, for implementation of high priority demonstration projects at the city, state and national level.

Action #4: Thoroughly document all efforts undertaken through the entire planning and implementation phases and make them accessible to the public.

At Salem, the ongoing assessment study of the House of Seven Gables is perceived as a model demonstration project for the city to carry out further assessment of all neighborhoods along the shoreline. However, there have been no active implementation projects that demonstrate the adoption of adaptation and mitigation measures methods that comply with FEMA regulations and maintain the historic character.

Goals & Objectives Addressed:

- Build and enhance local mitigation capabilities to ensure individual safety, reduce damage to public and private property and ensure continuity of emergency services. (HMP Update 2020)
- Increase cooperation and coordination among private entities, City officials and Boards, State agencies and Federal agencies. (HMP Update 2020)
- Increase awareness of the benefits of hazard mitigation through outreach and education. (HMP Update 2020)
- Commission a planning study that focuses specifically on Salem's historic resources most at risk from rising sea level. (Historic Preservation Plan Update 2015)
- Encourage and incentivize property owner participation in deep energy retrofits. (BD-1, Beverly & Salem: Resilient Together Action Plan, 2021)
- Host, promote, and invest in training and collaborative learning for municipal staff, boards/commissions, and building industry partners to support energy efficiency and decarbonization practices, from design to ongoing maintenance. (BD-5, Beverly & Salem: Resilient Together Action Plan, 2021)
- Evaluation of buildings for flood proofing opportunities. (34-O, Ready for Tomorrow, 2014)
- Flood proof buildings to protect the existing buildings, critical systems and equipment. (42-O, Ready for Tomorrow, 2014)

<u>Resources and Precedents:</u>

- The City of Charleston in collaboration with the Preservation Society of Charleston has undertaken several demonstration projects that have opted to elevate vulnerable historic properties over the base flood elevation, by employing suitable measures to

maintain historic context and integrity. 113 Calhoun Street, a 125-year-old, three-story house that stands in the heart of the downtown historic district of Charleston, South Carolina, is an example of such an effort. Vulnerable to damage from multiple hazards (including coastal storms, earthquakes, and flooding), the regional "single house" style was abandoned for several years before Hurricane Hugo struck in 1989, and the structure was in danger of collapse by 1997. Instead of demolishing the building, though, the City of Charleston donated it to the 113 Calhoun Street Foundation, a non-profit partnership, who converted the abandoned structure into an educational facility showcasing low-impact, sustainable-living design principles. FEMA provided the primary funding for the initial building, with additional assistance from the private sector coming in the form of gifts of goods and services. It was found that elevating 113 Calhoun Street over the BFE would not have been appropriate. Such proposed elevation would have lifted the structure by more than 5 feet, which was out of character for the historic district's streetscape and character. Instead, the company simply raised the house by one foot while making numerous other inside and exterior changes to make it safer.

Conclusion

In addressing the initial problem statement, the study, therefore, recommends specific actions, such as developing design guidelines, updating local preservation ordinances, and creating demonstration projects to showcase successful preservation-sensitive adaptation and mitigation methods in Salem. These efforts are essential to protect the historical and cultural significance of vulnerable areas like Salem, while integrating climate change considerations into preservation practices. It also underlines the need for

comprehensive exposure analysis and standardized data collection to inform decision-making and prioritize preservation efforts. Overlay zoning and zoning code amendments are essential tools in incorporating climate change considerations and adaptation strategies for historic resources.

It is also imperative for stakeholders, including state and federal governments, preservation organizations, and local communities, to work together in a cohesive and proactive manner to safeguard historic resources from the impacts of climate change. In the case of Salem, the recommended adaptation strategies are intended to provide the city Preservation Planner and SHC with the sole responsibility of decision-making in regard to adaptation strategies. However, the local government, with limited resources, personnel and expertise, requires the state legislature to support the efforts by providing the necessary technical assistance. Such actions align with the State's Climate Action Plan objectives as well as the State's Preservation Plan. By following the recommended actions and integrating adaptation planning within existing preservation legislation, a sustainable and holistic approach can be achieved, preserving the unique cultural heritage of vulnerable coastal areas for future generations.

The chapter therefore concludes the thesis highlighting the critical importance of adaptation planning for historic resources in vulnerable coastal areas, as they face threats to their integrity and existence due to climate change impacts. The unique preservation needs of historic resources necessitate supplemental policies, legislation, and actions to support effective adaptation efforts. The text emphasizes the significance of considering socio-economic factors, environmental justice, and collaboration among stakeholders in the planning process.

CONCLUSION

The thesis has delved into the pressing issue of integrating climate change adaptation practices within historic preservation planning to address the impacts of sea-level rise on historic and cultural resources. The research has shed light on the alarming rise in sea levels and the hazards it poses to historic coastal cities, emphasizing the need for proactive adaptation planning that intersects with preservation concerns. Historic resources hold immense cultural value, representing a community's identity, history, and traditions, making their preservation vital for cultural heritage continuity. Additionally, these landmarks play a crucial role in the economic vitality of coastal communities, attracting tourism and supporting local economies. Preserving historic resources also fosters social cohesion and community identity, contributing to overall community resilience in the face of environmental challenges.

The study has highlighted the importance of localized adaptation strategies that consider regional variations and contextual vulnerabilities of historic coastal sites. Site-specific assessments and stakeholder engagement have been emphasized as critical components of effective adaptation planning to protect historic resources from immediate sea-level rise risks. By incorporating flexibility, compliance with local regulations, and timely responses, local adaptation planning ensures the preservation of historic resources for future generations and supports the sustainable development of coastal communities. The study has further discussed the transition from climate change awareness to actual planning and implementation of adaptation strategies. Various international, governmental, and local organizations, along with scientific studies and climate activists, have contributed to a broadened understanding of climate change adaptation, leading to increased responses and

guidance for implementation. The research has also explored the role of federal agencies such as FEMA and NPS in providing guidance and tools for integrating cultural resource considerations into hazard mitigation and adaptation planning.

Through the case study of Salem, Massachusetts, the thesis has identified the challenges faced by historic coastal cities in integrating preservation considerations into adaptation planning. The lack of interagency coordination, personnel, and resources within the city agencies has hindered a more integrated approach that encompasses preservation considerations. However, efforts within distinct sectors have set important precedents for collaborative adaptation practices, especially through neighborhood-scale strategies. The research has underscored the need for a cohesive approach that harmonizes preservation and adaptation, streamlining permitting processes and securing funding opportunities to facilitate smoother project implementation. To enhance Salem's climate adaptation strategies and preservation efforts, the thesis recommends specific actions, such as developing design guidelines, updating local preservation ordinances, and creating demonstration projects. These efforts are essential to protect the historical and cultural significance of vulnerable areas like Salem while incorporating climate change considerations into preservation practices. Additionally, fostering collaboration among stakeholders and aligning with regional and state priorities will ensure a more resilient and sustainable path forward for the city.

In conclusion, the findings of this thesis underscore the critical importance of adaptation planning for historic resources in vulnerable coastal areas. By integrating climate change considerations within existing preservation legislation and policies, we can effectively preserve and protect the unique cultural heritage of historic coastal cities for

future generations. It is imperative for stakeholders, including governments, preservation organizations, and local communities, to work together proactively in safeguarding these invaluable resources from the impacts of climate change. As the challenges of climate change continue to evolve, ongoing research, collaboration, and adaptive management will be crucial in preserving and protecting historic resources for the benefit of both present and future generations.

While this study has sought to provide valuable insights into the integration of climate change adaptation practices within historic preservation planning to address the impacts of sea-level rise on historic and cultural resources, it is essential to acknowledge its limitations and omissions. Firstly, the research primarily focused on the Atlantic Coast in the United States, particularly with the case study of Salem, Massachusetts. As a result, the findings may not be fully representative of the challenges faced by historic resources in other coastal regions along the Gulf Coast and west coast that are also vulnerable to sea level rise. A more extensive geographical scope could have provided a more comprehensive understanding of the implications of sea-level rise on cultural heritage.

Additionally, the study predominantly examined adaptation planning efforts at the federal, state, and local levels within the United States. While the inclusion of case studies from Florida and Annapolis contributed valuable insights, the exclusion of examples from other countries limited the cross-cultural comparison of adaptation strategies. Exploring international best practices in climate change adaptation for historic preservation could have enriched the analysis and offered a broader perspective on effective approaches.

Moreover, the thesis primarily focused on the integration of climate change adaptation within the existing framework of historic preservation planning. While this approach is essential for enhancing resilience, the study did not extensively explore the potential conflicts or trade-offs between adaptation measures and preservation principles. Investigating instances where adaptation strategies might inadvertently impact the authenticity and integrity of historic resources could have provided a more nuanced perspective on the challenges faced during implementation.

Lastly, due to the evolving nature of climate change research and preservation practices, the study's findings and recommendations are subject to the knowledge available up to the time of the research, which is subject to change as new data and approaches emerge. Continuous advancements in climate science and preservation methodologies may necessitate updates and revisions to the proposed strategies over time.

Building on the insights and findings presented in this thesis, there are several potential avenues for further research that could expand on this topic. Conducting comparative case studies of other coastal regions and historic sites, both within the United States and internationally, would provide a broader perspective on adaptation challenges and solutions across diverse contexts. These studies could assess how different geographical, cultural, and regulatory factors influence the effectiveness of adaptation strategies. Additionally, engaging with a wider range of stakeholders, including local communities, indigenous groups, and preservation practitioners, would allow for a more inclusive and community-centered approach to adaptation planning. Exploring the social and cultural impacts of climate change and adaptation measures on communities and cultural identities could enrich our understanding of the complexities involved in preservation efforts.

APPENDIX

Impacts of Sea Level Rise on Historic Resources:

Exposure Mapping and Analysis of Historic Districts in Salem, MA

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CRP 5080 Introduction to GIS Planners

Spring 2023

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Introduction:

The research paper focuses on the city of Salem, Massachusetts, as the site for conducting an exposure analysis, predominantly a GIS exercise, which lays the groundwork for a comprehensive climate change vulnerability assessment. Known for its rich history in trade and maritime, federal style architecture and cultural heritage assets, the study aims to investigate the impact of sea level rise and other coastal hazards on individual structures within both National Register historic districts and local historic districts.

The methodology employed for this study is derived from the National Park Service's *Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment Protocol*, published in 2022. This protocol serves as a comprehensive framework for evaluating the susceptibility of coastal areas to climate change impacts. To conduct the exposure analysis, three key exposure indicators will be utilized, that will be examined in conjunction with the spatial distribution and characteristics of the historic districts, to identify specific areas and structures that are particularly vulnerable to climate change impacts.

Thus, the research outcome will not only enhance understanding of the vulnerability of Salem's historic resources but also serve as a foundation for developing effective adaptation and mitigation strategies. By identifying the areas most at risk, stakeholders, preservation organizations, and local authorities can prioritize resources and implement targeted measures to safeguard the historical integrity and cultural significance of Salem's unique heritage.

Background:

Salem, Massachusetts, known for its rich history and intriguing past, is a city that boasts a remarkable array of historic resources. From its well-preserved architecture to its significant role in the Salem Witch Trials, Salem's historical heritage attracts visitors from around the world. The preservation and protection of these historic resources are of utmost importance to the community, both in terms of cultural significance and economic development.

Recognizing the exceptional historical significance of Salem's architectural and cultural assets, many sites within the city have been listed on the National Register of Historic Places. The National Register, administered by the National Park Service, is a prestigious

designation that acknowledges and protects historically significant properties throughout the United States. Salem's inclusion on this esteemed list helps to promote tourism, generate interest in the city's heritage, and attract investments. In addition to the National Register, Salem has established several local historic districts to safeguard its heritage at the community level. These districts, comprising cohesive neighborhoods with unique architectural styles and historical integrity, play a vital role in preserving the city's character. The establishment of local historic districts empowers communities to protect and maintain the architectural, cultural, and aesthetic attributes that define Salem's identity.

The historic resources of Salem hold immense value for the local community. They serve as tangible links to the city's past, fostering a sense of pride, identity, and cultural continuity. Historic buildings, monuments, and landscapes contribute to the overall quality of life, enhancing the visual appeal of the city and providing a living history that residents can experience and explore. These resources often serve as venues for community events, celebrations, and educational programs, promoting social cohesion and community engagement. Salem's historic resources are not only cherished by the community but also play a crucial role in driving economic development. Tourism, in particular, is a significant economic engine for the city, attracting visitors from around the world who come to experience Salem's unique historical ambiance. Historic sites, such as the House of the Seven Gables, the Peabody Essex Museum, and the Salem Maritime National Historic Site, draw tourists, generating revenue and supporting local businesses, including restaurants, shops, and accommodations.

While Salem's historic resources provide invaluable cultural and economic benefits, they face an imminent threat from sea level rise caused by climate change. As a coastal city, Salem is vulnerable to flooding and storm surges. Rising sea levels can cause significant damage to historic buildings and infrastructure, undermining the city's cultural and economic resources. The effects of climate change pose a significant challenge for the preservation of historic sites, and action is needed to protect these resources. Increased flood risks, erosion, and saltwater intrusion endanger the structural integrity of these assets, placing them at risk of irreversible damage or loss.

The City of Salem under the direction of the Department of Planning and Community Development attempted to undertake a vulnerability assessment as a part of its *2014 Climate Change Vulnerability Assessment and Adaptation Plan* which "investigates some of the most serious climate change impacts, the resulting stresses to different sectors in the City, and outlines project ideas to address some of the most critical issues."[1] With a goal to set adaptation priorities that can be incorporated not local policies and projects, the plan was based on the ICLEI approach in *Preparing for Climate Change: A Guidebook for Local, Regional and State Governments.*[2] The general steps of the plan included determining future climate change impacts, identifying affected sectors, prioritizing vulnerabilities, developing adaptation strategies and publishing the final adaptation plan. Thus, the plan accounts not only for sea-level rise but four most critical climate change impacts including storm surge and extreme precipitation on six sectors. Within this methodology, "historic and culturally significant buildings and areas" are identified as one of the components within the Critical Building Infrastructure sector. The vulnerability assessment carried out as part of this initiative treated it as function of the sensitivity to climate change and the adaptive capacity to climate changes where each component was ranked on a five-point scale. To further prioritize the vulnerable components the Plan undertakes a risk assessment based on four consequences, namely, economic, health and safety, cultural and historical, and ecological and environmental. This analysis along with another prescribed evaluation criteria outlined 17 vulnerable, stressed components to be addressed to increase the City's resiliency to climate change.[3]

While the plan serves as a valuable starting point for understanding the potential impacts of climate change in the city, the vulnerability assessment lacks a detailed level of data with an exposure analysis. The plan also fails to recognize the historic resources, structures and areas as assets at potential risk and to provide specific and localized information on the level of exposure. A comprehensive vulnerability assessment should include detailed maps, data on specific at-risk areas, and a thorough analysis of the potential impacts on critical infrastructure, historic resources, and vulnerable populations. Without these specifics, it

[1] City of Salem, *Ready for Tomorrow: The City of Salem Climate Change Vulnerability Assessments and Adaptation Plan* (Salem, Mass: City of Salem, 2014), 9

[2] City of Salem, *Ready for Tomorrow,* 10

[3] City of Salem, *Ready for Tomorrow,* 22

becomes challenging not only to develop targeted and effective adaptation strategies, but also to educate and engage the community about the potential threats of climate change and sea-level rise.

Through its ongoing efforts to address climate change impacts, the City of Salem is now in the process of preparing an amendment to the City's Flood Hazard Overlay District (FHOD) Special Permit zoning ordinance that proposes requirements for new and renovated buildings to be resilient to projected increasing future flood risk.[4] An exposure analysis is immensely prudent at such a stage to communicate to the population, especially for historic property owners, the level of risk posed to their assets, in turn encouraging informed decision making.

Literature Review:

As the threat of sea-level rise intensifies, it is becoming more imperative to assess coastal vulnerability and plan suitable adaptation methods. Vulnerability assessments are critical in this process because they provide specific climate input for a complete understanding of the imminent risks posed by sea level rise and facilitate informed decision-making in adaptation planning. The IPCC Sixth Assessment Report describes vulnerability as: "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity."[5] Generally based on future climate estimates and two or more scenarios of possible future conditions, vulnerability assessments often investigate the relationship between the exposure of resources to climate change and their sensitivity to that change. This potential impact of a climate hazard is then weighed against the ability of those resources to adapt to change.[6] Sensitivity is a way to assess how likely a species or system is to be affected by a given climate change hazard. Exposure is an indicator of how much a

[4] "Flood Resiliency Ordinance Public Forum | Salemma," Salem, March 27, 2023, https://www.salemma.gov/home/news/flood-resiliency-ordinance-public-forum.
[5] Intergovernmental Panel on Climate Change (IPCC), "Annex II: Glossary," in *Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK and New York, NY, USA: Cambridge University Press, 2022) pp. 2897-2930.
[6] "Assess Vulnerability," Climate Change, National Park Service, last updated October 20, 2021, https://www.nps.gov/subjects/climatechange/vulnerability.htm

species or system will likely be impacted due to climate change and related implications. Adaptive capacity refers to the potential for improving a species' or system's sensitivity or exposure.[7]

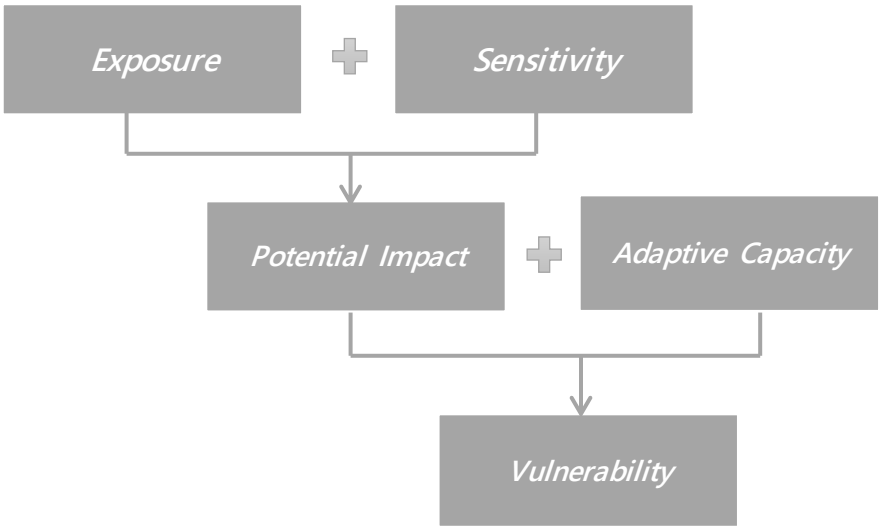


Figure 4: Key components of vulnerability, illustrating the relationship among exposure, sensitivity, and adaptive capacity. (Source: Glick et al., 2011)

While vulnerability assessments for natural systems have been created effectively, some components are less suitable for adoption in the context of built settings including historic and cultural resources. Structures, for instance, cannot organically adapt to climate change or other risks, although natural resources typically can.[8] As a result, the inherent adaptive capacity of a built resource cannot be factored in the methodology to carry out vulnerability assessments of historic assets. Recongnizing this, the National Park Service (NPS), a federal agency within the United States Department of the Interior that is responsible for managing

[7] Patty Glick, Bruce A. Stein, and Naomi A. Edelson, eds., *Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment* (Washington, DC: National Wildlife Federation, 2011), 19-20, https://www.fs.usda.gov/rm/pubs_other/rmrs_2011_glick_p001.pdf
[8] National Park Service, "Assess Vulnerability."

and preserving the country's national parks, monuments, historic sites, and other designated areas of natural and

cultural significance, provides a modified formula for the vulnerability of the built environment. While the adaptive capacity of an asset is not included in the vulnerability score as per the formula, it is still relevant and is evaluated separately.

Figure 5: Modified Vulnerability Assessment formula (Source: NPS, 2022)

Employing this methodology, the Park Service partnered with the Program for the Study of Developed Shorelines at Western Carolina University to create a *Coastal Hazards and Sea-Level Rise Asset Vulnerability Assessment Protocol* in 2022, which built on the previous 2016 protocol document. This protocol aims to establish "a standard methodology and set of best practices for conducting vulnerability assessments for coastal facilities." Standardization of the basic methodologies, process and data utilized in vulnerability assessments allows for park management to also compare the relative vulnerability of coastal parks across local, regional, and national levels.[9]

The first step dictated by this vulnerability assessment protocol is exposure analysis of NPS assets based on five exposure "indicators." i.e., flooding potential, shoreline change, sea-level rise inundation, extreme event flooding, and reported coastal hazards. All the exposure indicators adopted by the NPS Protocol are assessed to the year 2050, which is considered by park management as reasonable timeframe for adaptation planning for park assets. As exposure is directly dependent on location and site elevation, the analysis is predominantly a GIS exercise which is made available to park management in the form of a report summarizing the results. Data is used only from nationally available and consistent sources to allow for a direct comparison of relative exposure scores of one park to another.

[9] Katie McDowell Peek, Blair R. Tormey, Holli L. Thompson, and Robert S. Young, *Coastal hazards & sea-level rise asset vulnerability assessment protocol: Updated project description & methodology (*Fort Collins, Colorado: National Park Service, 2022), ix.

Indicator	Description	Common Data Sources
Flooding Potential	1% annual flood chance ± velocity/waves	Federal Emergency Management Agency flood zones (VE or AE); digital elevation models
Shoreline Change	Erosion, coastal proximity, or cliff retreat	Shoreline buffers derived from USGS, state, or NPS shoreline change data; cliff retreat rate buffers; shoreline proximity buffers
SLR Inundation	2050 scenarios	NPS-specific SLR modeling [A]; NOAA SLR projections & inundation model [B]; digital elevation models
Extreme Event Flooding	Storm surge, tsunami, or extreme high water	NPS-specific storm surge projections & models [A]; digital elevation models; NOAA SLOSH models [C]; digital elevation models
Reported Coastal Hazards	Historic flooding, visible slope instability	Park surveys/questionnaire results; storm imagery & reconnaissance

[A] Caffrey et al. 2018

[B] Sweet et al. 2017; 2022

Figure 6: Exposure Indicators and Common Data Sources (Source: NPS, 2022)

Each park asset is generally assigned a score of 4 or 1 for each of the five exposure indicators. Assets located within an exposure indicator zone receive a score of 4, while assets located outside the indicator zone receive a score of 1. The exposure evaluation system offers a binary scoring technique, with 4 being unfavorable and 1 being favorable, as higher overall scores indicate a higher level of exposure. This scoring structure is consistent with the Federal Highway Administration Vulnerability Assessment Scoring Tool, which uses a 1-4 numeric scoring system. A raw total indicator score is then calculated for each asset and categorized or binned into one of four exposure rankings based on the number of hazard zones as follows:

1. Minimal or no exposure - assets are not within any mapped zone.
2. Low exposure- asset is located in any one mapped zone.
3. Moderate exposure- asset is located in two or three mapped zones.
4. High exposure - asset is located in four or five mapped zones.

Exposure Analysis Data Results							
Definitions of WCU Columns on Next Sheet (Click Here to View)							
		Step 1: Score for Exposure Indicator Zones					
ID	Location	1a. FEMA VE Zone Score	1b. FEMA A Zone Score	1c. Shoreline Change Score	1d. SLR Score	1e. Extreme Flooding Score	1f. Historic Flood Score
1	Asset Name		4	1	1	4	4
2	Asset Name		1	1	1	4	1
3	Asset Name		4	1	1	4	1
4	Asset Name		4	1	1	4	4
5	Asset Name	4		1	1	4	4
6	Asset Name		4	4	1	4	4
7	Asset Name		4	4	1	4	4
8	Asset Name	4		1	1	4	4
9	Asset Name		4	4	1	4	4
10	Asset Name		4	1	1	4	4

Figure 7: A portion of an Exposure Analysis Data Results Excel sheet, showing an example of scoring for each exposure indicator (Source: NPS, 2022)

After final exposure are determined for each asset the sensitivity of the asset is calculated by a similar methodology based on 4 sensitivity indicators including flood damage potential, storm resistance & condition, historical damage, and protective engineering. This aspect of the process is not a spatial analysis, but rather is dependent on-site surveys, documentation, and institutional knowledge. Having obtained the exposure and sensitivity scores, the raw scores are calculated using a simple summation formula. The scores are then categorized or into final scores and rankings based on natural breaks, which are then reported within the Final Vulnerability Score and Final Rank columns of the Vulnerability Assessment Data Results Excel sheet.

Raw Score	Scoring Options	Final Score	Final Rank
7–8	high (4) exposure + high (4) sensitivity; high (4) exposure + moderate (3) sensitivity; moderate exposure (3) + high (4) sensitivity	4	High
6	high (4) exposure + low (2) sensitivity; moderate (3) exposure + moderate (3) sensitivity; low (2) exposure + high (4) sensitivity	3	Moderate
4–5	moderate (3) exposure + low (2) sensitivity; low (2) exposure + moderate (3) sensitivity; low (2) exposure + low (2) sensitivity	2	Low
1	minimal (1) exposure + null sensitivity	1	Minimal [A]

[A] Assets with a vulnerability score of 1 are those with minimal (or no) exposure.

Figure 8: Vulnerability scoring summary (Source: NPS, 2022)

Data Sources & Methodology:

The exposure analysis carried out in this study is based on the National Park Service's *Coastal Hazards & Sea-Level Rise Asset Vulnerability Assessment Protocol* that is discussed in the previous section. The study thus calculates the level of exposure of every individual historic asset within a historic district based on potential sea-level rise indicators. In contrast to the five indicators adopted in the NPS Protocol, this study evaluates the exposure posed by only three indicators, namely flooding potential, sea level rise inundation and extreme event flooding.

These indicators were chosen on the basis of data availability and limitations posed to conduct on-site data collection. The flowchart illustrated below organizes in sequence the steps adopted in this study to carry out an exposure analysis of the impact of sea-level rise to the historic and cultural resources within the city of Salem, MA. This methodology is further explained in detail with the steps followed in ArcGIS for data preparation and spatial analysis.

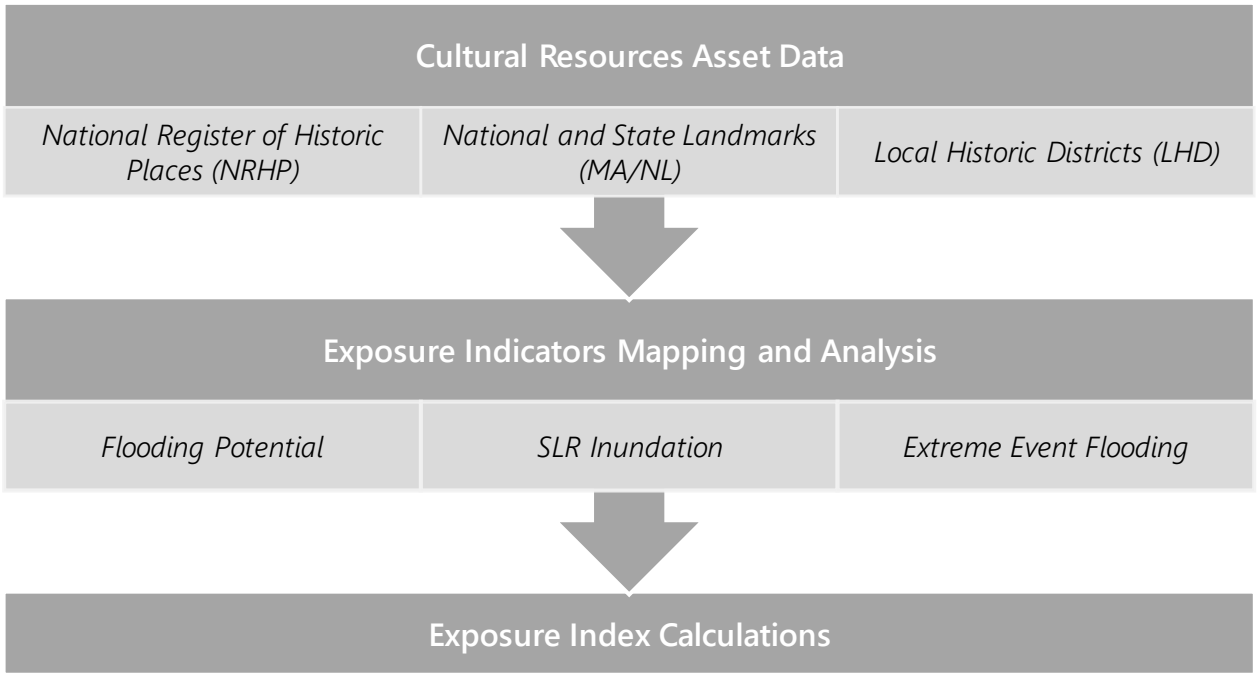


Figure 9: Flowchart of primary steps adopted for the Exposure Analysis of historic resources in Salem.

Historic Resources Asset Data

Historic and cultural resources within the United States are protected by means of "designation" process that evaluates the resource for its significance conforming to its architectural characteristics or relationship to history and its integrity. A historic resource can be a district, building, site, structure, or object and can be designated at the national, state, and/or local level. The process and criteria for evaluation is prescribed at the federal level by the National Historic Preservation Act of 1966 (NHPA) and at the state and local level by their respective statutes and local preservation ordinances. For the purpose of this study, we are investigating the designation categories as described below, with a focus on the historic districts' typology encompassing individual contributing buildings and structures.

1. National Register of Historic Places (NRHP):
   At the federal level, the NHPA established the NRHP which is administered by the National Park Service (NPS). It is the official federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture. Properties listed on the National Register receive recognition for their historical significance and become eligible for various preservation incentives, such as federal tax credits and grant programs. To be listed on the National Register, the nomination process involves research, documentation, and evaluation of the property's significance based on established guidelines. State and tribal historic preservation offices play a crucial role in this process by providing recommendations and assisting property owners and communities with the documentation and submissions.
2. Massachusetts Historic Landmark (MA/HL):
   Individual states have their own historic preservation programs that implement the provisions of the NHPA within their jurisdictions. State historic preservation offices (SHPOs) are responsible for identifying and documenting historic resources, coordinating preservation efforts, and managing historic preservation programs.
3. Local Historic Districts (LHD):
   Local historic districts are specific geographic areas that possess a concentration of historically significant buildings, structures, or landscapes. These districts are

regulated by local preservation ordinances that govern alterations, renovations, and demolitions to ensure the preservation of the district's character and integrity. Individual landmark designations recognize and protect specific structures or sites of historical importance within a community.

Data Sources:

The Massachusetts Historical Commission (MHC) maintains the Massachusetts Cultural Resource Information System (MACRIS) and online mapping. Three data layers are available for public perusal through the Mass.gov GIS Data portal.[10]

1. Inventory Points (MHCINV_PT): Points layer representing locations of buildings, burial grounds, structures, and objects (e.g., statues, monuments, walls).
2. Inventory Polygons (MHCINV_POLY): Polygon layer representing historic districts and areas containing point symbols.
3. Inventory Towns (MHCTOWNS_POLY): Polygon layer possessing a binary field that reads "Y" if the town has designated historic resources or left blank.

However, for the exposure analysis with various indicator layers, we require the building footprints to be linked with the point symbol data of individual designated building. This, therefore, requires the 2D Building layer available on the Mass.gov GIS Data portal to be spatially joined with the MHCINV_PT layer, so as to retain its historic designation attributes.

Steps for Data Preparation:

The following steps were followed to prepare the Historic Resource Asset Database (HRAD) for the exposure analysis:

1. Add the MHCINV_PT, MHCINV_POLY and the BUILDINGS shapefiles into the map.
2. Change Symbology of the MHCINV_PT and MHCINV_POLY layers to represent the chosen categories of Cultural Resources, i.e., LHD, MA/HL, NRHP and LHD & NRHP.

[10] "MassGIS Data: MHC Historic Inventory," Mass.gov, February 2023, https://www.mass.gov/info-details/massgis-data-mhc-historic-inventory.

3. The attribute tables of the MHCINV_PT layer and the BUILDINGS layer do not have any common field to facilitate a join field. The two layers, therefore, need to be spatially joined using the **Spatial Join** tool from the Toolbox. The spatial join parameters are as follows:
   Target features: BUILDINGS
   Join Features: MHCINV_PT
   Join Operation: One to one
   Match Option: Closest
   The output of the spatial serves as the database for the exposure analysis.
4. Change the symbology of the new output layer accordingly.

Sea Level Rise Exposure Indicators

Deriving from the methodology used by the Coastal Hazards study of the NPS, the exposure analysis in this study is based on the three climate change exposure indicators:

1. Floding Potential
2. Sea Level Rise (SLR) Inundation
3. Extreme Flooding Event.

Mapping is undertaken for each of the indicators overlaying the data layer over the cultural resource asset database created in the previous section. The cultural assets are accordingly assigned a binary score of 1 if it is located within the indicator zone and 0 if it is not located within the indicator zone. The data sources and steps for preparation for each indicator is elaborated in the following sections.

1. Flooding Potential

Data Sources:

The flooding potential indicator depicts "hazards related to the 1% annual flood chance, including waves and water velocity".[11] Flood Insurance Rate Maps or FIRM, maintained by the Federal Emergency Management Agency's (FEMA) through the National Flood Hazard Layer geodatabase are used as the data source for the flooding potential indicator. These

[11] Katie Peek, et.al, *Coastal Hazards,* 9.

maps depict flood zones and other flood-related information for specific geographic areas, typically at the county or community level is used by the National Flood Insurance Program (NFIP) for floodplain management, mitigation, and insurance purposes. They and classify areas into different zones based on the likelihood and severity of flooding, including:

- *Special Flood Hazard Areas (SFHAs):* These are areas with a high risk of flooding. They are typically labeled as Zones A, AE, AH, AO, VE, or V.
- *Moderate Flood Hazard Areas:* These areas have a moderate risk of flooding and are labeled as Zones X or X500.
- *Minimal Flood Hazard Areas:* These areas have a lower risk of flooding and are labeled as Zone C or X.[12]

Relevant to this study is Zone AE and VE of the Special Flood Hazard Areas which are defined as the "areas subject to inundation by the 1-percent-annual-chance flood event, with additional hazards due to storm-induced velocity wave action," and as "areas subject to inundation by the 1-percent-annual-chance flood event" respectively.[13]

Steps for Data Preparation:

The following steps were followed to prepare the FEMA data overlay:

1. Add the FEMA_NHFL_POLY layer to the map.
2. Export Zone VE and Zone AE data by exporting the **select by attributes** features using AE and VE of FLD_ZONE as the value field.
3. Change Symbology to appropriate colors based on FLD_ZONE value field.
4. **Select by location** features in Historic Resource Asset Database (HRAD) polygons that "intersect" with the exported FEMA_NFL_POLY layer.
5. **Add field** to the HRAD with the name FEMA_SCORE. Save changes.
6. Use **Calculate Field** to assign a score of 1 to all selected features and then switch the selection to assign a score of 0 to the other features.

[12] Federal Emergency Management Agency, *How to Read A Flood Map* (Washington D.C.: FEMA, 2022), https://www.fema.gov/sites/default/files/documents/how-to-read-flood-insurance-rate-map-tutorial.pdf
[13] Katie Peek, et.al, *Coastal Hazards*, 9

2. Sea Level Rise (SLR) Inundation

Data Sources:

The SLR inundation indicator depicts hazards related to the potential inundation by sea level rise by the year 2100.[14] In 2022, the National Oceanic and Atmospheric Administration (NOAA) updated the sea level rise and storm surge data and projections for U.S. Coastal waters. Based on this information that is visually presented on the NOAA DIGITAL COAST Mapping Tool, the local scenario of the Boston station (closest scenario location to Salem) suggests an inundation of 4.92ft in the Intermediate-High Scenario by the year 2100. The mapping of the SLR Inundation is therefore chosen to a projection of 5ft of MHHW for the purpose of the exposure analysis.

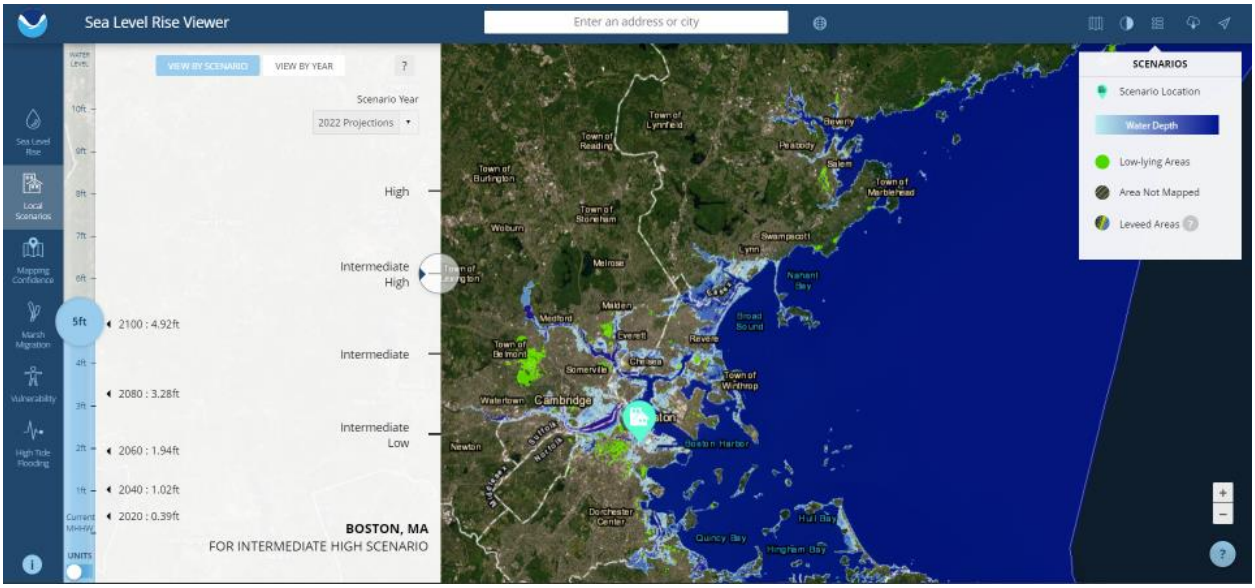


Figure 10: NOAA Local Scenario Viewer on DIGITALCOAST. (Source: https://www.coast.noaa.gov/slr/)

Data files are available on both the NOAA ArcGIS Online portal as well as the Mass.gov MassGIS data website. These polygon data files used for the study depict "the potential sea level rise inundation of coastal areas resulting from a projected 1 to 10 feet rise in sea level above current Mean Higher High Water (MHHW) conditions."[15]

Steps for Data Preparation:

[14] Katie Peek, et.al, *Coastal Hazards*, 14

[15] "MassGIS Data: NOAA Sea Level Rise," Mass.gov, June 2019, https://www.mass.gov/info-details/massgis-data-noaa-sea-level-rise.

1. Add the NOAA_SLR_MA_POLY to the map.
2. The analysis considers only up to 5ft of sea level inundation based on the 2100 scenario, therefore inundation levels between 5ft-10ft would need to be deleted. Use **Select by Attributes** tool and export all features between 1ft to 5ft.
3. Change Symbology to appropriate colors based on SLR_CODE_NUM value field.
4. **Select by location** features in HRAD that "intersect" with the exported NOAA_SLR_MA_POLY layer.
5. **Add field** to the HRAD with the name SLR_SCORE. Save changes.
6. Use **Calculate Field** to assign a score of 1 to all selected features and then switch the selection to assign a score of 0 to the other features.

3. Extreme Flooding Event

Data Sources:

The extreme event flooding indicator represents risks associated with storm surges, tsunamis, and other extreme high-water events. Extreme flooding events along the Atlantic Ocean and Gulf of Mexico coasts of the United States are most commonly caused due to storm surge. Storm surge inundation models from NOAA's SLOSH (Sea, Lake, and Overland Surges from Hurricanes) are the most widely employed data source for this exposure indicator. The National Storm Surge Hazard Maps, Version 2 (SLOSH), from NOAA, were also referenced. Developed by the National Hurricane Center, the data layer depicts worst-case Hurricane Surge Inundation areas for Category 1 through 4 hurricanes striking the coast of Massachusetts. The GIS data is made available on the Mass.gov MassGIS Data website.[16]

Following the NPS Protocol, the category 3 storm surge inundation maps were utilized in this analysis. While all hurricanes have life-threatening winds, those ranked Category 3 and

[16] "MassGIS Data: Hurricane Surge Inundation Zones," Mass.gov, October 2013, https://www.mass.gov/info-details/massgis-data-hurricane-surge-inundation-zones.

higher are classified as "major hurricanes." Because of the severity of their winds, major hurricanes can cause damaging to catastrophic wind damage and significant loss of life.[17]

Steps for Data Preparation:

1. Add the HURR_INUN_ZONES_POLY to the map.
2. The layer, as mentioned above, includes inundation zones associated with storms from Category 1 through Category 4 indicated by the HURR_CAT field. Use **Select by Attributes** tool and export features into layer that only include Category1-3 inundation zones.
3. Change Symbology to appropriate colors based on HURR_CAT field.
4. **Select by location** features in HRAD that "intersect" with the exported HURR_INUN_ZONES_POLY layer.
5. **Add field** to the HRAD with the name HURR_SCORE. Save changes.
6. Use **Calculate Field** to assign a score of 1 to all selected features and then switch the selection to assign a score of 0 to the other features.

Sea Level Rise Exposure Index Calculation

Having completed the analysis as per the steps for data preparation outlined in the previous sections, to determine individual indicator scores, the Historic Resource Asset Data layer would include the three score fields i.e., FEMA_SCORE, SLR_SCORE and HURR_SCORE. To now further the analysis and to obtain a final, comprehensive exposure score the followings steps are to be undertaken:

1. **Add field** to the HRAD with the name EXP_SCORE. Save changes.
2. Use **Calculate Field** to assign a cumulative score using formula:

   EXP_SCORE = FEMA_SCORE + SLR_SCORE + HURR_SCORE

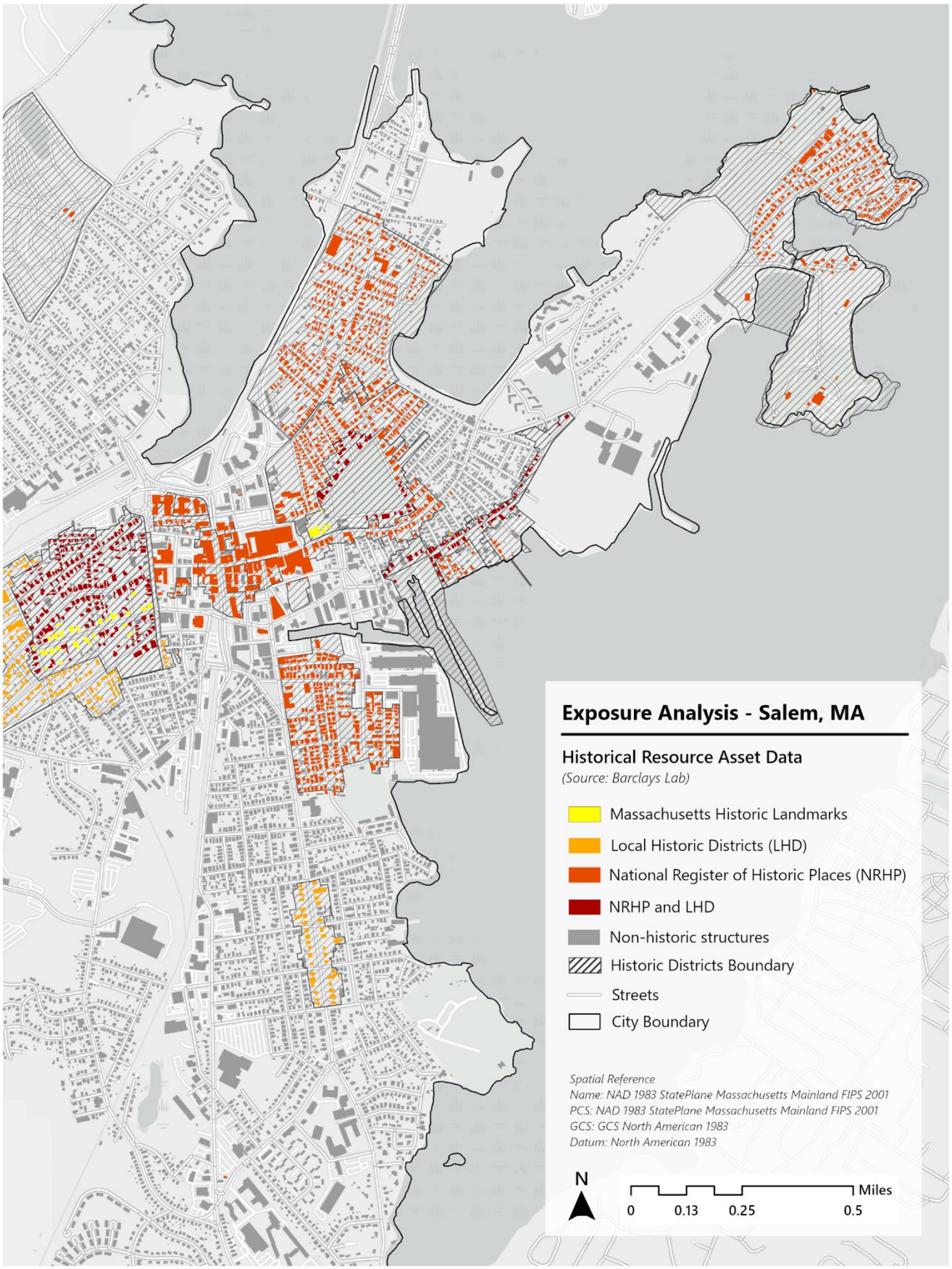
   This step would now assign a score between 0-3 for all historic resource assets.
3. Change Symbology to appropriate colors (unique values) based on EXP_SCORE field.

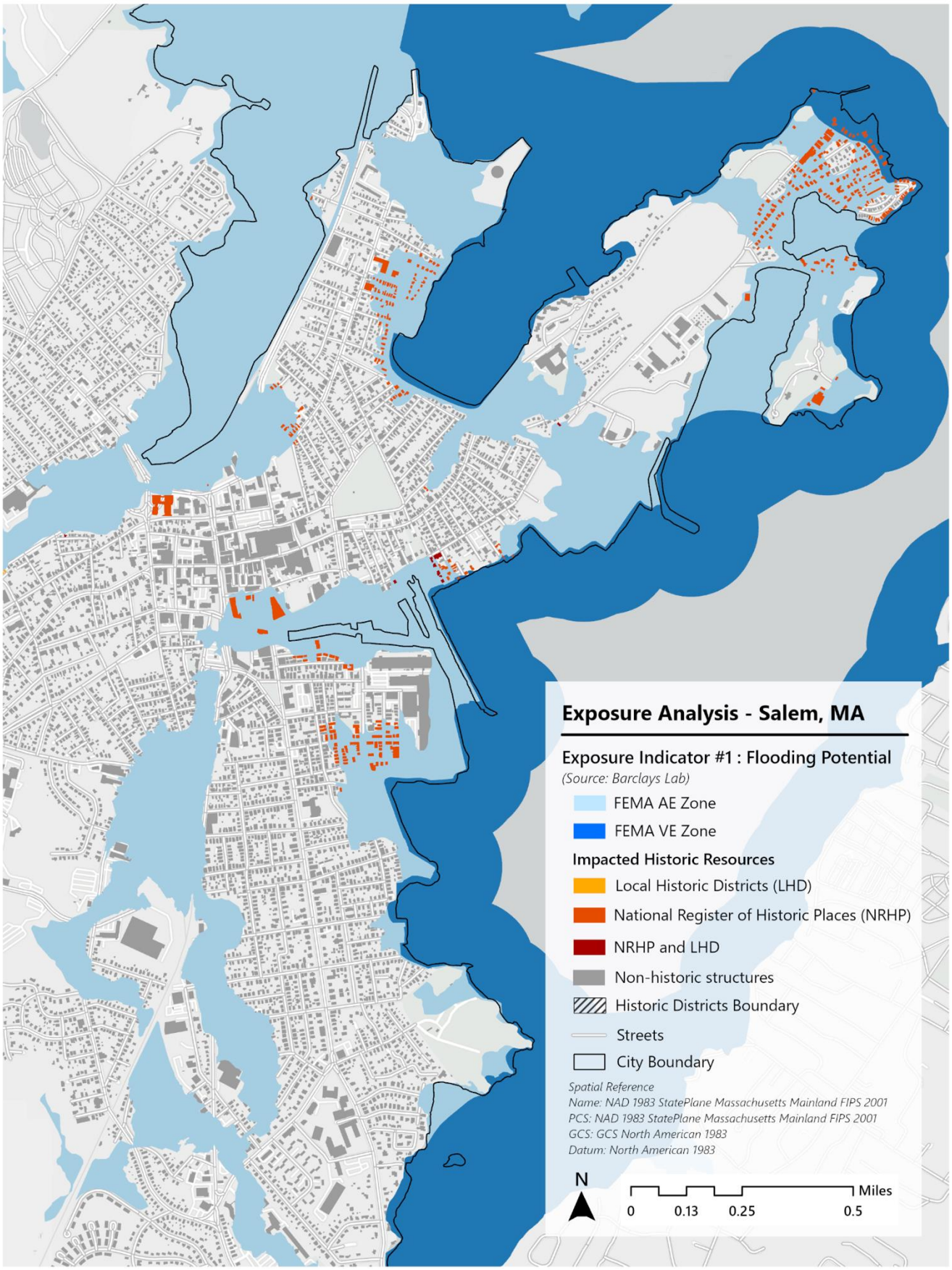
[17] "Saffir-Simpson Hurricane Wind Scale," National Hurricane Center and Center Pacific Hurricane Center, https://www.nhc.noaa.gov/aboutsshws.php#:~:text=While%20all%20hurricanes%20produce%20life,the%20strength%20of%20their%20winds.

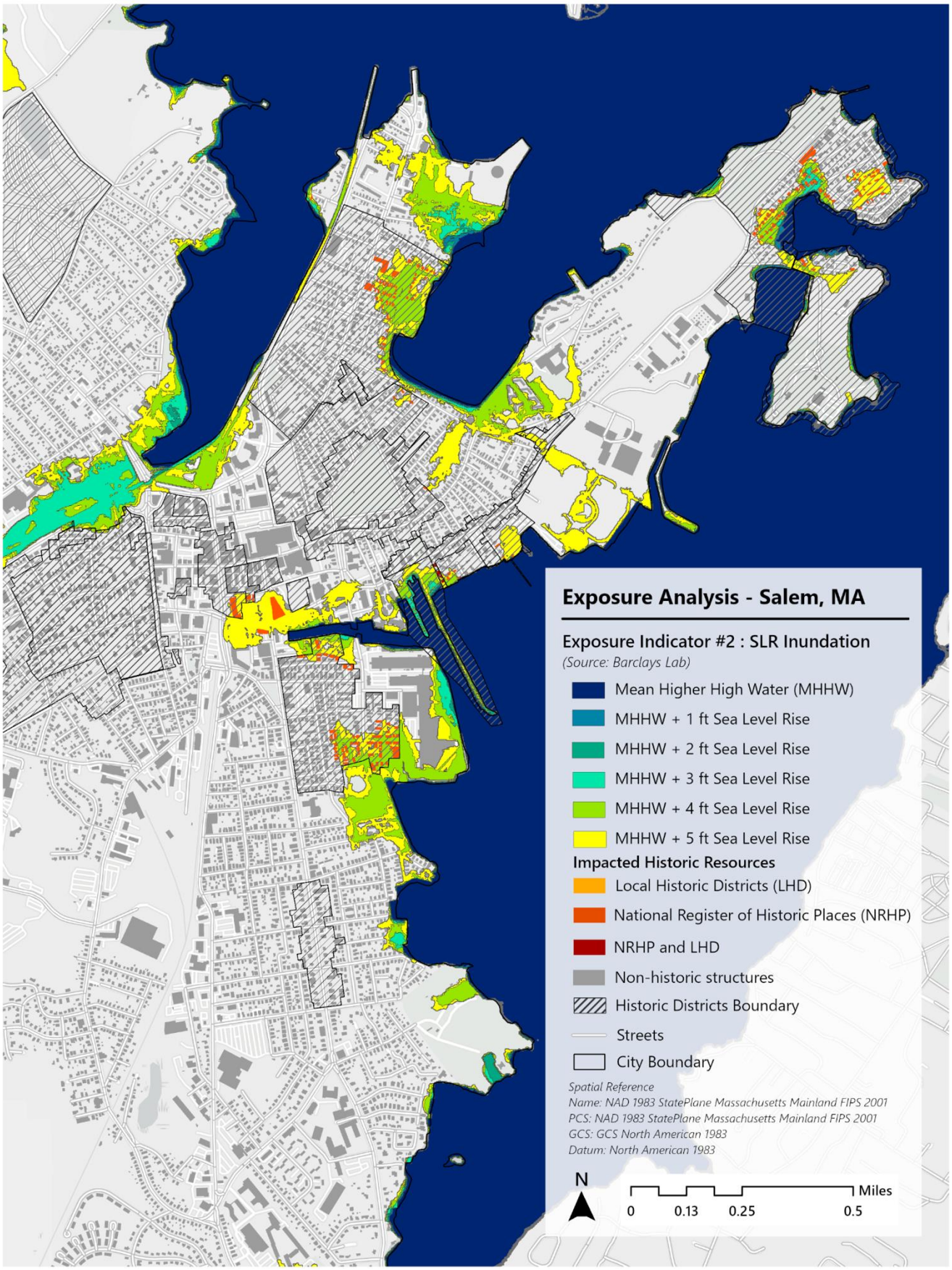
This Exposure Analysis, hence, evaluates the exposure of assets to multiple coastal hazards combined and can be ranked as per the following indices:

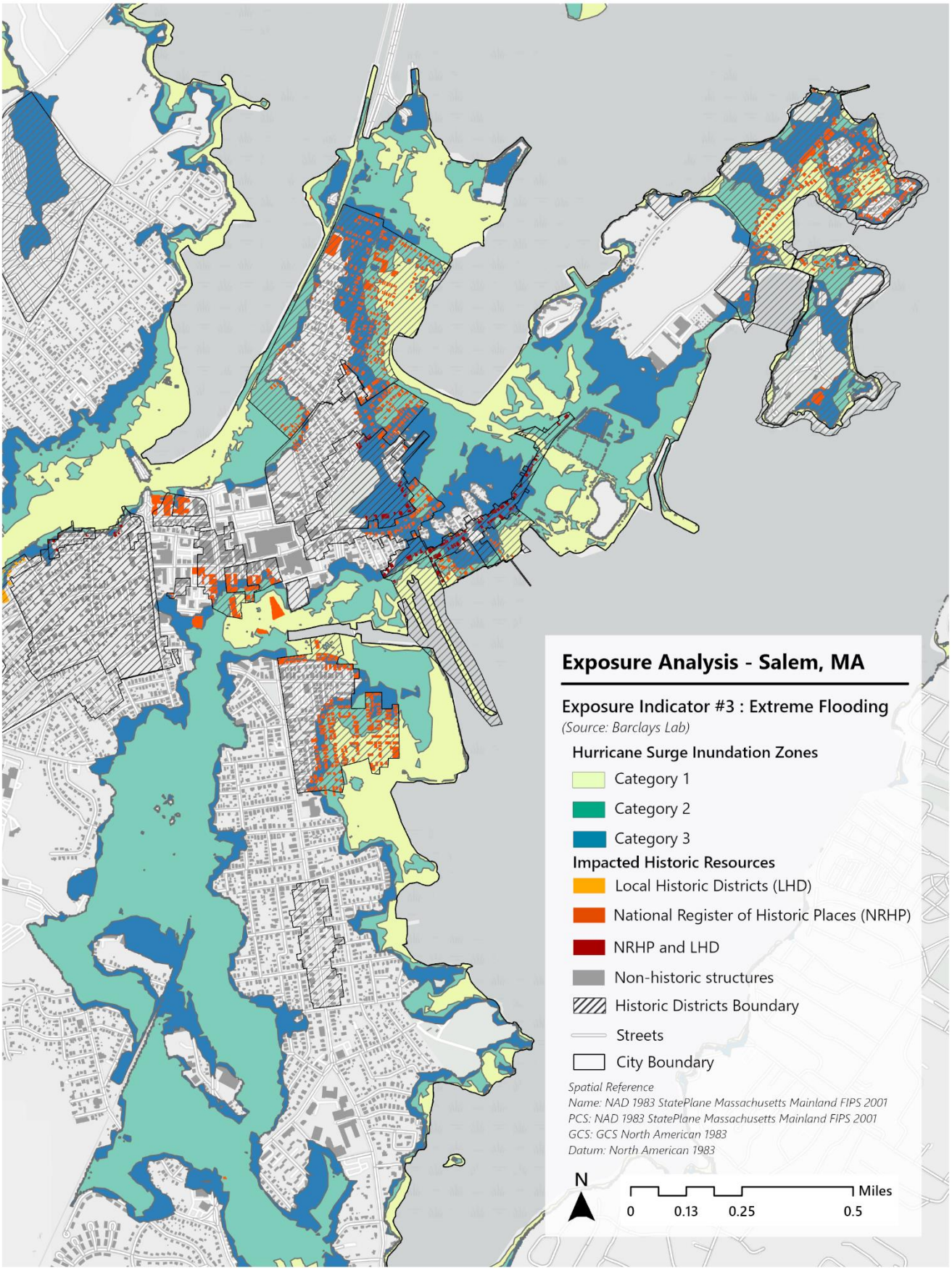
- **High Exposure -** Assets within *all three* exposure indicator hazard zones.
- **Moderate Exposure -** Assets within *two* exposure indicator hazard zones.
- **Low Exposure -** Assets within *one* exposure indicator hazard zone.
- **Minimal or No Exposure** – Assets are *not in any* exposure indicator hazard zone. This does not indicate that the asset is not vulnerable to coastal hazards, but it does not fall within the scope of the exposure hazard data used in this analysis.

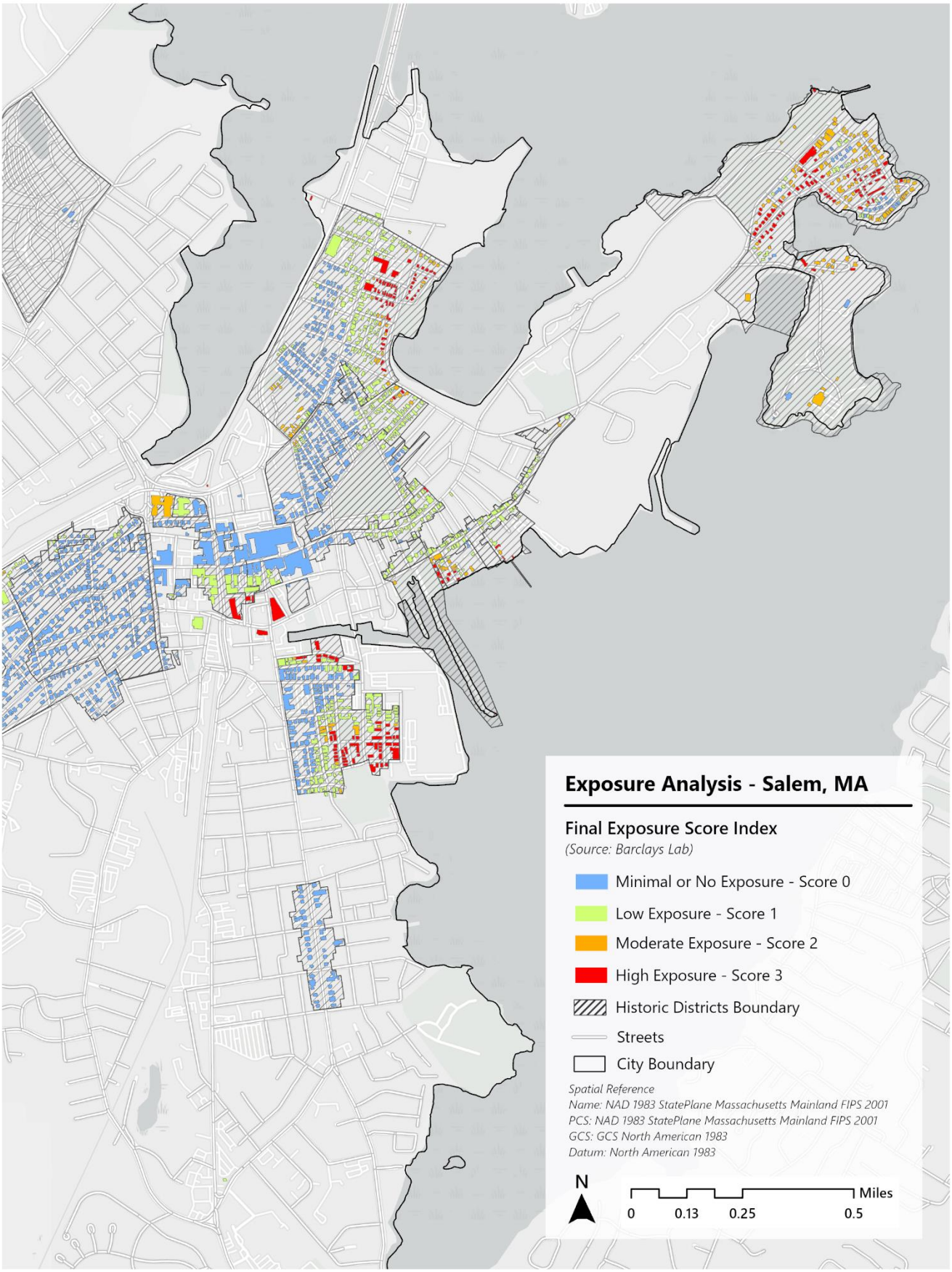
Exposure Mapping:


Exposure Analysis - Salem, MA
Historical Resource Asset Data
(Source: Barclays Lab)
Massachusetts Historic Landmarks
Local Historic Districts (LHD)
National Register of Historic Places (NRHP)
NRHP and LHD
Non-historic structures
Historic Districts Boundary
Streets
City Boundary
Spatial Reference
Name: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
PCS: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
GCS: GCS North American 1983
Datum: North American 1983
N
Miles
0
0.13
0.25
0.5


Exposure Analysis - Salem, MA
Exposure Indicator #1 : Flooding Potential
(Source: Barclays Lab)
FEMA AE Zone
FEMA VE Zone
Impacted Historic Resources
Local Historic Districts (LHD)
National Register of Historic Places (NRHP)
NRHP and LHD
Non-historic structures
Historic Districts Boundary
Streets
City Boundary
Spatial Reference
Name: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
PCS: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
GCS: GCS North American 1983
Datum: North American 1983
N
0
0.13
0.25
0.5
Miles


Exposure Analysis - Salem, MA
Exposure Indicator #2 : SLR Inundation
(Source: Barclays Lab)
Mean Higher High Water (MHHW)
MHHW + 1 ft Sea Level Rise
MHHW + 2 ft Sea Level Rise
MHHW + 3 ft Sea Level Rise
MHHW + 4 ft Sea Level Rise
MHHW + 5 ft Sea Level Rise
Impacted Historic Resources
Local Historic Districts (LHD)
National Register of Historic Places (NRHP)
NRHP and LHD
Non-historic structures
Historic Districts Boundary
Streets
City Boundary
Spatial Reference
Name: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
PCS: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
GCS: GCS North American 1983
Datum: North American 1983
N
0
0.13
0.25
0.5
Miles


Exposure Analysis - Salem, MA
Exposure Indicator #3 : Extreme Flooding
(Source: Barclays Lab)
Hurricane Surge Inundation Zones
Category 1
Category 2
Category 3
Impacted Historic Resources
Local Historic Districts (LHD)
National Register of Historic Places (NRHP)
NRHP and LHD
Non-historic structures
Historic Districts Boundary
Streets
City Boundary
Spatial Reference
Name: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
PCS: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
GCS: GCS North American 1983
Datum: North American 1983
N
0
0.13
0.25
0.5
Miles


Exposure Analysis - Salem, MA
Final Exposure Score Index
(Source: Barclays Lab)
Minimal or No Exposure - Score 0
Low Exposure - Score 1
Moderate Exposure - Score 2
High Exposure - Score 3
Historic Districts Boundary
Streets
City Boundary
Spatial Reference
Name: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
PCS: NAD 1983 StatePlane Massachusetts Mainland FIPS 2001
GCS: GCS North American 1983
Datum: North American 1983
N
0
0.13
0.25
0.5
Miles

Results:

The Exposure Mapping and Scoring now provides a detailed site-specific evaluation for each contributing and non-contributing building within a historic district. Within the limits of each Historic district boundary, we observe structures of varying exposure levels. The impact of sea level rise is therefore not limited to individual historic resources, but in this case affects and endangers the significance and setting of entire designated historic districts and areas. The analysis of exposure levels within historic districts is thus necessary and imminently vital to protect and preserve the historic resources.

Based on the exposure indices calculated on the city level we now zoom into the historic districts most at risk to sea-level rise and related climate hazards, to assess the level of exposure, which can further inform adaptation planning and strategies at a neighborhood level that can collectively protect the entire areas of significance.

The study, thus looks into four of the 22 National Register Historic Districts and 4 Local Historic districts, including:[18]

1. Point Neighborhood: Primarily a residential historic district in Salem, Massachusetts, immediately south of downtown, it is a densely developed, roughly rectangular grid of streets.
2. Derby Waterfront Historic District: The potential area of affect encompasses not only the NRHP and LHD of Derby Waterfront but also the historic district of the House of Seven Gables and the Salem Maritime National Historic Site, owned and maintained by the National Park Service.
3. Salem Willows Historic District: Located on the north-eastern tip of Salem, it is surrounded by waterbodies on three sides. It is currently a well-populated residential neighborhood, that was built as a 19th century summer resort community.
4. Bridge Street Neck Historic District: On the opposite fork from Salem Willows is the Bridge Street Historic District that is located on the peninsula land northeast of downtown Salem between Collins Cove and the North River. Predominantly residential it houses the maximum of Salem's housing stock.

[18] Salem Historical Commission, *Salem Historical Commission Guidelines Notebook*, by Lisa Easton, (Salem, Massachusetts, 2022), 32-38, https://www.salemma.gov/historical-commission.

1. Point Neighborhood Historic District: [19]

Also recognized as an environmental justice area, the Point or "El Punto" district sees maximum inundation in the southeast portions and along the North River.

Of the total 240 buildings within the district analyzed in this study, 51 structures fall in the high exposure risk and 12 in moderate risk.

This suggests that almost 25% of the total building stock would be impacted by sea-level rise and coastal hazards.

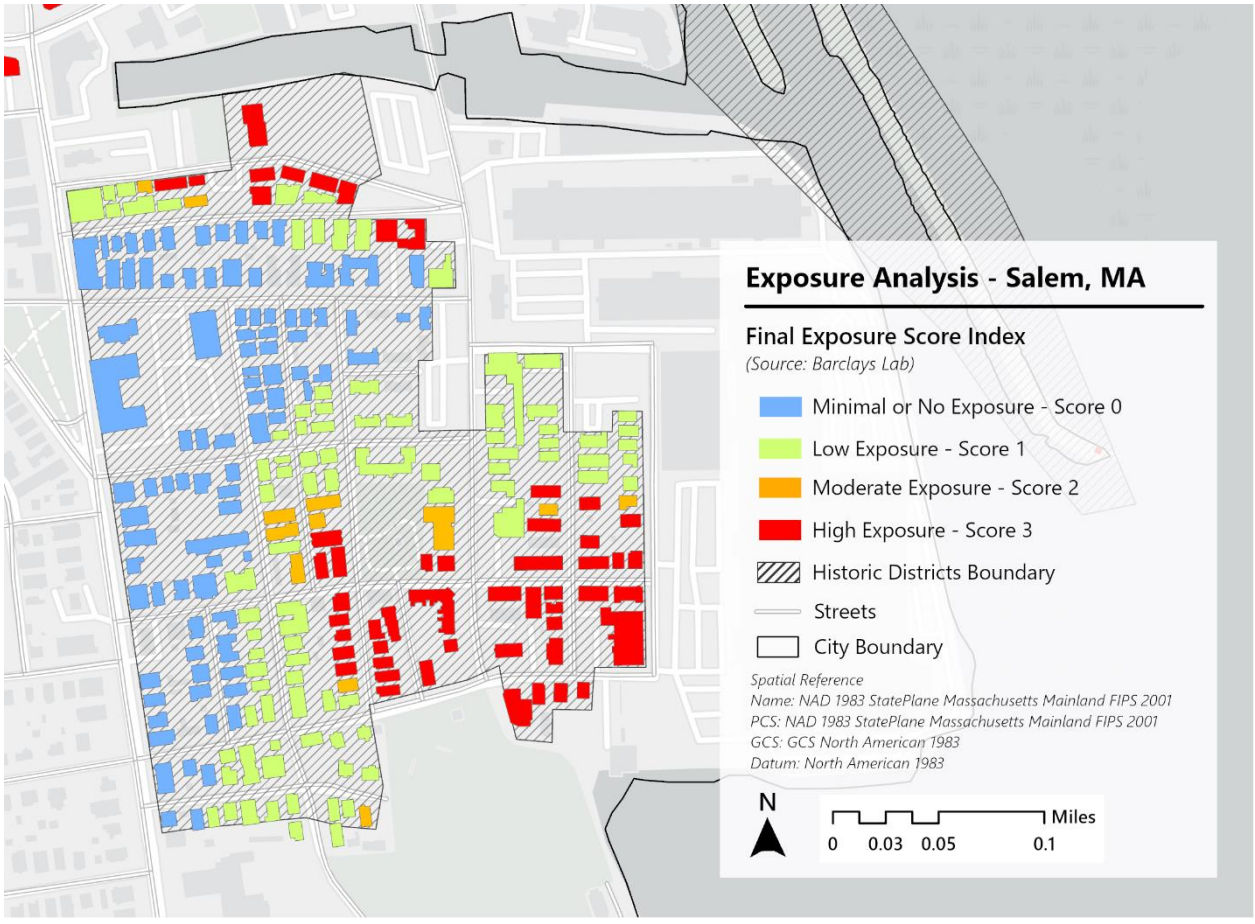
Designation:
National Register of Historic Places

Category of Property: District

Number of Resources within Property
Contributing: 278 Total- 245 buildings, 33 structures

Non-contributing: 14 Total- 6 buildings, 8 sites

Use: Domestic, Commerce, Industry



[19] National Park Service, *National Register of Historic Places Registration Form: Point Neighborhood Historic District*, by Patricia Kelleher and Maureen Cavanaugh (Maynard, Massachusetts, 2014), https://mhc-macris.net/Documents/NR/14000972.pdf.

2. Derby Waterfront Historic District & Salem Maritime National Historic Site: [20]

The Derby Waterfront Historic District that encompasses the Salem Maritime National Historic Site and The House of Seven Gables historic district, is the city's most significant historic asset which is also at the highest level of exposure to SLR hazards.

Of the 83 buildings, 24 are at high and moderate risk, i.e., almost 30% of the building stock, with the entire National Historic site submerged by all three indicators.

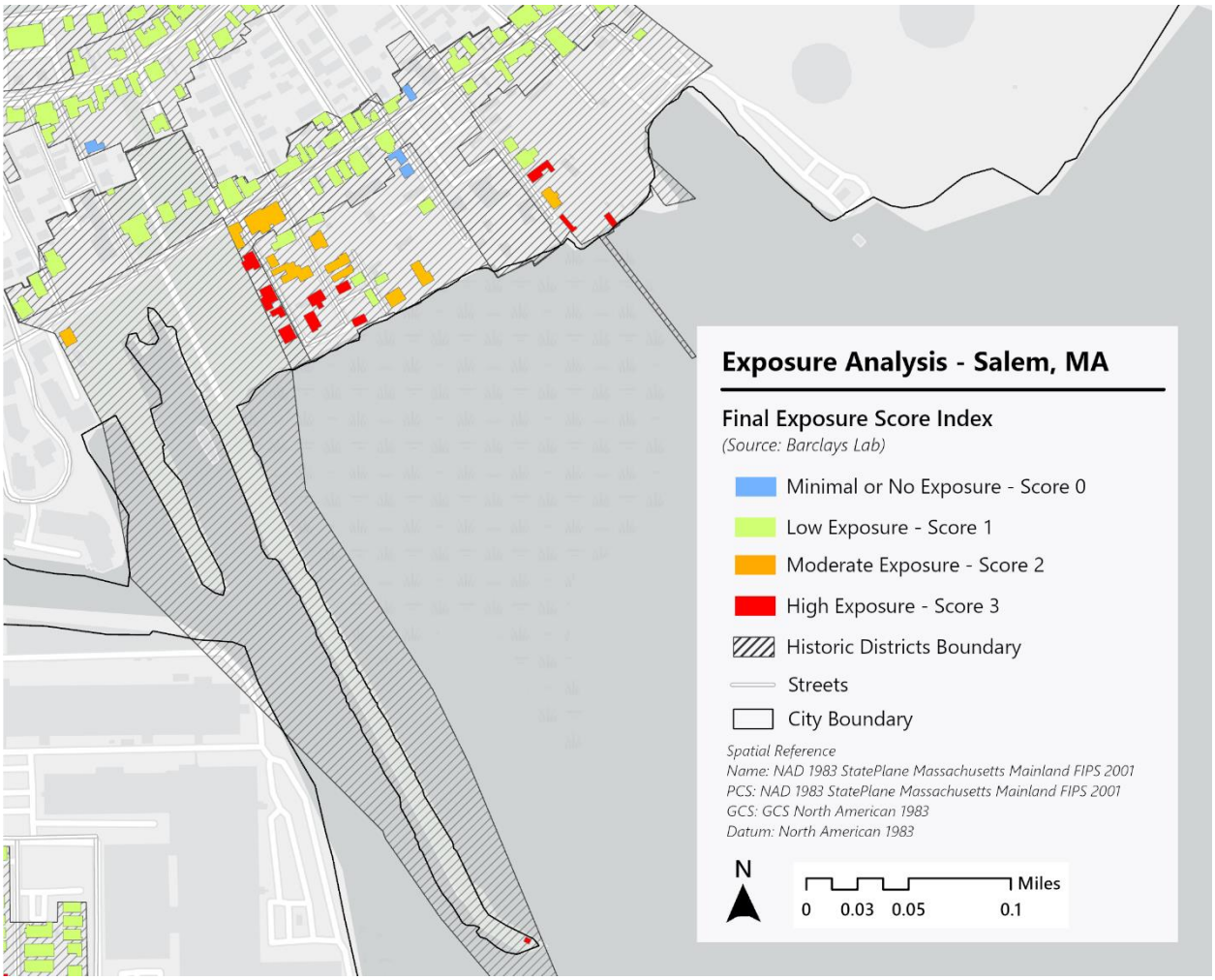
Designation:
National Landmark; National Register of Historic Places + Local Historic District

Category of Property: District

Period of Significance: 1700-1749; 1750-1799

Areas of Significance: Commerce, Architecture

Use: Commercial, Mixed-use



[20] National Park Service, *National Register of Historic Places Inventory- Nomination Form: Derby Waterfront District*, by Judy D. Dobbs, (Boston, 1975), https://mhc-macris.net/Documents/NR/76000297.pdf

3. Salem Willows Historic District: [21]

A predominantly residential neighborhood with the "Salem Willows Park" as an important public space, a majority of buildings within the Salem Willows Historic District are at high and moderate risk from coastal hazards.

With a total of 201 buildings identified in this study, 75.62% of the built heritage is at-risk with 65 buildings having a high exposure score and 87 buildings having a moderate exposure score, endangering the entire neighborhood in case of a flooding event.

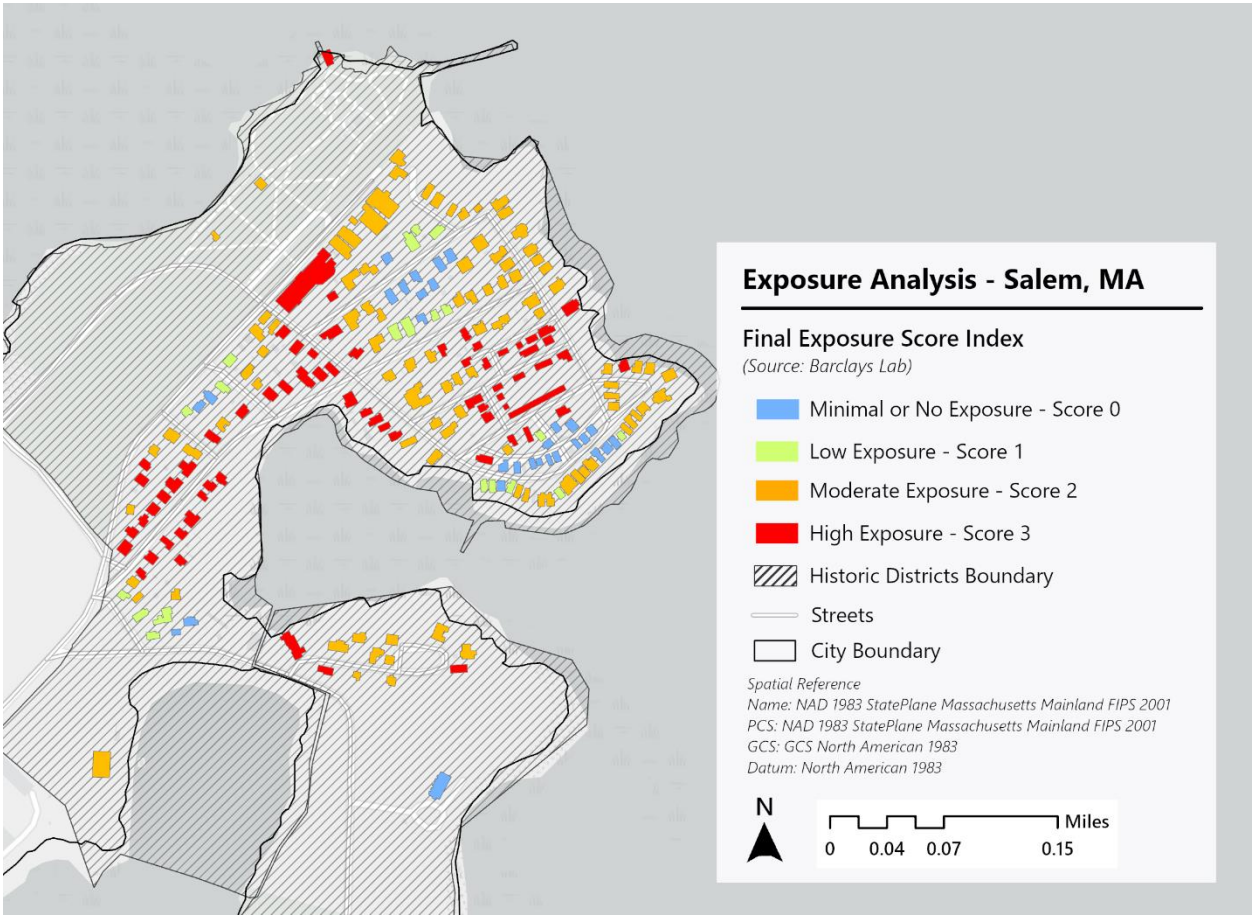
Designation:
National Register of Historic Places

Category of Property: District

Number of Resources within Property
Contributing: 226 Total- 201 buildings, 3 sites, 8 structures, 14 objects

Non-contributing: 61 Total- 53 buildings, 1 site, 6 structures, 1 object

Use: Domestic, Cultural, Recreation



[21] National Park Service, *National Register Historic Places Registration Form: Salem Willows Historic District*, by Kim Withers Brengle and Betsy Friedberg (Boston, 1994), https://mhc-macris.net/Documents/NR/94000265.pdf.

4. Bridge Street Neck Historic District: [22]

Area-wise one of the largest historic districts, the Bridge Street Neck Historic District is predicted to experience maximum inundation to the northeastern areas that front Collins Cove. This area sees the maximum number of buildings in the high exposure zone, with a few in the moderate zone.

Out of the 356 total buildings, 52 buildings have a high exposure index while 33 have a moderate exposure index. This accounts for 23.87% of the total building stock to be impacted by sea level rise and coastal hazards.

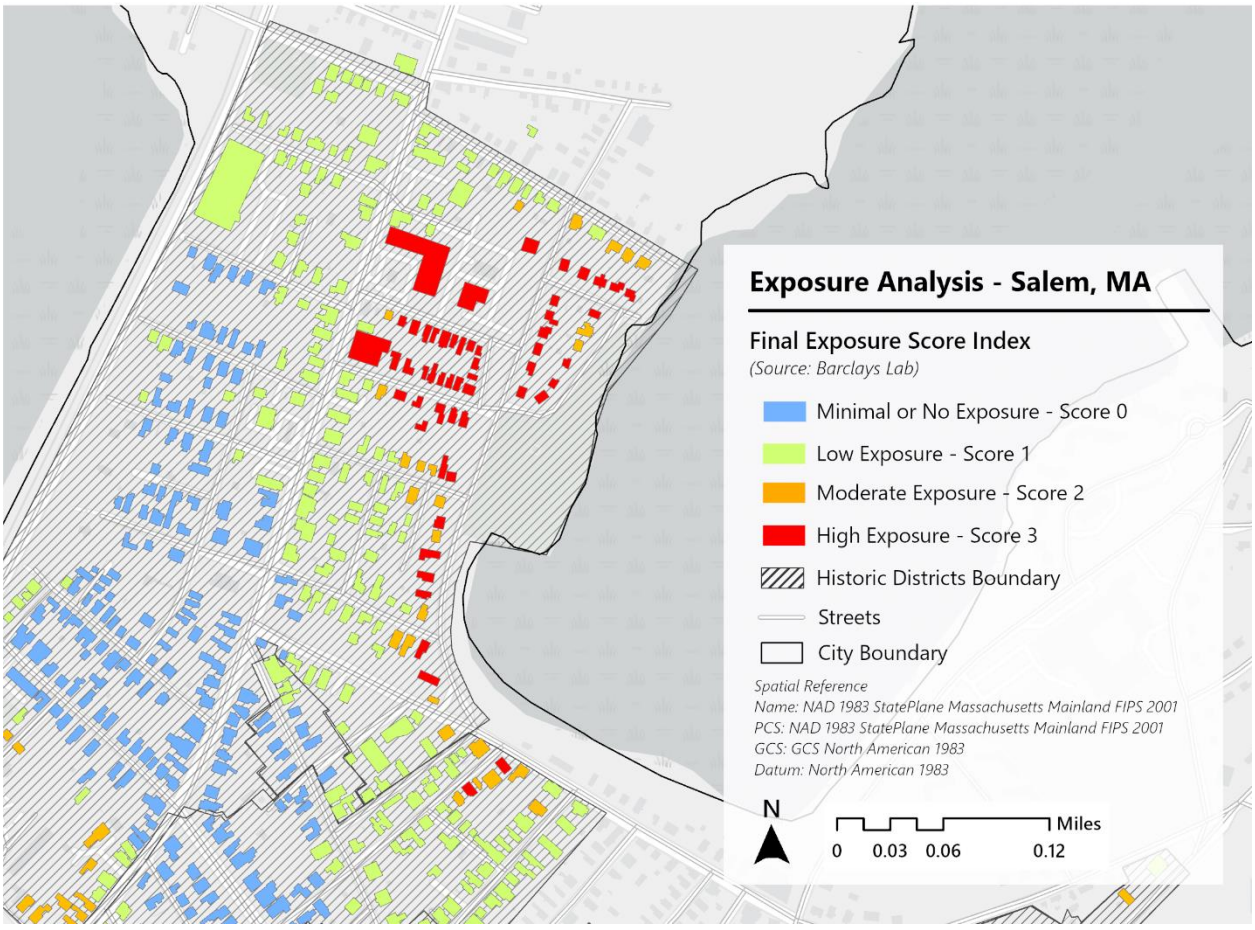
Designation:
National Register of Historic Places

Category of Property: District

Number of Resources within Property
Contributing: 383 Total- 382 buildings, 1 site

Non-contributing: 33 Total- 31 buildings, 1 site

Use: Domestic, Commercial, Education, Landscape, Religion



[22] National Park Service, *National Register of Historic Places Inventory -Nomination Form: Bridge Street Neck Historic District*, by Lisa Mausolf and Betsy Friedberg (Boston, 2002), https://mhc-macris.net/Documents/NR/02000790.pdf.

Conclusion:

The Exposure Analysis conducted by this study and the subsequent results achieved successfully elucidate the extent of the impacts of sea-level rise and the resulting coastal hazards on the historic and cultural resources of the city of Salem, gaining valuable insights into the potential risks faced by individual structures within National Register Historic Districts and local Historic Districts.

The creation of GIS mapping, which displays the spatial distribution of exposure indicators and highlights areas of increased susceptibility, is one of the study's significant outcomes. GIS mapping is an effective tool for explaining and displaying the findings of the exposure analysis. Its numerous potential uses can substantially help with decision-making and the creation of successful adaptation methods.

With the lack of standardization in vulnerability assessments carried out in historic neighborhoods, this methodology can be adopted to bring in more consistency in historic preservation planning practices. GIS mapping can inform historic preservation, land-use planning and zoning regulations, by which local authorities can implement measures to restrict certain activities or promote adaptive land use practices. This proactive approach can prevent future damage to historic structures and reduce the potential loss of cultural heritage.

The GIS mapping can also aid with resource allocation and prioritizing preservation initiatives. It is essential to identify the buildings that are most vulnerable to the effects of climate change given the limited funding and resources available. With the use of the GIS mapping, stakeholders, more specifically private historic property owners and preservation organizations can set priorities and focus their efforts on the most vulnerable historic resources, while planning ahead for the others in the various exposure zones.

Lastly, this study serves as a valuable educational and outreach tool as a visualization of the vulnerability of the historic and cultural resources in Salem. It can help foster a sense of urgency and inspire collective action toward preserving and adapting historic resources for future generations.

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GLOSSARY

Adaptation: Adjusting or preparing natural or human systems to a new or changing environment that moderates harm or exploits beneficial opportunities.

Adaptive Capacity: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Atlantic Meridional Overturning Circulation: The Atlantic Meridional Overturning Circulation (AMOC) is a thermohaline circulation system that circulates water from north to south and back in a long cycle within the Atlantic Ocean. This circulation brings warmth to various parts of the globe and carries nutrients necessary to sustain ocean life. (NOAA.gov)

Climate: In a narrow sense, climate is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands of years. These quantities are often surface variables such as temperature, precipitation, and wind. (IPCC, 2012:557)

Climate Change: Climate change refers to any significant change in the measures of climate lasting for an extended period. In other words, climate change includes significant changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer. (NPS, 2010: 27)

Exposure: The magnitude of change in climate and other stressors that are source, asset, or process has already or may experience in the future. (NPS, 2016: 139))

Flood: A general and temporary condition of partial or complete inundation of normally dry land areas from overflow of inland or tidal waters, unusual or rapid accumulation or runoff of surface waters, or mudslides/mudflows caused by the accumulation of water.

Global Warming: The recent global average temperature increase near the Earth's surface.

Greenhouse Gas (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Hazard: The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources. (IPCC, 2012: 560)

Hazard Mitigation: Any action taken to reduce or eliminate the long-term risk to human life and property from hazards. The term is sometimes used in a stricter sense to mean cost-effective measures to reduce the potential for damage to a facility or facilities from a disaster event.

Impacts: Effects on natural and human systems. In this report, the term 'impacts' is used to refer to the effects on natural and human systems of physical events, of disasters, and of climate change. (IPCC, 2012: 561)

Inundation: The submergence of land by water, particularly in a coastal setting.

Mean sea level: Sea level measured by a tide gauge with respect to the land upon which it is situated. Mean sea level is normally defined as the average relative sea level over a period, such as a month or a year, long enough to average out transients such as waves and tides. (IPCC, 2012: 561)

Mitigation: A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.

Relative Sea Level Rise: The increase in ocean water levels at a specific location, considering both global sea level rise and local factors, such as local subsidence and uplift. Relative sea level rise is measured concerning a specified vertical datum relative to the land, which may also be changing elevation over time.

Global Mean Sea Level: Global mean sea level (GMSL) rise is a direct effect of climate change, resulting from a combination of thermal expansion of warming ocean waters and the addition of water mass into the ocean, largely associated with the loss of ice from glaciers and ice sheets. (NOAA, 2022:1)

Resilience: A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Saltwater Intrusion: Displacement of fresh or ground water by the advance of salt water due to its greater density, usually in coastal and estuarine areas.

Scenarios: A plausible and often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and critical relationships. (IPCC, 2012:563)

Scenario Planning: Scenario planning is a vehicle for taking an imaginative look into the future by creating stories about several equally plausible futures. The purpose of scenario planning "is to make strategic decisions that will be sound for all plausible futures." Scenarios are not predictions, and the end result is not an accurate picture of tomorrow – but they can result in better decisions for the future. (NPS, 2010: 28)

Sea Surface Temperature: The temperature in the top several feet of the ocean, measured by ships, buoys, and drifters.

Sensitivity: The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea **level rise).**

Storm Surge: An abnormal rise in sea level accompanying a hurricane or other intense storm, whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone.

Subsiding/Subsidence: The downward settling of the Earth's crust relative to its surroundings.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

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