

ABSTRACT

Title of Thesis: BEYOND THE BARRIER:
THE RESILIENCE OF CONNECTING
PEOPLE TO PLACE

Eric Joshua Resnick, Master of Architecture,
Master of Historic Preservation, 2022

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Atlantic City, New Jersey is globally cited as one of the most vulnerable cities to the effects of climate change and sea level rise, representing the socioeconomic, cultural, and ecological threats that all coastal communities will face within the next half-century. 2060 projections indicate that Atlantic City will experience up to 155+ flood events per year and 50% of the city could be uninhabitable. In leveraging the city's coastal location, current institutions, and historic tourism-based infrastructure, the Resilient Transect becomes a framework for adaptation and growth, engaging the public and attracting an international cohort of researchers, designers, and policymakers to test and implement globally applicable and revolutionary strategies for coastal resilience. The iconic Atlantic City Boardwalk is abstracted as a beach-to-bay datum to catalyze adaptation, support, research, and participation along the transect, adaptable to environmental change and socioeconomic needs within and beyond Atlantic City.

BEYOND THE BARRIER:
THE RESILIENCE OF CONNECTING PEOPLE TO PLACE

by

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Preface: Beyond the Barrier

Change is a constant that is guaranteed; the ability to recover, adapt, and strengthen in response to change defines resilience. With the effects of climate change and sea level rise exponentially affecting the natural, built, and sociological ecosystems of our planet, resilience and survival are becoming synonymous terms. However, nature's inherent resilience is impacted by human decision making, and human resilience is adversely impacted by socioeconomic inequities and environmental injustices. As marginalized and disenfranchised communities are stripped of social, political, and economic power, climate change and sea level rise make equitable access to “clear air, safe drinking water, sufficient food, and secure shelter” increasingly difficult.¹ The World Health Organization estimates that climate change contributes to 150,000+ deaths per year and the United Nations estimates that 21.5 million people are displaced each year due to “weather-related hazards”.²

Rising seas and the increased frequency of storm events will continue to disproportionately affect vulnerable communities, especially those living in coastal areas. More than 600 million people worldwide live in coastal communities that are less than 10m (32.8 feet) above sea level, with nearly 2.4 billion living within 60 miles of a coast.³ In the United States alone, 130+ million people live in coastal counties that are vulnerable to “coastal hazards”, and 53+ million are employed within these communities.⁴ With approximately 12,000 miles of coastline, FEMA estimates that 13 million are immediately at risk from coastal flooding (storms and surges), fluvial flooding (swollen rivers and streams),

¹ The Health and Environment Linkages Initiative, *Climate Change and Health* (Geneva, Switzerland: World Health Organization, February 1, 2018), <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>.

² Ibid; The Ocean Conference, *Factsheet: People and Oceans*, (New York, NY: United Nations, June 2017), <https://www.un.org/sustainabledevelopment/wp-content/uploads/2017/05/Ocean-fact-sheet-package.pdf>.

³ Ibid.

⁴ “People and the Coast.” Missions. US Army Corps of Engineers, 2021. <https://www.iwr.usace.army.mil/Missions/Coasts/Tales-of-the-Coast/Sharing-the-Coast/People/>; Office for Coastal Management, *Coastal Fast Facts*, (Silver Spring, MD: National Oceanic and Atmospheric Administration, 2021), <https://coast.noaa.gov/data/nationalfacts/pdf/hand-out-coastal-fast-facts.pdf>.

and pluvial flooding (trapped stormwater).⁵ By these statistics, climate change and sea level rise not only affects vulnerable populations living within coastal communities, but the livelihoods of those that depend upon coastal economies and tourism.

This adjacency to water has been fundamental in the growth and shaping of civilization's global network, however, the densification of development on coastal lands has created ecological and socioeconomic impacts that are now exacerbated due to climate change, more frequent storm events, rising sea levels, and land subsidence.⁶ Coasts have always been dynamic landforms that continuously develop with geological and climate shifts, but permanent settlement and built infrastructure has disallowed these natural shifts, forcing coastal communities to contemplate their degree of permanence. Urbanized coastal communities are not merely tourist destinations and swaths of vacation homes, but home to year-round residents, businesses, and institutions. These communities are repositories of history, culture, and memory; they represent freedom, independence, and intergenerational growth; they maintain knowledge of the local environment and resilient practices. With coastal communities in the United States ranging in population from several hundred to several million, strategies for coastal resilience must be dynamic, adaptable, and scalable per community. Despite differences in vulnerability and size, research initiatives and design strategies for coastal resilience can be collaborative, inclusive, and globally applicable. To test the research-based design of this thesis, Atlantic City, New Jersey (Fig. 1) will serve as the primary study area and site of the final thesis design proposal; The Resilient Transect.

⁵ Karen M'Closkey and Keith VanDerSys, and Carolyn Kousky, Billy Fleming, and Alan M. Berger, "For Whom Do We Account in Climate Adaptation?" in *A Blueprint for Coastal Adaptation and Policy* (Washington, DC: Island Press, 2021).

⁶ Sergio Jiménez and Wilver Salinas and Jesús Campos, "Impacts Of Urbanization On Coastal Zones. Case Study: Altamira-Madero-Tampico Conjoined Area, Tamaulipas, Mexico" (Texas A&M University: Harte Research Institute for Gulf of Mexico Studies), <https://www.harte.org/sites/default/files/inline-files/13.pdf>.

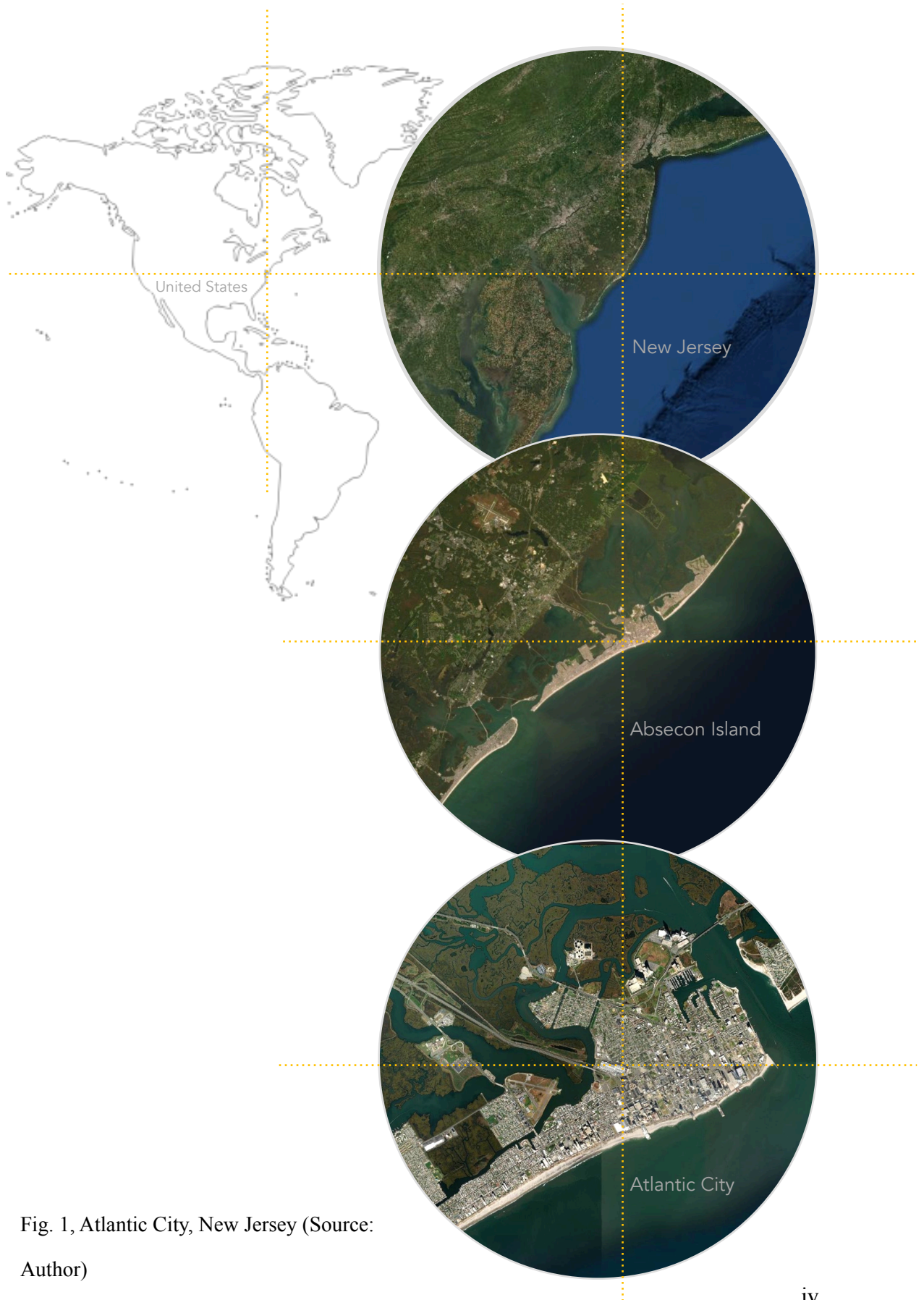


Fig. 1, Atlantic City, New Jersey (Source:
Author)

Atlantic City is located on the Atlantic Ocean and has relied on coastal industry and tourism since its incorporation in 1854. Atlantic City's socioeconomic and ecological vulnerability serves as a precedent to assess how climate change is affecting the social, economic, cultural, and ecological health of urbanized coastal communities. The increased frequency of acute coastal storms and chronic tidal flood events, paired with the economic disparities of a tourism-based economy, has disproportionately affected the city's residents and work force (Fig. 2). Not only are people and place threatened, but the ecological health of ocean and wetland habitats are at risk.



Fig. 2, Atlantic City's North Inlet neighborhood after Superstorm Sandy, 2012 (Source: The Conversation/ Michael Reynolds/AAP)

Historically, strategies for coastal planning and protection have taken a top-down or siloed approach. Federal, state, and/or local agencies receive government funding and implement “gray” infrastructure projects in the hope of mitigating storm and flood damage. Despite the failure to consider longterm environmental and social impacts, investment in mitigation projects has been calculated to provide a fourfold return (Fig. 3).⁷

⁷ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.



Fig. 3, Atlantic City's North Inlet neighborhood, construction of 1,340 foot seawall and Boardwalk after Superstorm Sandy damage, 2017 (Source: U.S. Army Corps of Engineers)

By rethinking this narrative and designing for coastal resilience, there is opportunity for local stakeholders and professional disciplines to collaborate on strategies that strengthen communities and ecosystems proactively rather than reactively. With “green” strategies becoming more accepted, the role of the designer is becoming increasingly important, and design thinking methodologies call for increased public participation to empathize, vision, ideate, test, and implement resilient strategies (Fig. 4). Designers are trained to collaborate and question the status quo, providing further opportunity for discovery and innovation that would be difficult to achieve by taking a siloed approach. Design strategies and programmatic approaches are evaluated in this thesis as methods for urban coastal resilience, with preservation of people, place, and ecosystem as the impetus for adaptation and growth. Gray infrastructure, green infrastructure, and social infrastructure will also be assessed for their applicability within and beyond Atlantic City.



Fig. 4, Left: *Open Shore* by Ecosistema Urbano, resilient design for West Palm Beach FL, 2017 (Source: Ecosistema Urbano); Right: *Southern Connecticut Conceptual Design for Coastal Resilience*, public presentation, 2016 (Source: Timothy Terway)

Building upon the significant relationship between preservation and coastal resilience, this thesis will analyze methods for leveraging tangible and intangible resources in vulnerable coastal communities. Preservation is the protection and interpretation of tangible and intangible resources deemed significant for their historical, cultural, environmental, and archaeological value; resilience is the ability to grow and “reach a higher level of functioning” in response to adversity.⁸ Fundamentally, resilience and preservation are dependent upon one another, both enabling the sustenance of people, place, culture, history, economies, and natural environments.

The design of the The Resilient Transect will serve as a case study to test and implement the research of this thesis, further developing a globally applicable precedent. It is the interrelation of social, economic, cultural, and ecological environments that provides the capacity for sustenance and resilience, but the deleterious effects of climate change and sea level rise continue to threaten the individual and aggregated functionality of these environments. Damage to the social environment affects the ability of people to maintain community; damage to the economic environment affects the ability to earn income and

⁸ J. Kulig, cited in Pooley, Cohen, and O Connor, 2006. Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

provide capital for growth; damage to the cultural environment erases the history and identity which make places unique; and damage to the ecological environment affects health and wellbeing of all species, and their ability to sustain terrestrial and aquatic ecosystems. This thesis builds upon contemporary practice and posits that coastal resilient design strategies will be even more effective if they:

- provide capacity for vulnerable communities to leverage existing resources and landscapes
- provide facilities to strengthen social networks and promote climate education
- provide resources to protect cultural and historic resources
- support the diversification of coastal economies — especially those based on tourism and aquaculture — by leveraging the assets of existing industries as catalysts for research, education, collaboration, and innovation in coastal resilient design

The Resilient Transect will test an “adapt + grow” future scenario, interconnecting a decentralized network of adapted buildings and landscapes across a beach-to-bay transect of Atlantic City’s Chelsea Neighborhood (Fig. 5).



Fig. 5, Atlantic City, Resilient Transect site analysis, 2021 (Source: Author)

Rather than propose large-scale civil interventions that attempt to mitigate the threat, this research aims to develop a programmatic strategy that provides an equitable and inclusive public infrastructure for those who live in vulnerable urban coastal communities. The Resilient Transect will establish interior and exterior programming for research, community support, and public engagement, combined with green, gray, and social infrastructure approaches. The aggregation of the aforementioned starts to galvanize a resilient framework that supports the needs of residents, researchers, and visitors alike, proactively supporting growth before the next chronic or acute climate event. In times of adversity, the social, economic, cultural, and ecological environments of urbanized coastal communities can be maintained and strengthened.

Dedication

To my Grandpa Mike...

.... whose first glimpse of a new life appeared as the coastline of New York Harbor appeared over the horizon. The lone survivor of his family following the attempted genocide of his people, he was given a second chance at life and manifested compassion in all those around him. There was symbolism in living near the coast; no longer landlocked, the endless horizon a symbol of infinite freedom. From Brighton Beach to Coney Island to Atlantic City, the Boardwalk was his gravitas, his American dream; his soul walks the wooden boards for eternity. My grandfather's resilience is leveraged so that I can work to help strengthen another's American dream through responsible design and preservation of memory and place, while balancing the beauty of the ocean, beach, and Boardwalk.

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List of Abbreviations

APA - American Psychological Association

BFE - Base Flood Elevation

EPA - Environmental Protection Agency

FEMA - Federal Emergency Management Agency

FIRM - Flood Insurance Rate Map

IPCC - Intergovernmental Panel on Climate Change

NASA - National Aeronautics and Space Administration

NCA - National Climate Assessment

NOAA - National Oceanic and Atmospheric Administration

NJDEP - New Jersey Department of Environmental Protection

NPS - National Park Service

NHPA - National Historic Preservation Act of 1966

NRHP - National Register of Historic Places

TWL - Total Water Level

UN - United Nations

UNESCO - United Nations Educational, Scientific, and Cultural Organization

USACE - United States Army Corps of Engineers

USGS - United States Geological Survey

WHO - World Health Organization

Chapter 1: Climate Change and Sea Level Rise: Research

Context, Definitions, and Baselines

“Heraclitus, I believe, says that all things pass and nothing stays, and comparing existing things to the flow of a river, he says you could not step twice into the same river.” – Plato

Introduction

Climate change and sea level rise will continue to disproportionately affect vulnerable communities, especially those living in coastal areas. More than 600 million people worldwide live in coastal communities that are less than 10m (32.8 feet) above sea level, with nearly 2.4 billion living within 60 miles of a coast (Fig.1).⁹ In the United States alone, 130+ million people live in coastal counties that are vulnerable to “coastal hazards”, and 53.6 million are employed within these communities.¹⁰ Urbanized coastal communities are not merely tourist destinations and swaths of vacation homes, but home to year-round residents, businesses, and institutions. Not only are people and place threatened, but the ecological health of ocean and wetland habitats are at risk.

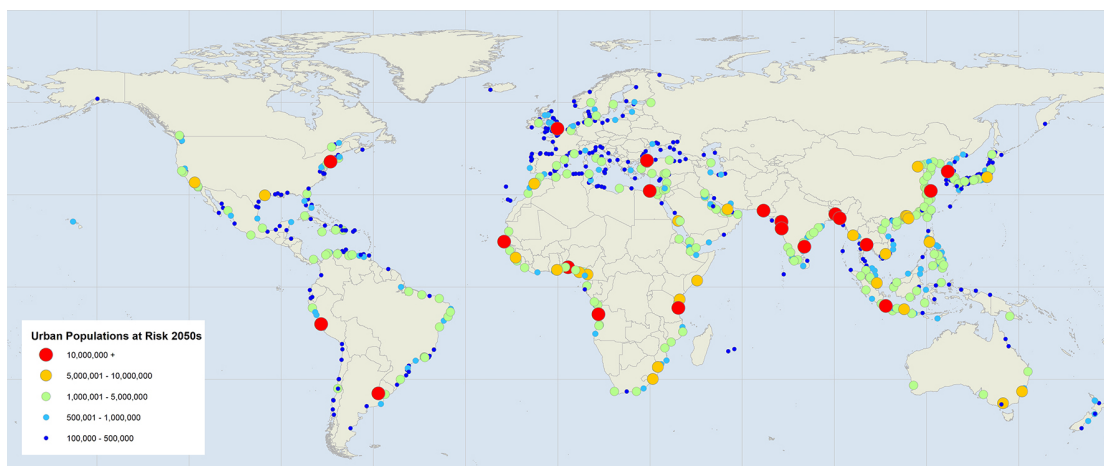


Fig. 1, Urbanized areas at risk from sea level rise, 2021 (Source: C40 Cities)

⁹ The Ocean Conference, *Factsheet: People and Oceans*, (New York, NY: United Nations, June 2017), <https://www.un.org/sustainabledevelopment/wp-content/uploads/2017/05/Ocean-fact-sheet-package.pdf>.

¹⁰ “People and the Coast.” Missions. US Army Corps of Engineers, 2021. <https://www.iwr.usace.army.mil/Missions/Coasts/Tales-of-the-Coast/Sharing-the-Coast/People/>; Office for Coastal Management, *Coastal Fast Facts*, (Silver Spring, MD: National Oceanic and Atmospheric Administration, 2021), <https://coast.noaa.gov/data/nationalfacts/pdf/hand-out-coastal-fast-facts.pdf>.

This chapter provides the requisite knowledge required to understand the context, definitions, and baselines of this thesis research and the final design proposal.

Research Context

Atlantic City is globally cited as one of the most vulnerable cities to the effects of climate change and sea level rise, a citation that has been published regionally, nationally, and internationally (Fig. 2). This section introduces the context of Atlantic City, presents the research-based design questions and methods, and provides the data projection sources that this thesis cites.

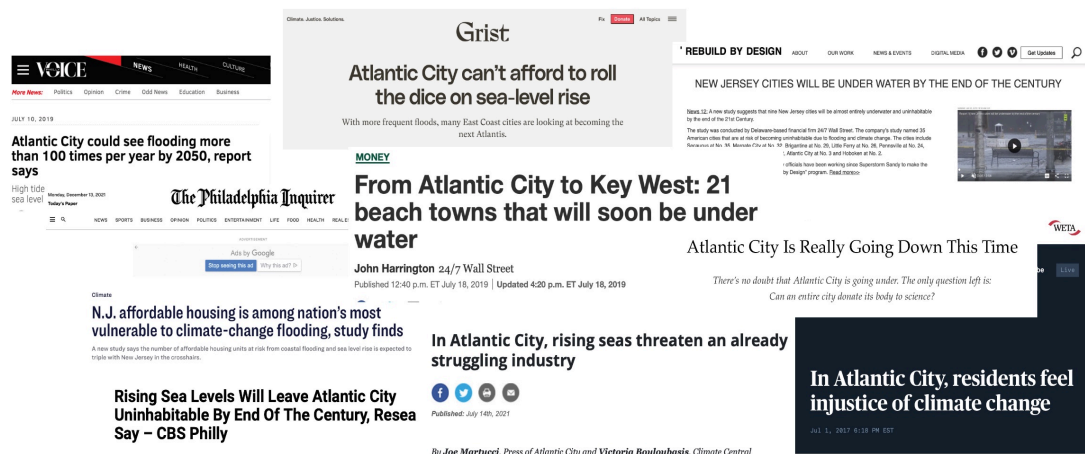


Fig. 2, Media collage citing Atlantic City's vulnerability, 2021 (Source: Author)

Study Area: Atlantic City, New Jersey

Atlantic City, New Jersey is an urbanized barrier island community located on southern New Jersey's eastern coast, and has an average elevation of 7 feet above mean sea level. The city is part of the Absecon Island barrier formation and is one of four incorporated cities that share the island formation (Fig. 3).



Fig. 3, Absecon Island: cities, population, and average home value, 2021 (Source: Author, NOAA basemap)

In total, the city has 112.5 miles of vulnerable shoreline, 90.1 miles of which are marsh shorelines and 22.3 miles of which are upland, or developed shorelines.¹¹ Atlantic City's developed shoreline is defined by its famous 3.4 mile stretch of sandy beaches, vegetated dunes, and Boardwalk. The city's remaining edges are adjacent to inlets, waterways, marinas, and bays. Of the city's 15.7 square mile area, 4.1 sq. miles are developable, 5.8 sq. miles are tidal salt marsh wetlands, 4.8 sq. miles are waterways, and 1 sq. mile is impervious roadway (Fig. 4 and 5).¹²

¹¹ "Living Shoreline Snapshot: Atlantic City, New Jersey," NJ Municipality Snapshots, *The Nature Conservancy*, 2021, <https://maps.coastalresilience.org/newjersey/#>.

¹² "Atlantic City Master Plan," City of Atlantic City, September 2008. https://www.acnj.gov/_Content/pdf/Atlantic-City-Master-Plan-2008.pdf.

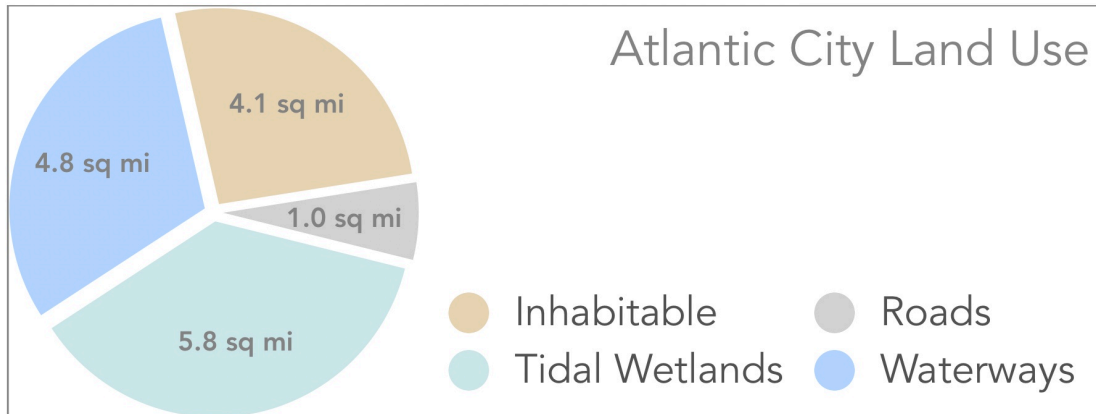


Fig. 4, Atlantic City land use, 2021 (Source: Author, data from City of Atlantic City)

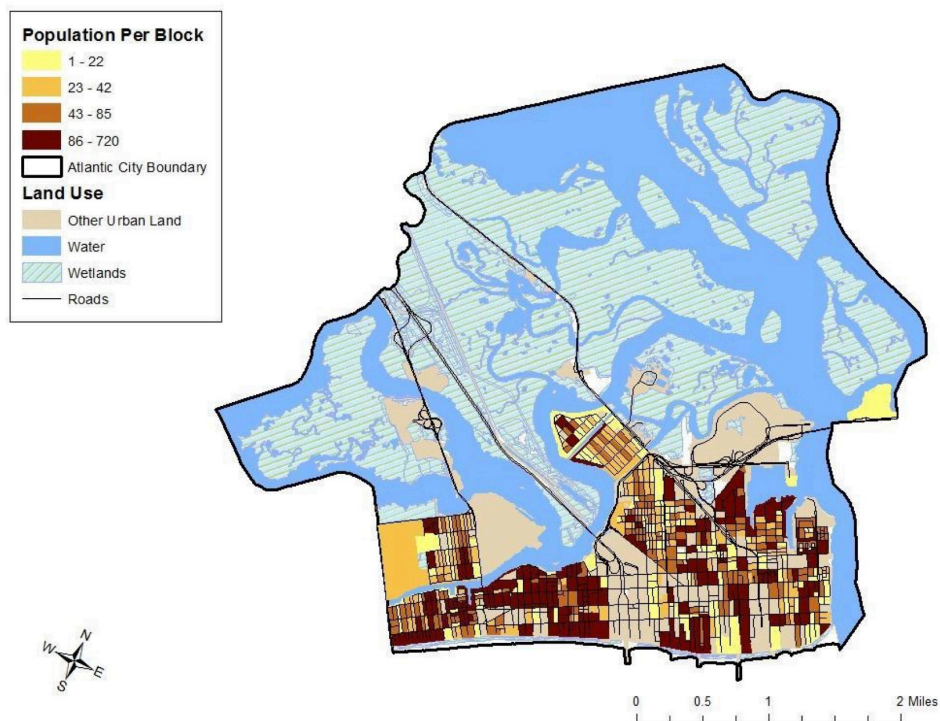


Fig. 5, Atlantic City land use and density, 2014 (Source: Rutgers University)

As of the 2020 Census there are 38,000+ residents that represent 28 nationalities and over 30 dialects spoken.¹³ A majority of residents are employed in tourism and hospitality industries and work within the city; health care, education, transportation, and trade industries provide additional sources for employment. Despite \$3.29 billion in 2019 casino revenue —

¹³ "Census Quick Facts: Atlantic City, NJ," United States Census Bureau, 2019, <https://www.census.gov/quickfacts/fact/table/atlanticcitycitynewjersey/RHI125219#RHI125219>.

plus an additional \$277 million in non-casino revenue — 37% of residents live in poverty and the per capita income is \$20,380, half of the state average (Fig. 6).¹⁴ Of the city’s 20,429 housing units, only 15,526 units are occupied and 27% of these units are owner-occupied.¹⁵ 22% of the city’s occupied housing units are subsidized with rental assistance.¹⁶

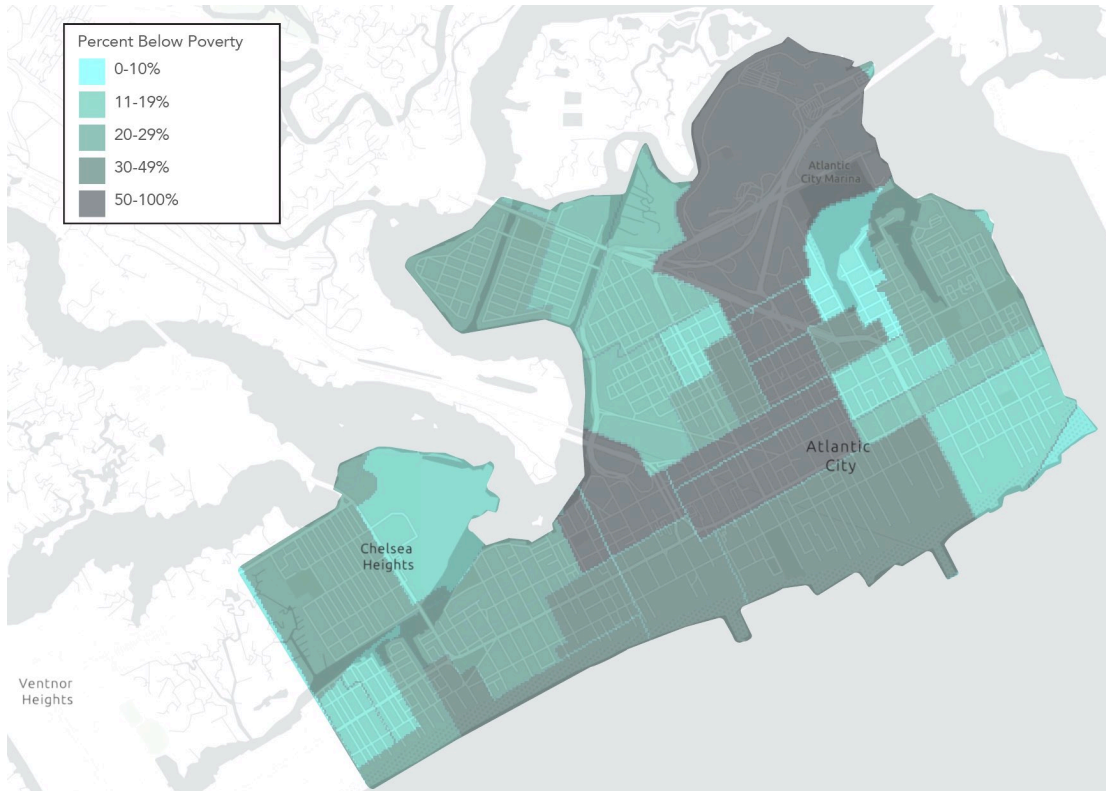


Fig. 6, Atlantic City population living at or below poverty, 2021 (Source: Author; data overlay from The Nature Conservancy)

Based on Rutgers University’s sea level rise projection of 0.7 to 2.6 feet by 2050, it is projected that over 3,167 of Atlantic City’s affordable housing units will be affected by climate change and sea level rise (Fig. 7).¹⁷

¹⁴ “2019 Annual Report,” New Jersey Casino Control Commission, 2020, https://www.nj.gov/casinos/about/reports/pdf/2019_ccc_annual_report.pdf.

¹⁵ “Census Reporter: Atlantic City, NJ,” 2019, <https://censusreporter.org/profiles/06000US3400102080-atlantic-city-city-atlantic-county-nj/>; “Census Quick Facts: Atlantic City, NJ”, United States Census Bureau, 2019, <https://www.census.gov/quickfacts/atlanticcitycitynewjersey>.

¹⁶ Ibid.

¹⁷ Jon Hurdle, “NJ Has the Most Affordable-Housing Units Exposed to Sea-Level Rise, Report Says,” *NJ Spotlight News*, December 1, 2020, <https://www.njspotlight.com/2020/12/affordable-housing-sea-level-rise-flooding-poverty-climate-change-nj/>.

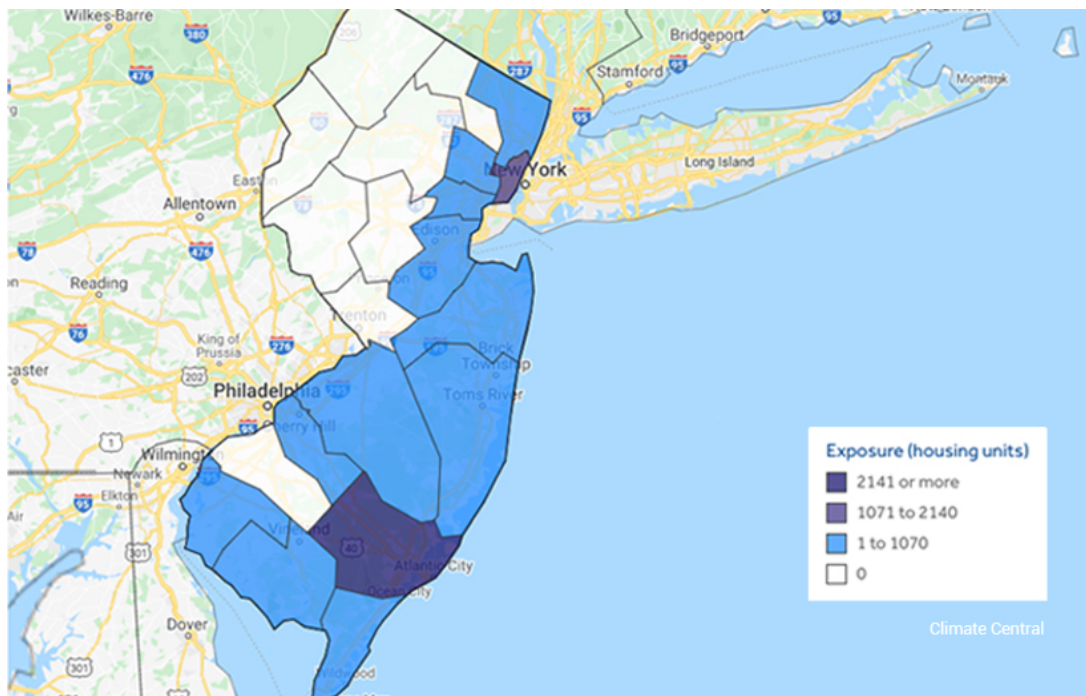


Fig. 7, New Jersey housing units at risk, 2020 (Source: Rutgers and Climate Central)

By 2050, the National Oceanic and Atmospheric Administration (NOAA) projects that Atlantic City could experience up to 155+ flood days per year, and by 2060, the Union of Concerned Scientists — based on the National Climate Assessment’s “high risk” scenario — projects that up to 43% of housing will be uninhabitable, 50% of the city will be flooded permanently, and \$1.05 billion in residential property will be lost.¹⁸ Based upon the percentage of the city’s population and housing units at risk, Atlantic City is globally cited as one of the most vulnerable cities to the effects of climate change and sea level rise.¹⁹

Because of its social, economic, cultural, and ecological vulnerabilities, Atlantic City has been chosen as the primary study area for this thesis and its design proposal — the Resilient Transect. The context of Atlantic City has the potential to reveal globally applicable data and trends to help researchers, designers, policymakers, business organizations,

¹⁸ “The State of High Tide Flooding and Annual Outlook,” Tides and Currents, National Oceanic and Atmospheric Administration, 2021, https://tidesandcurrents.noaa.gov/HighTideFlooding_AnnualOutlook.html; “Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate,” Union of Concerned Scientists, June 18, 2018, <https://www.ucsusa.org/resources/underwater>.

¹⁹ New Jersey Climate Resource Center, *A Seat at the Table: Integrating the Needs and Challenges of Underrepresented and Socially Vulnerable Populations into Coastal Hazards Planning in New Jersey* (New Brunswick, NJ: Rutgers University, May 31, 2020), <https://njclimateresourcecenter.rutgers.edu/wp-content/uploads/2020/06/A-Seat-at-the-Table-Final-Report-5-31-20.pdf>.

community leaders, residents, and visitors better understand how climate change is affecting the health of urbanized coastal communities, and better inform resilient design strategies to preserve people and place. Further, this research and design aligns with the State of New Jersey’s 2021 “Atlantic City Restart and Recovery Working Group Report”, which recommends reducing the city’s dependence on casino gaming and tourism, and shifting towards a “Blue Economy”. Coastal resilience, eco-tourism, recreation, job creation, renewable energies, fisheries, healthcare, transitional housing, aesthetic revitalization, and the redesign of streets are part of the included recommendations.²⁰

Research Design: Questions and Methods

This thesis analyzes the impacts of climate change and sea level rise on vulnerable urban coastal communities, synthesizes current and proposed resilient design strategies by contemporary designers and institutions, and proposes local resilient strategies that have global applicability. The analysis and synthesis of statistical data, projections, design precedents, and current design initiatives informs the programmatic proposal and design. Thus, the primary research questions are summarized as follows:

How can the amalgamation of civic design, landscape design, building adaptation, and preservation provide a framework for resilience and environmental justice in our most vulnerable coastal communities?

Can a new urban typology — the resilient transect — sustain the tangible and intangible environments of our flooding cities?

The research design of this thesis is a mixed-method design, relying on the combination of quantitative data gathered via historical design methods (archives, data sets),

²⁰ New Jersey Department of Community Affairs, *Report of the Atlantic City Restart and Recovery Working Group*, (Trenton, NJ: State of NJ, 2021), <https://www.nj.gov/dca/images/library/stories/ACRRWG-MAY-2021-Report.pdf>.

and qualitative data gathered via field research design methods (observation, case studies, interviews) and exploratory research (literature review, case studies, media analysis). Quantitative methods are utilized to analyze facts, measurements, statistics, and projections, sourced from government, academic, and non-profit sources; qualitative methods are utilized to analyze descriptions, concepts, behaviors, trends, stakeholder interviews, design precedents, and design proposals. Archival records from federal agency and university databases provide primary source documents and accounts, while secondary sources provide a synthesis of information that leads to further review of data and sources. Precedent analysis is conducted by analyzing existing coastal resilience design initiatives, including but not limited to: Boston's "Coastal Flood Resilience Design Guidelines", Clark Nexsen's design for the University of North Carolina's Coastal Studies Institute, MoMA's "Rising Currents" exhibit, and Rebuild by Design proposals (Fig. 8).



Fig. 8, Left: Construction of artificial oyster reefs at Gandy's Beach, Delaware, 2016 (Source: U.S. Fish and Wildlife Service); Upper Right: Plan for "sponge city" in Udon Thani, Thailand, 2018 (Source: CGIAR); Lower Right: Floating houses of IJburg Amsterdam, 2015 (Source: Wohtek Gurek)

Data Projection: Sources and Variables

It is acknowledged that data projections pertaining to climate change, sea level rise, flooding, geological changes, and ecological changes are statistical projections of future conditions, based on past and present data. Data projections are sourced from academic, government agency, and non-profit research organizations. It is the responsibility of this research to analyze these projections, provide sources, and provide an unbiased recapitulation based on the available data. For this reason, the data sources in Table 1 are considered reliable.

Table 1, Research Data Sources, 2021 (Source: Author)

	Agency or Institution	
International	• United Nations (UN) • Intergovernmental Panel on Climate Change (IPCC) • World Health Organization (WHO) • World Bank	
National	• National Oceanic and Atmospheric Administration (NOAA) • National Aeronautics and Space Administration (NASA) • Federal Emergency Management Agency (FEMA) • United States Army Corps of Engineers (USACE)	• Environmental Protection Agency (EPA) • National Park Service (NPS) • NJ Department of Environmental Protection (NJDEP) • National Climate Assessment (NCA) • Rutgers University (RU) • Climate Central (CC)

Depending on political and economic variables, projections may be inaccurate and present a lower risk, making an area seem more inhabitable, or a present higher risk, making an area seem less inhabitable. The FEMA Flood Insurance Rate Map (FIRM) shown in Fig. 9 provides an example of a nationally accepted but widely misinterpreted data set. For context, FEMA manages the National Flood Insurance Program (NFIP) and its risk rating criteria, establishing a base flood elevation (BFE) based on a 1% annual chance flood and a .02% annual chance flood. In order to receive insurance, participating municipalities and policy holders are required to build or raise their structures above the area's calculated Base Flood Elevation (BFE), and further recommended to add a "Freeboard" safety factor of 1 to 2 feet to

determine the final Design Flood Elevation (DFE). In Atlantic City the BFE ranges from 9 to 11 feet, and the Freeboard factor is 1 foot. These FIRMS are still based on data from 1985.



Fig. 9, FEMA 1% and .02% annual chance flood, Absecon Island, 2021 (Source: NJ Adapt)

It should be clarified that FIRM's do not provide flood projection data, but highlight areas of risk and indicate the minimum design flood elevation required for a property owner to receive flood insurance benefits. When compared to the baseline projections introduced later in this chapter, the base flood elevations of Atlantic City's current FIRM is approximate to a future Total Water Level (TWL) of 8 feet above the current Mean Higher-High Water level (MHHW). This base flood elevation is applicable to certain parts of the city but other areas have been given a base flood elevation that is disproportionate to the actual risk they face within the span of a 30-year mortgage. Although FIRM maps do not account for climate change or sea level rise, as of October 2021, FEMA announced Risk Rating 2.0; a plan to

modernize its projection standards with plans to include climate change and sea level rise data.²¹

To ensure a greater degree of accuracy that accounts for climate change and sea level rise, this thesis will use a Total Water Level (TWL) as a baseline. The Total Water Level projection is calculated by adding the projected sea level rise and projected flood event height to the current high tide level (Mean Higher High Water) (Fig 10).

Total Water Level Approach

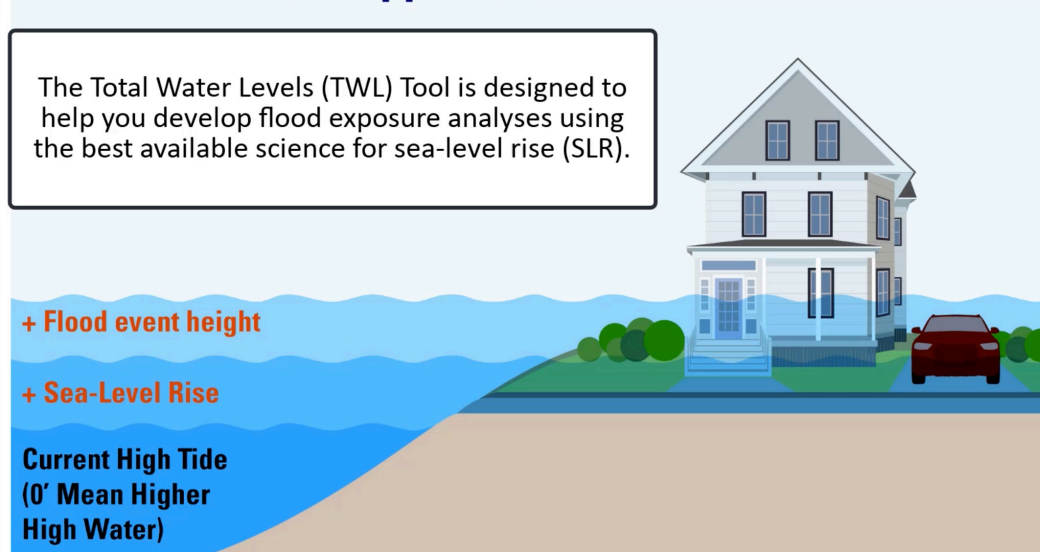


Fig. 10, Total Water Level Approach, 2021 (Source: Rutgers University, NJFloodMapper.org)

In Atlantic City, the Mean Higher High Water level (MHHW) is 2.39 feet above NOAA's Mean Sea Level (MSL) datum. It should be noted that the North American Vertical Datum of 1988 (NAVD88) is still used by many sources as a measure of average sea level height, but this datum is becoming inaccurate. In Atlantic City, the MSL datum is currently 0.4 feet below the NAVD88 datum (Fig. 11).

²¹ "Risk Rating 2.0: Equity in Action", Federal Emergency Management Agency, 2021, <https://www.fema.gov/flood-insurance/risk-rating>.

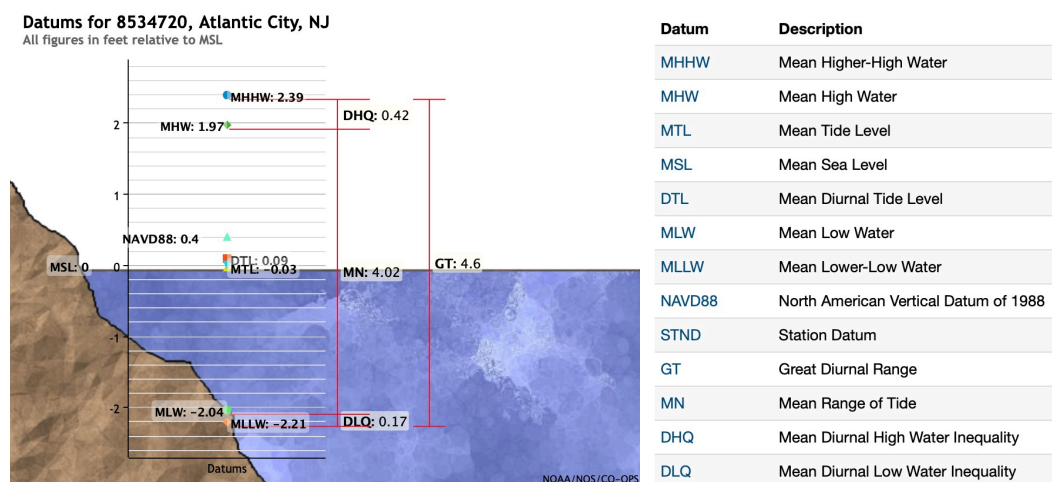


Fig. 11, Tidal Datums for Atlantic City, 2021 (Source: NOAA, NOS, CO-OPS)

Definitions

A requisite understanding of climate change, sea level rise, resilience, urbanization, and historic preservation is necessary to engage with the content of this thesis.

Climate Change

Armstrong, Krasny, and Schultdt's 2018 publication, *Communicating Climate Change: A Guide for Educators*, provides a thorough recapitulation of the requisite knowledge required to understand climate change science, psychology, and education. This publication posits that to understand — and believe in — climate change science, one must first understand that atmospheric changes can be categorized as short-term or long-term. Short-term change that is cyclical and varies by minute, hour, day, month, and/or season is termed weather; long-term variations that provide an average weather — typically measured over a period of 30 years — is termed climate.²² By definition, climate change is a “long-term shift in temperature and weather patterns” and occurs naturally.²³ It is estimated that the Earth's climate has undergone “seven cycles of glacial advance and retreat” in the last 650,000 years,

²² Anne K. Armstrong, Marianne E. Krasny and Jonathon P. Schultdt, “Climate Change Science: The Facts,” in *Communicating Climate Change: A Guide for Educators* (Ithaca, NY: Cornell University Press, 2018), 7. <http://www.jstor.org/stable/10.7591/j.ctv941wjn.5>.

²³ “Climate Change: How Do We Know?” Global Climate Change: Vital Signs of the Planet, National Aeronautics and Space Administration, <https://climate.nasa.gov/evidence/>.

with the last ice age ending approximately 11,700 years ago.²⁴ While changes in climate are expected over the long-term, anthropogenic activity has exacerbated atmospheric changes and created dire conditions for Earth's population.

The advent of the industrial revolution in the late 18th century mechanized industrial processes and relied on fossil fuel to power machinery. Coal was used early and considered to be an efficient fuel source for generating steam-based power, and by the mid-19th century, oil refinement provided an alternative fuel source that enabled the creation of the combustion engine and further mechanization. As manufacturing became more standardized and mobility more accessible, opportunity within urban centers led to increased density and production yield; the burning of fossil fuels powered this revolution (Fig. 12).



Fig. 12, Industrial Revolution in England; pollution due to increased manufacturing and fossil fuel consumption, late 19th-century (Source: University of Cambridge)

As a result of industrialization, urbanization, deforestation, commercial agriculture, energy production, transportation, and waste, increased concentrations of greenhouse gases — carbon dioxide, methane gas, nitrous oxide, and fluorinated gases — have been released into the atmosphere.²⁵ Although greenhouse gases, such as carbon dioxide, are essential for

²⁴ “What is Climate Change?” National Aeronautics and Space Administration, May 14, 2014, <https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-climate-change-k4.html>.

²⁵ Armstrong et al, p.10.

plant life and help maintain the Earth's temperature, above average concentrations in the atmosphere prevents the sun's heat from being released back into space.²⁶ The Earth is now an average of 1.8 °F warmer than it was in the late-19th century, with the decade from 2011 to 2020 being the warmest on record (Fig.13).²⁷ The increased concentration of heat has resulted in unprecedented changes to the Earth's climate that has resulted in more extreme droughts, fires, storm events, flooding, warming oceans, ocean acidification, increased water salinity, and atmospheric temperature fluctuations.²⁸ These changes have affected the quality of water, air, and ground, which has impacted the health of humans, terrestrial environments, and aquatic environments.

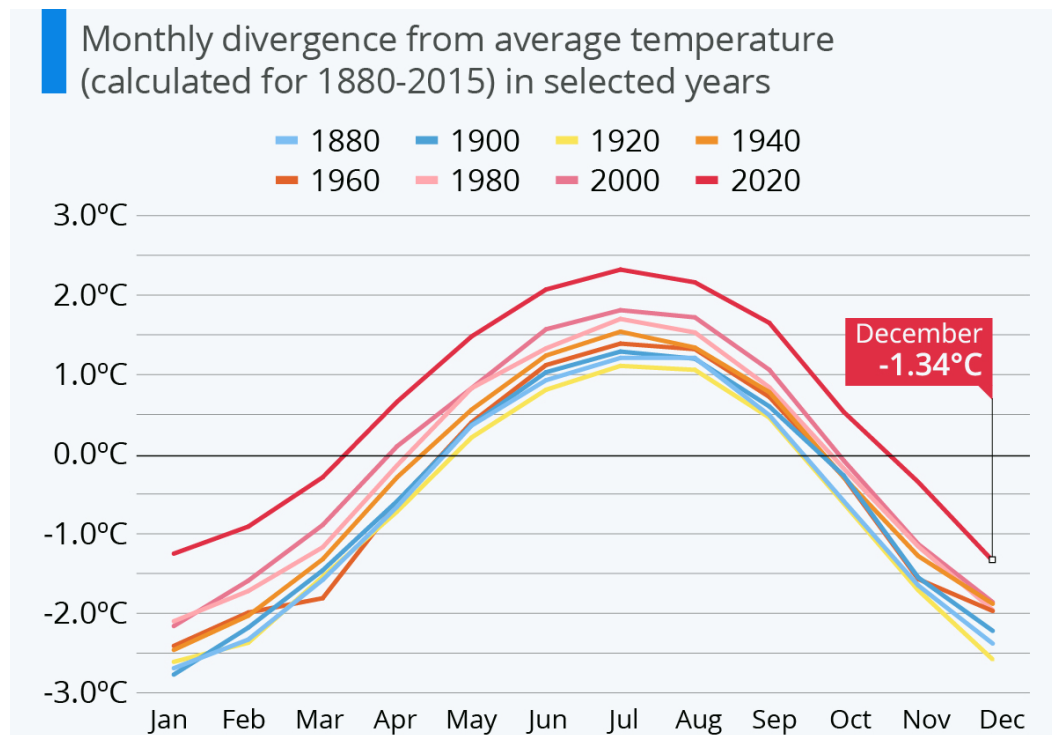


Fig. 13, Monthly average temperature increase 1880-2020, 2020 (Source: NASA)

Note: 1.0 °C = 1.8 °F

²⁶ Armstrong et al, p.8.

²⁷ "What is Climate Change?" Climate Action, United Nations, 2021, <https://www.un.org/en/climatechange/what-is-climate-change>.

²⁸ "Climate Change: How Do We Know?" NASA. <https://climate.nasa.gov/evidence/>.

In a 2018 report by the United Nations, international scientists and government officials agreed that reducing emissions and limiting global temperature rise to no more than 2.7°F could prolong the effects of climate change, but current projections estimate that by 2100, temperatures could rise an additional 8°F.²⁹

Sea Level Rise

Sea level is dynamic; it has fluctuated with climate over the course of hundreds of thousands of years. It is estimated that sea levels have risen approximately 400 feet over the past 20,000 years, with levels stabilizing around 1000 B.C.E.³⁰ Up until the 20th-century these levels remained stable but during the 20th-century sea level rose globally at around 0.7 inches/decade. Between 2000 and 2020 this figure has exponentially risen to 1.3 inches/decade.³¹ As a result of climate change and the Earth's rising average temperature, the polar ice caps and glacial forms have begun to melt at alarming rates. The rise in sea level has led to more frequent coastal flooding triggered by storm and non-storm events. Storm surges and prevailing winds force already rising seas further into coastal communities while subsidence — the sinking of land formations — exacerbates the effects of sea level rise along barrier and island communities. Nuisance flooding or “sunny-day flooding” does not require a storm event and is the result of a high tide and a full/new moon cycle occurring concurrently.

Along the New Jersey coast, sea level has risen nearly 16 inches during the 20th-century, likely faster than any other century in a 4,000 year period.³² The 2019 report by Rutgers University's Science and Technical Advisory Panel, *New Jersey's Rising Seas and Changing Coastal Storms*, has synthesized substantial sea level rise data for New Jersey and the Atlantic City region. This work categorizes sea level rise projections off of New Jersey's coast in the “low end, likely range, and high end”, based off of low, moderate, and high future

²⁹ Armstrong et al, p.8.

³⁰ Kenneth G. Miller, Robert E. Kopp, James V. Browning, and Benjamin P. Horton, “Sea Level Rise in New Jersey Fact Sheet,” Rutgers University Department of Earth and Planetary Sciences, Institute of Marine and Coastal Sciences, 2014, https://geology.rutgers.edu/images/stories/faculty/miller_kenneth_g/Sealevelfactsheet7112014update.pdf.

³¹ Ibid.

³² Ibid.

emission scenarios. Based on these categories and a moderate emissions scenario, by 2050, projections indicate sea level will rise between 0.7 feet and 2.6 feet; by 2100, projections indicate that sea level will rise between 1.3 feet and 6.9 feet (Fig.14).³³ The relative rate of sea level rise must also account for land subsidence, and it is estimated that due to groundwater withdrawal, Atlantic City is subsiding at a rate of 1.0 ± 0.2 millimeters per year.³⁴ Sea level rise not only affects developed land areas, but affects the health of natural ecosystems that serve to nourish and protect the coast.

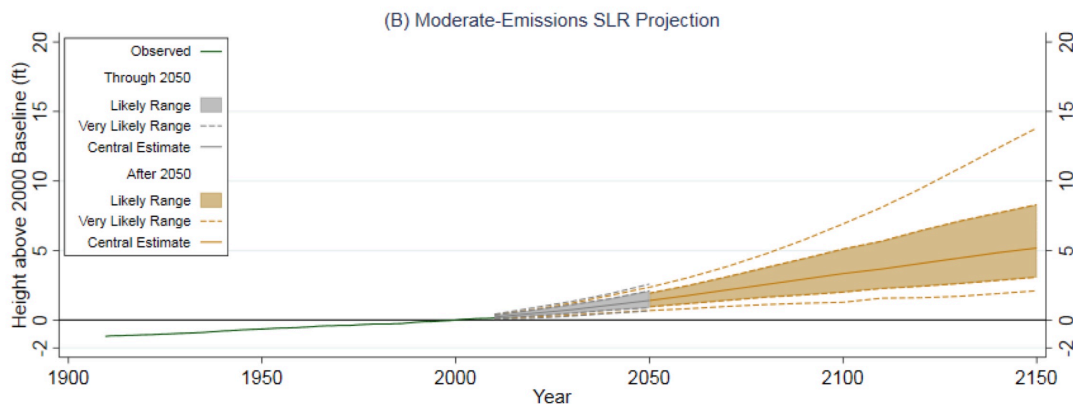


Fig. 14, Projections of relative sea level rise at the New Jersey shore, 2019 (Source: Rutgers)

Resilience

Resilience is a dynamic term that is continuously evolving as natural and built environments adapt to ecological, hydrological, and sociological changes. In its most rudimentary meaning, resilience is defined as “an ability to recover from or adjust easily to adversity or change”.³⁵ More specifically, coastal resilience is the “ability of a community to ‘bounce back’ after hazardous events such as hurricanes, coastal storms, and flooding”.³⁶ The National Oceanic Service notes that resilience is about proactively “building” this ability rather than reacting to impacts. The ability to “rebound” from damaging climate events

³³ R.E. Kopp et al, “New Jersey’s Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel,” Rutgers University, November 2019, https://climatechange.rutgers.edu/images/STAP_FINAL_FINAL_12-4-19.pdf.

³⁴ Kenneth G. Miller, Robert E. Kopp, Benjamin P. Horton, James V. Browning, and Andrew C. Kemp, “A Geological Perspective on Sea-Level Rise and its Impacts Along the U.S. Mid-Atlantic Coast,” *Earth’s Future* 1, no. 1 (December 2013): 3-18, <https://doi.org/10.1002/2013EF000135>.

³⁵ “Resiliency.” Merriam-Webster Dictionary. <https://www.merriam-webster.com/dictionary/resiliency>.

³⁶ “What is Resilience?” National Oceanic and Atmospheric Administration, <https://oceanservice.noaa.gov/facts/resilience.html>.

reduces negative impacts to human health, environmental health, and the economic health of a community.³⁷ Further defined, resilience is the “ability of a community to not only deal with adversity but in doing so reach a higher level of functioning”.³⁸

Trusted and contemporary publications on the specific subject of coastal resilience and its design include Timothy Beatley’s 2009 book, *Planning for Coastal Resilience*, Routledge’s 2019 case study compilation, *Towards Coastal Resilience and Sustainability*, Kate Orff + SCAPE’s 2016 publication, *Toward an Urban Ecology*, and Island Press’s 2021 research compilation, *A Blueprint for Coastal Adaptation*. Based on these texts it is determined that a truly resilient community has the capacity to adapt, strengthen, and grow in response to both acute and chronic climate events. Coastal resilience is a dynamic practice that must be reevaluated as climate conditions change and the severity of climate events develop; strategies for resilience must be assessed and updated as conditions change. Exploring hazards, assessing vulnerability and risk, investigating options, and prioritizing actions provides a framework for resilience that can be adapted to specific socioeconomic and geographic conditions. Though resilience infers the ability to maintain a presence after a climate event, contemporary thought considers planned retreat as a resilient practice to ensure human populations are protected and the longevity of natural ecosystems sustained.

Urbanization

Urbanization has multiple definitions due to the variations in the “form, shape, function, and history” of urban environments.³⁹ Bai, Griffith, and Kremer’s publication, *Coastal Zones and Urbanization*, concisely defines urbanization as the “growth of cities and towns relative to the population of rural areas”, with growth inferring demographic, spatial,

³⁷ Ibid.

³⁸ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

³⁹ John E. Akubia, “Coastal Urbanization and Urban Land-Use Change,” *WaterPower Working Paper* 10 (2016), https://www.uni-trier.de/fileadmin/fb6/prof/RAU/Publications/Working_Paper/10_Akubia-John_Coastal-Urbanization-and-Urban-Land-Use-Change.pdf.

and/or economic change.⁴⁰ Urban areas — whether a city or adjacent community — are more densely populated than their rural counterparts. The industrial advancements during the 18th, 19th, and 20th centuries led to a significant shift of populations from rural to urbanized areas as opportunities for employment and growth prevailed. As a result of rapid industrialization and population growth, urban areas formed as consolidated hubs for trade, governance, and social growth. The potential benefits of urbanization — resource efficiency, economic growth, and well-being — must be considered alongside its potential threats — resource depletion, increased poverty, and the deleterious effects of pollution.⁴¹ As of 2021 it is estimated that nearly 50% of the world’s population lives in urban areas, a figure that is estimated to increase to two-thirds by 2050.⁴²

Historic Preservation

Preservation is the protection and interpretation of tangible and intangible resources deemed significant for their historical, cultural, environmental, and archaeological value. Preservation studies the past to inform the future, thus, present actions determine what is curated for future generations. Both substantive and procedural protections have been written to protect resources at the international, national, state, and local levels. The UNESCO (United Nations Educational, Scientific, and Cultural Organization) World Heritage Convention is an international agreement signed by 188 nations, intended to protect cultural and natural heritage sites for the world’s population to enjoy. In the United States the National Historic Preservation Act of 1966 (NHPA) is the adopted law that is meant to protect historic resources from Federal actions and undertakings. The NHPA established the National Register for Historic Places (NRHP) to provide a national inventory of historic resources deemed worthy of recognition, based on significance and integrity. Listing does not provide substantive protection, but establishes procedural guidelines that consider the impact of

⁴⁰ Xuemei Bai, Corrie Griffith, Hartwig Kremer, et al, “Coastal Zones and Urbanization,” International Human Dimensions Program on Global Environmental Change, June 2015, https://www.researchgate.net/publication/279455992_Coastal_zones_and_urbanization.

⁴¹ “Urban Nations,” United Nations Population Fund, <https://www.unfpa.org/urbanization>.

⁴² Hannah Ritchie and Max Roser, “Urbanization,” *Our World in Data*, November 2019, <https://ourworldindata.org/urbanization>.

Federal actions on listed and eligible resources via the Section 106 review process. Local Historic Preservation Ordinances and Historic District Design Guidelines — based on local, state, or national criteria — provide the most substantive protections for listed resources, resources deemed eligible, or resources contributing to a designated historic district. To date, federal, state, and local regulations have been hesitant to consider the significance and integrity of intangible resources or places of “recent history”.

Strategies for coastal resilience must plan for preservation of tangible resources, but also the preservation of people, place, culture, tradition, and memory in lieu of physical resources. Both resilience and preservation plan for inevitable change, so their relation to one another is significant. When considering the value that historic, cultural, environmental, and archaeological resources have in informing the future, preservation planning must inform coastal resilience to prevent erasure of the tangible and intangible past. Texas A&M University Press’s publication, *Protecting Historic Coastal Cities*, is unique in that it is one of the only contemporary publications to place historic preservation within the context of coastal resilience, providing nine case studies by nine experts. Perspectives from the fields of historic preservation, urban studies, oceanography, and anthropology are presented, and the case studies reference diverse geographic locations within and beyond the United States, including Galveston, Miami, New Orleans, and the Netherlands. Both gray and green infrastructural approaches to coastal resilience are presented and proposed, ranging from the active use of building materials and methods in Louisiana, to the passive coastline regeneration of the Netherlands’ “Zandmotor” (Fig. 14). This publication provides great precedence in developing strategies for Atlantic City’s resilience and preservation.



Fig. 15, Zandmotor (Sand Motor) in Rijkswaterstaat, Netherlands replenishes the beach from a single source of placed sand, negating the need for machine intensive replenishment projects, 2016 (Source: Jurriaan Brobbel)

Research Baselines

Depending on the data source and projection timeline, climate change predictions and sea level rise projections will vary. However, all projections indicate that the planet will continue to warm, exponentially increasing the threat of chronic climate events — those that occur regularly, such as flooding — and acute climate events — those that are more rare, but could result in significant damage or loss of life and property. All projections also indicate that the frequency and amplitude of such events will increase exponentially with time. Low end, likely range, and high end projections are compared, as are the design timelines of 2050 and 2100. NOAA's 'Coastal Flood Exposure Mapper' and 'NJFloodMapper.org' serve as the primary graphic interfaces for projections and base images; these interfaces synthesize data from NOAA, USGS, EPA, NPS, and ESRI.

Projected Timelines

The years 2050 and 2100 are regularly cited as future thresholds for climate change baselines, providing context for mid-century and end-of-century conditions based on current trends and projections. 2050 provides a threshold that will likely be lived by those conducting and studying current research; 2100 provides a threshold that may not be experienced by the current generation, but will be experienced by the next generation and their offspring. A moderate emissions scenario will be used as it corresponds to the warming expected under current international policy and practice.

Sea Level Rise

Rutgers University defines sea level rise projections along the New Jersey coastline in the “low end, likely range, and high end”.⁴³ Based on Rutgers’ reputability and their research in tracking climate change along New Jersey’s coast, these projections serve as a reliable baseline (Tables 2 and 3). Figure 16 depicts sea level rise scenarios for Atlantic City under moderate emissions, for 2050 and 2100.

		2030	2050	2070			2100			2150		
				Emissions								
	Chance SLR Exceeds			Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	> 95% chance	0.3	0.7	0.9	1	1.1	1.0	1.3	1.5	1.3	2.1	2.9
Likely Range	> 83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50 % chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	< 5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

*2010 (2001-2019 average) Observed = 0.2 ft

Table 2, New Jersey sea level rise projections in feet, 2020 (Source: Rutgers)

Scenario /Year	2000	2030	2050	2070	2100
Moderate Emissions <i>Likely</i> (3.3 ft SLR by 2100)					
100-year flood (1% AEP)	4.8	5.6	6.2	7.0	8.1
Sandy Storm Tide	4.1	4.9	5.5	6.3	7.4
10-year flood (10% AEP)	3.3	4.1	4.7	5.5	6.6
Annual Flood (99% AEP)	2.5	3.3	3.9	4.7	5.8
High Tide Flooding Threshold	1.8	2.6	3.2	4.0	5.1
Permanent Inundation (MHHW)	0.0	0.8	1.4	2.2	3.3

Table 3, Atlantic City projections, current and historic flood events, 2019 (Source: Rutgers)

⁴³ Miller et al, “Sea Level Rise in New Jersey Fact Sheet”.

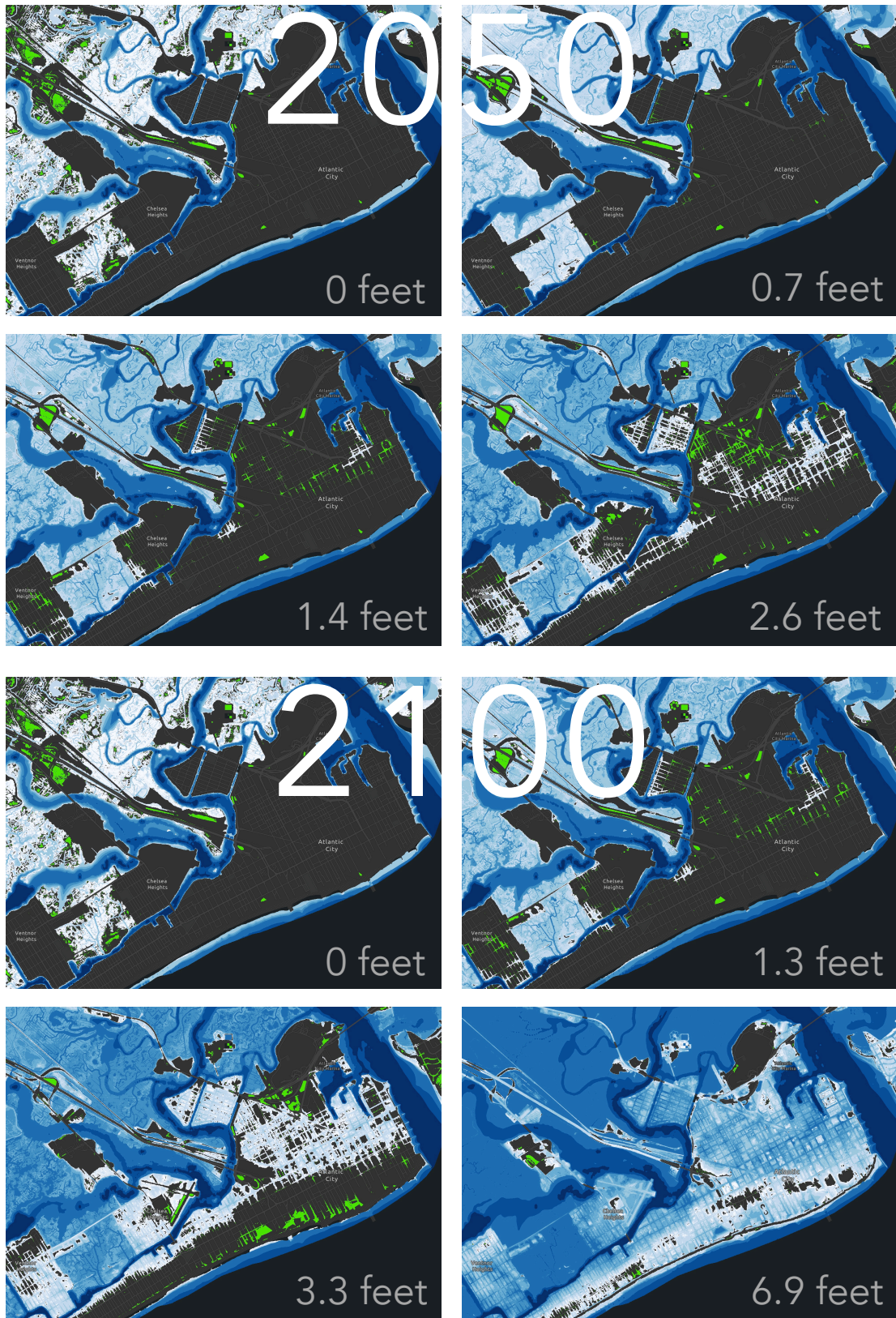


Fig. 16, 2050 and 2100 sea level rise projections for Atlantic City without flood or surge conditions: current, low end, likely range, high end, 2021 (Source: Author, NJ Adapt data)

Based on the projections above, this thesis will refer to Rutgers' 2100 "likely range" projection for Atlantic City; 3.3 feet in sea level rise. To calculate the projected Total Water Level of a future climate event, the storm surge experienced during Superstorm Sandy (4.3 feet above MHHW) is added to the sea level rise projection of 3.3 feet. This results in a projected Total Water Level (TWL) of 7.6 feet during a storm surge in the year 2100. The TWL will be rounded up to 8 feet and serve as the baseline for the design proposal, a flood level that is commensurate with data sets citing a FEMA 1% annual chance flood (Fig. 17).

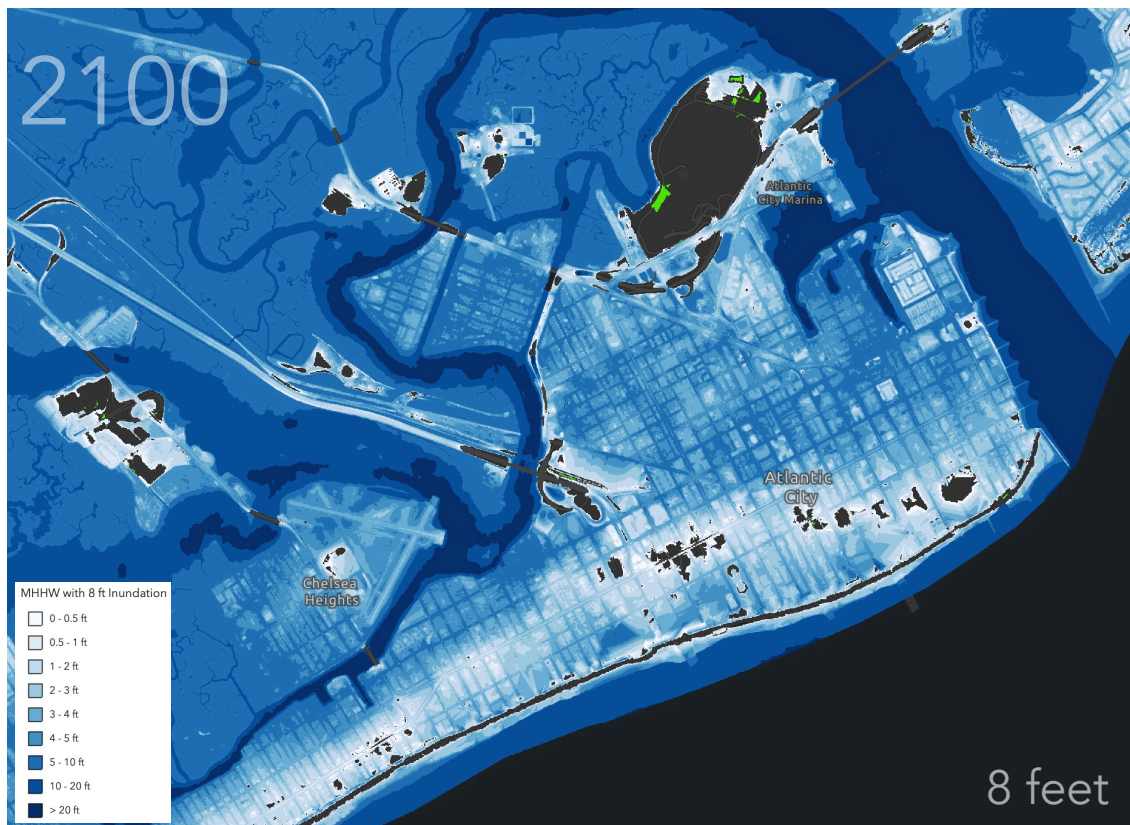


Fig. 17, "Likely Range" flood projection for Atlantic City, 2100; based on Superstorm Sandy the surge results in a Total Water Level of 8-feet, 2021 (Source Author, NJ Adapt data)

Limitations

Given the context of this thesis research, there are certain limitations pertaining to data access and whether public data is up-to-date. For scientific data retrieved by federally funded agencies, accessible data could be limited due to sensitive or confidential information

contained within; there are also biases in climate projections depending on agency leadership, political views, and financial interests. This results in data that could be several years out-of-date or contains polarizing projections. Conversely, other data sets are constantly changing and being re-released; data that was sourced at the beginning of this research process has already changed, and will continue to change. Despite these limitations, every effort has been made to source data from the most recent sets available.

Another limitation is the ability to access recent Census and demographic data. This information is only provided in QuickFact format through the Census Bureau website; actual surveys are made public 72 years after the Census year in which they were completed. These QuickFacts are moderately reliable but depend on the amount of residents willing to participate and the honesty of resident responses.

An additional limitation is the inability to conduct surveys and receive design input from community stakeholders. Ideally, the design proposal of this thesis would require community feedback, participation, and design charrettes. The author *has* met with local stakeholders, community leaders, and attended community listenings sessions to develop the programmatic requirements of the final design proposal, but final design decisions are based on the synthesis of qualitative and quantitative sources, local trends, and informal conversations with community stakeholders over the course of several years. Despite these limitations, the author was able to discuss the context of the thesis proposal with: Climate Adaptation Partners, a New York City research firm who's Founder has worked closely with the Atlantic City Planning Department to develop strategies for coastal resilience; Anna Knoell of LTL Architects, who helped design the proposal for the "Amphibious Suburb", a resilient design for Atlantic City's Upper Chelsea neighborhood; Julia Chapman, coauthor of the 2018 book *Structures of Coastal Resilience*; and Christina Noble, project manager of "Stories of Atlantic City", a local journalism project supported by Stockton University, which actively engages with the community to capture the oral histories and narratives of the city's residents.

Contribution to Field

This research seeks to contribute to the cross disciplinary fields of architecture, historic preservation, urban design, and coastal resilience. By studying the inequities that vulnerable coastal communities are faced with due to climate change and sea level rise, this thesis proposes design strategies that are equitable and provide for the socioeconomic and cultural resilience of coastal communities. The majority of contemporary research focuses on the ecological, social, and/or economic resilience of a community, but rarely considers preservation of cultural resources as a strategy for resilience. Providing capacity for vulnerable coastal communities to preserve tangible and intangible resources not only protects community identity but strengthens community networks in times of adversity. In addition, this thesis proposes strategies that work to diversify coastal economies and leverage the assets of existing coastal industries as catalysts for global research, education, collaboration, and innovation in coastal resilient design.

Chapter 2: Coastal Urbanization



Atlantic City and the urbanization of New Jersey's coastline, 2019 (Source: Author)

Introduction

Urbanization of coastal lands is rooted in ancient precedents. Early civilizations realized the importance of water as a source for food, energy, transportation, and drinking, thus catalyzing settlement along shorelines, estuaries, and rivers. From seasonal settlement to permanent development, adjacency to water has been fundamental in the growth and shaping of civilization's global network.⁴⁴ However, the densification of development on coastal lands has created ecological and socioeconomic impacts that are now exacerbated due to climate change, worsening storm events, rising sea levels, and land subsidence. Coasts have always been dynamic landforms that continuously develop with geological and climate fluctuations, but permanent settlement and built infrastructure has disallowed these natural shifts, forcing coastal communities to contemplate their degree of permanence. This chapter will inform the urban context of coastal resilient design practices by reviewing coastal typologies, coastal settlement and development patterns, and the current impact of coastal urbanization.

⁴⁴ Sergio Jiménez and Wilver Salinas and Jesús Campos, "Impacts Of Urbanization On Coastal Zones. Case Study: Altamira-Madero-Tampico Conjoined Area, Tamaulipas, Mexico," Texas A&M University: Harte Research Institute for Gulf of Mexico Studies, <https://www.harte.org/sites/default/files/inline-files/13.pdf>.

Coastal Typologies: Form and Function

Coasts are dynamic landforms that can be classified either by their geological composition or the way in which they form.

Coasts classified by geology are either active or passive. Active coasts are located near a plate boundary, formed by tectonic activity, and are more solid in form; passive coasts are farther from plate boundaries and are more dynamic due to their sedimentary composition.⁴⁵ Alternatively, coasts classified by the way in which they form are either primary or secondary. Primary coasts are formed by land-driven processes such as tectonic shifts, erosion, and sedimentation. Secondary coasts are formed by ocean-driven processes such as wave erosion and marine growth.⁴⁶ For the purpose of this thesis, the primary and secondary classification system will be referenced.

Primary Coast

Primary coasts are classified as ria, glacia, delta, volcanic, and fault/tectonic (Fig. 1).

- Ria coasts are the result of a flooded river valley, likely formed after the ice age.⁴⁷ The ria coastal typology is essentially an estuary where the ocean's salt-water meets a river's fresh-water. Estuaries support a diversity of plant, terrestrial, and aquatic life, and aid in the migratory patterns of bird species. On the Eastern Seaboard, the Chesapeake and Delaware Bays are examples of this typology. Atlantic City is located between the Great Egg Harbor and Great Bay estuaries.
- Glacia coasts or fjords are flooded river valleys, except the land is formed when a glacier retreats, resulting in a carved U-shape valley with steeper slopes than a ria.⁴⁸

⁴⁵ "Coastal Dynamics," National Oceanic and Atmospheric Administration, 2010, <https://repository.library.noaa.gov/view/noaa/16270>.

⁴⁶ Ibid.

⁴⁷ The Editors of Encyclopaedia Britannica, "Ria.," *Encyclopedia Britannica*, July 20, 1998. <https://www.britannica.com/science/ria>.

⁴⁸ "What is a Fjord?" Go Fjords, <https://www.fjords.com/what-is-a-fjord/>.

- Delta coasts are considered to be a land-deposition coast, formed as rivers flow into oceans and sediment accumulates.⁴⁹ Delta coasts include those at the mouths of major rivers such as the Nile or Mississippi. This coastal type is highly dynamic and susceptible to changes due to water, wind, and marine growth.
- Volcanic coasts are formed by volcanic activity and are typically circular or undulating in pattern, forming islands, groups of islands, and peninsulas. These coasts are composed of igneous rock and considered structural coasts.⁵⁰
- Fault or tectonic coasts are formed from the shifting of tectonic plates and are typically steeper and linear in nature, but not limited to these characteristics.⁵¹

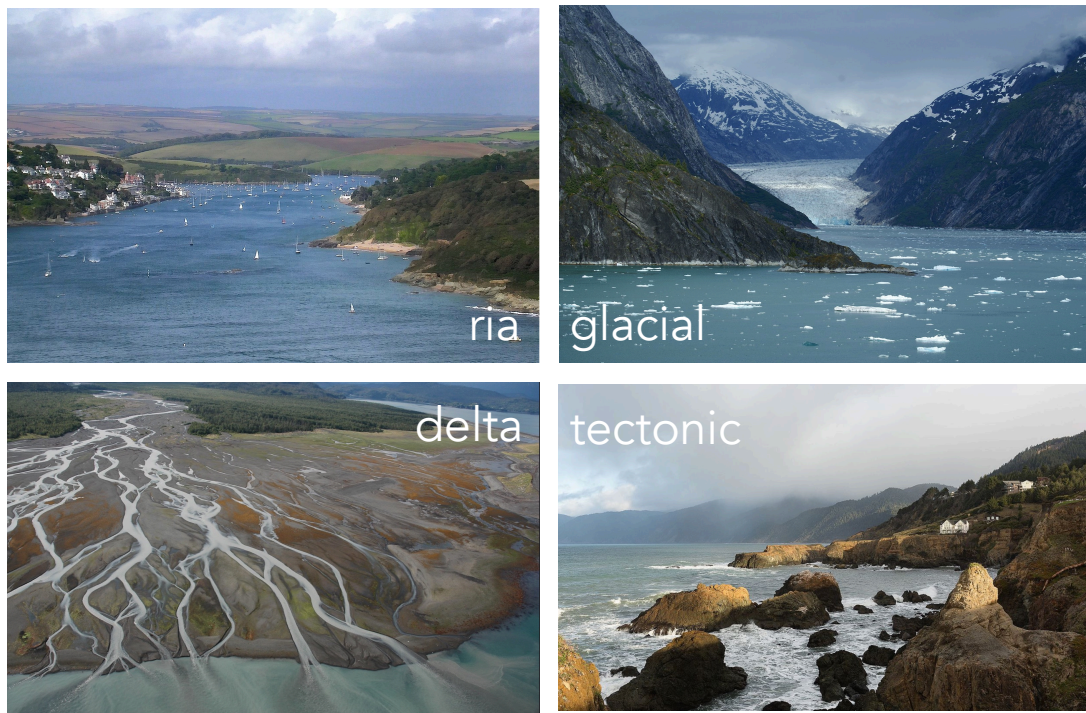


Fig. 1, Primary coasts (Source: John Stumbles, 2004 (ria); Richard Martin, 2008 (glacial); NOAA, 2014 (delta); Frank Schulenburg, 2017 (tectonic))

⁴⁹ "Coastal Dynamics," NOAA.

⁵⁰ Jose F. Araya-Vergara, "Volcano Coasts," *Beaches and Coastal Geology, Encyclopedia of Earth Sciences Series*, New York, NY: Springer, 1982, https://doi.org/10.1007/0-387-30843-1_479.

⁵¹ Roger F. McLean, "Fault Coast," *Beaches and Coastal Geology, Encyclopedia of Earth Sciences Series*, Springer, New York, NY, 1982, https://doi.org/10.1007/0-387-30843-1_183.

Secondary Coast

Secondary coasts are classified as barrier island, salt marsh, and coral-reef formations (Fig. 2). Because these coasts are formed by ocean-driven processes, they are very dynamic and susceptible to rapid change or disappearance. Climate change poses a great risk to secondary coasts. Sea level rise, storm frequency, storm intensity, increasing ocean temperatures, and changing salinity levels threaten the biodiversity of these coasts.

- Barrier island coasts are typically parallel to the primary shoreline and are formed by the accumulation of sediment — either sand or shingle — by means of waves, tides, and wind.⁵² Though dynamic in nature, barrier islands “stand permanently above high tide level” in order to be classified as such.⁵³ Barrier islands are also classified as submergent because they form when “sea levels rise relative to land”.⁵⁴ A key characteristic of barrier islands is their susceptibility to rapid growth, erosion, movement, subsidence, and erasure.⁵⁵ Atlantic City is a barrier island coast.

- Salt marsh coasts are typified by: low-lying meadows; halophytic plants capable of withstanding high salinity and tidal inundation; and aquatic species that can withstand the high salinity and “mechanical stress” due to tides and waves.⁵⁶ Salt marsh coasts can further be classified as: fringing marshes at the mouths of estuaries and bays; lagoon marshes that are adjacent to spits and barrier bars; and deltaic marshes that are at the mouths of rivers carrying sediment.⁵⁷ Salt marsh coasts also act as a buffer for the primary shoreline and help to sequester pollutants present in air and water. The bayside of Atlantic City’s barrier formation has the same characteristics of a salt marsh coast.

⁵² John R. Hails “Barrier Island Coasts,” *Beaches and Coastal Geology, Encyclopedia of Earth Sciences Series*, New York, NY: Springer, 1982, https://doi.org/10.1007/0-387-30843-1_42.

⁵³ Ibid.

⁵⁴ “12 Coastlines,” *An Introduction to Geology*, Salt Lake Community College, <https://opengeology.org/textbook/12-shorelines/>.

⁵⁵ “What is a Barrier Island?” National Oceanic and Atmospheric Administration, <https://oceanservice.noaa.gov/facts/barrier-islands.html>.

⁵⁶ Linda C. Newby, “Salt Marsh Coasts,” *Beaches and Coastal Geology, Encyclopedia of Earth Sciences Series*, New York, NY: Springer, 1982, https://doi.org/10.1007/0-387-30843-1_383.

⁵⁷ Ibid.

- Coral-reef coasts typically form in the warmer, shallow waters of tropical coastal environments and require a balance of salinity and fresh water for the coral to grow and expand.⁵⁸ Coral, a living organism, attaches to rocks and other hard surfaces and leaves lime-stone deposits, forming vertical reefs.⁵⁹ Reefs closer to the coast can help protect the coastline, while reefs farther from the coast can actually create “funnels” that result in further coastal erosion.⁶⁰ In addition to coral reefs, mollusks such as oysters can form reef formations that act as breakwaters and filters, with a single oyster capable of filtering 50 gallons of polluted water per day.⁶¹



Fig. 2, Secondary coasts (Source: Leo Chiou, Ruth W., Creative Commons)

As an alternative to these classifications, Rutgers University narrows the classification of North American Eastern Seaboard coasts to barrier island, headlands, and inland bay coasts.⁶² Absecon Island, on which Atlantic City was settled, is a barrier island coast of sand, evolving since the end of the last Ice Age approximately 10,000 years ago. Ocean waves, tides, wind, and settlement continue to shape this sedimentary coast.

⁵⁸ Edgar Frankel, “Coral Reef Coasts,” *Beaches and Coastal Geology*, *Encyclopedia of Earth Sciences Series*, New York, NY: Springer, 1982, https://doi.org/10.1007/1-4020-3880-1_100.

⁵⁹ Ibid.

⁶⁰ Ibid.

⁶¹ “Oyster Fact Sheet,” Chesapeake Bay Foundation, <https://www.cbf.org/about-the-bay/more-than-just-the-bay/chesapeake-wildlife/eastern-oysters/oyster-fact-sheet.html>.

⁶² Sasaki, Rutgers, Arup, “Resilience + The Beach,” Rebuild by Design Competition Entry, March 2014.

Coastal Settlement and Development

An overview of coastal settlement and development patterns is provided to better understand the sociological factors that catalyzed the transition of coastal areas from seasonal settlements to urbanized communities. This overview is divided into two time periods; pre-1850 C.E. and 1850 C.E. to present day. 1850 C.E. was chosen because of the social, technological, and economic growth that rapidly occurred as a result of the industrial revolution. With advances in transportation and building technology, societies could now access and build in areas previously deemed uninhabitable. In addition, increasing wealth and a developing focus on health spurred the creation of coastal communities as retreats from the rapidly urbanizing city. Though urbanized coastal communities were not a new development, the pursuit of leisure and respite led to an increasingly popular urban coastal typology; the seaside resort.

Historic Settlement (pre-1850 C.E.)

Simply stated, water supports life. The climatic conditions towards the end of the ice age (c. 11,700 B.C.E) led to the formation of coastal conditions highly suitable to support terrestrial, aquatic, and plant life. The transition from nomadic patterns of hunting and gathering to neolithic patterns of agrarian settlement catalyzed the pursuit of fertile, inhabitable land. Although settlements in the Eastern Mediterranean Levant region have been dated to c. 13,000 B.C.E., changing climatic conditions and reliance on foraging forced this early civilization to disperse.⁶³ It wasn't until c. 8,000-7,000 B.C.E. that more permanent settlement occurred in Jericho, adjacent to springs and what is now the Jordan River.⁶⁴ The consolidation of peoples into communities adjacent to water supported terrestrial and riparian agriculture, and provided sustenance for developing neolithic civilizations.

⁶³ "Neolithic Revolution," Northern Arizona University, <https://www2.nau.edu/~gaud/bio301/content/neolith.htm>.

⁶⁴ Heikki Vuorinen and Petri Juuti and Tapio Katko, "History of Water and Health From Ancient Civilizations to Modern Times," *Water Science & Technology: Water Supply* 7, (March 2007) <https://doi.org/10.2166/ws.2007.006>.

Whether these settlements were seasonal or permanent depended on the type of coast, the elevation of settlement, and the threat of seasonal flooding and storm events. It should be noted that archaeological and built evidence of ancient coastal urbanization remains in areas that are elevated and classified as primary coasts; there is less evidence of permanence in areas with low-lying or secondary coasts. This does not discount the fact that areas abundant in fertile ground and aquatic life were settled seasonally, including barrier islands and rias.

While coastal areas were originally settled due to the abundance of natural resources, the potential of water-based navigation was realized by the Phoenicians as early as 4,000 B.C.E.⁶⁵ Port cities became nodes in a developing regional and global network. Ancient civilizations in China, India, Egypt, Greece, Rome, India, and East Africa had developed some form of coastal urbanization to accommodate water-based trade.⁶⁶ The benefits of coastal development were tested as civilizations began to use coastal development as a medium for conquest, globalization, slave trade, and colonization.

Technological developments in navigation during the 15th century further expanded the global network, and from a western perspective, allowed for the discovery of new lands. The Indigenous civilizations of the Americas had already established networks for trade and developed precedents for living on or near coastal edges. The ancient Aztec city of Tenochtitlan had fully embraced the prospect of coastal development, and engineered the urban design and expansion of their capital city on Lake Texcoco (Fig. 3).

Docks, canals, and artificial land masses, called chinampas, allowed for Tenochtitlan to thrive as an urbanized island city in a broader network of cities and tribes. The Spanish conquest of Tenochtitlan in 1521 razed almost all tangible signs of Aztec civilization, but the engineered coastal city was a model that persisted. As Spanish, English, Dutch, and French kingdoms crossed the Atlantic in pursuit of resources and global expansion, cities were developed along coastal edges, harbors, and rivers. As more Europeans navigated to the

⁶⁵ "History of Navigation at Sea," Science and Issues, *Water Encyclopedia*, <http://www.waterencyclopedia.com/Mi-Oc/Navigation-at-Sea-History-of.html>.

⁶⁶ James Hancock, "The Eastern Trade Network of Ancient Rome," World History Encyclopedia, June 2, 2021, <https://www.worldhistory.org/article/1761/the-eastern-trade-network-of-ancient-rome/>.

Americas in pursuit of opportunity and religious freedom, Indigenous civilizations and tribes were killed or forcibly expelled from their coastal settlements; cities and trading posts were now developed under the ideals of European urbanization and planning, following the planning principles dictated by the Law of the Indies.



Fig. 3, Aztec Capitol of Tenochtitlan, 2016 (Source: Creative Commons Wiki)

Depending on the region, earthen buildings, log buildings, heavy frame buildings, and stone buildings became the dominant vernacular style of early settlement. Those with greater wealth had access to better resources and tools, resulting in more permanent construction and stylistic ornamentation within coastal communities. Buildings were not limited to the ground plain or slab style foundations; post-in ground construction techniques allowed the elevation of buildings above wet or saturated ground conditions (Fig. 4). However, due to the fluctuating water table and cyclic exposure to oxygen, submerged foundation posts required frequent replacement.



Fig. 4, Raised Creole plantation house in St. Charles Parish, Louisiana, c. 1800s (Source: State of Louisiana Department of Culture, Recreation, & Tourism)

The Industrial Revolution of the late 18th and early 19th century resulted in drastic changes to the once vernacular landscape; density and production increased, resources were extracted and made abundant, and formal policy for city planning was adopted. As cities densified, the water and air quality worsened, disease spread, and socioeconomic disparities led to poverty and slum conditions. Areas that were historically unsettled due to flooding were either artificially fortified or forced upon the poor.

Contemporary Development (1850 C.E. to present)

Technological advancements in transportation, energy production, resource extraction, manufacturing, and building technology aided in the exponential growth of coastal urbanization in the 19th century. Buildings achieved new heights and populations continued to grow as many migrated towards urban areas for the “real and perceived presence of greater economic opportunity”.⁶⁷ The advancement of railways made it possible to

⁶⁷ Xuemei Bai, Corrie Griffith, Hartwig Kremer, et al, “Coastal Zones and Urbanization,” International Human Dimensions Program on Global Environmental Change, June 2015, https://www.researchgate.net/publication/279455992_Coastal_zones_and_urbanization.

commute between urban centers and rural areas, and along with shipping, allowed the transportation of goods to developed and developing areas. Railways also provided a means to temporarily escape the dense urban environment. While the idea of “seaside retreat” had precedents in mid-18th century England, the pursuit of health became more popular during the 19th-century as a response to the worsening environmental conditions of urban environments.⁶⁸

In North America, undeveloped coastal areas — the same areas that served as seasonal fishing grounds for Indigenous tribes prior to colonization — were surveyed as potential landscapes for health and religious retreats; simply put, the air and water was cleaner and cooler than the rapidly industrializing city. To attract patrons to these retreats, rail lines were created, small ports built, and lodging constructed. In order to build and sustain the seasonal nature of these communities, construction labor and staff was needed. Along the eastern coast, formerly enslaved and freed African Americans provided a major source of labor for building and servicing these developing seaside resorts. As seasons came to a close in the north — or hurricanes approached in the south — seasonal guests would return to their urban dwellings while service staff would be left to decide their next move.⁶⁹ With the increasing popularity and accessibility of these coastal destinations, lodging structures were built for permanence, infrastructure was added to support transportation and civic services, and residential neighborhoods developed to support the working-class residents (Fig. 5).

The development of commercial fishing, canning, transportation, and other water-based industries required year-round residency, and these former coastal retreats began to develop into urbanized coastal communities, ranging in size and population density (Fig. 6). Development of maritime defenses, such as the Navy and Coast Guard, led to further permanent development in otherwise seasonal coastal communities. The risks of living in a coastal community — especially those on barrier islands — was known, but the working-

⁶⁸ John K. Walton, “The Seaside Resort: A British Cultural Export,” Department of Humanities, University of Central Lancashire, <https://archives.history.ac.uk/history-in-focus/Sea/articles/walton.html>.

⁶⁹ Bryant Simon, *Boardwalk of Dreams: Atlantic City and the Fate of Urban America* (Oxford, UK: Oxford University Press, April 2006).

class incomes of year-round residents made settlement elsewhere difficult. As automobiles prevailed and air travel became more affordable, the regional appeal of these smaller urbanized coastal communities faced external pressures. Some communities became more popular and developed into metropolitan cities, while other communities lost their appeal and remained as seasonal attractions.



Fig. 5, Atlantic City: a seaside resort develops into an urbanized coastal community, 1905

(Source: Library of Congress)

The growth of major cities such as Miami, New York, Boston, Guangzhou, Shenzhen, and Mumbai are attributed to their coastal edge and ability to support production, trade, and tourism, but they are also some of the most at-risk cities in terms of expected flood damage costs.⁷⁰ The ecological, social, and built infrastructure of urbanized coastal communities has already been tested against climate change and sea level rise, with infrastructural and social vulnerabilities revealed. While some cities have adopted strategies

⁷⁰ Xuemei Bai et al, "Coastal Zones and Urbanization." June 2015.

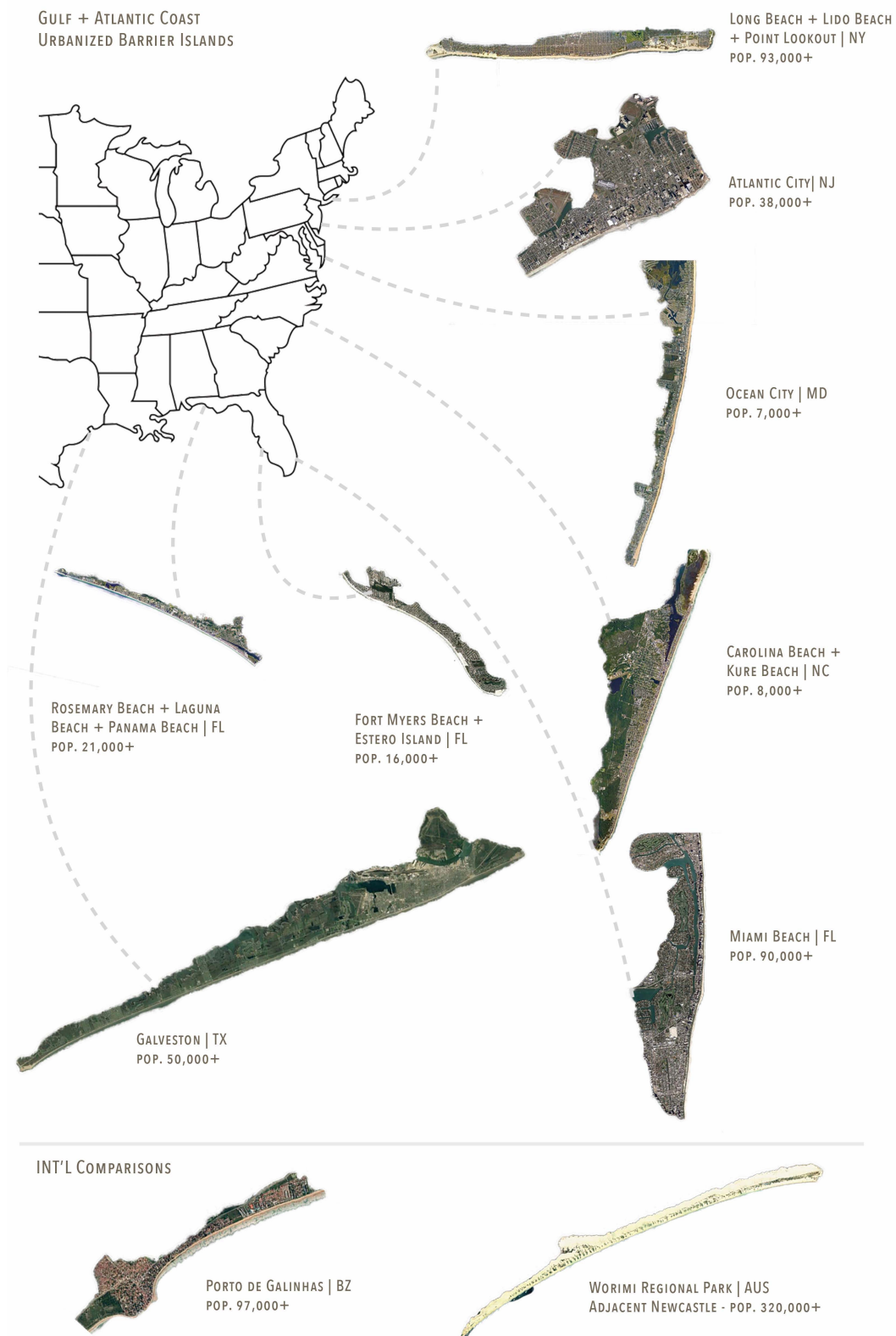


Fig. 6, Urbanized barrier islands compared by location and population, 2021(Source: Author)

for coastal resilience and set moratoriums on waterfront construction, others continue to develop in floodplains and on subsiding barriers at exponential rates.

Impact of Coastal Urbanization

The urbanization of coastal communities — whether it was a result of trade, conquest, colonization, production, industry, or freedom — catalyzed significant shifts in population that resulted in densified urban centers. The late 19th and early 20th century appeal of coastal areas for health, leisure, and recreation also aided in the development and densification of ocean coastlines as tourist destinations, spurring tourism based economies. However, the ability of the coastline to remain dynamic and act as natural infrastructure has been impaired by this urbanization. There are now significant ecological and socioeconomic impacts due to development and introduction of the built environment. Climate change and sea level rise have exacerbated the conditions that coastal communities expect to face, and has worsened the threat and impacts of flooding, storm events, subsidence, habitat destruction, social inequities, and environmental injustices.

Ecological Impact

Despite coastal and estuarine ecosystems only covering 6% of the world's surface, it is estimated that they contribute to 38% of the “total estimated global value of ecosystem services” (Fig. 7).⁷¹ Coastal urbanization has severely affected the health of coastal ecosystems and habitats, and impaired the natural ability of these ecosystems to remain resilient and adapt. Human activity and construction has led to the displacement, endangerment, and even extinction of terrestrial, aquatic, and plant species along coasts. As terrestrial lands are cleared and reshaped for human activity, native grasses, shrubs, trees, and plants are removed, destroying the homes of waterfowl, migratory birds, raptors, insects, mammals, and reptiles.

⁷¹ Mark Pelling and Sophie Blackburn, “Megacities and the Coast: Risk, Resilience and Transformation,” London: Routledge, December 2013. https://www.researchgate.net/publication/321875951_Megacities_and_the_Coast_Risks_Resilience_and_Transformations.

As development extends to the water — whether through the subtraction of land for channels and docks, or the addition of land for artificial appendages — aquatic plants are also destroyed. The fish, mammals, crustaceans, mollusks, and reptiles that depend on these habitats are either displaced or starved. The salt marshes of the Atlantic coast were severely altered in the 1930s due to the mosquito control method of “ditching”, a process in which narrow channels were hand dug 100-150 feet from one another.⁷² This process altered the natural processes that maintain marsh elevation and continues to prevent non-tidal ponds from forming, inhibiting habitat growth and feeding (Fig. 8).



Fig. 7, Global coastal plains, 2016 (Source: Author, data from MarineSpecies.org)



Fig. 8, 1930s mosquito ditches (purple) are highly concentrated in Atlantic City’s back bay salt marshes, 2021 (Source: Author; data from The Nature Conservancy NJ)

⁷² Marianna Walch, Ph.D., “Ditching the Salt Marsh Ditches”, Delaware Center for the Inland Bays, May 2019, <https://www.inlandbays.org/ditch-the-salt-marsh-ditches/>.

The destruction of these habitats affects the ability of terrestrial and aquatic species to perform essential ecosystem services. Shoot and root systems of terrestrial plant species filter toxins from the air, sequester pollutants from the soil, stabilize sediment, and provide a home for animals and insects; aquatic plant species release essential oxygen into the water, sequester pollutants, stabilize sediment, and provide areas for spawning, refuge, and foraging.⁷³ Coasts also act as a natural infrastructure to protect mainlands from wave action, flooding, erosion, and storm surges. Wetlands in particular aid in groundwater replenishment, water purification, and air filtration.⁷⁴

The addition of impermeable surfaces, human activity, and non-native plantings puts a significant burden on natural coasts by preventing their dynamic development and ability to protect the inland. By eliminating the ability of sedimentary coastlines to absorb and filter storm and tidal water, pooling and tidal flooding occur. Overburdened storm sewers regularly backflow into streets, and when relieved, carry polluted stormwater into waterways via discharge points. Cities with combined sewer overflows (CSO) combine storm and sewer piping for wastewater treatment, but when systems are overburdened the combined stormwater and raw sewage are diverted from the treatment plant and released into waterways. Hybrid approaches to stormwater management are being pursued to combine traditional built stormwater infrastructure with green infrastructure and natural processes. OMA's design for the Rebuild by Design: Hudson River Project aims to: resist stormwater by constructing edges and soft landscapes; delay water's rate of infiltration with landscape; store excess water in built and natural basins; and discharge water via pumping stations (Fig. 9).

Development also leads to increased rates of subsidence, or the sinking of land. Subsidence can be a natural occurrence for sedimentary and ocean-driven coasts, but

⁷³ "Why are Aquatic Plants so Important?" National Oceanic and Atmospheric Administration. <https://oceanservice.noaa.gov/facts/underwaterplants.html>.

⁷⁴ Xuemei Bai et al, "Coastal Zones and Urbanization." June 2015.

alterations to the relative water-table and aquifer compaction speed the rate of subsidence, making sea level rise an even greater threat independent of forecasted projections.⁷⁵

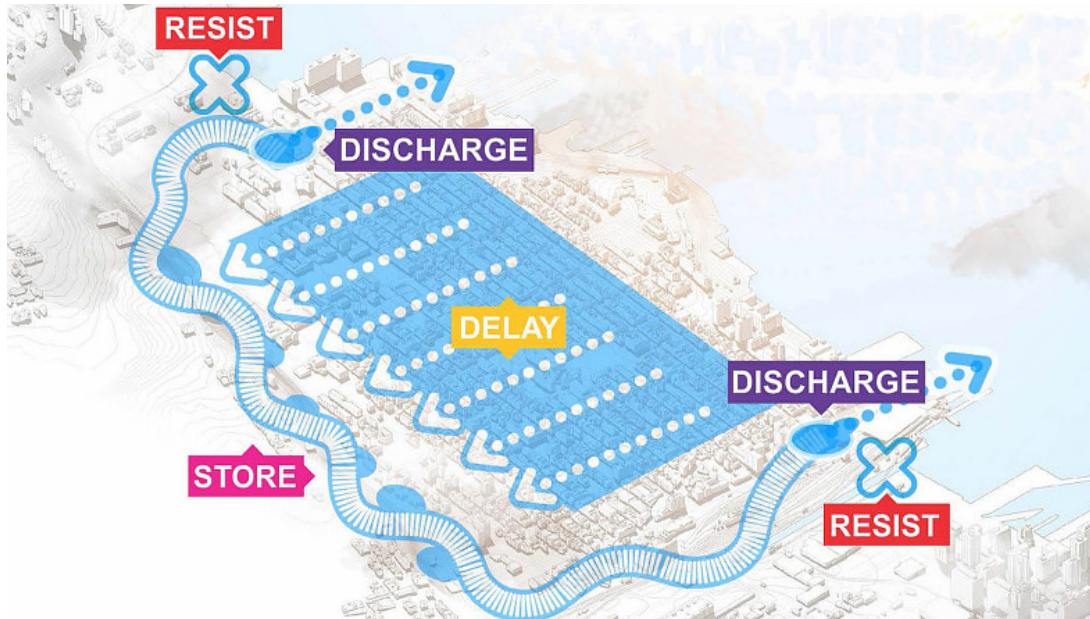


Fig. 9, Rebuild by Design: Hudson River Project, Hoboken, NJ, 2013 (Source: Smithsonian, Cooper Hewitt, OMA; Image link per usage terms: https://www.si.edu/object/resist-delay-store-discharge:chndm_USA.047)

Artificial measures for erosion control and coastline replenishment have been engineered as responses to coastal urbanization. Government, commercial, and residential stakeholders have applied these civil strategies in an attempt to protect and restore their most important asset, the coast. However, these endeavors harm natural habitats, are expensive, and are not permanent. Erosion control measures that absorb wave and tidal energy include seawalls, bulkheads, revetments, and ripraps.⁷⁶ Groins prevent the displacement of sedimentary sands and act as catchments, while jetties act in a similar manner to keep channels and waterways clear. The implementation of these measures affects the natural

⁷⁵ S. E. Ingebritsen and D. L. Galloway, "Coastal Subsidence and Relative Sea Level Rise," *Environmental Research Letters* 9, No. 9 (September 23, 2014): <https://iopscience.iop.org/article/10.1088/1748-9326/9/9/091002#erl500883f1>.

⁷⁶ Mena Ciarmiello and Michele Di Natale, "Coastal Erosion Control," *Encyclopedia of Estuaries, Encyclopedia of Earth Sciences Series*, Dordrecht, NE: Springer, 2016, https://doi.org/10.1007/978-94-017-8801-4_386.

development of coastlines and can actually lead to further erosion at their base. It is estimated that by 2100, 33% of shorelines in the United States will be “hardened” by these tactics, adversely impacting the ability of living shorelines to support habitat life and biodiversity.⁷⁷

Beach replenishment is a temporary protection that adds dredged or imported sands to rebuild sandy coastal beaches. Replenishment is costly and essentially ineffective. In New Jersey, the Sierra Club has proclaimed that an estimated \$1.5 billion in beach replenishment since 1989 has largely been a waste.⁷⁸ While replenishment supports seasonal tourism and local economies, single storm events have washed away entire replenishment projects. Replenishment also disturbs and kills protected wildlife on land and in the water. On land, nesting locations of turtles are destroyed by heavy machinery; in water, dredging pipes and loud pumps interrupt the circulation and communication networks that marine life rely on.⁷⁹

Socioeconomic Impact

While it is true that urbanized coastal communities are a place of economic opportunity rich with natural resources for trade and production, marginalized populations have not been provided the same opportunity to acquire land, secure safe shelter, build intergenerational wealth, or preserve their histories. Basic application of the supply and demand model makes the scarcity of coastal property ostensibly more valuable. In the United States, out of 3,797,000 square miles in total land area, 95,471 miles are classified as coastline — this includes oceans, rivers, bays, islands, and lakes.⁸⁰ 40% of the population lives in 2.5% of the country’s land area (Fig. 10).⁸¹

⁷⁷ “Living Shorelines,” Habitat Blueprint, National Oceanic and Atmospheric Administration, <https://www.habitatblueprint.noaa.gov/living-shorelines/>.

⁷⁸ Dan Radel, “No End in Sight: Coalition Argues \$1.5B in NJ Beach Replenishment Has Been a Waste,” *Asbury Park Press*, October 8, 2021, <https://www.app.com/story/news/local/land-environment/2021/10/08/nj-beach-replenishment-coalition-calls-waste-billion/6033691001/>.

⁷⁹ “Beach Replenishment: Vital Defense or Futile Gesture?” Delaware Public Media, June 8, 2013, <https://www.delawarepublic.org/post/beach-replenishment-vital-defense-or-futile-gesture>.

⁸⁰ “How Long is the U.S. Shoreline?” National Oceanic and Atmospheric Administration, 2021, <https://oceanservice.noaa.gov/facts/shorelength.html>.

⁸¹ “What percentage of the American population lives near the coast?” National Oceanic and Atmospheric Administration, <https://oceanservice.noaa.gov/facts/population.html>.

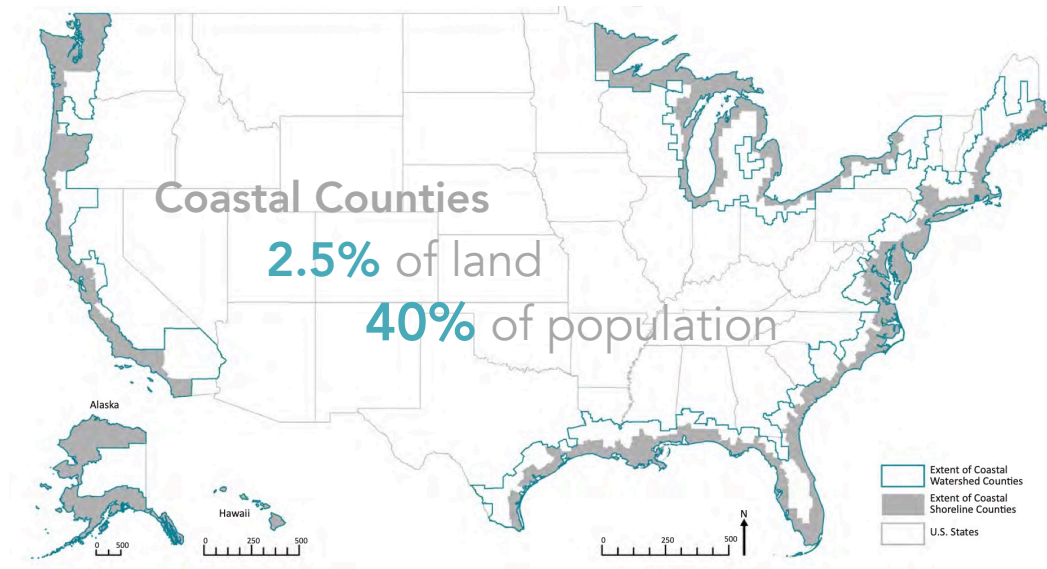


Fig. 10, Coastal shoreline and watershed counties, 2013 (Source: NOAA, US Census Bureau)

The density and scarcity of available land in coastal areas raises the property values and essentially makes ownership inaccessible to lower income families. If land is acquired, the added cost of flood insurance in flood zones makes ownership even less affordable. Without an equitable opportunity to maintain ownership, lower income groups are forced to rent which makes wealth accumulation and transfer of intergenerational wealth that much more difficult. Gentrification adds to the disparity as those with greater wealth move into neighborhoods with less wealth. Wealthier residents who have access to capital, credit, and local powers instigate improvements that raise the values of property and rent to rates that are no longer affordable for long-term residents. While displacement is not a guaranteed result of gentrification, it is common for gentrified areas to undergo a form of indirect cultural displacement that leads to erasure of tangible and intangible historic resources.⁸²

As coastal edges maintain their value and desirability, public access becomes limited due to development. What was once natural and public land becomes privatized or commercially controlled. Municipalities that have protected their coastal edges as public or

⁸² "Understanding Gentrification and Displacement." The Uprooted Project. University of Texas. <https://sites.utexas.edu/gentrificationproject/understanding-gentrification-and-displacement/>

park land do not face the same threat, but areas with private property that abuts coastal edges leads to privatization of coastlines.

There is also a disparity in how urbanized coastal communities prepare for and provide protections against tidal and storm events. Tax paying landowners that have greater wealth and power are statistically proven to be more likely to participate in city council meetings and hearings than non-owners.⁸³ With this investment, owners are able to voice their concerns and see how resources are allocated. In a telling example of this social inequity, beachfront property owners in a New Jersey beach town successfully curtailed the construction of an U.S. Army Corps of Engineers dune project, citing potential drainage issues; local accounts recall the real issue was sight-lines.⁸⁴ The dune system was eventually completed and serves to protect the entire barrier island, but the fact that several land owners were able to successfully delay a federally funded civil project shows the inherent disparities of coastal ownership and local power. Adding to this, municipalities that rely on commercial or tourism development often prioritize the needs of visitors over residents. In Atlantic City, beach replenishment and seawall construction have occurred adjacent to the tourism district, but the bulkheads that are supposed to protect the more vulnerable back bay neighborhoods continue to disintegrate into the bay.

Exacerbation of Threats Due to Climate Change

The ecological and socioeconomic impacts noted would exist regardless of climate change and sea level rise, as there is an inherent risk with developing along coasts. The threat of storms, flooding, subsidence, and erosion are expected, and the introduction of built elements into an otherwise dynamic and diverse ecosystem will have detrimental impacts on the environment. However, climate change has resulted in more frequent and amplified storm events, a rise in sea level, more frequent tidal or “sunny day” flood events, warmer ocean and

⁸³ Jesse Yoder, “Does Property Ownership Lead to Participation in Local Politics? Evidence from Property Records and Meeting Minutes,” *American Political Science Review* 114, No. 4 (2020): 1213-1229, Cambridge University Press, <http://stanford.edu/~yoderj/localmeetings.pdf>.

⁸⁴ “Margate & Ventnor Beaches To Suffer From Mid-Summer Dune Building,” *Downbeach Buzz*, May 3, 2017, <https://downbeachbuzz.com/margate-ventnor-beaches-suffer-mid-summer-dune-building/>.

river temperatures, increased water salinity, reduced air quality, and endangerment of habitats within coastal ecosystems.

Industrialization and the rapid growth of the built environment has exacerbated the effects of climate change, as the amount of greenhouse gases released into the atmosphere is proportionate to increased consumption and development. As noted, the built and impervious form of urbanized coasts hinders the ability of coasts to perform as natural barriers, resulting in the retention of storm water and intensifying the health impact of urban heat gain.

Vulnerable populations — those that are least able to prepare for and recover from the social, economic, cultural, and ecological impact of climate events — experience inequities that further affect physical, mental, and fiscal health. With limited access to the support systems and credit required for preparation and recovery, vulnerable communities are susceptible to losing personal, communal, historic, cultural, and ecological assets. Should communities disband and disperse as a result of climate change, intangible assets such as history, culture, tradition, and sense of place are threatened.

Mitigating the Impact of Coastal Urbanization

Recognition of past and present fallacies in design and development can aid in the reimagining, regeneration, and resilience of our most vulnerable urbanized coastal communities. This is not an extreme idea, and its applicability is already being tested. Within the last decade, significant strides have been made that have invited disciplines in design and architecture to collaborate with disciplines in science, reimagining what coastal resilience could be. One of the first collaborative efforts to reimagine the responsibilities of the design discipline was the Museum of Modern Art's 2011 design initiative "Rising Currents: Projects for New York's Waterfront". This exhibit invited collaboration among urban designers, architects, landscape architects, and ecologists to re-conceptualize the design of multiple sites within New York Harbor, in anticipation of rising sea levels. Strategies seek to reverse the damage of urbanization by reincorporating natural edges, regenerative ecosystems, outdoor recreation, and aquaculture. ANO and djandstudio's design for Lower Manhattan, "New

Urban Ground”, proposes an extended wetland edge for Lower Manhattan, aiding in tidal absorption and pollutant sequestration (Fig. 11). Rather than devise a master plan, the intention was that the strategy could be globally adapted to other coastal cities.



Fig. 11, “New Urban Ground” proposal for Lower Manhattan, 2009 (Source: Smithsonian, Cooper Hewitt, ARO, dlandstudio; Image link per usage terms: https://www.si.edu/object/new-urban-ground-proposal-rising-currents-exhibition-museum-modern-art-new-york-ny:chndm_2013-52-2)

After Superstorm Sandy impacted the entire northeast coast in 2012, worst case scenarios were realized and the intersection of urban design, architecture, landscape architecture, and ecology gained significant recognition. In response to Superstorm Sandy, Rebuild by Design began as a design competition sponsored by the U.S. Department of Housing and Urban Development (HUD), but quickly gained traction as its own forward thinking design collaborative. It continues to inspire collaboration, advocacy, discussion, and implementation of coastal resilient design and engineering projects.

Chapter 3: The Impact of Climate Change on Urbanized Coasts: Atlantic City, NJ

“When Americans dream of that perfect society which is someday to be, what form does their imagination take? Atlantic City, New Jersey . . . obviously.”
– Bruce Blevin, *New Republic*, 1920

Introduction

The previous chapter, *Coastal Urbanization*, described patterns of historic settlement, assessed the ecological and socioeconomic impacts of urbanizing coastal edges, and contextualized the exacerbated threat of climate change on urbanized coastal communities. In the United States alone, there are approximately 12,000 miles of coastline and 130+ million people living in coastal counties.⁸⁵ Of this population, FEMA estimates that 13 million are immediately at risk from coastal flooding (storms and surges), fluvial flooding (swollen rivers and streams), and pluvial flooding (trapped stormwater).⁸⁶ With coastal communities in the United States ranging in size from 8.3+ million residents (New York City) to just over 1,500 residents (Rehoboth Beach, Delaware), strategies for coastal resilience must be dynamic, adaptable, and scalable per community (Fig. 1). Despite differences in vulnerability and size, research initiatives and design strategies for coastal resilience should not be siloed or “top-down”, but collaborative and inclusive. In developing the programmatic framework of this thesis, Atlantic City, New Jersey has been chosen as the primary study area to assess social, economic, cultural, and ecological vulnerabilities, and conceptualize the programmatic framework for The Resilient Transect.

⁸⁵ “Economics and Demographics”, Office for Coastal Management, *National Oceanic and Atmospheric Administration*, 2018. <https://coast.noaa.gov/states/fast-facts/economics-and-demographics.html>

⁸⁶ Karen M’Closkey and Keith VanDerSys, and Carolyn Kousky, Billy Fleming, and Alan M. Berger, “For Whom Do We Account in Climate Adaptation?” in *A Blueprint for Coastal Adaptation and Policy* (Washington, DC: Island Press, 2021).

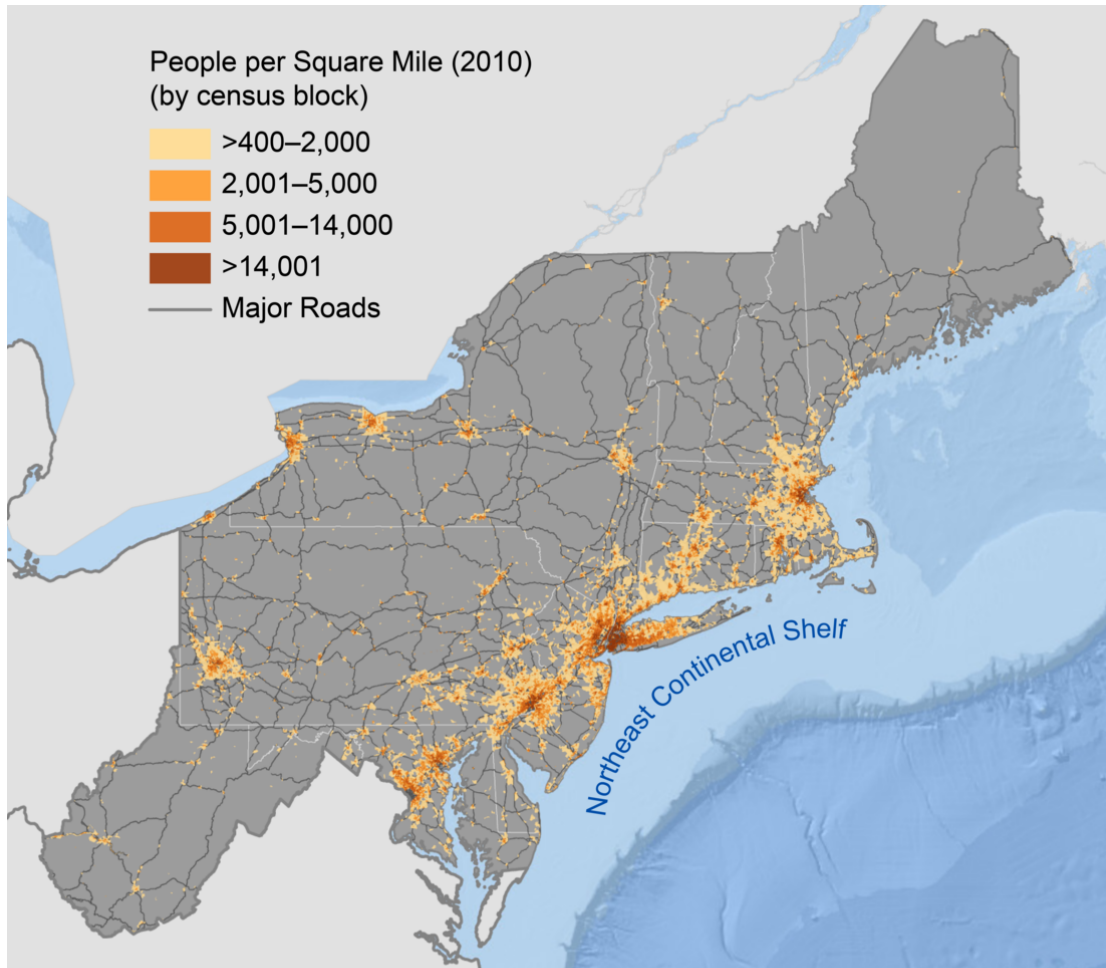


Fig. 1, People per square mile in northeast United States, 2010 (Source: NOAA)

Significance

Atlantic City's spatial size, diverse population, geographical location, and increased vulnerability to climate change makes it an ideal study area to bring researchers, designers, policymakers, business organizations, community leaders, and residents together to discuss, hypothesize, present, test, and implement strategies for urban coastal resilience. With an inhabitable area of just over 4.1 square miles and a moderate population of 38,000+ year-round residents, the city's tourism industry employs an additional 25,000+ workers and in a given day, can attract over 500,000 visitors. For comparison, a summer surge in Atlantic City results in a density of 125,000 people per square mile; New York City has an average

population density of 27,000 people per square mile.⁸⁷ Essentially, Atlantic City is a small city that must meet the demands of a much larger city. Existing transportation networks in the city support automobile, bus, train, marine, and air travel, and an international airport is only 12 miles in-land of the city. The city's location on New Jersey's southeastern coast makes it regionally accessible to Philadelphia, New York City, the Washington, DC region, and Boston (Fig. 2). Existing hospitality infrastructure provides over 20,000 hotel rooms, over 2 million square feet of convention space, 240+ restaurants, and 3.4 miles of public beach access.

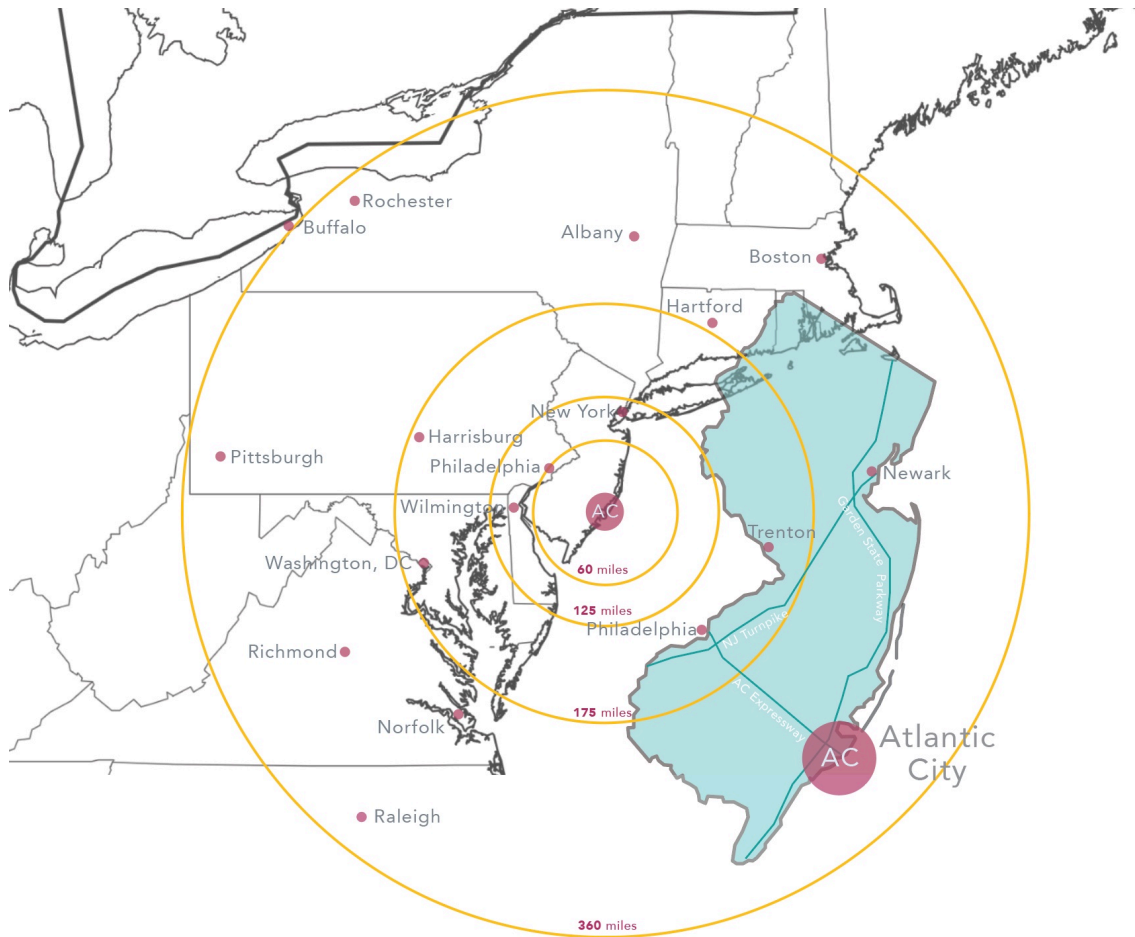


Fig. 2, Atlantic City Regional Radius, 2021 (Source: Author, data from Tour AC)

⁸⁷ "Population: New York City Population Fact", NYC Planning, 2021, <https://www1.nyc.gov/site/planning/planning-level/nyc-population/population-facts.page>.

While the casino industry reported a gross revenue of \$3.29 billion in 2019 alone, the city's median household income is \$29,232, \$53,000 below the state average.⁸⁸ With 15,526 occupied housing units susceptible to flooding, 3,167 of which are categorized as affordable, multiple studies have cited Atlantic City as one of the world's most vulnerable cities to the effects of climate change. Despite this statistic, minimal effort has been taken to address the impact of climate change and sea level rise on residential neighborhoods and local access routes. Not only does Atlantic City rely on tourism and its accessibility, but the surrounding county relies on the city for its regional economic impact. Just as climate change and sea level rise threaten the social, cultural, and economic health of the city, the ecological health of the city's 10.6 square miles of tidal salt marshes and wetlands are also threatened. This natural infrastructure supports a multitude of diverse ecosystem services — valued at \$1.24 billion per year statewide — and remains as the only natural barrier for the mainland community and its watersheds, part of a network that protects approximately 90% of the state's coastline.⁸⁹

Despite projections that indicate 50% of the city could be underwater by 2060, the resilience and growth of Atlantic City is necessary for the 38,000+ residents who live within its boundaries and the 263,000+ county residents that rely on it as a regional economic center.⁹⁰ Strategies for coastal resilience must strengthen the city and catalyze responsible growth, as relocation and abandonment would have dire consequences for the entire region. The development of The Resilient Transect — and the aggregation of similar transects throughout Atlantic City — provides multiple social, economic, cultural, historic, and ecological conditions to research, learn from, design for, test against, and implement, within and beyond the city.

⁸⁸ "Economy: Atlantic City", Data USA, 2021, <https://datausa.io/profile/geo/atlantic-city-nj#economy>

⁸⁹ "Climate Change Resilience Strategy", State of New Jersey, 2021.

⁹⁰ "Quick Facts: Atlantic County, New Jersey", U.S. Census, 2021, <https://www.census.gov/quickfacts/fact/table/atlanticcountynewjersey,US/PST045219>

Historical Overview

Settlement

Absecon Island, the barrier island on which Atlantic City was settled, is the former Indigenous land of the Lenni Lenape tribe, an Eastern Algonquian people. The Unalachtigo — “People Who Live Near the Ocean” — were the southern sect of the Lenni Lenape and settled Absecon Island in the summer season.⁹¹ Prior to its development as a flat, urbanized barrier island, Absecon Island was a hilly landscape with natural dunes, forested areas, and a variety of flora and fauna. Marine-based food sources such as fish, crustaceans, and mollusks were sought after in the summer months, as was flora that could only be found along the coast and estuaries. Though there is evidence of Indigenous presence in the region dating to the Paleoindian Period (c. 12000 - 8000 B.C.E.), the rapid rise in sea level following the Ice Age obscures this data in the Outer Coastal Plain region.⁹² The discovery of projectile points dating to the Archaic Period (c. 8000 - 1000 B.C.E.) are more abundant and signify scattered patterns of seasonal settlement at riverine, lacustrine, and coastal sites, but erosion and subsidence has diminished the available archaeological data from this period.⁹³ Evidence of tools and food preparation stones dating to the Woodland Period (c. 1000 B.C.E - 1600 C.E.) provides the most concrete evidence of seasonal settlement in the coastal region.⁹⁴ When the summer months concluded, the Unalachtigo migrated back to the mainland to harvest their crops and resume terrestrial hunting activities.

The first European account of the southern New Jersey coastal region was conducted in 1609 by English explorer Henry Hudson, and the region was chartered between 1614 to

⁹¹ “Our Tribal History,” The Nanticoke Lenni-Lenape: An American Indian Tribe, 2007, <https://nanticoke-lenape.info/history.htm>

⁹² Sydne B. Marshall, “Aboriginal Settlement in New Jersey During the Paleo-Indian Cultural Period (ca. 10,000 B.C. - 6000 B.C.)”, c. 1980, https://www.nj.gov/dep/hpo/1identify/pg_10_AboriginalSettleNJMarshall.pdf.

⁹³ Herbert C. Kraft and R. Alan Mounier, “The Archaic Period in New Jersey (ca. 8000 B.C. - 1000 B.C.)”, 1982, https://www.nj.gov/dep/hpo/1identify/pg_52_ArchaicPeriodNJCraft_Mounier.pdf.

⁹⁴ Lorraine Williams and Ronald A. Thomas, “The Early/Middle Woodland Period in New Jersey (ca. 1000 B.C. - 1000 A.D.)”, c. 1980, https://www.nj.gov/dep/hpo/1identify/pg_103_EarlyMiddleWdLndPeriodNJWilliams_Thomas.pdf.

1624 by Cornelius Jacobsen Mey.⁹⁵ In the late 1670's, Absecon Island — derived from the Lenni Lenape word Absegami, or "little water"— was acquired by English Quaker Thomas Budd as part of a larger inland land deal. The first permanent settlement on the island was recorded in 1783 by Revolutionary War veteran Jeremiah Leeds. Leeds purchased several acres, built a cedar log structure, and cleared land for a farm known as “Leeds Plantation”; it is unknown when the Unalachtigo were barred from utilizing the island’s resources (Fig. 3). Over the next several decades the Leeds family expanded their land holdings to over 1000 acres and remained as the primary residents. In 1839, Jeremiah’s widow, Millicent Steelman Ingersoll, was proprietor of the city’s first business, a boarding house and tavern called “Aunt Millie’s Boarding House”.⁹⁶ By 1850 there were seven permanent dwellings on the island.



Fig. 3, Painting of Atlantic City coast, mid-19th century (Source: William Trost Richards)

In 1852, local physician and state delegate Dr. Jonathan Pitney, a resident of the inland community of Absecon, realized the benefits of Absecon Island as a seaside healing

⁹⁵ “History of Atlantic County”, Atlantic County, NJ, <https://www.atlantic-county.org/history/>.

⁹⁶ “Jeremiah Leeds Historical Marker”, Atlantic City Free Public Library, 2021, <http://www.acfpl.org/markers/28-historical-markers/atlantic-city-historical-markers/265-jeremiah-leeds>.

retreat. Dr. Pitney and engineer Richard Osbourne drafted plans and acquired land for a railroad to connect Camden, New Jersey (across the Delaware River from Philadelphia) to the edge of Absecon Island — a boat was still required to cross the back bay. In 1853 the name Atlantic City was adopted, in March of 1854 the city was incorporated, and in July of 1854 the Camden-Atlantic City Railroad was in operation. By 1864 an initial city grid had been established and the population had grown to 700 residents. As "America's Seaside Resort", the cross streets were aptly named after the states and the longitudinal avenues named after the seven seas.⁹⁷ In 1870, the city's tourism-based infrastructure had increased to 42 hotels and 50 boarding houses, and the increased traffic of guests — plus the nuisance of sand in hotel lobbies and train cars— prompted construction of the world's first Boardwalk in the same year.⁹⁸ With the completion of the narrow gauge rail-line in 1878, guests now had direct access from Philadelphia into Atlantic City. Additional transportation infrastructure, construction of permanent lodging, and the addition of seaside attractions catalyzed Atlantic City's 19th century growth into the early 20th century. (Fig. 4).



Fig. 4, Map of Atlantic City, 1880 (Source: Library of Congress)

⁹⁷ "Atlantic City," https://www.livingplaces.com/NJ/Atlantic_County/Atlantic_City.html.

⁹⁸ "Bridge over Elder Creek", Historic American Engineering Record report, NJDOT, 2008.

The city made the Boardwalk into a permanent linear avenue, built amusement piers that expanded thousands of feet into the Atlantic Ocean (1898), built one of the first and largest reinforced concrete hotels in the world (1906), and established the world's first “airport”, coined because of its facilities for both airplanes and seaplanes (1910) (Fig.5).⁹⁹



Fig. 5, Left: Atlantic City Boardwalk and Steel Pier, 1900 (Source: Library of Congress)
 Right: Shelbourne, Dennis, Marlborough-Blenheim, Claridge, photo taken mid 1970s
 (Source: Library of Congress, HABS Survey)

Atlantic City's growth not only relied on its seasonal appeal, but on the labor and Great Migration of formerly enslaved African American's traveling north for freedom and opportunity. Since its incorporation in 1854, African American's built, served, and resided in the city. Atlantic City was initially an integrated city but by 1900, pressure from southern tourists forced division among visitors and residents.¹⁰⁰

By the mid 1920s the city had become a year round destination and a hub for prohibition-era commerce. Commercial fishing, boat building, and convention services sustained the economy in the winter months and provided further cover for the city's network of illegal activities. This period of development and wealth led to the (re)construction of ornate hotels, dedication of grand civic buildings, and densification of low, middle, and

⁹⁹ “A Timeline of Atlantic City History”, The Atlantic City Experience, *Atlantic City Free Public Library*, 2021, <https://www.atlanticcityexperience.org/timeline-of-atlantic-city-history.html>

¹⁰⁰ Bryant Simon, *Boardwalk of Dreams: Atlantic City and the Fate of Urban America* (Oxford, UK: Oxford University Press, April 2006).

upper-income residential fabric. In 1930 the city hit its peak population of 66,198+ residents.¹⁰¹ From the mid 1930s to the 1950s the resort town continued to flourish and attracted visitors from all over the east coast. Supper clubs and music venues attracted legendary musicians, singers, and performers, entertaining crowds with vaudeville, jazz, blues, and swing. Atlantic Avenue, the city's longitudinal main street, became a dividing line between the mostly white, tourism based development adjacent to the Boardwalk, and the predominantly Black, Italian, and Jewish neighborhoods along the north inlet and back bay (Fig.6). To the northwest of this dividing line, the Northside neighborhood became a mecca for Black residents and travelers, a microcosm of the city itself. During World War II tourism slowed but the city was utilized by the United States military to support the war effort. "Camp Boardwalk" transformed the unoccupied hotels and convention hall into training grounds and infirmaries for soldiers departing and returning from war.

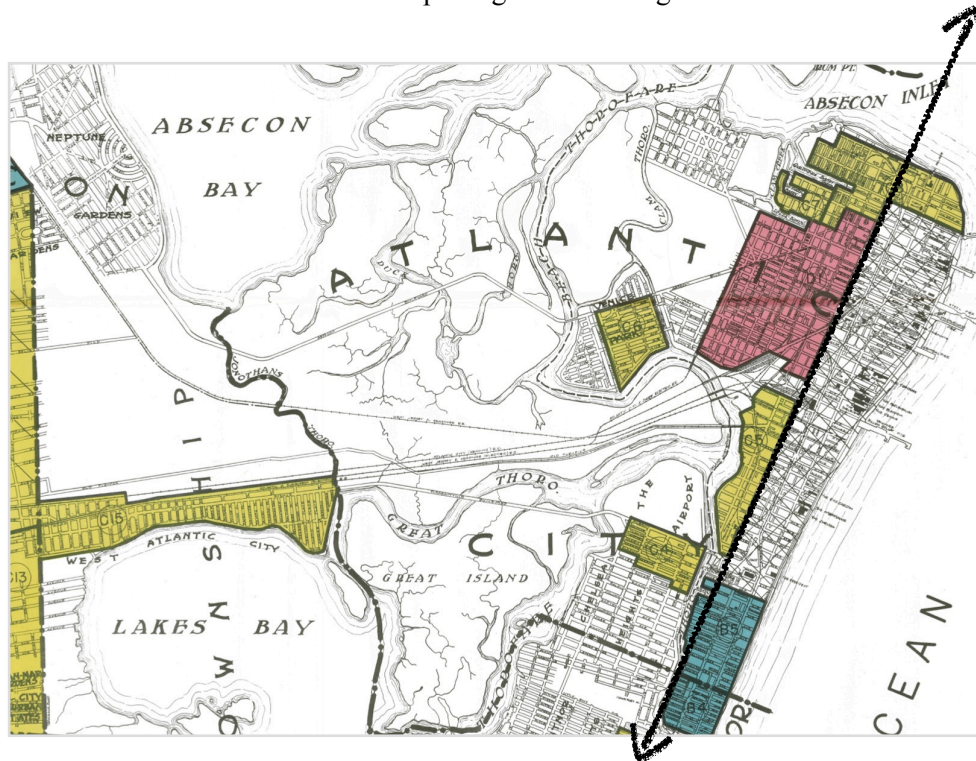


Fig. 6, HOLC "Redline" Map; minority neighborhoods northwest of Atlantic Avenue were discriminately considered "at-risk", 1926/1940 (Source: University of Richmond)

¹⁰¹ "Number of Inhabitants: New Jersey", US Census Bureau, 1950, <https://www2.census.gov/prod2/decennial/documents/23024255v2p30ch1.pdf>.

Like many U.S. cities, Atlantic City was particularly affected by post World War II development. The construction of the federal highway system combined with affordable domestic flights diminished Atlantic City's prominence as a resort destination and instigated a period of blight. By the mid 1960s Atlantic City was suffering economically and its appeal as a tourist destination had waned; many of its Black and white residents sought better living conditions in the suburbs. In 1964 the city hosted the Democratic National Convention in hopes of boosting its reputation, but instead, the city's derelict state was reported to a national audience (Fig. 7). Despite this negative press, Atlantic City was stage to a pivotal Civil Rights moment, as Fannie Lou Hamer's televised testimony described the racism, discrimination, and abuse that Black voters and delegates faced, forcing change within the Democratic party.



Fig. 7, Democratic National Convention at Atlantic City Convention Hall; when built, Convention Hall was the largest arch span structure in the world, and still contains the world's largest pipe organ, 1964 (Source: LBJ Presidential Library)

The city's first business, Millie's Tavern, foreshadowed the city's future dilemma; could it portray itself as a family friendly seaside resort and concurrently meet the demands

of those seeking vice and debauchery? Without a stable industry and an image of crime and blight, the 1970s provided a new hope; in 1976 New Jersey approved casino gaming and limited it to Atlantic City. The first casino opened in 1978 and adaptively reused the historic Haddon Hall beachfront hotel. As the prospect of casino development spurred, the 1970s was an era of optimism and mass demolition. Historic properties were razed, entire blocks were displaced, and neighborhood histories erased to make way for casinos and parking garages.

Projects that could not secure financing or regulatory approval remained as empty lots, eventually converted to surface parking. The 1980s saw a new wave of entertainment, investment, and another wave of destruction; late 19th century and early 20th century hotels, civic buildings, theaters, and storefronts were either demolished or juxtaposed with post-modern hotel towers and multi-level parking structures (Fig. 8).



Fig. 8, The juxtaposition of old and new. L-R: Golden Nugget, Ocean Club condos, Tropicana Casino, Ritz Carlton, Atlantis Casino, Convention Hall (National Historic Landmark), Trump Plaza Casino, 1984 (Source: CC)

In this period, the city streets were taken from the residents and transformed to funnel car and bus traffic directly into the casino parking garages. The image of the city was hidden so visitors could be fortified in windowless casinos without stepping foot in the city; space, time, and place was obscured (Fig. 9).



Fig. 9, The skybridge model was popularized in the 1980s; 2021 (Source: Author)

By the 1990s, competition from Las Vegas diminished Atlantic City's stronghold on the gaming market and in the early 2000s, the city faced further competition with the approval of casinos in Pennsylvania, New York, and Maryland. Outside competition should've been no surprise, but the culmination of greed and corruption resulted in another wave of blight. Development and investment continued in Atlantic City, but outside competition and increased crime rates once again damaged the city's draw as a year round tourist and entertainment destination. Due to the 2008 economic crisis, planned developments withdrew and acres of beach front lots sat abandoned (Fig. 10). Historic sites sat vacant, were razed due to neglect, or damaged by storms. In 2014, Atlantic City and Atlantic County saw one of the highest foreclosure rates in the country and the volatility of a tourism economy had proven itself; four casino closures in one year resulted in 12,000 jobless.¹⁰²

¹⁰² Wayne Parry, "2014 Timeline of Atlantic City's Decline", *WHYY*, December 2014, <https://whyy.org/articles/2014-timeline-of-atlantic-citys-decline/>



Fig. 10, Site of The Sands Casino, demolished in 2007 to make way for the unbuilt "Pinnacle Resort". In 2014, the site was temporarily used as an Art Park. Photo depicts current state, 2019 (Source: Wikimedia Commons)

The most recent wave in development has seen mixed investment from international conglomerates, private entrepreneurs, and local community leaders. There has also been a resurgence in arts and culture, focus on education and engagement, and acknowledgement of history and cultural landscapes. In October of 2019, the city adopted its first Historic Preservation Ordinance and elected its first Historic Preservation Commission. Despite signs of positive growth, the COVID-19 pandemic highlighted the volatility of a tourism based economy and tested the city's resilience; within one month the city lost 15,000 hospitality jobs and ranked third in the nation for most jobs lost (as a percentage of total workforce).¹⁰³

This history highlights that Atlantic City's reliance on tourism and entertainment has made it highly susceptible to economic shocks and disruptions since its incorporation. Industries based on disposable income have proven unsustainable for Atlantic City's future, a future which residents and the surrounding region rely upon. However, Atlantic City still exists and continues to charter its resurgence; in many ways, Atlantic City and its residents

¹⁰³ "Rank of Atlantic City Among U.S. Metro Areas That Lost Jobs During 2020 COVID-19 Recession", NJ Spotlight News, June 2021, <https://www.njspotlightnews.org/2021/06/atlantic-city-job-loss-employment-decline-16-leisure-and-hospitality-35-employment-decline/>.

are inherently resilient. To better understand the city’s ability to remain resilient in spite of weather and climate events, a brief history of storms and weather events will be summarized.

Historic Storms + Weather Events

Atlantic City’s location along the mid-Atlantic makes in highly susceptible to damage from tropical cyclones, hurricanes, tropical storms, nor’easters, and blizzards. The frequency of storms along the New Jersey coast has steadily increased since the 1970s (Fig. 11).

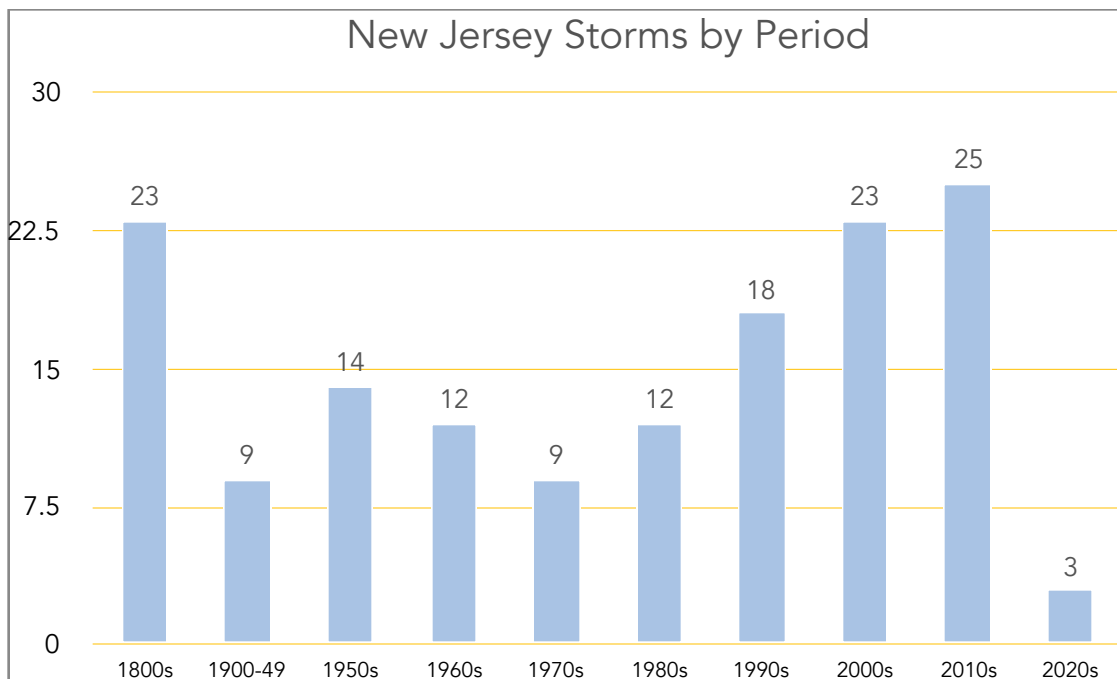


Fig. 11, Frequency of New Jersey storm events by decade, 2021 (Source: Author)

The storm events listed below are cited for their size, intensity, and overall destruction. In these examples, human life, property, and natural habitats were damaged or lost. This list is not exclusive, and each storm that nears the coast — despite its categorization or whether it makes landfall — causes damaging rains, winds, and storm surges. If storms occur during a high tide *and* there is a full/new moon lunar cycle *and* prevailing winds are blowing towards the shore, the potential for flooding and damage is eminent. A joint study by Stevens Institute of Technology, Rutgers University, and Climate Central determined that sea

level rise has not only increased the frequency and amplitude of these storm events, but has resulted in more damage when compared to average sea level heights of the early 20th century; this study was based on data from Superstorm Sandy (2012). It is estimated that in New Jersey alone, sea level rise accounted for an additional \$3.7 billion in Superstorm Sandy damages and an additional 24,500 people and 16,700 housing units impacted.¹⁰⁴ In Atlantic City alone, 5,000 housing units were damaged.¹⁰⁵

Significant storm events that have impacted Atlantic City include:

- *“Vagabond” Hurricane (1903)* - a September hurricane with recorded winds of 80 mph. The hurricane caused several casualties and caused an estimated \$1 million in local damage (\$31.1 million, 2021) and \$7.8 million in east coast damage (\$244 million, 2021).¹⁰⁶
- *Great Atlantic Hurricane (1944)* - a September hurricane with recorded winds of 96 mph and waves peaking at 25 to 30 feet. The surge caused an estimated \$100 million in regional damage (\$1.5 billion, 2021) and destroyed infrastructure, commercial properties, and housing. The Atlantic City-Brigantine bridge was destroyed (Brigantine Island's only route in/out), blocks of the Boardwalk were washed into the city, the Steel Pier was damaged (rebuilt), and the Heinz Pier was lost to the sea (Fig. 12)
- Tropical Storm Brenda (1960) - recorded winds of 55 mph and a record daily rainfall of 2.31 inches (Fig. 13).
- *March Storm (1962)* - a winter storm with recorded winds of 50 mph and 9-foot tides. During high tide the bay and ocean waters met, flooding more than 50% of Absecon Island. Three lives were lost, 85 homes destroyed, and 2,075 homes were damaged. As estimated \$10 million in local damage was recorded (\$90.8 million, 2021), and 150 feet of the famous

¹⁰⁴ Adriana Navarro, “New Study Exposes Multi-Billion Dollar Factor in Superstorm Sandy’s Destruction”, *AccuWeather*, May 2021, <https://www.accuweather.com/en/hurricane/climate-change-added-billions-in-cost-superstorm-sandy-damage/947865>.

¹⁰⁵ Sarah Watson, “Report Says Atlantic City Has Highest Number of Sandy-Damaged Homes in State”, *Press of Atlantic City*, March 2013, https://pressofatlanticcity.com/news/breaking/report-says-atlantic-city-has-highest-number-of-sandy-damaged-homes-in-state/article_7de17cc4-8389-11e2-9464-0019bb2963f4.html.

¹⁰⁶ Joe Martucci, “The Ten Hurricanes and Tropical Storms to Make Landfall in South Jersey Since 1900”, *The Press of Atlantic City*, July 2020, https://pressofatlanticcity.com/news/the-ten-hurricanes-and-tropical-storms-to-make-landfall-in-south-jersey-since-1900/collection_371722e2-83f2-11e9-8b4f-c3078d0f6d4f.html#1.

Steel Pier were lost to the sea. Note: schools, civic buildings, and churches served as shelters for 6,100+ residents. Within 2-days the city was reopened and the Steel Pier was operational by April (Fig. 13) .¹⁰⁷



Fig. 12, Atlantic City after the Great Atlantic Hurricane, 1944, (Source: NJ State Library)

- Tropical Storm Doria (1971) - approximately 6.87 inches of rainfall and a storm surge of 5.3-feet. An estimated \$250,000 in local damage was recorded (\$1.6 million, 2021) and \$134.2 million in east coast damage was recorded (\$909 million, 2021).
- Tropical Storm Irene (2011) - the eye of the storm made landfall in Atlantic City, and sustained winds were recorded at 60 knots. Evacuation was required, and seven fatalities occurred along the coast.
- *Superstorm Sandy* (2012) - one of the most destructive hurricanes in the history of the Northeast. Its diameter of 950 miles made it one of the largest and the second-most costly; the result was 147 deaths along the Atlantic and Caribbean Coasts, over \$635.7 million in local damages, and \$70.2 billion in total damages.¹⁰⁸ As Sandy approached the coast of New Jersey it developed into a post-tropical cyclone, described as a “decaying hurricane and evolving nor’easter”.¹⁰⁹ Sandy made landfall just north of Atlantic City during high tide

¹⁰⁷ “March Storm of 1962”, The Atlantic City Experience, *Atlantic City Free Public Library*, <https://www.atlanticcityexperience.org/march-1962-storm.html>.

¹⁰⁸ Andrea Peer, “2012 Hurricane Sandy: Facts, FAQs, and How to Help”, World Vision, September 2018, <https://www.worldvision.org/disaster-relief-news-stories/2012-hurricane-sandy-facts>

¹⁰⁹ Len Melisurgo, “The 12 Most Destructive Hurricanes and Tropical Storms to Ever Hit N.J.”, *NJ.com*, June 2016, https://www.nj.com/weather/2016/06/monster_storms_the_most_destructive_tropical_systems_to_ever_hit_nj.html.

with recorded winds of 90 mph. Waves peaked at 30-feet and a storm surge tide was measured at 8.9 feet above the Mean Low Water level (Figs. 13 and 14).¹¹⁰

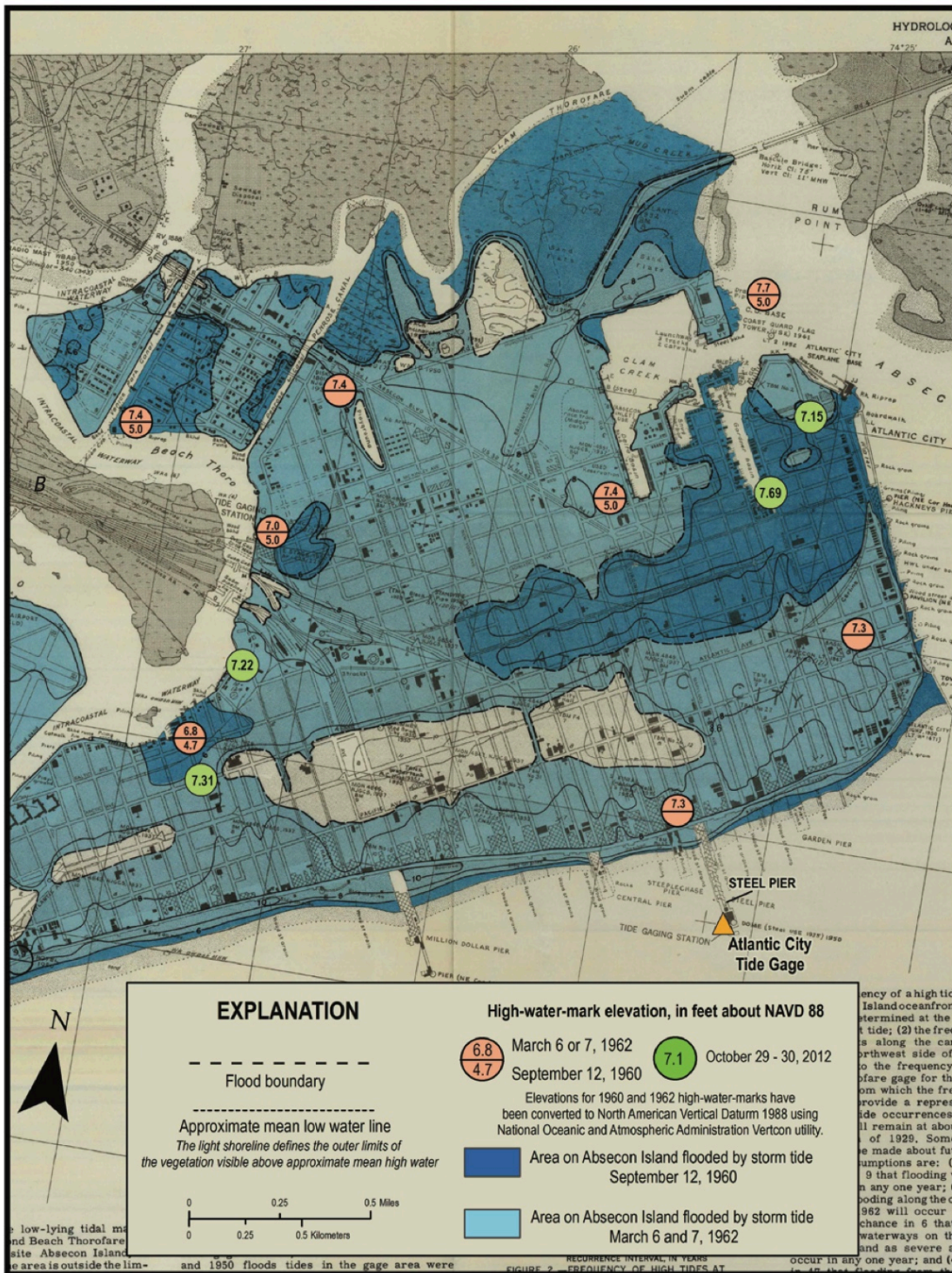


Fig. 13, Comparison of Brenda, March Storm, and Sandy, 2016 (Source: USGS)

¹¹⁰ Andrea Peer, "2012 Hurricane Sandy: Facts, FAQs, and How to Help".



Fig. 14, Atlantic City's North Inlet after Superstorm Sandy, 2012 (Source: National Archives)

Present and Projected Impact

Atlantic City and all urbanized coastal communities are faced with the imminent threat of the next “big storm”. Tropical cyclones — referred to as hurricanes and tropical storms on Atlantic and northeast Pacific coasts; typhoons on the northwest Pacific coast; and cyclones on the Indian and South Pacific coasts — can be forecasted in advance with a relative degree of accuracy, providing an opportunity for preparation and evacuation. However, climate change has intensified the frequency and amplitude of these storms. Due to rising sea levels even moderate storms can cause significant damage depending on the tide, lunar cycle, direction of offshore winds, bathymetry of the coast, the ability of the ground to absorb water, and the condition of stormwater infrastructure to manage previous rain fall. The continued urbanization and densification of these coastal areas proportionately affects the amount of population in harms way, the amount of property and infrastructure at stake, and the ability for natural ecosystems and land formations to protect and absorb the impact of coastal storm events. As noted, sea level rise off of New Jersey's coast is projected to rise between 0.7 and 2.6 feet by 2050, and 1.3 to 6.9 feet by 2100, accounting for subsidence.

Even if full climate mitigation and a stop to all carbon emissions occurred this year (2022), it is predicted that the planet's atmosphere would continue to warm and sea levels would continue to rise. To assess the impact of future storm and climate events on Atlantic City, a Total Water Level (TWL) of 8-feet will be used as a 2100 baseline (Fig 15).

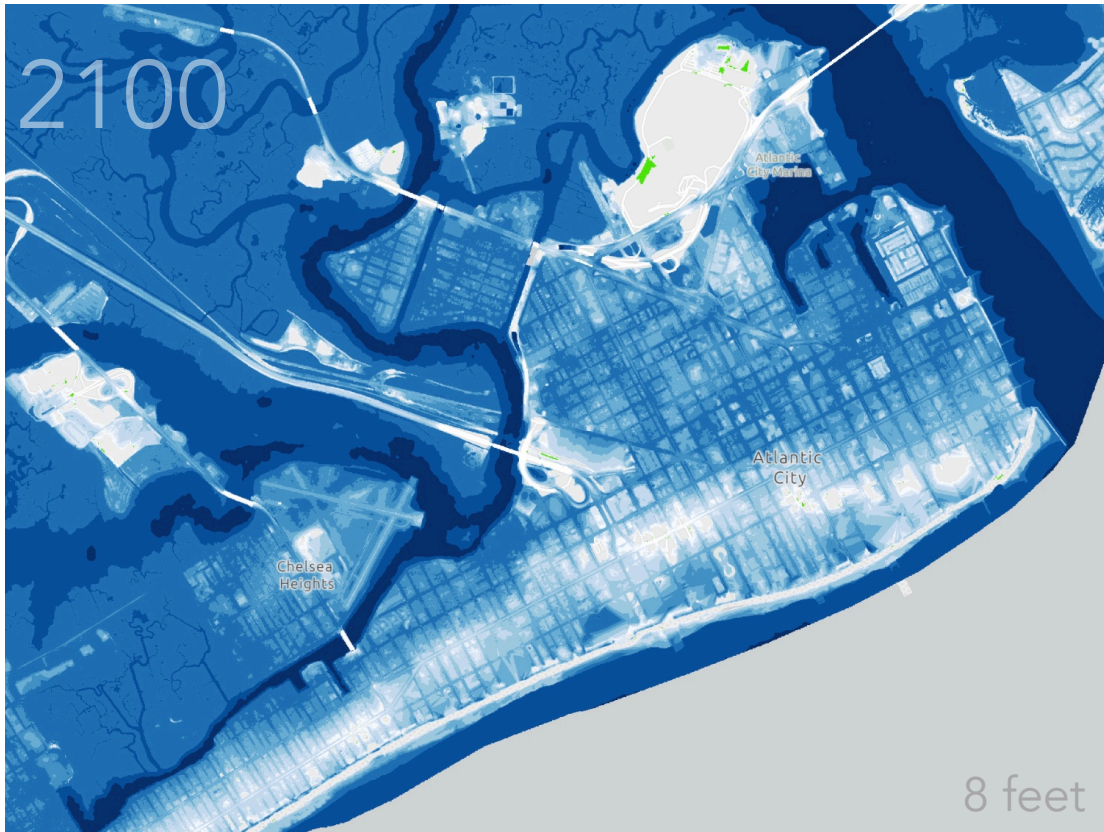


Fig. 15, Flood projection for Atlantic City, 2100; 3.3-feet of sea level rise + 4.7-foot storm surge = 8-feet Total Water Level (TWL), 2021 (Source: Author, NJ Flood Mapper data)

Impact on Ecological Environments

Atlantic City is located on a barrier island formation, centered between two riverine estuaries (Fig. 16). As a sedimentary secondary coast, the city's ocean side is characterized by sandy beaches and dunes, and its mainland side is characterized by estuarine intertidal emergent salt marshes, mudflats, lagoons, and bays. Despite urbanization of the barrier formation, the city's sandy edges and wetlands continue to sustain a variety of aquatic and terrestrial flora and fauna (Fig. 17).

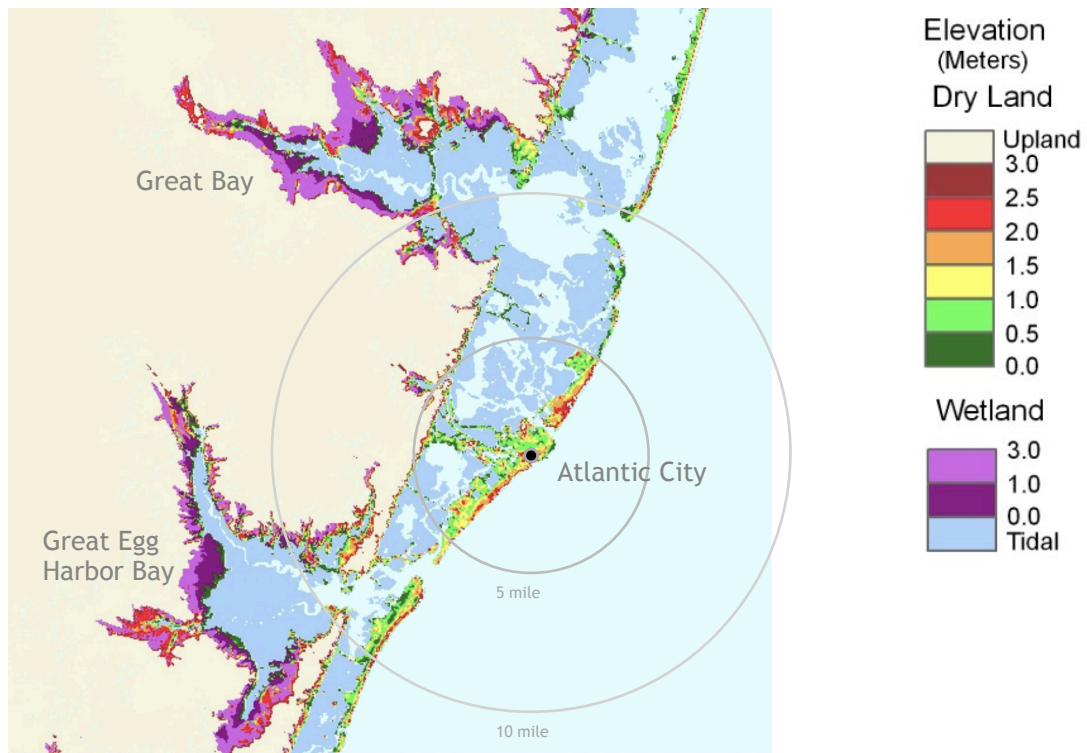


Fig. 16, Atlantic City's ecological context, 2008 (Source: EPA)



Fig. 17, Absecon Wildlife Management Area; Blue Heron in the foreground and Atlantic City in the background, 2021 (Source: Author)

The beach and wetlands absorb wave energy to mitigate flooding, prevent erosion, aid in the recharge of the aquifer, and sequester pollutants from air and water. NOAA estimates that one square mile of salt marsh wetlands can store the “carbon equivalent” of 76,000 gallons of burned gasoline.¹¹¹ These natural conditions provide imperative ecosystem services to the city and region, but the city’s built condition — foundations, impervious surfaces, and hard edges — have made it impossible for the barrier and wetlands to adapt and naturally retreat with sea level rise. The island’s ability to absorb stormwater is severely affected, and tidal flood events, also known as “sunny day” or nuisance floods, have become a significant issue regardless of rainfall. NOAA’s 2018 report on high tide floods concluded that Atlantic City and Boston experienced the second most high tide flood days in the nation, each experiencing 22 high tide flood days in 2017.¹¹²

Backed-up storm sewers trap water and cause pluvial flooding, and when relieved, street debris and warm polluted water is rejected back into the ocean and bay. By 2100, a TWL of 8-feet would flood 99.9% of the city’s 4,372 acres of tidal marshes and beaches. The flooding and water pressure from this inundation would physically damage the habitats of aquatic and terrestrial species, affect the concentrated level of water salinity, and cause erosion via sediment displacement.¹¹³ Damage and destruction to the barrier and its wetland environments would impact both island and mainland communities, exposing estuaries and inland watersheds to waves, tides, and storm surges, and further inhibiting the dynamic tidal cycle that is necessary to filter contaminants and bring new nutrients to these ecosystems.

Impact on Social, Physical, and Mental Health

In Atlantic City and coastal communities worldwide, storm events have and will continue to affect the physical and mental health of residents, especially those that are

¹¹¹ “Living Shorelines,” Habitat Blueprint, National Oceanic and Atmospheric Administration, <https://www.habitatblueprint.noaa.gov/living-shorelines/>.

¹¹² William Sweet, Doug Marcy, Gregory Dusek, John Marra, and Matt Pendleton, *2017 State of U.S. High Tide Flooding with a 2018 Outlook* (Silver Spring, MD: National Oceanic and Atmospheric Administration, 2018), https://www.ncdc.noaa.gov/monitoring-content/sotc/national/2018/may/2017_State_of_US_High_Tide_Flooding.pdf.

¹¹³ “Atlantic City: Natural and Working Lands Exposure Snapshot”, NJFloodMapper, Rutgers University, 2021, <https://climatesnapshots.rutgers.edu/0102/naturalAndWorkingLands/>.

vulnerable and/or currently living within active flood zones. In Atlantic City, a TWL of 8-feet would impact approximately 88% of the city's inhabitable land and expose 160 ground contaminated sites, 18 of which are EPA Superfund sites. Current physical health impacts include: respiratory disease; cardiovascular disease; asthma; food and waterborne illness; and injury or pre-mature death due to extreme heat or drowning.¹¹⁴ Following a climate or flood event, the growth of mold, removal of debris, and reconstruction activities continue to release toxic airborne particulates into the air. The demolition or renovation of building stock that is over 50-years-old increases the risk of exposure to toxic particulates from asbestos, cement-based, and lead-based material. Current and projected mental health impacts due to climate induced loss and fear include: depression; stress; anxiety; post-traumatic stress disorder; loss of personal identity; helplessness and fatalism; strains on personal relationships; and substance abuse.¹¹⁵ The American Psychological Association notes that the impact on physical and mental health directly correlates with communal health, resulting in social instability, loss of community cohesion, disrupted sense of belonging, and an increase in violence and crime (Fig. 18).

Impact on Local Economies

It is estimated that 14,385 (37%) of Atlantic City's residents live below the poverty level, and 12,641 of those residents would be exposed with a TWL of 8-feet. With a median household income of \$29,232, Atlantic City's residents are highly vulnerable to the economic disruptions caused by a climate event, including the time and cost of recovery, relocation, and reemployment. 72% of residents are renters and are not included in the decision making processes that could potentially fortify, raise, or protect their dwelling. Following Superstorm Sandy, renters accounted for 43% of damage but only received 22% of federal funding.¹¹⁶ A

¹¹⁴ "Mental Health and Our Changing Climate: Impacts, Implications, and Guidance", American Psychological Association, March 2017, <https://www.apa.org/news/press/releases/2017/03/mental-health-climate.pdf>.

¹¹⁵ Ibid.

¹¹⁶ Karen M'Closkey and Keith VanDerSys, and Carolyn Kousky, Billy Fleming, and Alan M. Berger, "For Whom Do We Account in Climate Adaptation?" in *A Blueprint for Coastal Adaptation and Policy* (Washington, DC: Island Press, 2021).

significant percentage of the city's residents live in low and medium-rise towers but still require ground transportation to access healthcare services, supermarkets, schools, and workplaces; the city's current public transit options cannot operate if streets are flooded. For those who do own, NFIP insurance rates are expected to increase 5% to 18%, yet property values remain stagnant; a home purchased for \$35,000 in the 1990s recently sold for the same price in 2017.¹¹⁷

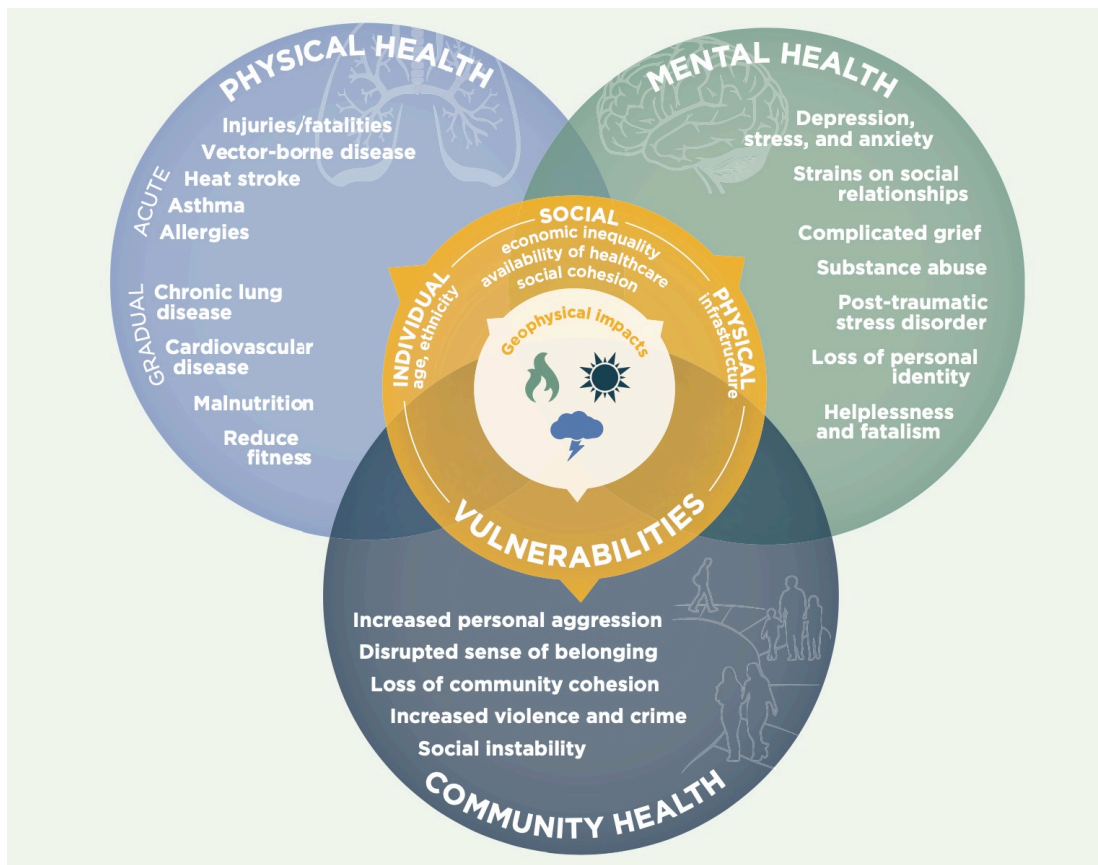


Fig. 18, Physical, Mental, and Community Health Impact of Climate Change, 2017 (Source: APA).

Additionally, the city is considered a food desert and there is no full-service supermarket for fresh produce, grains, proteins, and pharmaceuticals (update: in November 2021, the city started building its first supermarket but as of May 2022 construction has not begun). The city's unemployment rate averages around 5.9% but an economic disruption can

¹¹⁷ John Upton, "The Injustice of Atlantic City's Flood's," *Climate Central*, May 10, 2017, <https://reports.climatecentral.org/atlantic-city/sea-level-rise/>.

raise this to 12% (closure of 3 casinos in 2014) or up to 25.5% (COVID-19 furloughs).¹¹⁸ Reliance on tourism and seasonal employment has created a volatile job market that impacts socioeconomic mobility and the ability to relocate outside of flood zones. The devaluation of property in flood zones makes it even more difficult for home-owners to relocate; values have remained stagnant compared to the inflated values of mainland and tower residences. The disparity of wealth is even more evident when compared to \$3.29 billion in casino revenue and an additional \$277 million in non-casino revenue (2019).¹¹⁹ A disruption to the tourism industry and transit networks could cause dire consequences for a majority of the city's residents. This condition is not unique to Atlantic City since many barrier and coastal communities have built their economies around tourism and hospitality.

Impact on Cultural and Historic Resources

The preservation of cultures, traditions, histories, and places allows current and future generations to learn from and engage with the past, both tactilely and emotionally. However, the environmental impacts of climate change and sea level rise directly impacts the ability of the current generation to protect the tangible and intangible integrity of these resources and artifacts. Flooding, excessive humidity, drought, extreme heat, freeze-thaw cycles, and fire threaten built, natural, and archaeological resources. The social and economic impact of these events can lead to the displacement of populations and entire communities, ultimately affecting the ability to maintain intangible histories, cultures, traditions, events, folkways, and foodways. With the loss of local stewards, curators, and elders, cultural traditions and histories are prone to erasure.

A resilient framework must take into account both tangible and intangible resources, and provide the community with the tools necessary to preserve their definition of culture, tradition, history, and place. By providing a cultural and social framework for resilience, a

¹¹⁸ "Atlantic City Area Economic Summary," United States Bureau of Labor Statistics, October 2021, https://www.bls.gov/regions/new-york-new-jersey/summary/blssummary_atlanticcity.pdf.

¹¹⁹ "2019 Annual Report", New Jersey Casino Control Commission, 2020, https://www.nj.gov/casinos/about/reports/pdf/2019_ccc_annual_report.pdf.

community can take ownership of place and grow stronger in times of adversity. The city has recently adopted a Historic Preservation Ordinance and received certification as an NPS Certified Local Government, working to develop a policy-based approach to historic preservation. Grassroots initiatives supported by Stockton University, Stories of Atlantic City, the Atlantic City Free Public Library, the African American Heritage Museum of South Jersey, and the Chicken Bone Beach Jazz Foundation are actively archiving the intangible and cultural histories of the city, and sharing histories through exhibition and free events. To counter the community threats of climate change and sea level rise described by the American Psychological Association, a sense of belonging must be retained through preservation of culture, tradition, history, and place.

Precedents in Planning

National, state, and local organizations have acknowledged the risks Atlantic City faces due to climate change, sea level rise, tidal flooding, and economic instability. Princeton-based research group Climate Central has cited the threats the city faces, Rutgers University has released multiple reports warning of the future condition, and international design firms have proposed master plans for socioeconomic and ecological resilience. These plans include:

- *Atlantic City Tourism Master Plan by Jerde (2012)* - as a vision for sustainable development, the plan considers existing building stock and develops a series of infill projects that would support a year-round tourism based economy. Coastal edges are developed as opportunities for engagement and entertainment.¹²⁰
- *Amphibious Suburb by LTL and Princeton University (2014)* - the plan focuses on the Upper Chelsea neighborhood in Atlantic City by reimagining it as a de-densified urban neighborhood situated in harmony with the surrounding wetlands. The proposal studied environmentally sensitive strategies for fortification, elevation, and evacuation (Fig. 19).¹²¹

¹²⁰ "Atlantic City Tourism Master Plan" Jerde, 2012, <https://www.jerde.com/projects/8058/atlantic-city-tourism-master-plan>.

¹²¹ "Structures of Coastal Resilience: The Amphibious Suburb," LTL Architects and Princeton University, 2014, <http://ltlarchitects.com/structures-of-coastal-resilience>.

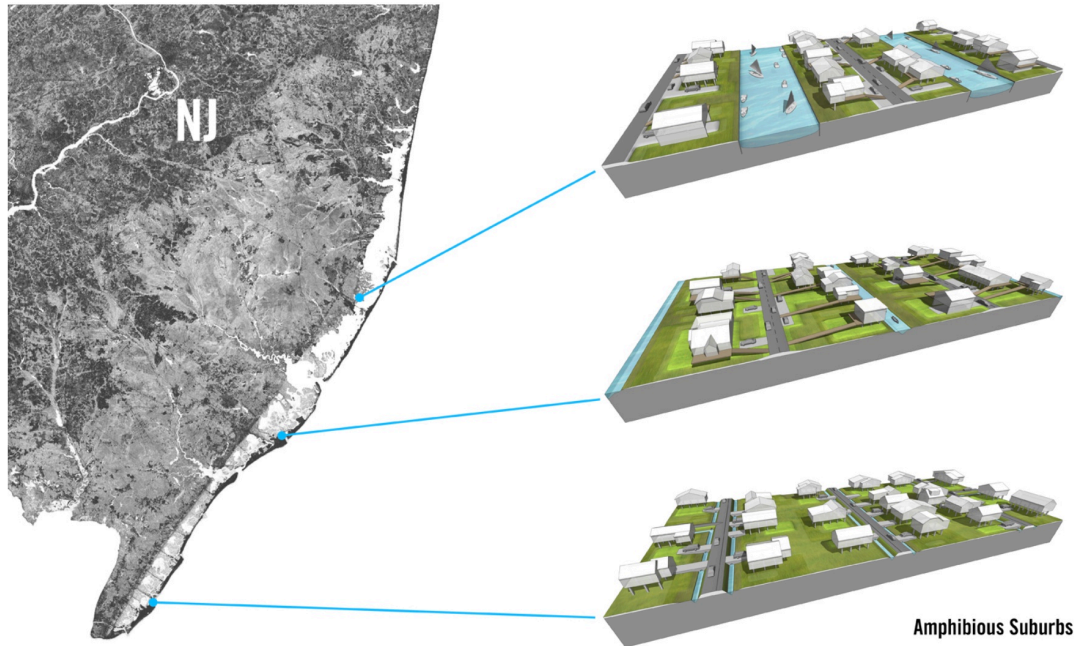


Fig. 19, Amphibious Suburb Proposal, 2015 (Source: LTL Architects)

- *Coastal Resilience Innovation Hub by Perkins + Will (2015)* - the pilot plan reimagines Atlantic City as a hub for research and resilience, forecasting that the economic crisis in the city would leave the casinos and convention centers abandoned, presenting an opportunity for innovative adaptation. The intention was to turn Atlantic City into a campus for research and innovation by balancing its existing ecological and economic resources (Fig. 20).¹²²



Fig. 20, Resilient Innovation Hub Proposal, 2015 (Source: Perkins + Will)

¹²² Sarah Lawson, "Could Atlantic City Become An Innovation Hub For Climate Change And Resiliency?" *Fast Company*, July 2015, <https://www.fastcompany.com/3049167/could-atlantic-city-become-an-innovation-hub-for-climate-change-and-res>.

understanding; promote climate-informed investments and innovative financing; and develop a coastal resilience plan. The plan is revolutionary from a state governance perspective, but the success of the strategies depends on community engagement, political will, and public-private financing. A notable component of the plan is that, as of 2019, New Jersey is the first state in the nation to require climate change be part of K-12 academic curriculum, integrating climate change studies into science, social studies, health, and world language classes.¹²⁴ This presents an amazing opportunity for Atlantic City to be an integral part of the state's plan, as development of the Resilient Transect not only becomes a framework for community resilience, but a framework for research and learning to further support climate education summits and field trips throughout the 180-day academic calendar.

¹²⁴ "Climate Change Resilience Strategy", State of New Jersey, 2021.

Chapter 4: Design Strategies for Coastal Resilience



Dune reconstruction and the living shoreline, Absecon Island, 2019 (Source: Author)

Introduction

Historically, strategies for coastal planning and protection have taken a top-down or siloed approach. Federal, state, and/or local agencies receive government funding and implement “gray” infrastructure projects in the hope of mitigating storm and flood damage. Despite the failure to consider longterm environmental and social impacts, investment in mitigation projects has been calculated to provide a fourfold return; every dollar spent results in four future dollars saved.¹²⁵ By rethinking this narrative and designing for coastal resilience, there is opportunity for local stakeholders and professional disciplines to collaborate on strategies that strengthen communities and ecosystems, proactively rather than reactively. With “green” strategies becoming more accepted, the role of the designer is becoming increasingly important and design thinking methodologies call for increased public participation to empathize, vision, ideate, test, and implement resilient strategies. Designers are trained to collaborate and question the status quo, providing further opportunity for discovery and innovation that would be difficult to achieve by taking a siloed approach. This chapter serves to inventory resilient design strategies and adaptation methods, specifically

¹²⁵ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

applicable to the urbanized coastal environment of Atlantic City. Gray infrastructure, green infrastructure, and social infrastructure will be assessed (Fig. 1).

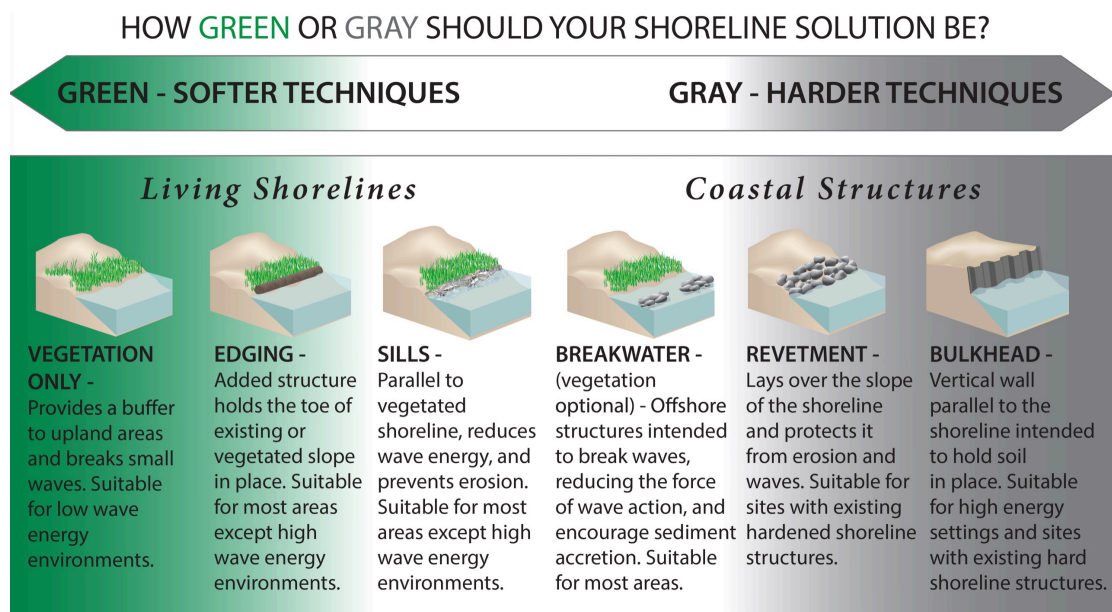


Fig. 1, Green and gray infrastructure compared, 2021 (Source: NOAA)

Grey Infrastructure

Gray infrastructure requires processed material resources and human-engineering in order to design, construct, and maintain permanence. Projects with hard edges, mechanical components, and mechanized processes are considered gray, resulting in built forms and networks that would not occur in the natural environment. Gray approaches to coastal resilience are typically accepted by federal, state, and local governments due to their predictability of cost, project timeline, performance, and maintenance.¹²⁶ However, these gray strategies can have long term effects that are costly, ineffective, or even detrimental.¹²⁷ The sense of security promoted by implementation of gray infrastructure has proven disastrous and even fatal. When projects such as seawalls, levees, flood gates, and pumping stations fail or are over inundated, adjacent and low-lying neighborhoods are directly affected with little to no warning. In 2005, the storm surge from Hurricane Katrina breached New Orleans levee

¹²⁶ Timothy Beatley, "Planning for Coastal Resilience", (Island Press, 2009).

¹²⁷ "What is a Living Shoreline?" National Oceanic and Atmospheric Administration, 2021, <https://oceanservice.noaa.gov/facts/living-shoreline.html>.

system in over 50 locations, flooding more than 83% of the city and resulting in more than 1,800 fatalities.¹²⁸

Whether at the regional, city, neighborhood, or building scale, a truly resilient gray infrastructure must account for the full lifecycle and embodied energy of these methods and processes. With reliance on materials and fossil fuel, these strategies must be reassessed to provide more than temporary protection, and designed to support social, economic, and ecological regeneration.

Edges, Barriers, and Channels

When the terms resilience and adaptation are used incorrectly or interchangeably, methods and processes promoted as proactive and resilient are actually reactive, defensive, and temporary. The fortification of edges, barriers, and channels often falls under this categorization, as projects are designed according to projections, previous storm levels, and previous failures. Methods for fortification aim to protect land forms in a static state, which is counterproductive to the dynamic evolution of coastlines and barrier islands. Introduction of hard edges also impedes the growth of flora and the mobility of fauna. Consequently, improper design of such edge hardening strategies results in further erosion as the base and eventual failure. As noted in Chapter 2, by 2100 it is estimated that 33% of the United States coastal edges will be hardened.¹²⁹

The following examples provide gray measures for protection by mitigating the impact of storm and flood damage:

- Seawalls and revetments are designed to reduce wave energy, storm surge, and erosion.

They are constructed of site-cast concrete, pre-cast modules, geometric concrete units, large boulders grouted together, or gabion cages filled with boulders (Fig. 2).

¹²⁸ “New Orleans Hurricane Katrina Levee Failures,” University of North Carolina, Charlotte, 2013, <https://eng-resources.uncc.edu/failurecasestudies/dam-failure-cases/new-orleans-hurricane-katrina-levee-failures/>.

¹²⁹ “What is a Living Shoreline?” NOAA, 2021.



Fig. 2, \$40 million seawall and revetment project along Atlantic City's North Inlet, 2018

(Source: United States Army Corps of Engineers)

- Bulkheads are designed to protect against tides, storm surge, and erosion. They are constructed of steel sheet piles, wood piles & sheets, or site-cast/pre-cast concrete (Fig. 3).



Fig. 3, Left: Wood bulkhead in disrepair, 2021 (Source: Author) Right: New steel sheet pile bulkhead, 2021 (Source: Author)

- Levees are designed as a berm to retain a constant high water level and protect against storm surge. They are constructed of compacted fill and synthetic filter layers.

- Groins are designed to prevent beach erosion and contain deposition due to ocean currents. They project perpendicularly from coastline, are typically built in multiples, and are constructed from interlocking boulders or geometric concrete units. Refer to the stone forms perpendicular to the seawall in Fig. 2.
- Jetties are designed to prevent sediment deposition into boating channels, harbors and bays. They are constructed in a similar manner to groins (Fig. 4).



Fig. 4, Jetty (bottom of photo) protects the inlet channel and acts as a deposition catchment, 2018 (Source: USACE)

- Flood gates control the flow of water into harbors, bays, and tidal marshes. They are constructed of steel or wood, and depend on a mechanized process to open and close.
- Pumps and canals collect and channel water away from flood prone areas, by means of mechanized check-valves and water pumps. Atlantic City's canal has recently been restored, but its effectiveness is inconclusive as vulnerable areas continue to flood.

- Breakwaters are designed to reduce wave energy and storm surges. They are constructed in water, parallel to coastal edges. They can be isolated or connected to land, and constructed in a similar manner to groins; site-cast, pre-cast, and organic reef examples exist.

When the above methods fail, processes for replenishment and dredging are undertaken. Beach replenishment restores the width of sandy coastal edges by pumping sand from the nearshore ocean floor and redistributing it on the beach via grading equipment (Fig.5). This process provides temporary protection for development and maintains the beach as a tourist attraction, but its efficacy has been debated. These projects are costly, interrupt spawning and habitat reproduction, and are washed away by major storm events; the process will require repeating. In *Chapter 2: Coastal Urbanization*, it was noted that the Sierra Club estimated \$1.5 billion in beach replenishment projects in New Jersey, dating back to 1989, have largely been a waste.¹³⁰ However, beaches are typically the primary draw of coastal tourism economies and the cost of their maintenance is considered incidental.



Fig. 5, Beach replenishment in Ocean City NJ, c. 2018 (Source: USACE)

The pumping process required for dredging is similar to replenishment, except that sediment is removed from boat channels to provide safe access for marine-based commerce and recreation. Sediment is typically pumped onto existing marsh beds resulting in the

¹³⁰ Dan Radel, "No End in Sight": Coalition Argues \$1.5B in NJ Beach Replenishment Has Been a Waste", *Asbury Park Press*, October 8, 2021, <https://www.app.com/story/news/local/land-environment/2021/10/08/nj-beach-replenishment-coalition-calls-waste-billion/6033691001/>.

destruction of habitats and vegetation (Fig. 6). There have been local efforts to mitigate these damages by testing advanced dredging techniques that *restore* marshlands and support habitat regeneration. The Wetlands Institute of Stone Harbor, NJ, in partnership with the USACE and State of New Jersey, created the Seven Mile Island Innovation Lab to promote sustainable dredging techniques and marshland regeneration (Fig. 7).¹³¹



Fig. 6, Left: dredging in Cape May County, NJ 2021 (Source: USACE, Wetlands Institute)
Right: ecosystem impacted by staging and preparation, 2021 (Source: Author)

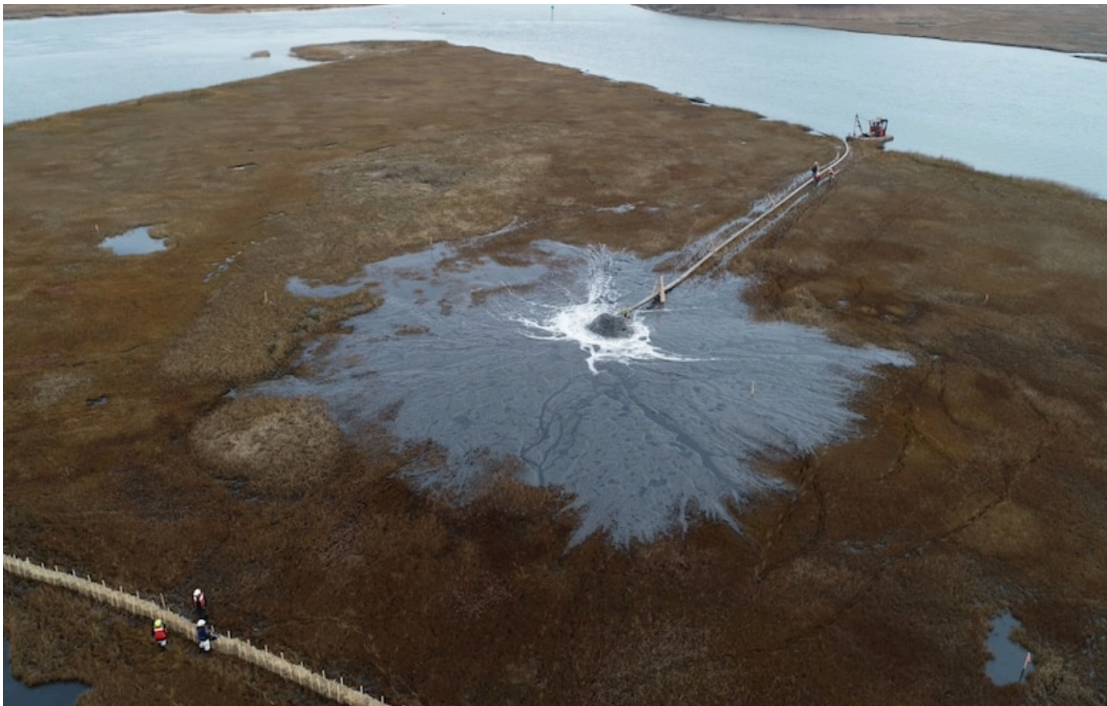


Fig. 7, Seven Mile Island Innovation Lab (27 miles south of AC), 2019 (Source: USACE)

¹³¹ "Seven Mile Island Innovation Lab," The Wetlands Institute, 2021, <https://wetlandsinstitute.org/smiil/>.

Renewable Energy

To harness the power produced by renewable energy sources requires material production, mechanical interventions, and distribution networks. Implementation of these systems within coastal communities provides an impetus to remain resilient and connected in anticipation of the increased frequency and amplitude of future climate events.

Photo voltaic panels, roof tiles, and glass can be implemented at the city, neighborhood, and building scale. Advances in storage capacity and distribution can provide an affordable — or free — energy alternative, considerably useful during storm events and mainland interruptions to transmission. Atlantic City currently has a 2700 panel solar farm located at the Atlantic County Utilities Authority (ACUA) wastewater treatment facility.

Wind turbines are a suitable energy source for coastal communities with sustained coastal winds. Atlantic City has a five turbine wind farm located at the ACUA wastewater treatment facility, capable of providing energy for 2500 homes and reducing carbon dioxide emissions by 66,200 metric tons since 2005 (Fig. 8).¹³²



Fig. 8, ACUA windfarm is situated on the edge of urbanization and natural wetlands (Source: Creative Commons)

¹³² "Jersey Atlantic Wind-Farm Facts," Atlantic County Utilities Authority, 2021, <http://acua.com/content.aspx?id=6611>.

There has been debate due to reports of wind turbines injuring or killing migratory birds, but ACUA reports an average of 10 migratory bird fatalities per year. As of 2021, New Jersey has approved the construction of two off-shore wind farms approximately 15 miles from Atlantic City's coast. These farms are expected to provide power for over 1.15 million homes and create 7,000 full and part-time jobs.¹³³ Debate has followed, regarding view sheds, property values, and disruptions to tourism.

Tidal and wave energy mechanisms harness the motion of tides, currents, and waves via turbines and buoyant motion. While this method has applicability offshore, studies have debated the impact of this method within inlets and estuaries, citing the potential damage to natural habitats and marine transportation.

Resilient Construction Methods and Materials

In contrast to gray infrastructure and large scale civil projects, resilient strategies can be implemented at the building scale. When these strategies are adopted as part of a building code or ordinance they can benefit the community as a whole, and ensure the ability to remain resilient after a climate or flood event. Methods and materials are not limited to new construction and they can be successfully retrofitted for existing buildings, adaptive reuse projects, and restorations. To date, Boston's "Coastal Flood Resilience Design Guidelines" provides one of the most comprehensive municipal guides for flood resilient construction and adaptation strategies, specifically designed to account for the city's projected water level and historic building typologies (Fig. 9).¹³⁴ FEMA and state agencies have published similar guidelines that are more regional in context and tactics.

¹³³ Michelle Lewis, "EGEB: New Jersey Approves US's Largest Combined Offshore Wind Farm", *Electrek*, July 1, 2021, <https://electrek.co/2021/07/01/egb-new-jersey-approves-us-largest-combined-offshore-wind-project/>

¹³⁴ "Coastal Flood Resilience Design Guidelines," Boston Planning & Development Agency, 2019, <http://www.bostonplans.org/getattachment/d1114318-1b95-487c-bc36-682f8594e8b2>.

Long-term Strategy

Building Envelope and Access

Relocate Ground Floor Use

Abandon basement and ground floor. Fill basement to the lowest adjacent grade. Eliminate any habitable spaces below SLR-DFE and convert ground floor use to storage and access.

Recuperate lost FAR at roof addition. Addition designs should be contextually sensitive per landmark district design standards and criteria.

Building Systems

Protect Critical Systems

Locate water heater and critical systems above the SLR-DFE.

Evaluate life of systems and upgrade where possible. Consider upgrading heating to high-efficiency mini-split heat pump system with equipment mounted outside and above the SLR-DFE.

Supporting Strategy

Enhanced Envelope

Conduct energy audit and blower door test. Air-seal at windows, doors, and penetrations.

Upgrade windows to historically sensitive low-e, low-U-factor units.

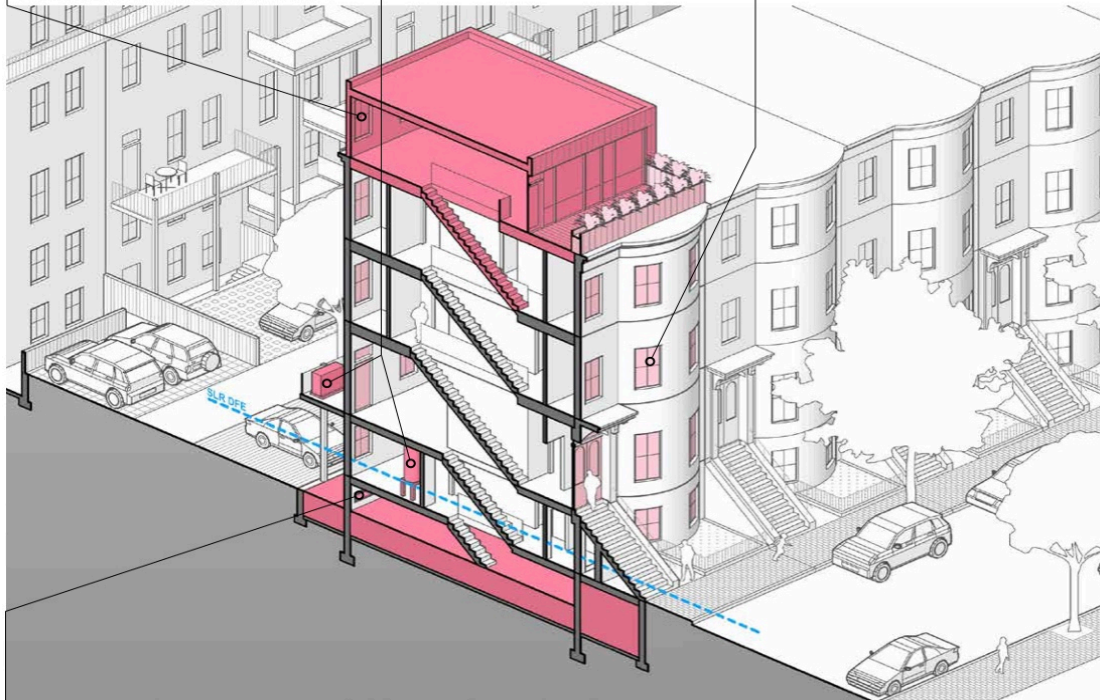


Fig. 9, Excerpt from Boston's "Coastal Flood Resilience Design Guidelines", 2019 (Source: Boston Planning & Development Agency)

Methods: Resilient construction methods maintain livability and occupancy post climate or flood event. There is a relationship between sustainable methods and resilient practice, and according to Timothy Beatley, the sustainability of an ecosystem, landscape, or city requires resilience.¹³⁵ The design of older buildings — prior to air conditioning or electricity — provides a precedent of what sustainable design was, and how its can support the resilience of a community. Site orientation, wall construction, materiality, natural light, floor to floor height, projection of roof lines, and natural ventilation results in a building model that can remain operational if traditional utility services are interrupted. While building

¹³⁵ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

on high ground proves the most effective method, the early densification of urbanized coastal communities required an early form of adaptation to the urban environment.

Elevation above the flood plain has historic and contemporary precedents, proving a traditional method for coastal constructions. Atlantic City's late 19th century beach front hotels were elevated to match the level of the Boardwalk promenade (Fig. 10), and as early as 1902, Galveston, Texas began an ambitious campaign to raise over 2,000 buildings and 500+ city blocks.¹³⁶



Fig. 10, Atlantic City's adapted architectural vernacular; elevation of Boardwalk, hotels, and theatres, 1910 (Source: Library of Congress, Detroit Publishing Co.)

¹³⁶ Mathew Pelz, *Protecting Historic Coastal Cities* (Texas A&M University Press, 2019).

Whether on pylons or a raised foundation, locating the primary occupiable area above the flood plain allows families, businesses, and services to return after an acute or chronic climate event, with little to no disruption. While this method protects property, if roads remain un-elevated it is difficult or impossible for emergency personnel to access the building should occupants require help (Fig. 11).

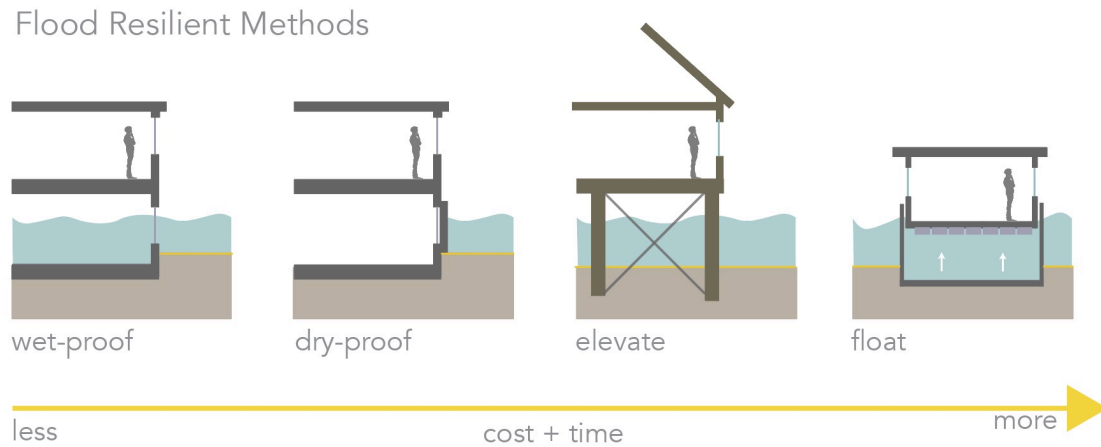


Fig. 11, Strategies for adaptation, simple to complex, 2021 (Source: Author)

If elevation is not possible, design of wall assemblies and landscapes can provide considerable relief. Dry flood-proofing techniques attempt to prevent water from entering a building by designing wall assemblies that withstand water pressure and inundation, from both wall and ground sources. Wet flood-proofing — or floodable architecture — assumes properties will be inundated by flooding and is designed so that water can enter and exit as quickly as possible. Flood vents, hollow wall cavities, rigid insulation, elevated mechanical systems, water resilient materials, and spacing between wall and floor layers allows surfaces to dry out quickly, inhibiting the growth of mold after a climate event. Floodable architecture allows for poetic gestures between the built environment and nature's powers, as exemplified in Carlo Scarpa's design for Querini Stampalia (Fig. 12).



Fig. 12, Querini Stampalia entry sequence, Venice, Italy, 2001 (Source: PresS/Tletter)

In coastal communities that are vulnerable to cyclones and typhoons, wind load must also be accounted for. Cross bracing, rigid connections, and shear walls must be designed to sustain lateral forces, and foundation, floor, and roof layers must be tied down to prevent uplift.

Alternative methods to traditional static construction are being proposed, and concepts for floating, buoyant, and amphibious architecture is being tested globally. The Netherlands, a third of which is below sea level, is fervently testing and implementing floating neighborhoods. The Waterwoningen housing complex located in Amsterdam is comprised of 75 individual homes that can be accessed by land or water (Fig. 13). Floating architecture is not limited to private residences and the Makoko Floating School in Lagos, Nigeria provides a civic example of how daily life can be maintained and communities strengthened, via education and innovation. Unfortunately, the early prototype suffered structural failure after heavy rains. ¹³⁷

¹³⁷ Lindsey DeSimone, "Floating Architecture is Making Waves", *Architectural Digest*, March 21, 2017, <https://www.architecturaldigest.com/gallery/floating-architecture-around-the-world-slideshow>.



Fig. 13, Waterwoningen housing in Amsterdam, Netherlands, 2013 (Source: Wojtek Gurak)

Materials: To support the construction methods described, water resistant and impenetrable materials should be used to prevent the growth of wood-decay fungus, black mold, corrosion, and insect invasion. Strategic material selection ensures the health of occupants and the environment as the need for demolition and rebuilding is mitigated. Typical construction materials such as plywood, drywall, cement board, mineral fiber, and polyvinyl are either inherently water resistant or have been developed to be water resistant, but the processes and embodied energy required to produce these materials has drastic environmental impacts. In coastal communities with historic buildings, much can be learned from the use of naturally resilient materials such as certain wood species, stone, and masonry. Reuse of existing materials provides the most sustainable solution in terms of embodied energy, and when combined with contemporary materials such as soy-based insulating foam, can maintain livability post climate or flood event.¹³⁸

The gray infrastructure methods listed above require material and mechanics to accomplish. Despite the intention to last indefinitely, a material's life cycle must be accounted for and planned for. Reuse and upcycling of materials prevents unnecessary waste in landfills,

¹³⁸ Mathew Pelz, *Protecting Historic Coastal Cities* (Texas A&M University Press, 2019).

reduces the carbon footprint from transportation and disposal, and preserves a material's embodied energy. A typical cast-in place concrete seawall is very resource intensive as it requires resource extraction, transportation, processing, delivery, and placement. These systems are prone to eventual degradation, but if geometric concrete units are designed to spawn reef and mollusk growth, nature fortifies the use as indefinite. EConcrete is an example of this; admixes are used as an alternative to Portland cement, and geometric shapes and voids protect and regenerate ecosystems.¹³⁹ Building materials should also be dried and reused when possible. Old-growth wood has great reuse value and hardness compared to newer species, but when historic structures flood these materials are often disposed of and replaced with less resilient species. While there is no policy to prevent this disposal, future moratoriums on landfill limits could force reuse and upcycling.

Green Infrastructure

According to Allen's 2012 journal article, "Advancing Green Infrastructure at All Scales", green infrastructure is the "strategic use of networks, natural lands, working landscapes, and other open spaces to conserve ecosystem values and functions and provide associated benefits to human populations".¹⁴⁰ Designers and engineers implement green infrastructure by building upon existing systems and networks, monitoring their growth, and evaluating their outcome for intervention and future implementations. Green infrastructure begins to implement a more collaborative "bottom-up" approach as local stakeholders and professional disciplines coordinate on values and stewardship. In terms of coastal resilience, green infrastructure balances social, economic, cultural, and ecological values to create resilient strategies that are self-sustaining and regenerative. Urbanization of coastlines disallows a return to a natural or previous state, thus, the importance of green infrastructure is to account for a future where population and nature live holistically and in harmony. Similar

¹³⁹ Kate Orff, *Toward an Urban Ecology* (The Monacelli Press, 2016).

¹⁴⁰ William L. Allen, "Environmental Reviews and Case Studies: Advancing Green Infrastructure at All Scales: From Landscape to Site," *Environmental Practice* 14, no. 1 (2012): 17–25.

to gray infrastructure, green infrastructure still requires design, human-engineering, and material intervention, but its intention is to establish a process for regrowth and resilience, rather than attempt a solution.

Living Shorelines

Living shorelines is a strategy for stabilizing coastal edges with natural materials and processes. It is intended to return a shoreline to its most natural state, or an adapted state that accounts for external variables. The softening of edges and reintroduction of native plant species has the potential to spawn the growth of aquatic and terrestrial habitats, resulting in a natural infrastructural edge. The growth of oyster reefs, mussel beds, and submerged aquatic vegetation provides further stabilization and ecological services which include: water purification, carbon sequestration, oxygen release, erosion prevention, and wave/tide absorption via natural breakwaters. Slightly inland of the coastal edge, dune systems can be restored to protect against wave energy and tidal surges, simultaneously providing a habitat for birds, small mammals, amphibians, reptiles, and insects (Fig. 14).¹⁴¹



Fig. 14, Atlantic City's dune systems stabilizes the shore from wave action and erosion, 2021

(Source: Author)

¹⁴¹ "Eco-Tips: Coastal Dunes," Montgomery County Planning Board, <https://www.co.monmouth.nj.us/documents/24%5CEco-Tips%20Dune%20Protection.pdf>.

Though living shorelines is a long-term approach that requires growth periods and reproduction, it is more economical and has been proven to perform better than a hardened shoreline (Fig. 15).¹⁴²

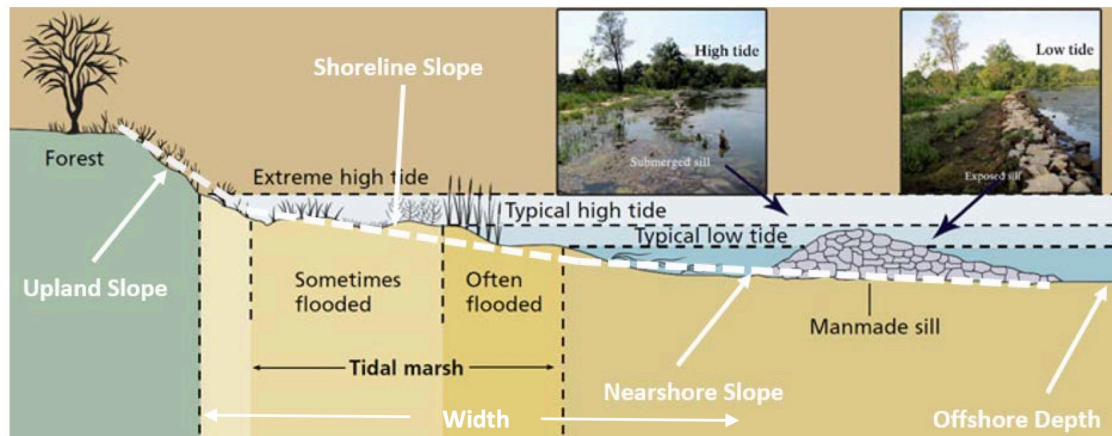


Fig. 15, The Hancock County Marsh living shoreline constructed 6 miles of breakwater and 46 acres of oyster reefs, to help absorb tidal energy and spawn habitat growth. A single oyster can filter 50 gallons of water per day, 2019 (Source: NOAA Fisheries)

The design of living shorelines and resilient coasts has transcended science, engineering, and policy disciplines, and is equally within the realm of the architecture and design disciplines (Fig. 16). Landscape architecture firms are setting a precedent for a new generation of thought and climate action. The "Living Breakwaters" project by SCAPE takes a multi-layered approach to resilience by re-conceptualizing how artificially spawned oyster reefs can serve as a measure for wave and surge absorption, while also providing ecological

¹⁴² "Understanding Living Shorelines," National Oceanic and Atmospheric Association, 2021, <https://www.fisheries.noaa.gov/insight/understanding-living-shorelines>

sustenance and cultural value (Fig. 17). Utilization of existing resources and innovative



products such as EConcrete are being used to create this resilient infrastructure.¹⁴³

Fig. 16, Design of living shorelines, 2016 (Source: Stevens Institute of Tech. for NJDEP)

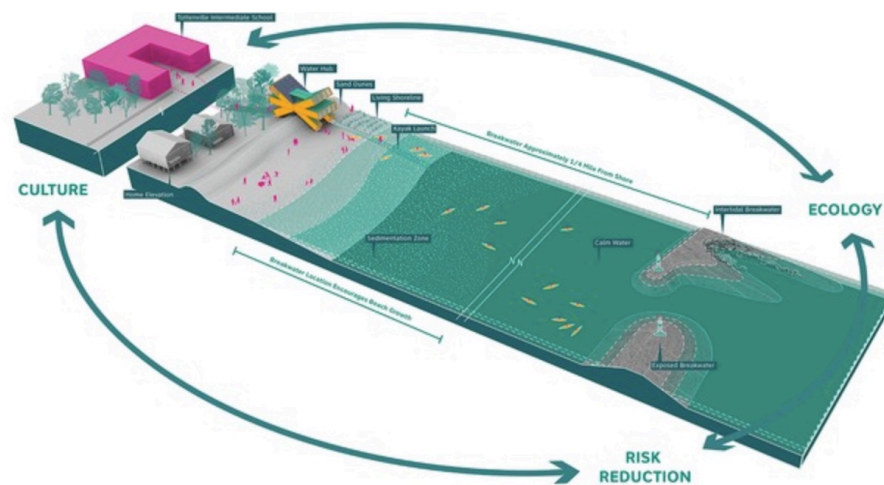


Fig. 17, Living Breakwaters uses natural ecological processes to reduce risk and preserve culture, 2014 (Source: SCAPE, Inmatteria)

Urban Ecosystems

Urban ecosystems is an umbrella term for all ecological activity that occurs in harmony and/or discord with built infrastructures. Urban ecosystems include the biodiversity of cities, conservation of resources, wildlife and aquatic management, ecosystem services and

¹⁴³ Kate Orff, *Toward an Urban Ecology* (The Monacelli Press, 2016).

values, landscape architecture, climate policy, geology, and urban planning.¹⁴⁴ The retention and viability of urban ecosystems is essential in the resilience of urbanized coastal communities, especially those with vulnerable populations (Fig. 18).

The most visible urban ecosystems include parks, vegetated open space, green corridors, and natural or constructed wetlands. Presence of trees and canopy provides ecosystem services in the form of habitat regeneration, shade, wind break, carbon sequestration, and water absorption. Shrubs, native grasses, and sedges provide an additional layer of carbon sequestration, water absorption, and erosion control. Permaculture practices that introduce edible landscapes and community gardens help to sustain insect and soil health, and provide a food source that is affordable and accessible pre or post storm event.¹⁴⁵



Fig. 18, Community urban garden in Montreal, 2016 (Source:Sandra Cohen-Rose)

With the increased presence of impermeable surfaces in coastal cities— roofs, roads, sidewalks, parking, and public plazas — stormwater absorption and filtration, especially during storm or tidal flood events, is necessary for the continued resilience of people and

¹⁴⁴ “Preface”, *Urban Ecosystems*, <https://www.springer.com/journal/11252>.

¹⁴⁵ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

environment. Despite flooding being inevitable, urban ecosystems can reduce the impact of flooding by speeding the rate of absorption, hence, minimizing damage and disruption. Conversion of impermeable surfaces to permeable can be accomplished by the introduction of bioswales, rain gardens, green roofs, and constructed wetlands (Fig. 19). While individual absorptive landscapes can be effective at reducing runoff and stresses on stormwater infrastructure, aggregation at the city or neighborhood scale can help to reduce the effects of tidal and nuisance flood events. Atlantic City is highly susceptible to nuisance flooding and flash storm events due to ineffective stormwater management and lack of permeable surfaces; reintroduction of permeable surfaces, bioswales, rain gardens, and green roofs can help retain stormwater and prevent it from accumulating on streets and sidewalks.



Fig. 19, Bioswale in NYC spawns growth and absorbs water, 2019 (Source: Chris Hamby)

Social Infrastructure

According to Lantham and Layton, “social infrastructure refers to the networks of spaces, facilities, institutions, and groups that create affordances for social connection”.¹⁴⁶ In the context of coastal resilience, it “sustains the capacity of people, communities, and societal institutions, to adapt and experience benefit from disaster”.¹⁴⁷ Social infrastructure empowers communities to maintain cohesion, share experiences, preserve cultural histories, advocate for change, and grow personally and communally. Social infrastructure differs from green and gray infrastructure in that it accounts for the purely human component of coastal resilience. Green and gray infrastructures provide the methods and processes to be resilient, but social infrastructure validates the societal will to remain resilient. Within vulnerable communities, the loss of life, property, and ecosystem services amplifies the inequities and environmental injustices related to urbanization and climate change. Building a social infrastructure of both tangible and intangible parts aims to mobilize and amplify the voices within vulnerable and affected communities. Similar to the dynamic growth of green infrastructure systems, the components of a social infrastructure cannot be prescribed, but must remain adaptable to the concerns of the community by forecasting trends and future needs.

Community Support

One of the most threatened assets due to climate change and sea level rise is community cohesion and stewardship. The increased frequency and amplitude of climate events continues to displace residents, either willingly or forcibly.¹⁴⁸ With this displacement resulting in a staggered exodus, local pride, accountability, and sense of place are threatened. In lieu of familiar faces and unity, interaction and trust wanes. When the inaccessibility of

¹⁴⁶ Alan Lantham and Jack Layton, “Social Infrastructure and the Public Life of Cities: Studying Urban Sociality and Public Spaces”, *Geography Compass* 13, no. 7 (2019). <https://doi.org/10.1111/gec3.12444>.

¹⁴⁷ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

¹⁴⁸ “Climate Change and Disaster Displacement,” The UN Refugee Agency, United Nations, 2021, <https://www.unhcr.org/en-us/climate-change-and-disasters.html>.

property ownership is considered, neighborhoods become transient environments and lose their advocacy.

Designing for community support requires strengthening of existing networks and relationships, and adding capacity to build new networks. Spaces designed for interaction must be designed from the bottom-up and allow for flexibility and ownership. In times of emergency and distress, these spaces must support mobilization so community networks can come together, advocate for one another, and work cohesively to rebuild and strengthen their network. The idealistic nature of this approach is countered by the fact that schools, community centers, and religious institutions act as sites for mobilization and recovery during emergencies, despite their limitation of temporary support (Fig. 20). Permanent spaces are required so the community can be proactive in addressing climate events rather than reactive. Informal spaces that encourage activity and engagement with nature can aid in wellbeing and health so it is important that natural and built forms be balanced, dynamic rather than prescriptive, and adaptable to future needs and environmental conditions.¹⁴⁹



Fig. 20, Emergency shelter and FEMA registration in Atlantic City, directly following Superstorm Sandy, 2012 (Source: National Archives)

¹⁴⁹ Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

Environmental Justice

According to the Environmental Protection Agency (EPA), environmental justice is the “fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies”.¹⁵⁰ This requires equitable protections from hazards and access to decision making processes. In designing a framework for coastal resilience, equality must be replaced by equity, providing those that have been historically marginalized or mistreated with a fair advantage based on current injustices. Examples of such injustices includes prioritizing upper-middle class communities as candidates for replenishment, bulkhead construction, and living shoreline implementation. Even within urbanized coastal communities, priority is given to neighborhoods and districts deemed to be more economically valuable. In Atlantic city, the dune system and seawall that protects the tourism district is maintained, while the bulkheads and drainage of the back bay neighborhoods continue to deteriorate (Fig. 21).



Fig. 21, In Atlantic City, a vital bulkhead stops where a historically disenfranchised neighborhood begins, 2021, (Source: Author)

¹⁵⁰ “Environmental Justice,” Environmental Protection Agency, 2021, <https://www.epa.gov/environmentaljustice>.

Establishing an inventory of past injustices and potential future injustices is necessary to plan for and establish a true justice-based framework. With injustices existing in nearly every realm from land use planning to park location to tree canopy distribution to preservation criteria, vulnerable neighborhoods must be given priority in the strengthening and resilience of these systems. As discussed earlier in the chapter, green infrastructure and renewable energies can negate the need for traditional infrastructural improvements, but access must be prioritized for areas that are most vulnerable to climate events and social, economic, cultural, and ecological shocks. Preservation and reuse of existing historic infrastructure can also negate the need for new construction and simultaneously provide a form of justice, especially in communities that have been historically barred from their own building stock.

A holistic approach to research, community support, and public engagement must be cognizant of history and the cultural context of a given neighborhood in order to customize an approach that equitably distributes public space, private space, and green space. Relative to social infrastructure, resilience can be redefined as “the ability of a community to not only deal with adversity but in doing so reach a higher level of functioning”.¹⁵¹

¹⁵¹ J. Kulig, cited in Pooley, Cohen, and O Connor 2006, p.163, in Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009), 50.

Chapter 5: Preservation Strategies for Coastal Resilience



Historic Coast Guard Station, Atlantic City, 2021 (Source: Author)

Introduction

Preservation is the protection and interpretation of tangible and intangible resources deemed significant for their historical, cultural, environmental, and archaeological value; resilience is the ability to grow and “reach a higher level of functioning” in response to adversity.¹⁵² Fundamentally, resilience and preservation are dependent upon one another, both enabling the sustenance of people, place, culture, history, economies, and natural environments.

Building upon the significant relationship between preservation and coastal resilience, this chapter will analyze methods for leveraging tangible and intangible resources in vulnerable coastal communities. Designing a framework for the Resilient Transect will serve as a case study to test and implement these strategies, further developing a globally applicable precedent. This chapter also addresses the potential need to plan for retreat and conceptualizes methods for retaining historic and cultural resources when place and setting are no longer inhabitable.

¹⁵² J. Kulig, cited in Pooley, Cohen, and O Connor, 2006. Timothy Beatley, *Planning for Coastal Resilience* (Washington, DC: Island Press, 2009).

Contemporary Preservation Practice

As climate change and sea level rise continue to affect the natural, built, and sociological ecosystems of our planet, the local and regional histories that maintain knowledge and provide a sense of place are also threatened. In concept, historic preservation practice — also referred to as heritage conservation — is meant to provide communities with the tools necessary to preserve and maintain historic resources deemed significant for the enjoyment, education, and development of current and future generations. Proactively pursuing preservation strategies can provide a community with the capacity to take ownership and protect their identity, further enhancing the will to recover, adapt, and grow in times of adversity.¹⁵³ If existing resources are leveraged for their reuse potential, sense of place is maintained and recovery time is significantly reduced.

Conversely, the validity of community driven preservation efforts is impeded by preservation policies, regulations, and incentives that prioritize physical integrity over intangible significance. In contemporary preservation practice, protections continue to prioritize histories that are over 50-years-old and exhibit tangible integrity. The financial capacity to fund and profit from preservation remain linked to property ownership, wealth, and/or power.¹⁵⁴ With less protections afforded to intangible resources and recent histories, the impending erasure of local histories and cultures threatens to disrupt the community fabric that maintains cohesion during times of emergency and regeneration. Maintaining tangible and intangible resources as assets for resilience provides communities with strength to recover, adapt, and grow in response to disruptions caused by chronic and acute climate events.¹⁵⁵

The Preservation Priorities Task Force, a joint effort by National Preservation Partners Network and the National Trust of Historic Places, has noted sustainability and

¹⁵³ Barnett et al., “Three Ways Social Identity Shapes Climate Change Adaptation,” *Environmental Research Letters* 16, no. 12 (November 24, 2021), <https://iopscience.iop.org/article/10.1088/1748-9326/ac36f7>.

¹⁵⁴ Eric Resnick, “How Can Historic Preservation Be More Equitable? Acknowledging the Histories of the Economically Marginalized” (University of Maryland, College Park, 2020).

¹⁵⁵ Mathew Pelz, *Protecting Historic Coastal Cities* (Texas A&M University Press, 2019).

climate action as a preservation priority. In Fall 2021, the "Sustainability and Climate Action: Issue Brief" was released as a requisite guide to frame how climate change and rising sea level is affecting historic resources, advocating for preservation guidelines to better align with sustainability and climate action goals.¹⁵⁶ As of December 2021, the strategies proposed in the "Response Plan" have not been published.

Methods for Participatory Action Research

To ensure that strategies for coastal resilience value preservation planning and remain equitable and inclusive to community needs, a participatory action-based research method (PAR) can be implemented to catalyze early collaboration between researchers and community stakeholders. According to Burns, Cooke, and Schweidler's 2011 guide, "A Short Guide to Community Based Participatory Action Research", PAR aims to "address the practical concerns of people in a community" to yield data that must be considered in future planning and community development.¹⁵⁷ Providing the community with the opportunity to participate in the development of resilient strategies, and the best methods to preserve their tangible and intangible histories, will yield data and insight that would be impossible to extract from statistical data, general surveys, or a sampling of verbal encounters. These participatory methods have been successfully implemented by communities across the United States and have proven successful in historic nomination of community revered resources.¹⁵⁸

Community Partnerships and Outreach

To ensure the voices of community stakeholders are heard and accounted for, partnerships can be forged between communities and local educational institutions, non-

¹⁵⁶ Preservation Priorities Task Force, *Sustainability and Climate Action*, (Woburn, MA, Washington, DC:National Preservation Partners Network and the National Trust of Historic Places, 2021), <https://static1.squarespace.com/static/60748c08c5e3c41f47c49cbd/t/61434da4f0fbc56ed870d59/1631800743277/PPTF+Sustainability+and+Climate+Action+Issue+Brief.pdf>.

¹⁵⁷ "A Short Guide to Community Based Participatory Action Research," University of California, Los Angeles, December 2011, <https://www.labor.ucla.edu/wp-content/uploads/2015/03/A-Short-Guide-to-Community-Based-Participatory-Action-Research.pdf>.

¹⁵⁸ Ibid, p.700

profits, municipal offices, and business. Within the context of Atlantic City, participating researchers, designers, and policymakers should be proactive in outreach and ensure spaces are provided that accommodate community needs and schedules.

Notable methods for participatory action-based research include: organizational learning, participatory workshops, reflective practice, and participatory geographical information systems. Organizational learning connects community stakeholders and institutions in an effort to create, retain, and transfer knowledge; participatory workshops establish a platform for sharing and co-generating knowledge; reflective practice allows stakeholders to reflect on individual experiences, setting a template for preservation priorities and resilient strategies; and participatory geographical information systems help to empower those who have been historically left out of spatial documentation and decision making. This will be discussed further in the section "Strategizing for Planned Retreat".¹⁵⁹

Tangible Resources

Tangible resources are those that have a physical presence and are able to be seen, touched, and manipulated in form. In the United States, the National Register of Historic Places (NRHP) lists over 1.4 million individual resources among 95,000+ properties, deemed significant for their national, state, and local historical value.¹⁶⁰ Buildings, sites, districts, structures, and objects are nominated to the National Register based on association with notable people, events, craft/design, and potential for data. Listing on the National Register provides procedural protections against Federal actions and must follow the regulations set forth in the National Historic Preservation Act of 1966 (NHPA), however, listing does not prevent demolition or alteration. Private property owners are free to alter or demolish their properties, as long as they are not receiving funding or located within a local historic district. Local preservation ordinances, historic district overlay zoning, and design guidelines provide

¹⁵⁹ "Participatory Methods," Institute of Development Studies, September 18, 2014, <https://www.participatorymethods.org/methods>.

¹⁶⁰ "National Register Database and Research," National Register of Historic Places, National Park Service, <https://www.nps.gov/subjects/nationalregister/database-research.htm>.

the most substantive protections against alteration and demolition, but even then, negligent actions are not punishable as criminal acts. Essentially, federal and state legislation establishes guidelines but substantive protection is achieved at the local level. Within Atlantic City there are seven existent National Register resources, one of which is within the boundaries of the Resilient Transect. Table 1 summarizes the listed, demolished, eligible, and identified resources within Atlantic City and Figures 1, 2, and 3 depict additional listed, eligible, and identified resources within the transect's boundaries.

Table 1 - Historic Resources within Atlantic City

Listing	Existent	Demolished
National Register of Historic Places (NR)	7	4
National Historic Landmark (NHL)	1	
NR Historic District	1	
NR Historic District (contributing resource)	6	
Eligible NR Historic District	5	
Eligible Individual	10	2
Identified Individual	410	650



Fig. 1, WWI Memorial, built 1922 and listed on NRHP in 1981, 2010 (Source: Wiki CC)



Fig. 2, Knife and Fork Inn, built 1912 and an eligible resource, 2021 (Source: Author)



Fig. 3, Masonic Temple, built in 1927 and an identified resource, 2021 (Source: Author)

Building Adaptation and Reuse

In designing for coastal resilience it is debated whether new construction should be allowed in high risk areas or if moratoriums should be imposed that prevent construction entirely. Coastal cities that are already developed continue to build in high risk areas, and have implemented design strategies that include elevation above flood plains, dry proofing against water infiltration, wet proofing to allow water infiltration, or conversion to floating structures. While access to credit, capital, and insurance continue to enable new construction along coastal edges, vulnerable communities are not provided with the same resources and opportunities to design and construct new structures. Continued development within coastal communities prevents the evolution of the coast line as a dynamic protective edge.

There is great opportunity for Atlantic City's Historic Preservation Commission (HPC) to establish a new precedent in how coastal communities identify, nominate, and strategically adapt their existing tangible and intangible historic resources to aid in resilience planning and growth. The Atlantic City Historic Preservation Ordinance (HPO) was signed into city code in October 2019, thus the HPC is in its nascent stage. This further positions the city to become a leader in resilient design by revolutionizing how contemporary preservation practice interfaces with resilience planning. Due to Atlantic City's tourism based economy, new construction is inevitable within the tourism district, so balance can be achieved by strategically reusing existing building stock within the residential and commercial districts, and allowing vacant land to remain permeable (Fig. 4).

Building adaptation and reuse can aid in the mitigation of climate based threats by reducing the amount of carbon released due to construction processes and material manufacture. Reuse can lead to the overall recovery, adaptation, and growth of vulnerable coastal communities by leveraging existing building stock to better serve the public-private realms of community. It has been widely regarded among preservation practitioners that the most sustainable building is the one that is already built, thus existing embodied energies are

utilized and waste is minimized.¹⁶¹ Adaptation processes that rely on labor and skill rather than new material and building assemblies invigorate local economies and job markets, creating twice as many jobs as new construction, and minimizing the lead times typical for new material manufacture and delivery.¹⁶² Conforming to existing building footprints and site setbacks can reduce the time required for zoning and planning review, expediting the time from project start to completion. The reuse of historic resources for ecological research is being pursued elsewhere in the state, with success. In November 2021 it was announced that a historic 19th century hotel in Cape May, “Saint Mary by the Sea Retreat House”, would be saved from demolition and converted to the “Cape May Point Science Center”.¹⁶³



Fig. 4, The historic Dennis Hotel reused as part of Bally’s Casino, 2010 (Source: Doug Kerr)

¹⁶¹ Preservation Priorities Task Force, *Sustainability and Climate Action*, (Woburn, MA, Washington, DC: National Preservation Partners Network and the National Trust of Historic Places, 2021), <https://static1.squarespace.com/static/60748c08c5e3c41f47c49cbd/t/61434da4f0fbc56ed870d59/1631800743277/PPTF+Sustainability+and+Climate+Action+Issue+Brief.pdf>.

¹⁶² Preservation Leadership Forum, *Economic Benefits of Historic Preservation*, (Washington, DC: National Trust for Historic Preservation), <https://forum.savingplaces.org/viewdocument/economic-benefits-of-historic-prese>.

¹⁶³ Steve Strunsky, “Historic Jersey Shore building won’t be razed after all. It’ll become a nature center,” *NJ.com*, November 1, 2021, <https://www.nj.com/cape-may-county/2021/11/historic-jersey-shore-building-wont-be-razed-after-all-itll-become-a-nature-center.html>.

Tangible resources that are not historic, not eligible, or do not contribute to a historic district do not require the same degree of regulatory review as historic or contributing historic resources. These resources may still maintain local historical significance or contribute to a neighborhood's identity, but they have not met the requirements of federal, state, or local nomination criteria. This allows more flexibility in resilient approaches to raise, dry-proof, wet-proof, or move existing buildings in hazard areas. With less scrutiny of material and system choices, more sustainable and resilient systems, such as photovoltaic panels, can be implemented into the design regardless of their visibility. Resources that are considered federal undertakings or receive federal economic incentives are subject to federal review before any alterations can be made, while resources that contribute to a local historic district are subject to local design guidelines and the judgment of the local historic preservation commission (HPO). Design proposals that alter a resource's appearance or setting are reviewable by local preservation commissions, but with the threats of climate change and sea levels rise becoming more threatening, alterations that raise, move, add, or remove elements are slowly becoming part of accepted preservation practice (Fig. 5).¹⁶⁴



Fig. 5, Left: Historically, new homes were elevated in Atlantic City, resulting in a coastal vernacular of traditional styles. Right: Resilient strategies that alter the appearance and form of buildings is being accepted to protect life and property, 2021 (Source: Cindy Guzman)

¹⁶⁴ "Guidelines on Flood Adaptation for Rehabilitating Historic Buildings," National Park Service Technical Preservation Services (Washington, DC: United States Department of the Interior, 2021).

Intangible Resources

Intangible resources do not have a physical presence, as they are the “practices, representations, expressions, knowledge, and techniques” associated with “communities, groups, and individuals”.¹⁶⁵ These resources include traditions, beliefs, events, performing arts, crafts, folkways, and foodways that are passed on from one generation to the next and help to maintain cultural and personal identity. Intangible resources are not afforded the same protections or economic incentives as tangible resources, but contemporary preservation and cultural heritage practitioners are working so that intangible resources are recognized and protected in lieu of tangible presence, and leveraged to provide tangible benefits. In their journal article, “Tangible Benefits From Intangible Resources: Using Social and Cultural History to Plan Neighborhood Futures”, practitioners Donna Graves and James Michael Buckley write on the participatory actions that local governments can take to protect the intangible histories of vulnerable populations. By identifying key community assets and adapting land use measures to account for places that support the promulgation of intangible resources, the histories and cultures of vulnerable populations can result in a tangible benefit.¹⁶⁶ In designing for coastal resilience, providing communities with the capacity to maintain their intangible resources following a chronic or acute climate event can maintain connectedness, cohesion, and ownership of place.

Global and National Recognition of Intangible Resources

UNESCO’s international “Convention for the Safeguarding of the Intangible Cultural Heritage” was adopted in 2003 to: “safeguard intangible cultural heritage; ensure respect for the intangible cultural heritage of the communities, groups, and individuals concerned; raise awareness at the local, national and international levels of the importance of the intangible cultural heritage, and of ensuring mutual appreciation thereof; and to provide for international

¹⁶⁵ “Convention for the Safeguarding of the Intangible Cultural Heritage,” UNESCO: Paris, France, 2003.

¹⁶⁶ James Michael Buckley & Donna Graves, “Tangible Benefits From Intangible Resources: Using Social and Cultural History to Plan Neighborhood Futures,” *Journal of the American Planning Association* 82, No. 2 (2016): 152-166, DOI: 10.1080/01944363.2016.1141663.

cooperation and assistance”.¹⁶⁷ The “Dive Into Intangible Cultural Heritage” project is a result of this Convention and actively documents living histories as a reference for participating nations and communities. Though the Convention is significant for the continued recognition of intangible cultural histories, it does not provide substantive protections or criminal punishment for violations that are detrimental to intangible heritage.

In the United States, Multiple Property Documentation Forms have proven successful in documenting intangible events and interconnected themes, but a tangible component is still required. In Los Angeles, the Chicano Moratorium marches (1969-1971) were pivotal in the fight for Latine civil rights across the United States, and the march was recently nominated to the National Register (2020).¹⁶⁸ While the history and route of this march is forever documented, the nomination still required tangible sites along the march route be identified and evaluated. The National Park Service has acknowledged the discrepancies in the diversity of National Register and National Historic Landmark sites, and has released several national theme studies focusing on *American Latino Heritage* (2013), *LGBTQ America* (2016), *Asian American Pacific Islander National Historic Landmarks* (2018), and *Civil Rights and Racial Discrimination in Housing* (2021). The National Trust’s 2021 publication, *Preserving African American Places: Growing Preservation's Potential as a Path for Equity*, analyzes past and current place-based injustices and the impact on African American cultural heritage, proposing preservation strategies for equitable growth and development.¹⁶⁹

Protecting Intangible Resources: Participation and Resilience

The above work has begun to document the protections afforded to intangible resources and the lasting injustices of a tangible bias in preservation practice. Despite recognition or documentation, the people and communities that practice and actively teach about intangible cultural heritage are the primary sources that maintain and protect the

¹⁶⁷ “Convention for the Safeguarding of the Intangible Cultural Heritage,” UNESCO: Paris, France, 2003.

¹⁶⁸ https://ohp.parks.ca.gov/pages/1067/files/CA_Los%20Angeles%20County_Latinos%20MPS_Chicano%20Moratorium%201970%20August%20March_DRAFT%202020-03-13.pdf

¹⁶⁹ <https://savingplaces.org/equity-report>

authenticity of these histories. A resilient design strategy must account for these histories and provide infrastructure for communities to maintain their diverse cultures and histories, especially in times of emergency, recovery, and growth. The protection of intangible resources and community networks as a strategy for resilience is ultimately informed by “bottom-up” participatory approaches.

City governments and preservation planning departments cannot effectively plan for the resilience of communities unless they communicate and listen to the needs of those whose intangible resources they seek to preserve. Governments should be careful that their participatory efforts are not a form of tokenism or placation, and that communities are provided with the capacity to make their own decisions as to what resources are significant, whether tangible or intangible. Spaces to practice, teach, learn, and celebrate intangible histories may be more relevant than the protection of a tangible landmark. In San Francisco’s Japantown neighborhood, the community favored spaces to maintain neighborhood culture rather than honorific protection of potential historic sites.¹⁷⁰

In addition to providing spaces and landscapes for development, cities can implement land use controls that limit incompatible activities seen as a threat to a community’s resilience. As an alternative to strict land use regulations, Special Use Districts can limit disruptive development by establishing design guidelines and economic incentives intended to maintain cultural growth and development.¹⁷¹ In lieu of land use controls, documentation of resources and cultures is used to inform future planning decisions. Local indexes, historic resource surveys, and historic context statements not only document tangible resources, but archive intangible resources for consideration in comprehensive planning and community development. San Francisco’s “Social Heritage Inventory Record” allows for both tangible and intangible resources to be identified and further legitimizes their significance. Legacy

¹⁷⁰ James Michael Buckley & Donna Graves, “Tangible Benefits From Intangible Resources: Using Social and Cultural History to Plan Neighborhood Futures,” *Journal of the American Planning Association* 82, No. 2, (Spring 2016): 157, DOI: <https://doi.org/10.1080/01944363.2016.1141663>.

¹⁷¹ Buckley & Graves, “Tangible Benefits From Intangible Resources” 155.

Business registries can further protect community institutions that are locally significant, but lack tangible integrity or a historic site.¹⁷²

Strategizing for Planned Retreat

Population retreat and relocation are considered to be the last viable options in a coastal resilient design scenario due to the social, economic, and cultural implications, but it is important to plan for the possibility and provide capacity for future generations to maintain resilient. While the research and design proposal for Atlantic City's multiple Resilient Transects assumes a semi-habitable condition (with disruptions) until the year 2100, it is projected that the city will no longer be inhabitable, or at the very minimum, able to support daily residential life beyond this year (refer to Chapter 1 for scenario projections). Proactively identifying, documenting, and curating historic and cultural resources — both tangible and intangible — provides a community with further capacity to return and reclaim their communal and individual identities following a chronic or acute climate event.¹⁷³ The design of a resilient framework that accounts for preservation of resources provides the community with infrastructure and social capacity to grow in spite of adversity.

Identification of Historic and Cultural Resources

The continued identification of resources, both historic and recently significant, establishes an index that can be referenced by current and future generations in historic master plans and resilience planning. As noted in the *Tangible Resources* section of this chapter, listing or eligibility does not provide substantive protection; an index must be maintained so resources can be accounted for, protected, and better utilized in resilient strategies. Currently, national listings are published on the National Register Database and

¹⁷² Ibid.

¹⁷³ Barnett et al., "Three Ways Social Identity Shapes Climate Change Adaptation," *Environmental Research Letters* 16, no. 12 (November 24, 2021): <https://iopscience.iop.org/article/10.1088/1748-9326/ac36f7>.

Research portal.¹⁷⁴ In New Jersey, the NJ Historic Preservation Office maintains its own GIS Cultural Resource Inventory, LUCY (Fig. 6).¹⁷⁵

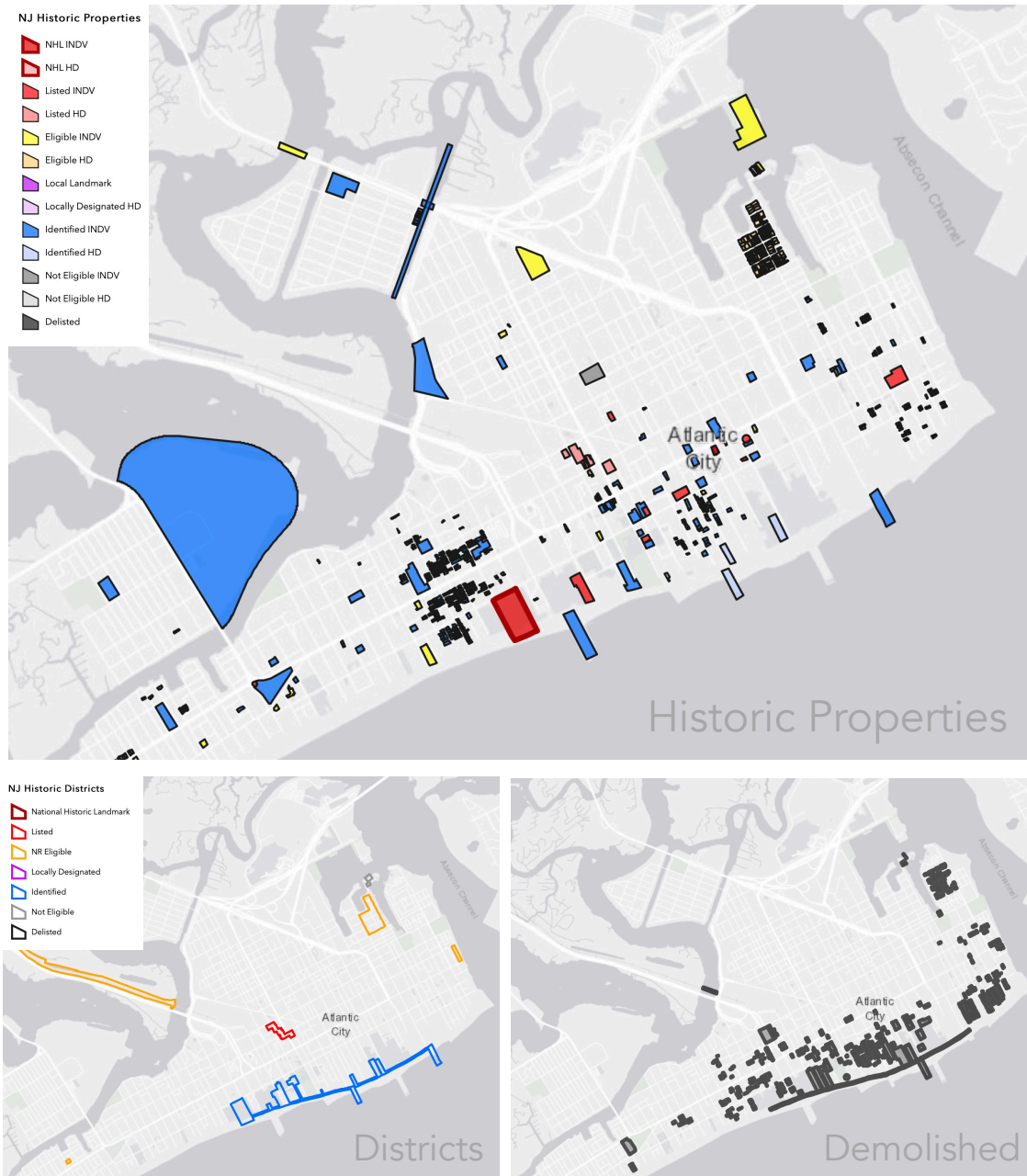


Fig. 6, Atlantic City historic properties and districts; NHL, NRHP, eligible, identified, demolished, 2021 (Source: LUCY GIS Cultural Resource Inventory, NJHPO)

¹⁷⁴ "National Register Database and Research," National Register of Historic Places, National Park Service, <https://www.nps.gov/subjects/nationalregister/database-research.htm>.

¹⁷⁵ "LUCY: NJ's Cultural Resources GIS Online Map Viewer," New Jersey Historic Preservation Office, <https://www.arcgis.com/apps/webappviewer/index.html?id=44ce3eb3c53349639040fe205d69bb79>.

The LUCY GIS inventory provides a fair degree of accuracy but many demolished resources are still listed as existent. The benefits of a statewide GIS inventory are not debated, but inputs for local comments, suggestions, and edits can strengthen the existing platform to be more accurate and more participatory. This approach has been successfully implemented by the organizers of the Texas Freedom Colonies Project Atlas, who have established an interactive GIS platform to receive community input, edits, and ephemera related to identified and unidentified historic Black settlements in Texas.¹⁷⁶ This platform not only identifies resources, but provides a platform to document and curate expanded and linked histories.

To further strengthen the accuracy of identified resources, a local survey can be maintained to identify, record, and evaluate tangible and intangible resources. The “Survey LA” historic resource survey provides an example of one of the most comprehensive local historic resource surveys in the nation. Its evaluation of over 880,000 properties proves that it is within the capacity of a community to survey their resources in order to make planning and policy decisions more inclusive and representative of the community's identity.¹⁷⁷

Documentation of Resources

Once sources have been identified, documentation of tangible and intangible attributes provides an archival record should resources be lost to climate events, sea level rise, development, or neglect. Tangible resources can be documented via photographs, drawings, 3D scanning (LIDAR or laser), and written descriptions. Historical data should also be collected and compiled to provide context, including deeds, plats, Sanborn Maps, Home Owners' Loan Corporation “Red Line” maps, historic photographs, aerial images, information about previous owners, and ephemera referencing the resource (Fig. 7 and 8).

¹⁷⁶ “Texas Freedom Colonies Atlas 2.1,” The Texas Freedom Colonies Project, <https://www.livingmaps.org/texas-freedom-colonies-project>.

¹⁷⁷ “Survey LA”, Los Angeles City Planning, 2016, <https://planning.lacity.org/preservation-design/historic-resources-survey>.

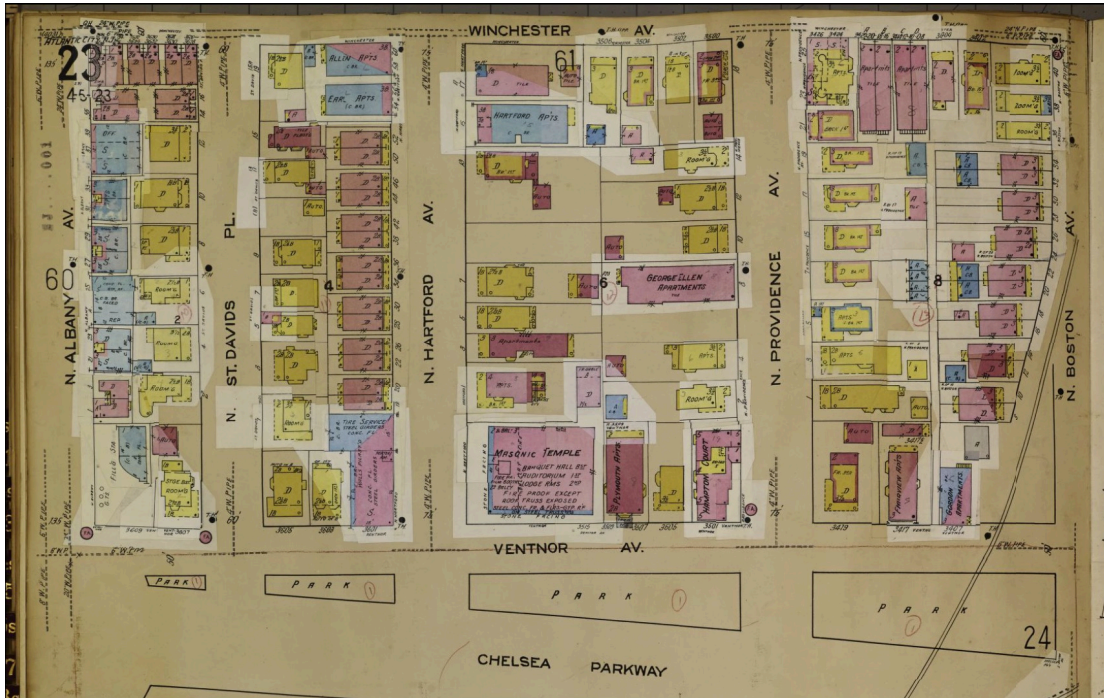


Fig. 7, Atlantic City Sanborn Map, 1921 with 1949 updates (Source: Library of Congress)



Fig. 8, Atlantic City historic aerial, O'Donnell Park, c. 1920 (Source: Atlantic City Community group)

Intangible resources can be documented via video recordings, audio recordings, photographs, drawings, written descriptions, and interviews. The documentation of resources not only provides an archival record, but reveals patterns, contexts, and unknown histories that provide a better understanding of place, community, and the people who once were, or continue to be, primary inhabitants.

Preservation and Curation of Resources

Once resources have been identified and documented, the ongoing preservation and curation allows current and future generations to learn from the past in order to inform the future. Tangible resources provide evidence of historic conditions, traditions, craft, and styles, providing a sociological context for contemporary time and place; intangible resources provide evidence of historic traditions, events, beliefs, and artistic expressions, by maintaining their context in the present.

In strategizing for planned retreat, community spaces provide the arena to maintain social connections and preserve intangible resources. Tangible resources that are unable to be relocated or raised will inevitably succumb to climate events and rising seas; their preservation provides future generations with the resources to digitally render lost landscapes, providing capacity to learn and inform their own decision making processes. A governmental structure cannot solely determine what will be significant or worth preserving should retreat occur; this should be pursued adaptively as a participatory and communal process. It is the current generation's responsibility to foresee the future condition — whether preserved, altered, or abandoned — and maintain the resources necessary for future generations to learn and grow.

Chapter 6: The Resilient Transect: Synthesizing a Programmatic Framework for Coastal Resilience



Introduction

In urbanized coastal communities it is the interrelation of social, economic, cultural, and ecological environments that provides the capacity for sustenance and resilience. The deleterious effects of climate change and sea level rise continue to threaten the individual and aggregated functionality of these environments. Damage to the social environment affects the ability of people to maintain community; damage to the economic environment affects the ability to earn income and provide capital for growth; damage to the cultural environment erases the history and identity which make places unique; and damage to the ecological environment affects health and wellbeing of all species, and their ability to sustain terrestrial and aquatic ecosystems.

Innovative design strategies for coastal resilience have implemented both natural and built approaches, going beyond the typified reactive approaches of elevation and fortification, and implementing a combination of green and gray infrastructural approaches that encourage participation and innovation. However, there are limitations to contemporary approaches, as they can be prescriptive and limited to a specific geographic context; their effectiveness —

and potential for global applicability — can only be assessed when tested by the next storm, surge, or flood event. Regardless of limitations, these projects contribute to the theoretical foundation of contemporary practice and continue to inspire innovation in the functionality, sustainability, and aesthetics of coastal resilient design. This thesis builds upon contemporary practice and posits that coastal resilient design strategies will be even more effective if they:

- provide capacity for vulnerable communities to leverage their existing resources and landscapes
- provide facilities to strengthen social networks and promote climate education
- provide resources to protect cultural and historic resources
- support the diversification of coastal economies — especially those based on tourism and aquaculture — by leveraging the assets of existing industries as catalysts for research, education, collaboration, and innovation in coastal resilient design

When combined with green and gray infrastructural approaches, the aggregation of the aforementioned starts to galvanize a resilient framework that supports the needs of residents, researchers, and visitors alike, preemptively supporting growth before the next chronic or acute climate event. In times of adversity, the social, economic, cultural, and ecological environments of urbanized coastal communities can be maintained and strengthened.

This chapter establishes the applicability of an “adapt + grow” future scenario, analyzes user needs, and proposes a programmatic framework for urban coastal resilience. The design result, the Resilient Transect, will interconnect a decentralized network of new and adaptively reused buildings and landscapes across a 2000-foot transect of Atlantic City, abstracting the iconic Atlantic City Boardwalk as a beach-to-bay datum for adaptation, support, research, and participation (Fig. 1). Interior and exterior programming for research, community support, and public engagement is created through the reuse of existing buildings and landscapes, and introduction of responsibly designed new construction.



Fig. 1, Site context for the proposed Resilient Transect (Source: Author)

Future Scenarios

A synthesis of current research in coastal resilience establishes that there are five scenarios a community can take in planning for coastal resilience: no action; plan, respond, recover; adapt + grow; planned retreat; and relocation. There are geological, ecological, and socioeconomic factors that must be assessed to determine which scenario is best suited to meet a community's current and future needs (Table 1).

Table 1 - Factors For Choosing a Scenario

Category	Factors	Questions
Geological	• location • elevation • bathymetry • coastal type	• How vulnerable is the community based on low, moderate, and high sea level rise projections? • What is the frequency of chronic and acute climate events? • Are edges susceptible to erosion and deposition?
Ecological	• health of terrestrial habitats • health of aquatic habitats	• Are flora and fauna able to absorb wave energy, surge, and tidal flooding? • Has development prevented natural systems from performing?
Socioeconomic	• population and density • condition of built environment • financial capital/credit • equitable access to resources • culture and history	• Is the community physically/mentally prepared for climate change? • Is there financial capacity to make changes necessary for a safe and healthy future? • What social/cultural networks are at risk?

The following provides decision making scenarios and their implications. The design proposal adopts the “adapt + grow” scenario.

No Action

The community and municipal government take no action in response to climate change and sea level rise, and continue life as normal. It has been determined that there is no risk (actual); there is no risk (perceived); the risk is negligible; risk is acknowledged, but the community does not have economic capacity to take action; or the community will take action when threats are perceivable.

Plan, Respond, Recover

The community and municipal government acknowledge that there is a future risk and publishes an emergency plan that establishes guidelines to prepare and recover from both chronic and acute climate events. It is also possible that the risk is more severe, but the community does not have the economic capacity — or desire — to implement more proactive strategies. Emergency checklists and evacuation routes are established; a list of local, state, and federal emergency contacts are published; public and private stakeholders are assigned emergency management and recovery tasks; those who have financial capacity protect their properties; public buildings are identified as emergency management and shelter locations; food, water, and sanitary products are kept in surplus; insurance agents, contractors, and public utilities agree to be on standby after a climate event; department of health and environmental services is prepared to conduct drinking water and mold tests following an event; and healthcare facilities, schools, and primary transportation routes are prioritized for recovery.

Adapt + Grow

The community and municipal government acknowledges that the risk is significant and has already been experienced. Despite the risk, the city determines it can remain inhabitable and proactively establishes criteria to adapt current systems and networks to be

more resilient. By providing the community with the resources necessary to adapt to a changing environment, future chronic and acute risks are less damaging to the social, economic, cultural, and ecological environments of the community. The ability and willingness of the community to adapt provides capacity to not only recover from climate events, but learn and grow. Rather than seek departure from the community, residents work together to preserve and continue building their community. Green-infrastructure replaces traditional gray infrastructure, establishing a living coastline that protects and regenerates; community institutions are established to provide arenas for communication, collaboration, and growth; high-risk areas are elevated and made amphibious; structures are raised, wet-proofed, dry-proofed, or made buoyant; introduction of urban ecosystems create permeable surfaces and microclimates; foodways are maintained locally and land is allocated for permaculture and urban farming; existing industries are transformed to support research, public engagement, and coastal education; and community history, culture, and identity is prioritized and maintained, resulting in stewardship and local pride.

Planned Retreat

The community and municipal government determine that the risk has exponentially increased and certain neighborhoods have already been deemed uninhabitable. According to sea level rise projections, it will be impossible to maintain the health and safety of the community in the long-term. It has been determined that the government should begin establishing guidelines and provide resources for planned retreat within and beyond the municipal boundaries. Moratoriums on new construction are established and as more land becomes vacant, plots are returned to natural landscapes with native vegetation. In order to maintain community networks, the phasing of this plan requires the sourcing or construction of clustered housing in more resilient areas. Existing buildings can be raised vertically or moved to higher ground, but raising does not guarantee continued public services in future years.

Relocate

The community and municipal government determine that the risk has become an immediate threat to the health and safety of the community. It has been decided that the community should begin preparing for their departure from their current location. The community's departure will be phased as government buybacks of land require time and compliance, while new housing is sourced. Abandoned infrastructure and buildings will need to be properly mitigated and disposed of. Unless clustered developments exist, community networks are broken and identity of place is lost. Unless planned for, tangible and intangible histories are also lost.

Analyzing User Needs

It has been previously determined that the Resilient Transect will serve the needs of residents, researchers, and visitors, creating networks for communication and interaction between user groups (Fig. 2). The following analysis will provide context for the programmatic framework and design strategies.

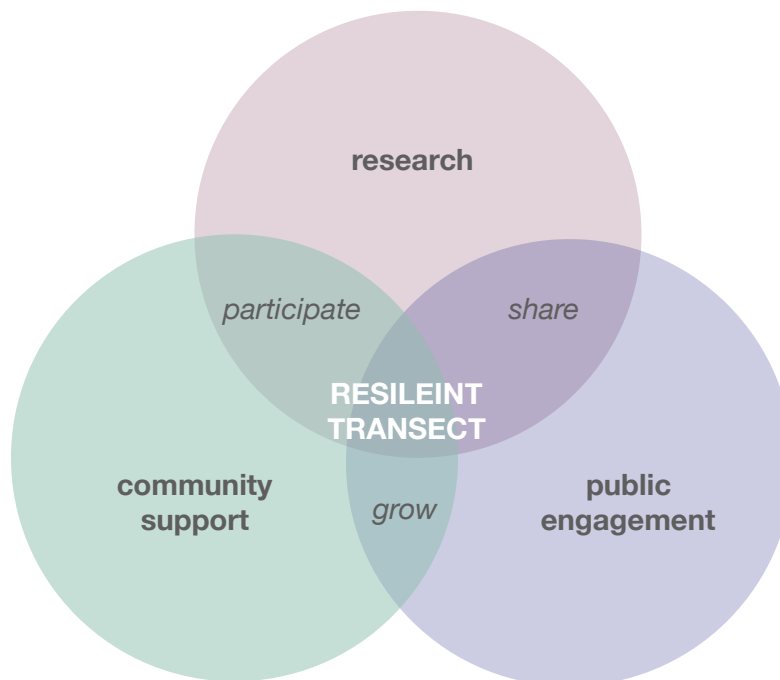


Fig. 2, Program Model for the Resilient Transect, 2021 (Source: Author)

Residents

The residential fabric of Atlantic City — or any community for that matter — must be maintained and promoted to achieve socioeconomic resilience. With 38,000+ residents representing 28 nationalities and over 30 dialects spoken, Atlantic City's residents contribute to the daily operations, culture, workforce, tax base, and overall sustenance of the city.

Despite the city's persona as a resort town, there has always been a residential component that supports the city. In referencing *Chapter 3*, Atlantic City's economic and geographic vulnerability has been tested time and time again yet the residents have remained, proving a historical trend of inherent resilience. With nearly 37% of the city's population living below the poverty level, and almost all that live within the city being affected by climate events (Fig. 3), residents require more equitable access to public resources, education, vocational training, and community spaces. Additionally, the Atlantic City region has an undocumented workforce of approximately 12,000 residents who, despite their societal and tax-based contributions, do not have the same access to government services and financial institutions.¹⁷⁸ The volatility of a tourism based industry has proven itself in Atlantic City and coastal communities worldwide, proving the need to provide stable residency, alternative career paths, professional opportunities, and ability to promote independence in growth and wealth accumulation.



Fig. 3, Chronic flooding of Atlantic City's residential neighborhoods, 2021 (Source: Author)

¹⁷⁸ "State and Local Contributions of Undocumented Immigrants in New Jersey," Institute on Taxation and Economic Policy, 2017, <http://www.njpp.org/wp-content/uploads/2018/04/NJ-Undoc-Immigrant-by-County-1.pdf>.

Existing institutions, businesses, religious practices, and spaces of cultural identity must be protected and made resilient in order to preserve and strengthen the fabric of the community. Table 2 lists existing resources within and adjacent to the Resilient Transect study area. Strengthening socioeconomic resilience and providing the impetus to remain and grow with the city is the foundation of a truly resilient framework.

Table 2 - Existing Chelsea Neighborhood Cultural Resources

Category	Name	Description
Cultural	• Masjid Al-Taqwa Mosque	Mosque
	• Muslim Community Organization of South Jersey	Community Center
Commercial	• Boom Food Market	Latine + Hispanic Grocery
	• New Latin Deli & Grocery	Latine + Hispanic Grocery
	• Deshi Bazaar & Produce	Bangladeshi Grocery
	• Awan Convenience Store	Market
	• Knife & Fork Inn	Historic Restaurant, 1912
	• China Inn	Chinese Restaurant
	• Sabor Salvadoreño	Salvadoran Restaurant
	• Once Again on Albany	Thrift Store
Educational	• Stockton University	Campus w. Residence Halls
	• Sovereign Avenue School	Middle School
	• Atlantic City Day Nursery	Daycare Center
Healthcare	• AtlantiCare Behavioral Health	Psychological Health
	• Trenton Avenue Pharmacy	Pharmacist

Researchers

Atlantic City's position as an urbanized coastal community — geographically located between two estuaries and adjacent to tidal saltwater marshes — provides researchers, scientists, educators, and policy makers with a diverse range of social, economic, cultural, and ecological environments to study, providing environments to monitor, test, and implement globally applicable strategies for coastal resilience. Leveraging the city's existing hospitality infrastructure, convention spaces, and university buildings establishes an

attainable framework to build upon. In balancing the study environments, researchers will need facilities that support field, laboratory, and archival research. Researchers will require marina's to access ocean and marshland environments; laboratories for research of organic and mineral specimens; archives to store analog and digital data; collaboration spaces to meet and develop strategies with peers and community stakeholders; and seminar rooms to present findings and support learning. Providing facilities and environments for research provides Atlantic City an opportunity to remain innovative and establish a precedent for a resilient framework. UNC's "Coastal Studies Institute" provides a great precedent as one of the only built examples of an academic building specifically designed for coastal resilience studies. With spaces for academic collaboration and living landscapes for ecological research, the building is elevated among the marshes, constructed with locally sourced materials and designed to be sustainable and passive in anticipation of interruptions and adversity (Fig. 4).



Fig. 4, Clark Nexsen's resilient design for University of North Carolina's Coastal Studies Institute, 2020 (Source: Wikimedia Creative Commons)

Visitors

It has been estimated that on a given summer day, Atlantic City's modest population of 38,500+ residents is countered with a surge of over 500,000 visitors. While these surges

are most notable in summer months and during events such as airshows, beach concerts, and firework displays, the city has proven the capacity to adapt to these occupant shifts of over 125,000 people per square mile. Visitors currently seek traditional tourism destinations and frequent the casinos, beaches, Boardwalk, amusement piers, entertainment venues, convention centers, and outlet shopping (Fig. 5).



Fig. 5, The mix of nature, hospitality, and entertainment, 2019 (Source: Author)

Diversifying Atlantic City's industry to include coastal resilience research provides new tourism opportunities to interact with, entertain, and educate the public. As noted in Chapter 3, the State of New Jersey is the first state to mandate climate change studies be integrated into K-12 education, a precedent that will likely be followed by other states. This provides additional opportunity to center Atlantic City as a statewide and regional destination for public school field-trips that teach about climate change, sea level rise, and coastal resilience. Accounting for the desires of the typical resort town visitor, while also providing stimulation for those seeking alternative entertainment and education, positions the Resilient Transect as an educational, curatorial, and interactive experience supported by interior and exterior exhibit, gallery, and auditorium spaces.

Programmatic Framework

The research of this thesis has determined that the programmatic framework of a resilient transect must provide interior and exterior programming for research, community support, and public engagement. The Boardwalk is abstracted as a beach-to-bay datum that accounts for the social, economic, cultural, and ecological needs of the city, positing the resilience of connecting people to place. Climate change and sea level rise projections are only an indicator of future conditions, so the programmatic approach will account for multiple future scenarios and provide a framework that is adaptable to environmental change and social needs within and beyond Atlantic City. Adaptively reusing existing building stock and adjacent landscapes, juxtaposed with strategically designed architectural and landscape interventions, will set a precedent for a resilient framework that is proactive to the threats of climate change and sea level rise in urbanized coastal communities. The aggregation of the natural and built programmatic framework invites an interdisciplinary mix of researchers, designers, and policymakers to work alongside intercollegiate research teams, community leaders, business organizations, residents, and visitors.

Natural Framework

In an effort to set a precedent for coastal communities with similar vulnerability, exterior program and restoration of native landscapes will acknowledge resilience as a designable opportunity. Residents, visitors, and researchers will be invited to immediately engage with the city, as newly conceived green infrastructure will transverse the barrier island and support the framework of the resilient transect (Fig. 6).

Exterior program will support best practices in resilient design and provide spaces for ecological restoration, urban ecosystems, public gathering, exhibition, entertainment, demonstration, and community engagement. Exterior spaces will act as an extension of interior spaces and remain in the public realm.

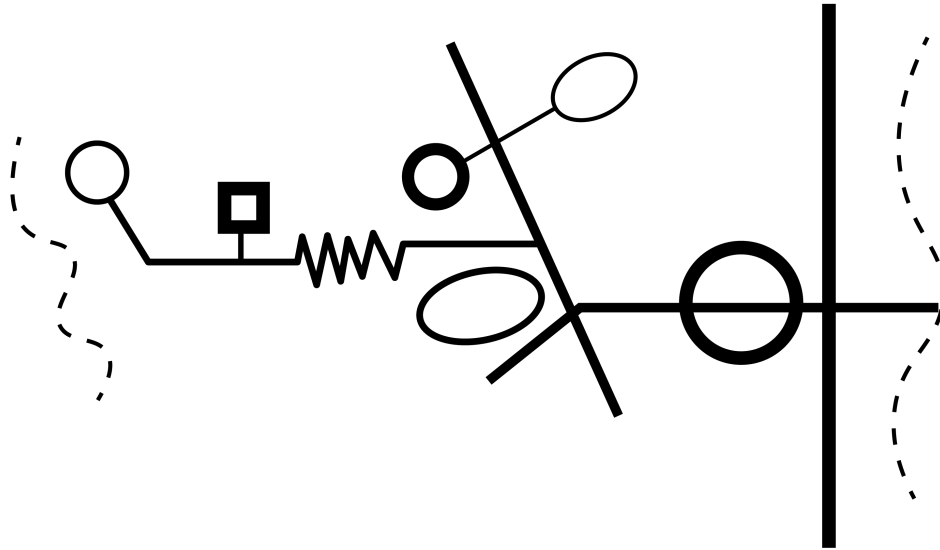


Fig. 6, Parti diagram of the Resilient Transect; connections and nodes, 2022 (Source: Author)

Restoration of native landscapes will act to stabilize geological and hydrological conditions. Vegetation will help to sequester pollutants, stabilize soil through root growth, act as windbreaks, provide shade, and provide habitats for animal species. A 2021 study by the University of Maryland found that a single urban tree can “capture, store, and release stormwater back into the atmosphere at a rate three times that of a tree in a forest”, further supporting urban planting.¹⁷⁹ The planting strategy appropriate for Atlantic City includes native cordgrass, narrowleaf cattail, reed, eelgrass, widgeon grass, Atlantic white cedar, and pitch pine (Fig. 7). The public realm of these environments will provide opportunities for interactive learning and participation.

¹⁷⁹ Graham Binder, “A Singular Weapon in Stormwater Management: Urban Trees”, *Maryland Today*, November 19, 2021, <https://today.umd.edu/a-singular-weapon-in-stormwater-management-urban-trees>.



Fig. 7, A mix of cordgrass, narrowleaf cattail, reed, Atlantic white cedar, and pitch pine naturally growing in Atlantic City's north inlet neighborhood, 2021 (Source: Author)

Built Framework

The interior program will require spaces for research, community support, and public engagement. Adaptive reuse and reconceptualization of abandoned structures, juxtaposed with resiliently designed architectural and landscape interventions, will support the programmatic elements. Due to the decentralization of the program, the Boardwalk datum described above will act to link the different programmatic elements from beach to bay, creating a resilient connection in times of adversity and growth. Adjacency to Stockton University's satellite campus will provide additional outlets for collaboration, and adjacency to the abandoned Atlantic Club Hotel and Casino will provide future spaces for research housing, emergency housing, and climate-based tourism. Adjacency to Stockton is a great opportunity to bolster the university's existing Coastal Research Center, which has been studying the New Jersey coast since 1981. Its current outpost is on the mainland edge of the wetlands, approximately 15 miles from Atlantic City.

The research program will be distributed, taking a proactive approach to adaptively reuse existing structures, juxtaposed with new and innovative resilient building stock (Fig. 8) This program will include classrooms, laboratories, collaborative spaces, archives, and

marina storage for researchers, students, and community members to study, test, and implement revolutionary strategies for coastal resilience.



Fig. 8, The Atlantic City Boathouse, owned by Stockton University, will be repurposed to provide spaces for resilient research, collaboration, and learning, 2021 (Source: Author)

The community support program will serve the needs of the immediate community, and provide proactive resources to adapt and grow with the threats of climate change and sea level rise. In reference to New Jersey’s Climate Resilience strategy, this program will support education, preservation, and economic growth.

This program will be located in the adaptively reused Masonic Temple, a building that has been abandoned since the late 1990s (Fig. 9). The first level is programmed for “sharing and gathering”, the former auditorium space adapted to serve as a primary gathering space for community meetings, cultural events, disaster preparedness, and shelter; the adjacent spaces will support business incubation, a community commissary, and startup restaurants. The second level is programmed for “preservation and learning”, the former shrine level becoming a “community shrine” to actively preserve, curates, and archive both tangible and intangible histories. The third level is programmed for “creating and making”, with art studios, makerspace, music practice rooms, and a digital media loft. The dynamic

nature of the spaces allows for “community labs” that teach residents about climate change, coastal resilience, and local ecology, providing information so residents are prepared and able to grow with the city. The fourth level is programmed for “community and support”, with administrative spaces that provide council to those in need, offices for cultural organizations, and meeting spaces. By supporting the health of the community, community members are provided opportunities to pursue resilient career paths, receive vocational training, and learn how to physically and operationally adapt their current or future businesses and homes. An exterior Building Condition Assessment of the Masonic Temple is provided as an Appendix to this document.



Fig. 9, The former Masonic Temple, designed by Charles D. Adams and completed in 1927, will be preserved and adapted to serve the needs of the community, 2021 (Source: Author)

To encourage participation and outreach, the Coastal Resilience Discovery Center will act as an organizing space that represents the ideals of the Resilient Transect, connecting researchers, designers, policymakers, residents, business organizations, community leaders, residents, and visitors in a forum like setting. This building will be constructed on a formerly developed beach front lot with direct boardwalk access; it will serve as a global precedent for coastal resilient design and public engagement (Fig. 10).

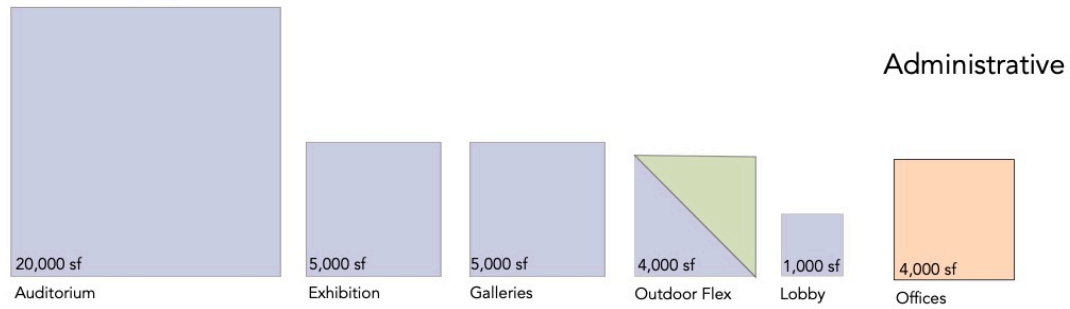


Fig. 10, Atlantic City Boardwalk lot, future site of Coastal Resilience Discovery Center and public engagement program, 2021 (Source: Author)

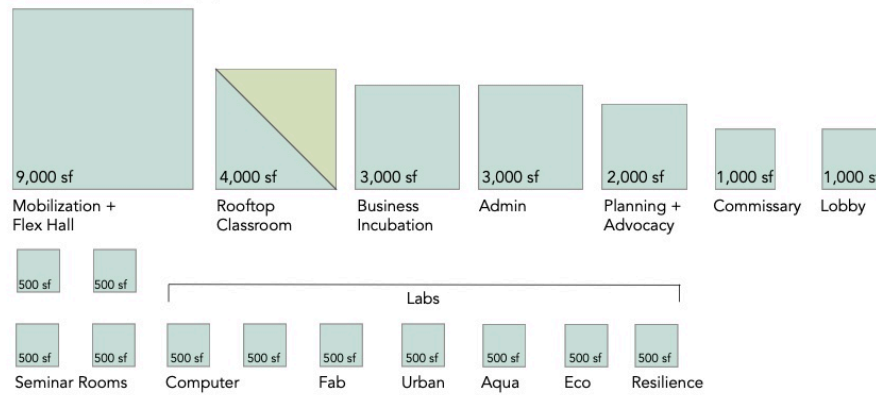
Interior and exterior exhibition spaces will curate themes of social, economic, cultural, and ecological coastal resilience, through interaction and engagement. Interior and exterior exhibition spaces will teach about resilience through scientific, historic, and cultural perspectives, drawing from local, regional, national, and international contexts. A flexible event space provides a public forum to teach about and discuss issues relating to coastal resilience. A research wing houses wet labs, dry labs, library, offices, classrooms, and seminar rooms. A synthesis of the program is presented in Fig. 11.

Resilience Forum Program

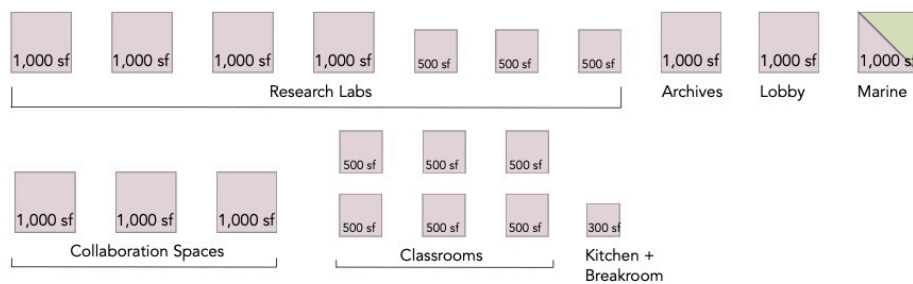
Public Engagement



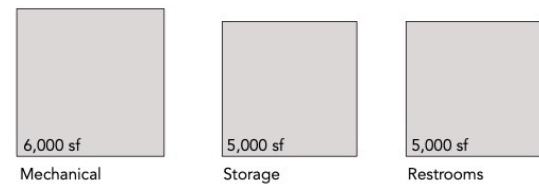
Community Support + Interaction



Labs + Research



Facilities



Vertical Circulation



Fig. 11, Resilient Transect, distributed program, 2021 (Source: Author)

Chapter 7: Design Proposal: The Resilient Transect



Introduction

The final design proposal for “Beyond The Barrier” maintains a framework-based approach to coastal resilience and abstracts the iconic Atlantic City Boardwalk as a beach-to-bay datum that proposes the resilience of connecting people to place. Adapted buildings, creation of stormwater landscapes, and proposals for responsibly built new construction creates a resilient network that aids in community support, public engagement, and research and learning. During the design process the significance of Atlantic City’s topographic evolution from Indigenous fishing grounds to the current tourism-dominant landscape remained a primary design driver, as well as the historic significance of the Atlantic City Boardwalk as a precedent for resilient coastal infrastructure. The following sections curate the evolution of this thesis from research to final design, and divide the framework of the Resilient Transect into three primary geographic zones: the bayside residential, reclaimed civic core, and beach and breakwaters.

A Sectional History of Atlantic City

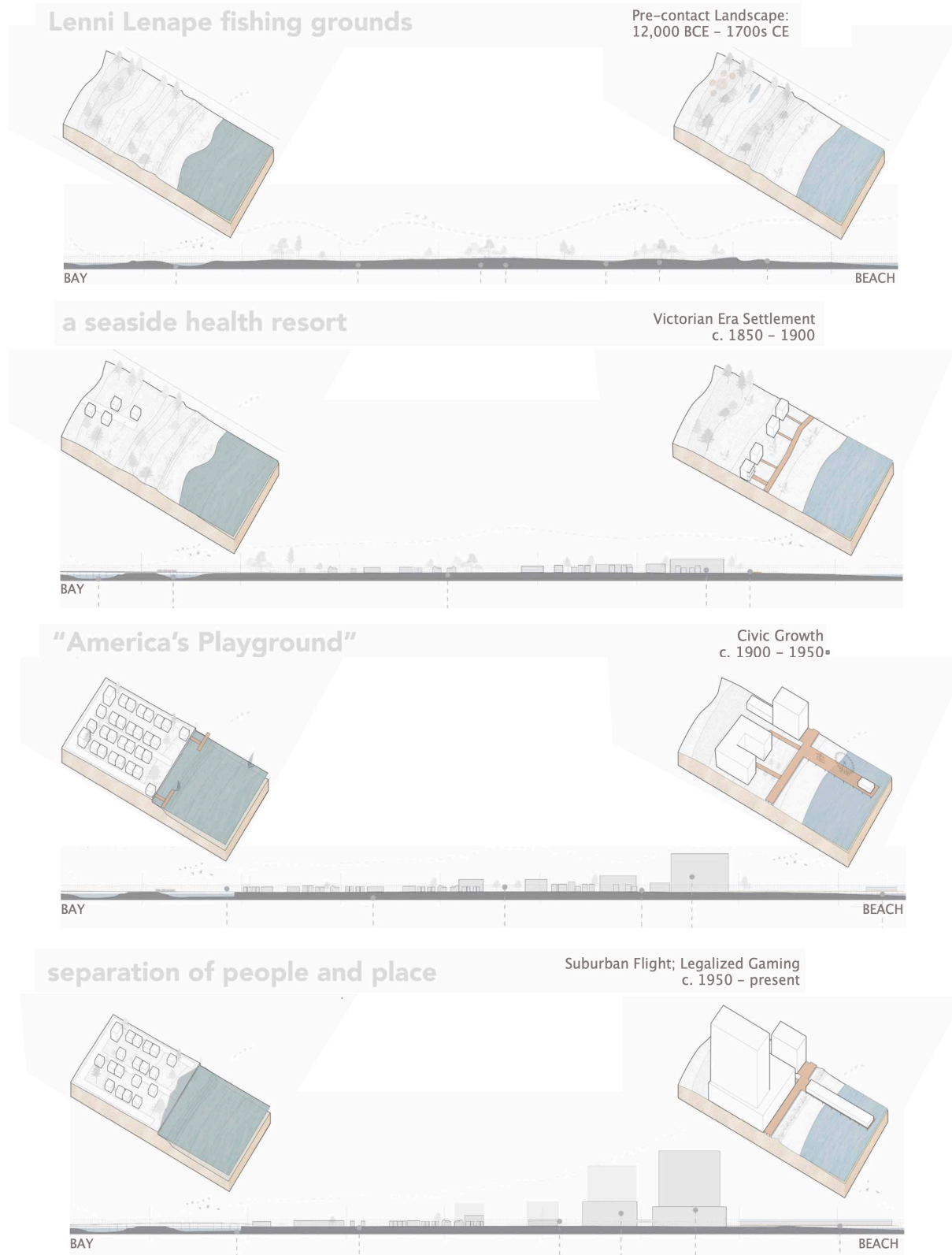


Fig. 1, A Sectional History of Atlantic City, 2022 (Source: Author)

[illegible]

Fig. 2, A chronological analysis of the world's first Boardwalk, 2022 (Source: Author)

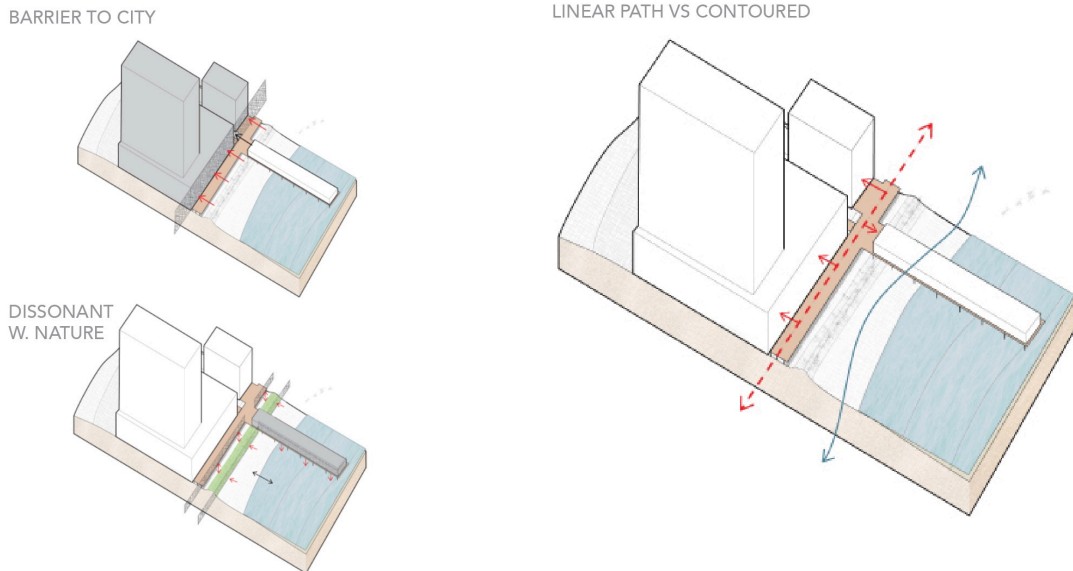


Fig. 3, A critique of the current Boardwalk, 2022 (Source: Author)

Abstracting the Boardwalk

ECOLOGICAL WALK



INFRASTRUCTURAL/AT GRADE



RAISED WITH SPACE BENEATH



Fig. 4, Abstracting the Boardwalk as a resilient datum; ecological, raised, infrastructural, 2022 (Source: Author)

The Resilient Transect



Fig. 5, The Resilient Transect, a framework to connect people to place, 2022 (Source: Author)

Site Plan

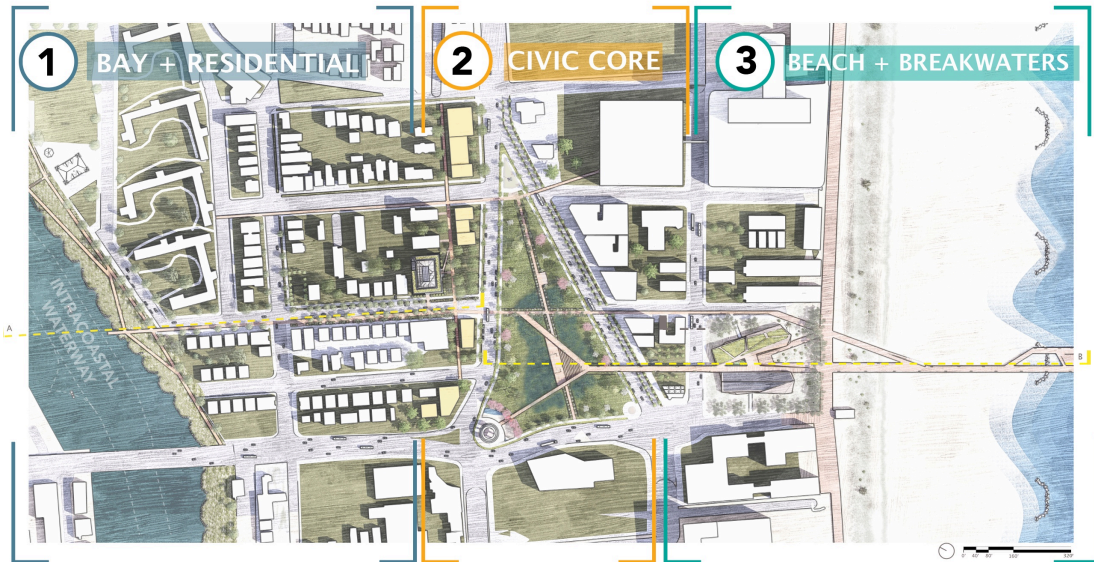


Fig. 6, Site plan and interconnection of three zones via the beach-to-bay Boardwalk datum, 2022 (Source: Author)

1

LIFE BY THE BAY

protecting and preserving community identity



Fig. 7, A framework for the bayside residential neighborhood; section proposal for a living shoreline and extended Boardwalk, 2022 (Source: Author)



Fig. 8, Birdseye of bayside living shoreline and extended Boardwalk, looking towards the city and Atlantic Ocean, 2022 (Source: Author)

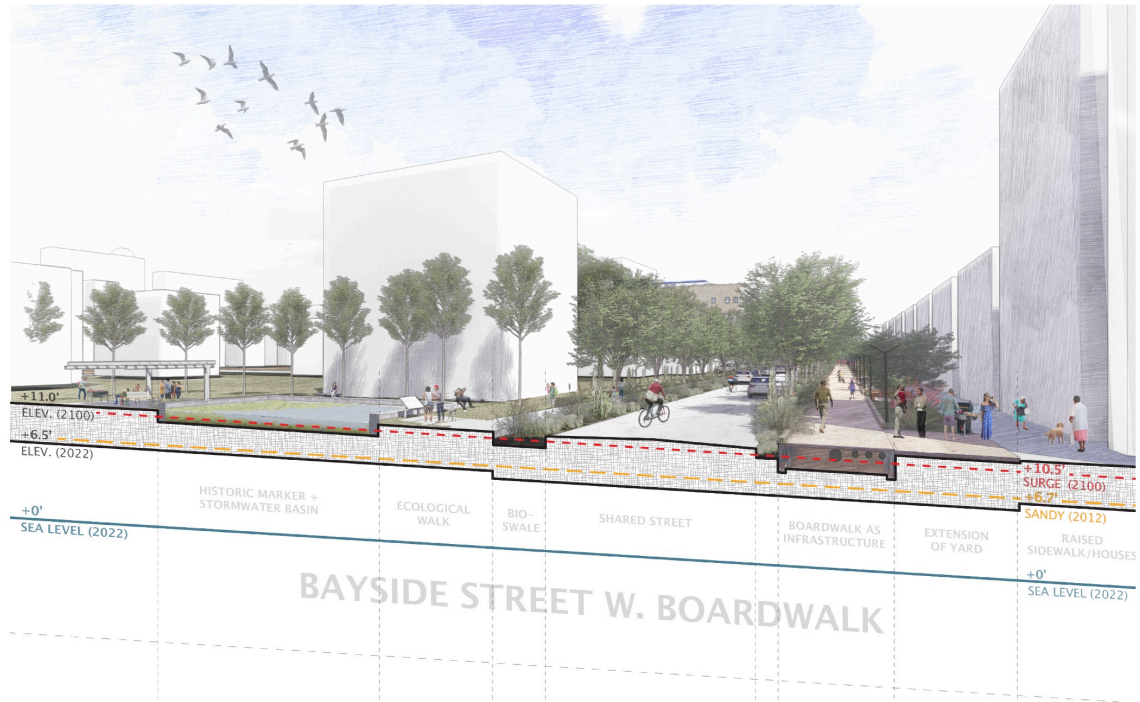


Fig. 9, Section of proposed street with Boardwalk infrastructure; extension of residential edge into public realm; conversion of abandoned lots into parks for stormwater infrastructure and historic markers, 2022 (Source: Author)



Fig. 10, Street with Boardwalk datum; spaces for public to take ownership of streetscape and preserve tradition of stoop culture, 2022 (Source: Author)

(re)Claimed Civic Core

②

(re)CLAIMED CIVIC CORE

the reuse of historic resources for participation and growth

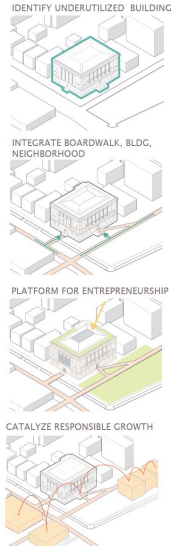


Fig. 11, A framework for the civic core; adaptive reuse of Masonic Temple into the Chelsea Cultural Center, a platform for resilience and community support, 2022 (Source: Author)



Fig. 12, Interior perspective of main gathering space within the Chelsea Cultural Center; the abstracted Boardwalk creates uplift through the building, creating visual and physical continuity of program, 2022 (Source: Author)



Fig. 13, Section perspective of Chelsea Cultural Center; Level 1: Share + Gather - spaces for meeting, performance, emergency response, business incubation, opportunity; Level 2: Preserve + Learn - spaces to collect, curate, and archive community history and culture; Level 3: Create + Make - spaces for art, music, technology, and other forms of expression and craft; Level 4: Community + Support - spaces for essential support services, emergency assistance, language translation, financial advising, 2022 (Source: Author)

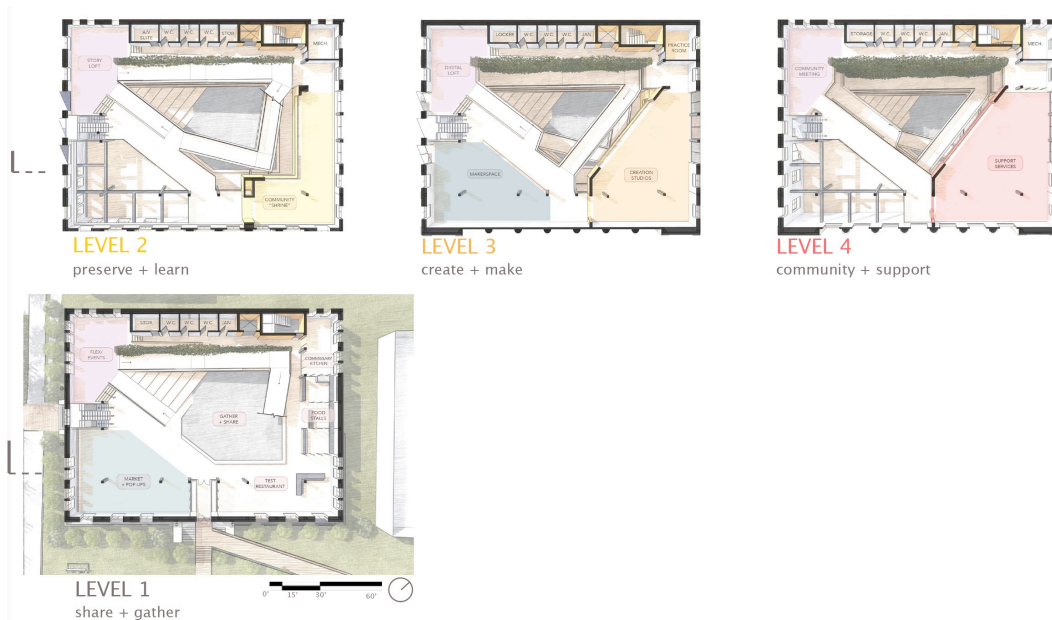


Fig. 14, Floor plans, Chelsea Cultural Center, 2022 (Source: Author)



Fig. 15, Ecological Boardwalk transecting O'Donnell Memorial Park; landscape is floodable during times of high water or heavy rains, 2022 (Source: Author)

A Better Beach



Fig. 16, A framework for the beach front edge; the Coastal Resilience Discovery Center provides a forum for research, exhibition, and public engagement, creating a threshold for discovery at the intersection of the existing and proposed Boardwalk transect, 2022 (Source: Author)

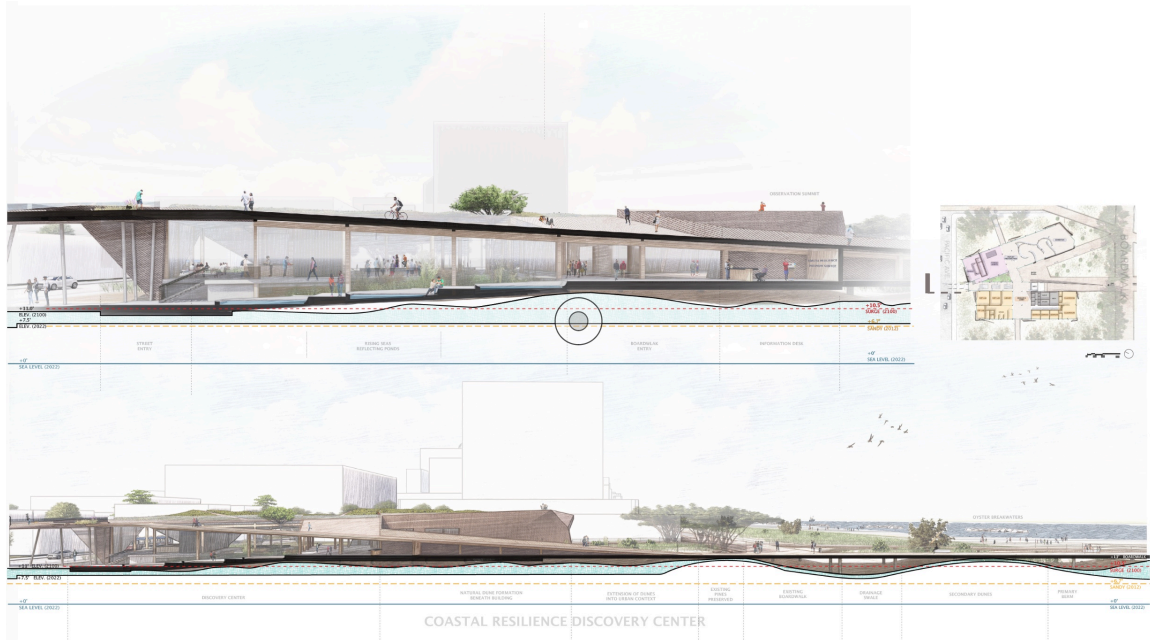


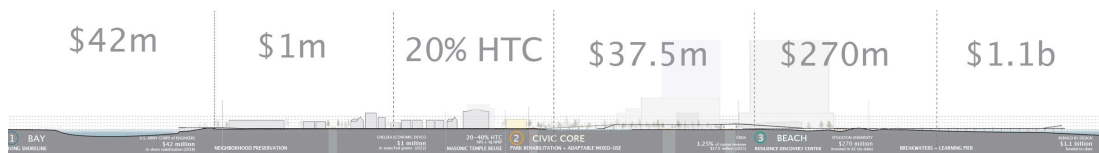
Fig. 17, Section perceptive of Discovery Center, depicting topographic relationship of landscape, dunescape, proposed building, and elevated Boardwalk, 2022 (Source: Author)



Fig. 18, Interior of Discovery Center; interaction of students, researchers, and visitors creates a participatory approach to coastal resilience through research, exhibition, and design, 2022 (Source: Author)



Fig. 19, Exterior observation deck of Discovery Center looking towards dunes, oyster breakwaters, learning pier + pavilion, and Atlantic Ocean, 2022 (Source: Author)



Section and Funding

Fig. 20, Transect section and possible funding streams, 2022 (Source: Author)

Conclusion

Findings

The aggregation of research, community support, and public engagement via the Resilient Transect — and its multiple iterations throughout the city — creates an amazing opportunity for Atlantic City to become an international precedent for coastal resilient design, promoting the values of adaptation, support, research, participation, engagement, preservation, communication, and cultural expression. Addressing the city's social, economic, cultural, and ecological vulnerabilities can be leveraged as opportunities for empowerment, growth, and resilience. In addition to providing a socioeconomic and ecological framework for Atlantic City's continued resilience, the Resilient Transect presents a globally applicable precedent to interact with and learn from. The city's location and adjacency to Philadelphia, New York, Baltimore, and Washington, DC creates a realistic opportunity to merge scientific and political discussions, hosting state, national, and international forums on climate change, sea level rise, and coastal resilience.

Limitations

The availability of updated data and projections, paired with the unpredictability of the future condition, makes it impossible to ascertain a future climate scenario. For this reason, this limitation has been leveraged as an opportunity to build adaptability into the thesis design's built, natural, and social framework. Another limitation is the willingness of governments, organizations, businesses, and citizens to accept an unpredictable science, and further agree on a strategy and funding. The economic framework is beyond the scope of this thesis, but it was highly considered in presenting strategies that are attainable, realistic, and built upon a city's current infrastructure.

Recommendations

Multiple data sets and projections indicate that Atlantic City — and most urbanized coastal communities — will continue to experience climate events with an increased frequency and amplitude; immediate action and participation is required. The design and implementation of the Resilient Transect must support a participatory framework for recovery and growth, adaptable to environmental change and socioeconomic needs within and beyond Atlantic City. Once this framework is built and tested, it should be expanded to meet other neighborhood transects, ones that are specifically designed for the culture and history of the given neighborhood. For example, Atlantic City's uptown neighborhood will have different social, economic, cultural, and ecological vulnerabilities, thus, the built and natural program must address those specific variables. The intersection of these multiple transects can create a new resilient grid, one that interconnects previously separated neighborhoods, and unites cities by leveraging the unique assets that each neighborhood maintains.

The design of the Resilient Transect serves Atlantic City but its applicability is global. This framework can be adapted to meet the vulnerabilities and needs of other urbanized coastal communities, developing further connections to exponentially strengthen a global network of resilient communities and populations.

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Appendix: Building Condition Assessment

Building Condition Assessment

Atlantic City Masonic Temple

3515 Ventnor Avenue
Atlantic City, New Jersey



Eric Resnick
HISP690
May 9, 2022

Context

The *Atlantic City Masonic Temple* is located in Atlantic City, New Jersey, an urbanized coastal community on the southeastern coastline of the state. The Masonic Temple, completed in 1927, is one of the few remaining examples of neoclassical architecture in Atlantic City and the surrounding Southern New Jersey vicinity. The Temple was first recognized for its architectural significance in the 1980 *Atlantic City Historic Building Survey* and has since been “identified” by the New Jersey Historic Preservation Office for its historic significance; there is no record that federal or state historic nomination has been pursued beyond identification.¹ The Masonic Temple was converted to a police precinct in the early 1980s and has been abandoned since 1998. Its local geographic context is the overlap of residential, commercial, and university districts.

Directly across from the Masonic Temple is O’Donnell Memorial Park, the city’s largest park and former civic triangle (Fig. 1). Recent university development adjacent to the Masonic Temple and O’Donnell Memorial Park has catalyzed revitalization in an area that has been stagnant for the better part of two decades (Fig. 2).



Fig. 1: Postcard of Atlantic City with O’Donnell Park and Masonic Temple, c.1940 (Source: Boston Public Library)

¹ “Atlantic City Historic Building Survey”, New Jersey Office of Historic Preservation, 1980.



Fig. 2: The Masonic Temple's urban setting, July 2022 (Source: Author)

History

The barrier island on which Atlantic City was settled — Absecon Island — was originally occupied by the Lenni Lenape American Indian tribe as seasonal fishing and hunting grounds. In the 1670s the first European settlers laid claim to the island and the first permanent settlement occurred in the 1780s.² It wasn't until the introduction of the railroad in 1854 that the city saw exponential growth as a seaside health retreat. By the turn of the 20th century Atlantic City developed into a year-round tourist destination with both permanent and temporary residency. Beginning in the 1920s the city experienced a significant period of civic growth and saw the construction of monumental buildings that replicated the architectural styles of the neoclassical, Beaux-Arts, and Romanesque. It was during this period that the Atlantic City Masonic Temple was first conceptualized as a civic monument that would serve as the primary meeting place for the city's three Masonic Lodges; Trinity Lodge #79, Belcher Lodge #180, and Atlantic Lodge #221.³ To ensure that planning and construction responsibilities were shared among the three lodges, the "Temple Association" was formed.

The land for the Masonic Temple was purchased in 1922. Atlantic City native Charles D. Adams was hired as principal architect and Phillip G. Hannum was hired as the principal contractor.⁴ The Masonic Temple was completed in 1927 and was estimated to cost \$500,000 (\$8.1 million in 2022). To celebrate the completion of the Masonic Temple, it was reported that 1500+ Masons celebrated the laying of the ceremonial

² "Atlantic City Timeline", Rutgers University, Center on the American Governor. <https://governors.rutgers.edu/atlantic-city-timeline/>

³ "Atlantic City Masonic Temple", Trinity Lodge #79. <http://nebula.wsimg.com/d62f93a5562b797a4d45466e9ec6a2c1?AccessKeyId=89F4EEDC1D1C8D0B4ACD&disposition=0&alloworigin=1>

⁴ Ibid.

corner stone (Fig. 3).⁵ The stone was quarried from King Solomon's Quarries and laid with the same trowel George Washington used to lay the corner stone of the United States Capitol (borrowed from Alexander-Washington Lodge #22 in Alexandria, VA).⁶



Fig. 3: "Laying Cornerstone and Dedicating Atlantic City's New \$500,000 Masonic Temple", December 13, 1927 (Source: Temple University Digital Archives)



Fig. 4: "Masonic Temple", May 1944 (Source: <https://www.cardcow.com/54911/atlantic-city-new-jersey-masonic-temple/>)

⁵ "Laying Cornerstone and Dedicating Atlantic City's New \$500,000 Masonic Temple", Temple University Digital Archives, December 13, 1927. <https://digital.library.temple.edu/digital/collection/p15037coll3/id/75917/rec/1>

⁶ "Masonic Temple", Trinity Lodge #79.

Current Plan

Following the Masonic Temple's period of significance (1927 to early 1980s), the building's interior was adapted to function as a temporary police precinct (early 1980s to 1998). Since 1998 the Masonic Temple has been unoccupied and is currently held by an out-of-state real estate development firm. Due to its multiple iterations and the extended period of abandonment, the interior plan of the Masonic Temple has been modified compared to its original 1927 layout. Despite interior modifications, the exterior massing and ornamentation has not undergone significant alteration. However, there is a fair amount of deterioration and vandalism due to neglect. The details of this deterioration will be described further in the following sections.

It is known that adaptation of the Masonic Temple into a police precinct in the 1980s required interior modifications and ultimately led to the removal of ceremonial vestiges, ornate woodwork, and custom hardware and etchings. Documentation by the Trinity Lodge indicates that significant architectural features were removed and "preserved" at the lodge's new location (approximately 10 miles inland). During this conversion interior partitions were added and the original interior layout altered. The building's steel grid structure remains intact and construction documentation indicates that steel reinforcement was performed in 2004.⁷ The addition of partitions within the original steel grid indicates that the original floor plan can be restored to its historic state.

Note: construction drawings that detail interior modifications are confirmed to exist by the city building department, but a public records request to the city has been delayed twice to date. The original floor plan is synthesized based on descriptions by former Lodge members and further supported by historic newspaper articles that reported the dedication ceremony in 1927. Sanborn Maps provide additional support and confirm these accounts (Fig. 5).

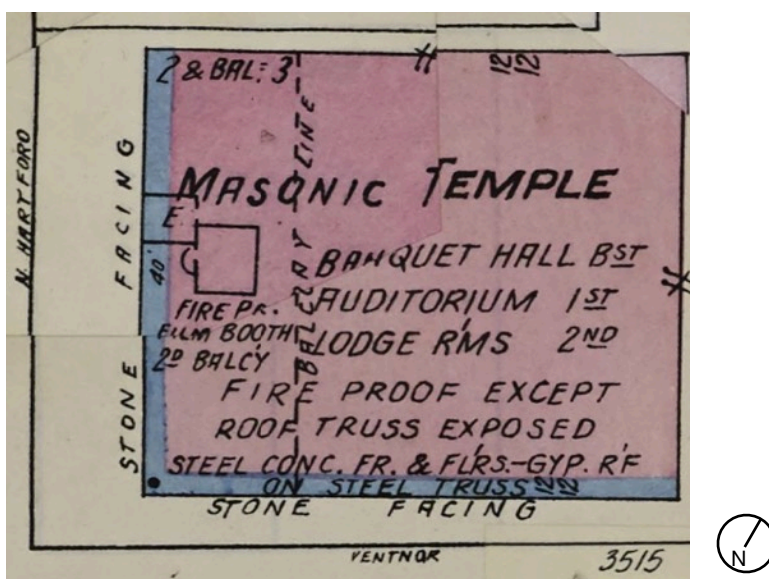


Fig. 5: "Atlantic City Sanborn Map", 1927 with 1949 updates (Source: Library of Congress, <https://www.loc.gov/>)

⁷ "Permit for Steel Construction", Atlantic City Building Department OPRA Request, December 11, 2003.

Interior program by floor:

Basement: dining room; kitchen; heater room; storage room; game room

1st level: auditorium with stage - 60' x 90' x 25'(h); projection balcony at rear; library room; sitting room

2nd level: (*mezzanine to 1st level*): Shrine room; women's lounge; meeting room

3rd level: two lodge rooms - 40' x 60' x 20'(h) each; cloak rooms; preparation rooms; storage; lavatory; fire-proof records room

4th level: (*mezzanine to 3rd level*): study rooms; men's room; women's room; organ loft

Materials

The foundation of the Masonic Temple is approximately 36 inches thick and extends six feet below and six feet above grade. Above grade, the water table is veneered with a light gray granite tile cut to 18" (h) by 42" (w) units, laid in a horizontal running bond pattern (Fig. 6). The primary front entry stair and secondary side entry stair are constructed from the same granite. The granite water table is capped with an Indiana limestone molding, embellishing the transition from the granite plinth to the limestone superstructure. Similar to the granite water table, the limestone is cut to 18" by 42" tiled units and laid in a horizontal running bond pattern from the water table to the parapet (approximately 50 feet in height). The Indiana limestone is not structural but acts as a veneer to the steel structure and brick infill. The same limestone is used to provide decorative ornamentation on the front facing south facade and side facing west facade (Fig. 7). This ornamentation replicates the Ionic architectural order and embellishes the street facing facades with fluted columns, pilasters, triangular aedicules, segmental aedicules, a dentilled cornice, and seashell themed acroterion at the parapet.



Fig. 6: Granite water table and steps; Indiana limestone upper facade, March 2022 (Source: Author)



Fig. 7: Detail of Indiana limestone at entablature and parapet, July 2021 (Source: Author)

The back facing north facade and side facing west facade are in close proximity to neighboring buildings and are not fully visible from the street or O'Donnell park, thus standard tan brick was chosen as an economical finish material (Fig. 8). The hipped roof structure is constructed from steel truss, covered with a gypsum layer for insulation, and finished with a rolled bitumen layer for waterproofing; it is not visible from street level.



Fig. 8: Tan brick laid in a running bond pattern on the less visible facade, March 2022 (Source: Author)

The original entry doors were solid wood and featured etched Masonic emblems. Oak and walnut served as the primary interior flooring and paneling, with tinted plaster walls in secondary spaces. The windows were originally single pane glass set in wooden frames, later replaced by double pane glass set in metal frames.

Front Elevation (south): Existing Conditions



Fig. 9: Front Elevation, March 2022 (Source: Author)

The front elevation faces the city's civic park, O'Donnell Memorial Park. A one-way residential street, a linear landscape, and a larger four-lane avenue act as a series of buffers between the Masonic Temple and O'Donnell Park. Due to the conditions described, it is impossible to view the front facade directly without some degree of vegetated obstruction (Fig. 9).

Where the granite water table meets the ground there is evidence that most of the granite veneer has been displaced due to moisture, but rather than replaced in-kind, the granite has been patched with tinted concrete (Fig. 10). The windows along the water table previously provided light to the basement and dining room level but have since been filled in with concrete masonry units. There is evidence that the granite has been repointed with a proper mortar mixture (no evidence of spalling), but the repaired joints are significantly thicker than the thinly struck historic mortar profile. There is also evidence of recent graffiti along the water table. The front entry steps are clad in the same granite and remain in fair condition, though there is some evidence of rust due to previously installed handrails. Evidence of repointing are present but does not appear to have caused significant damage to the granite steps. The front entry doors have been temporarily boarded with plywood so it is unknown if the original doors remain. To the right of the front entry there is an abundance of climbing ivy which has grown to a height of over 20 feet, covering both the granite water table and limestone veneer of the first level.



Fig. 10: The granite water table has been repaired with incompatible concrete patchwork; windows have been permanently infilled with concrete masonry units; repair to mortar joints is inconsistent in profile, March 2022 (Source: Author)



Fig. 11: The granite entry steps have minor rust staining due to previously installed metal handrails; minor spalling at joints; entry doors temporarily covered in plywood sheathing, March 2022 (Source: Author)

The limestone that clads the first level has weathered 95 years of coastal climate and storms, but the facings remain intact with minor textural wear. There is evidence that mortar joints have been repointed over the course of several decades, with evidence of properly and improperly struck joints. Where joints have been struck with a cement based mortar, edges of the limestone have begun to spall (Fig. 12a). A cornice line embellishes the transition from the first level to the second level and provides the aesthetic quality of a neoclassical temple base. The underside of this cornice line acts as a drip edge and is in constant shade, which has led to biological growth and a black biofilm (Fig. 12b). The top of this cornice line provides a base for the Ionic columns above but due to sitting water and solar exposure, a yellow-green algae has begun to spawn. The same condition is present at the underside of all southern facing aedicules. Above this line the remaining portion of the front veneer remains primarily intact with minor spalling at improperly repaired mortar joints. The windows of the first and second levels have been temporarily covered with plywood sheathing and the windows of the fourth level have been permanently sealed with gray brick. Similar biological growth is present at the underside cornice of the entablature and above the cornice at the parapet (Fig. 13). The “Masonic Temple” inscription above the front door appears to have been covered for protection but has since been exposed to the elements. Note: there are no windows or fenestration at the third level due to the privacy required for the ceremonial “lodge rooms”.



Fig. 12a: minor weathering of limestone faces; concrete mortar is causing spalling



Fig. 12b: Biological growth above and below cornice

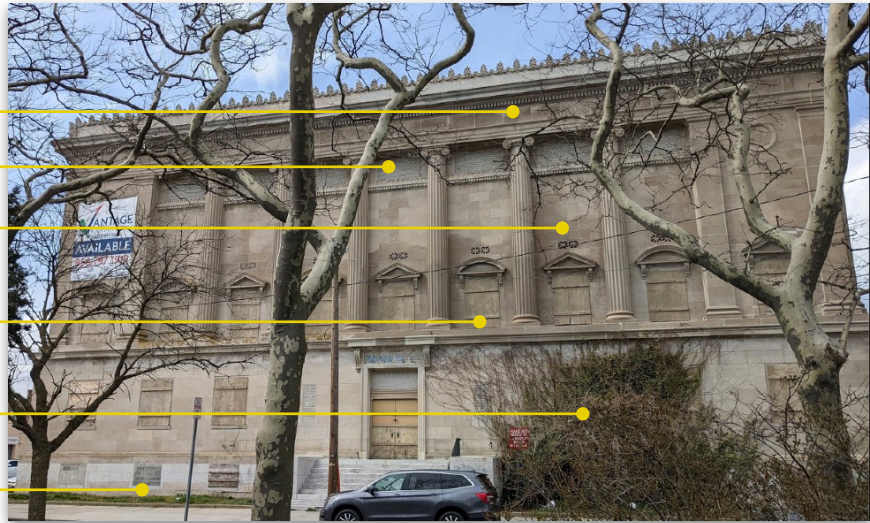


Fig. 13: Biological growth above and below cornice and aedicules; temporary protection of 2nd level windows; permanent infill of 4th level windows

Front Elevation (south): Summary

Considering the age and extended period of abandonment the existing condition of the front elevation is fair. Incompatible mortar repairs can be repointed, vegetative growth can be removed, and biological growth can be cleaned. The condition of the windows behind the temporary window coverings is unknown. Windows that have been filled permanently will require replacement units whether restoration or rehabilitation is pursued.

- biological growth
- window infill (permanent)
- minor spalling
- window cover (temporary)
- vegetative growth
- concrete patchwork and fill at water table



Southwest Corner: Existing Conditions



Fig. 14: The public facing front elevation and side elevation provide a continuity at the southwest corner of the Masonic Temple. These are the only two public facing facades and are clad in granite, Indiana limestone, and Ionic ornamentation, March 2022 (Source: Author)

Side Elevation (west): Existing Condition



Fig. 15: Side Elevation, March 2022 (Source: Author)

*Note: collage to capture entirety of elevation

The side elevation faces a neighborhood grocery store and marks the transition from the commercial to residential district (Fig. 15). The side elevation is treated in a similar manner to the front elevation, designed to represent the Ionic architectural order. The water table is veneered in granite and the superstructure veneered in Indiana limestone. The primary difference in the design of the side elevation are the Ionic pilasters in place of Ionic columns; windows are also present on the third level. The side entry stair is constructed of the same granite. There is a basement entry to the left of this side entry.

The granite at the water table has deteriorated in the same manner as the front elevation with a similar application of concrete patchwork (Fig. 16a). The secondary entry stairs have experienced a significant degree of deterioration and the masonry base is exposed, revealing that the granite steps are a veneer (Fig. 16b). Similar to the front elevation, biological growth is present on the underside of the first level cornice, above the cornice, and beneath the aedicules (Fig. 17).



Fig. 16a: Concrete repairs to the granite water table, March 2022 (Source: Author)



Fig. 16b: Severe deterioration of the granite entry steps reveals a rubble base, March 2022 (Source: Author)



Fig. 17: Biological growth (black biofilm) on the shaded underside of the cornice; biological growth (algae based) on the cap of the cornice, March 2022 (Source: Author)

There is significant discoloration across the facade, indicating evidence of hydrostatic water accumulation along the limestone. Three of the four fluted pilasters are in fair condition with the fourth having been completely removed from the facade (assumed to be deteriorating to a point that created a safety concern) (Fig. 17a). The deterioration of this pilaster has exposed the brick infill that supports the veneer. Similar to the fourth level, the windows have been permanently infilled with gray bricks. Also visible is the deteriorating roof membrane which has been torn and displaced by coastal winds.



Fig. 18a: Missing pilaster exposes brick fill material, March 2022 (Source: Author)

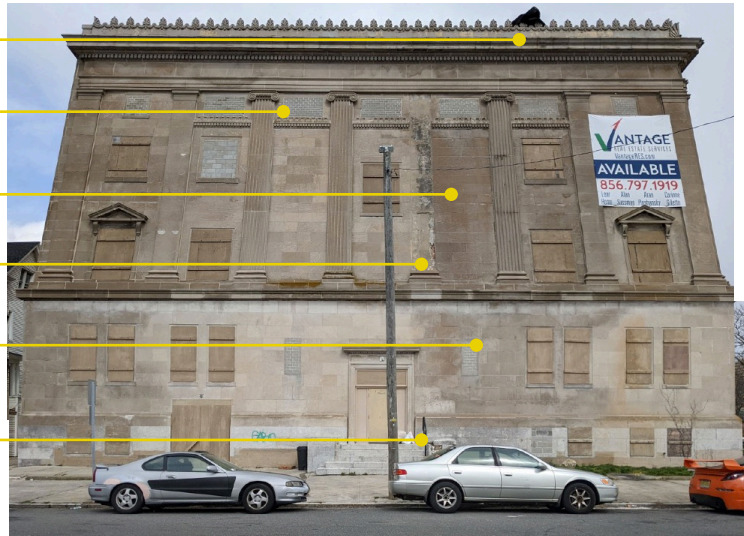


Fig. 18b: Severe spalling to the limestone due to concrete-based mortar repairs, March 2022 (Source: Author)

Side Elevation (west): Summary

The side elevation shows more severe signs of deterioration and neglect compared to the front elevation. Biological growth can be removed and windows restored, but reconstruction of the missing pilaster will require expert stone cutting and installation. The discoloration of the upper limestone is likely irreversible, but material core samples can provide data as to the depth of discoloration; refinishing may be an option. Due to the degree of incompatible mortar repairs, a full repointing is necessary.

- torn roof membrane
- window infill (permanent)
- significant discoloration due to water
- missing pilaster
- spalling of limestone at mortar joint
- deterioration of granite steps



Northwest Corner: Existing Conditions



Fig. 19: The northwest corner reveals the change in facade material and ornamentation. The rear (north elevation) faces an alleyway and most utility openings have been cut into this elevation, March 2022 (Source: Author)

Rear Elevation (north): Existing Conditions



Fig. 20: Rear elevation, March 2022 (Source: Author)

*Note: collage to capture entirety of elevation

The rear elevation is void of ornamentation and the primary material switches to a tan brick (Fig. 20). The brick is laid in a running bond pattern with a “flemish” style header/stretcher pattern every sixth row. There is slight deterioration to the brick mortar joints and visible patches where brick has been replaced and repointed (Fig. 21). Rust has built-up where concrete reinforcing bars were once present (at doors and window lintels) (Fig. 22). There is visible black staining beneath utility exhaust vents. It is also visible that the brick facade of the basement and first levels differs in tint compared to the second, third, and fourth levels; this appears to be original and likely due to the sourcing of materials at the time of construction. There is evidence that two service ramps were once present but only one remains. Windows on the second and fourth levels have been permanently infilled with concrete masonry units.



Fig. 21: Evidence of permanent infill; the outline of concrete reinforced service ramp; rust present where reinforcing bars were once present, March 2022 (Source: Author)



Fig. 22: Attempted mortar repair is visibly incompatible and high in cement content; mortar joints were not struck properly and show visible alteration in width; rust and concrete patchwork around basement windows indicates steel window grates were added and removed during period as a police precinct, March 2022 (Source: Author)

Rear Elevation (north): Summary

The rear elevation shows few signs of deterioration, but significant modifications due to the multiple periods of use. Restoration of the windows and service ramps are primary priorities. It is likely that replacement of the ramp will need to abide by ADA guidelines since it would be considered a new addition. Due to the degree of incompatible mortar repairs, a full repointing is likely to be necessary to elongate the life of the facade.

- black staining

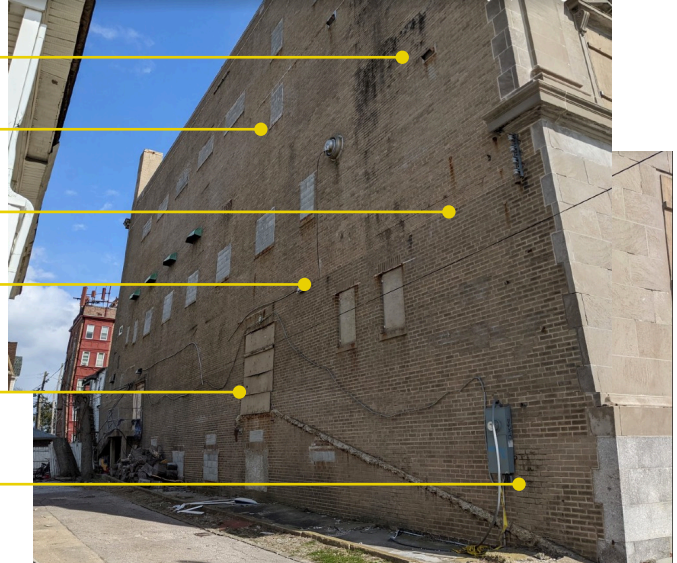
- window infill (permanent)

- rust

- change in brick

- removal of service ramp

- brick patchwork



Northeast Corner: Existing Conditions

*Inaccessible due to neighboring private property

Side Elevation (east): Existing Conditions



Fig. 23: Front facing photograph of elevation not possible due to neighboring property, March 2022 (Source: Author)

The east elevation is adjacent to an alley and neighbors a two-level apartment building, thus the uppers floors are visible from a distance (Fig. 23). The tan-tinted brick of the rear elevation wraps around the corner but switches from a flat running bond pattern to a more detailed coursework, imitating the rhythm and ornamentation of the publicly visible side (west) elevation. The pilasters of the west elevation are mimicked on the

east elevation by altering the depth of the brick coursing, both vertically and horizontally. This results in an economical version of the limestone clad front and side elevations. To transition back to the materiality of the front elevation, the limestone wraps around the corner and covers approximately fifteen feet of the side elevation. This provides a visual continuity from a distance. This elevation includes an emergency exit door and coal delivery door. Aside from minor biological growth below the upper cornice and slight deterioration of the limestone at the corner, this elevation is in fair condition (Fig. 24).



Fig. 24: Signs of deterioration at the corner pilaster; biological growth on underside of upper cornice; Masonic Emblems remain intact, March 2022 (Source: Author)

Side Elevation (east): Summary

This elevation has the least amount of deterioration compared to the other three. Restoration of the windows would require the most significant effort. Replacement of the limestone tile at the corner is necessary to prevent further water infiltration. Removal of biological growth at the cornice is recommended.

- missing limestone tile

- biological growth

- ornament in brick

- window cover (temporary)

- graffiti



Southeast Corner: Existing Conditions



Fig. 25: Alternative view of southeast corner showing transition from limestone front facade to brick faced side facade, March 2022 (Source: Author)

Assessment: Causes for Deterioration

NEGLECT

- property held by out-of-state developer
- no regular maintenance schedule
- damage and vandalism goes unnoticed

INCOMPATIBLE REPAIRS

- hard mortar mixes cause spalling of stone/brick
- infill of window/door thresholds
- concrete patches

BIOLOGICAL GROWTH

- temporary surface stains become permanent
- deterioration of mortar

VEGETATION

- retains surface moisture
- roots continue to grow through existing cracks



The primary cause of deterioration is **neglect**. The property is owned by an out-of-state real estate developer and has been unoccupied for 25+ years. There is no regular maintenance schedule to address damage due to age, weather, and vandalism. The building is clad in a very durable granite, limestone, and brick finish that, when maintained, are very durable in coastal climates. However, once small openings form and repairs go unaddressed, the Mid Atlantic freeze-thaw cycle causes significant cracking, displacement, and failure of the veneer cladding.

Where repairs have been attempted in the past, almost all have been **incompatible repairs**. The most significant issue is the use of hard mortar mixes. Three of the four elevations show evidence of mortar mixes that are highly concentrated in cement with some areas being repaired with pure concrete. Due to these hard mortar mixes, the granite, limestone, and brick joints are unable to expand and contract, thus the masonry or stone units crack before the mortar joint cracks. Concrete patches at the granite water table create a similar effect and will continue to cause damage to the surrounding stone. All window openings have been covered, either temporarily with plywood sheathing or permanently with brick or CMU block. The plywood is holding a significant amount of moisture and has likely caused significant corrosion to the metal window frames behind.

While **biological growth** is expected in a humid coastal climate, the extended presence on the underside of cornice lines could cause permanent staining and exponentially attract further growth. Where algae-based growth has formed at the upper side of cornices, moisture is held which leads to further deterioration of mortar joints. Where **vegetation** and climbing ivy is present, moisture has found its way into cracks, leading to further deterioration and material displacement during the freeze-thaw cycle.

Recommendations for Treatment

A series of incompatible repairs and window infill projects have significantly altered the aesthetic quality of the Masonic Temple, but the condition of the front elevation indicates that damage to the exterior can be reversed with intense cleaning, repointing, restoration of windows, restoration of roof covering, and ongoing maintenance. However, if repairs are deferred, moisture infiltration, freeze-thaw cycles, and vandalism will continue to deteriorate the building beyond a point of repair. The condition of the roof is unknown but evidence of the torn membrane is an indication that the building is susceptible to water damage from the top down. The following recommendations are provided in order of priority.

STABILIZATION

- roof repair and bi-annual inspection
- repair displaced or loose limestone

REVERSE INCOMPATIBLE REPAIRS

- repoint mortar with proper mortar mix
- replace concrete patches with proper material
- repair or replace windows

REMOVE VEGETATION AND BIOLOGICAL GROWTH

- remove ivy and prevent return
- removal of growth followed by annual cleaning

Treatment

Roof: The existing roof membrane must be replaced immediately and all drainage freed of debris and shells (note: it has been documented that seagulls use the roof as a dropping point to crack open mollusk shells; during multiple site observations there was no presence of seagulls). Repair to the roof remains the primary priority to prevent further deterioration of interior structure and finishes. Stormwater runoff should be led away from the building and displaced into the vegetated landscape across the street.

Walls: Once the roof is stabilized, all vegetation should be removed from the walls of the temple. Because the ivy attaches itself to the finish material, removal must be carefully completed to avoid further damage to the veneer beneath. Once vegetation is removed biological growth should be cleaned through the use of soft bristle brushes and a warm water/bleach mix. Power washing and heavy detergents should be avoided due to the sensitivity of the facade. Once growth is removed missing granite and limestone should be replaced with aesthetically compatible matches. Once all units are stabilized a majority of facades will need to be repointed with a mortar mix

that allows for expansion and contraction of the masonry and stone units. Windows and doors will need to be repaired or replaced to provide a waterproof seal at all openings.

Site: Where the water table meets the ground, grade should be sloped away from the building to prevent water accumulation.

Ongoing Care

Ongoing maintenance is necessary for the longevity of the Masonic Temple. Maintenance of roof, facades, windows, doors, and grading will elongate the life of the building and overall historic integrity of the temple.

Roof: The roof and drainage should be inspected twice a year (prior to and following hurricane season). The roof should also be inspected following acute weather events (hurricanes, tropical storms, nor-easters, blizzards, etc).

Walls: The durability of the granite, limestone, and brick facades have proven their longevity, but they must be kept free from biological growth in order to maintain both durability and aesthetic integrity. Replacement masonry/stone units should last indefinitely if mortar joints are maintained and repointed at the first sign of deterioration. To prevent the growth of mold and mildew, the facades should be cleaned annually with light water pressure and a soft bristle brush. Harsh chemicals are not necessarily required if regular maintenance is scheduled. Should graffiti occur, the expedited removal of paints prevents permanent damage and has been cited to deter further vandalism if it is visible that the building is cared for.

Site: Vegetation and landscape should be maintained bi-annually to prevent infestation of ivy and ground cover. Site grading should be monitored to ensure that surface water is diverted away from the building's foundation. All trash and debris should be kept away from the foundation of the building.

Further Investigation

Due to the unresponsiveness of the owner, an interior investigation has not been completed at this time. However, this report is intended to serve as an assessment of the exterior condition only. This exterior assessment is provided as a first step to provide guidance for the stabilization and protection of the Masonic Temple as a local historic resource and a potential state/national historic resource. It is evident that the current property owner is allowing "demolition by neglect", so should the property be transferred to a new owner or the city, repair work should prioritize weatherproofing and facade stabilization before pursuing interior rehabilitation or restoration.

Possible Futures

Given the surrounding urban context, size, and current condition of the Masonic Temple, it is foreseeable that the building's facade can be restored and the interior spaces rehabilitated for contemporary use. This Building Condition Assessment serves as a preliminary investigation that can be used by community stakeholders, local government, the city's Historic Preservation Commission, and interested private/public investors.

Historic Nomination

It is recommended that state and/or national historic register nomination be pursued under Criterion C, to signify the architectural and aesthetic characteristics of the building. The high quality of craft and stonework remains as one of the only existent examples of this architectural style not only in a coastal setting, but in the greater Southern New Jersey region. Despite the waring condition of the facade and alterations to the interior, the building still retains its historic integrity in terms of location, design, materials, workmanship, and to a lesser extent, setting. The adjacent park, monuments, and university buildings aid in maintaining a distinguishable civic district.

Adaptive Reuse

Given the Masonic Temple's location and steel structure, the building is apt to be rehabilitated as a community center, cultural arts center, events venue, or coastal resilience resource center. The author's attendance at community meetings and interviews with local stakeholders has indicated that these uses are most needed in the city and immediate neighborhood. Alternative uses could include commercial retail/ office space with residential or hotel units above.



Sources:

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