

Revisiting Barriers to Climate Change Adaptation in Coastal Municipalities in Massachusetts

by
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Submitted to the Department of Urban Studies and Planning on May 24, 2018
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ABSTRACT

Massachusetts has positioned itself as a leader in climate adaptation and mitigation action. However, there is little knowledge about how exactly climate adaptation is occurring at the local level and what barriers municipalities in the state face in implementing adaptation strategies. In response to a 2011 study on barriers to climate adaptation in coastal municipalities in Massachusetts that found ‘leadership’ and ‘values and beliefs’ as the two main barriers to adaptation, this thesis set out to ask: how, given the increase in extreme weather events and the presence of significant political leadership at the state level, have barriers to climate adaptation for coastal municipalities changed? And if the barriers have changed, what are the new barriers? The research draws on sixteen interviews with staff in six municipalities and arrives at the following findings: (i) barriers to adaptation have shifted from the understanding phase to barriers found in the implementation phase, and include the following cross cutting themes: (ii) private property interests are a significant barrier because publicly funded adaptation projects require public easements on all property that benefits from public funding; (iii) the potential of decreasing property tax revenue continues to be a concern for towns that rely on valuable waterfront property as a pillar of their municipal income; (iv) the town meeting process illuminates many concerns about equity in regards to who should pay for adaptation projects; (v) planners are aware of zoning and land use strategies for long-term adaptation, but such projects are still unpopular and unlikely to pass a town meeting vote in the near term; and (vi) uncertainty about significant damage caused by extreme weather events is more challenging to manage than slow-onset changes such as sea level rise or temperature changes. The findings lead one to believe that adaptation planning is not in fact a bureaucratic issue to be overcome with information, charts, and resources, but a much more fundamentally conceptual issue faced by a society grappling with the implications of shifting economic, social, and environmental conditions caused by climate change. By viewing the story of coastal adaptation through the unique challenges of individual towns and the experiences of the people who make these towns function, one finds that layered deep within this tension is the challenge and opportunity of restoring a highly privatized coastline to the commons.

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*Thank you
to all of the friends and family
who supported me along the way,
and my committee,
for working with me through uncertain times.*

Table of Contents

Introduction:	9
Challenges in the Transition from Adaptation Planning to Implementation	
An Analytical Framework for Climate Adaptation Barriers in Massachusetts	12
Research Design and Methodology	14
Findings:	15
Evaluating Changes Over Time	
Case Studies	18
<i>Hull</i>	20
<i>Scituate</i>	22
<i>Duxbury</i>	24
<i>Sandwich</i>	26
<i>Barnstable</i>	28
<i>Chatham</i>	30
Discussion: Cross-cutting Themes	32
<i>Private Property Rights and Easements</i>	
<i>Risky Properties: A Threat to the Municipal Tax Base</i>	
<i>Equity Concerns in Financing Adaptation</i>	
<i>Zoning and Land Use Strategies: Possible, but Improbable</i>	
<i>Extreme Uncertainty: How to Prepare for Stochastic Catastrophe</i>	
Conclusion: Confronting Barriers in Uncertain Times	50
Bibliography	52

Introduction: Challenges in the Transition from Adaptation Planning to Implementation

As global concern over climate change increases, there is a shift in conversation from solely climate mitigation into the need for increased resources for adaptation because the impacts of climate change are already being felt. As a result, climate change adaptation planning is becoming more mainstream (Moser et al., 2008; Ford & Berrang-Ford, 2011), but there is still limited research on how implementation is occurring after the planning phase. Adaptation processes and the barriers they encounter will be validated and calibrated by practical experience. While literature exists on barriers to the preliminary stages of climate adaptation, such as gathering information and conducting vulnerability assessments, (Füssel, 2007; Measham et al. 2011; Berrang-Ford et al., 2011), there is still a limited (but increasing) amount of research on case studies on adaptation implementation (Preson et al, 2011; Dierwechter & Wessells, 2012; Pasquini et al., 2015; Lorenz et al., 2017; Van der Voorn, 2017). As the literature on implementation continues to grow, lessons learned about barriers and ways to overcome them in the later phases of adaptation will become increasingly important, as they may be useful for building new analytical models for applied practice.

To analyze barriers to adaptation, a critical examination of adaptation literature is necessary. The Intergovernmental Panel on Climate Change Third (IPCC) Assessment Report defines adaptation as “adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts which moderates harm or exploits beneficial opportunities” (IPCC, 2014.) Adger et al.

(2005) slightly modify this definition, adding that “Adaptation can involve both building adaptive capacity thereby increasing the ability of individuals, groups, or organizations to adapt to changes and implementing adaptation decisions, i.e., transforming that capacity into action.” The literature on types of adaptation is wide-spread and covers both autonomous and planned adaptation as well as distinct functions associated with urban implementation (Bijlsma et al., 1995; Watson et al., 1996; Smit, 200; Bierbaum et al., 2013). Broadly, adaptation strategies can reduce vulnerability or increase resiliency of a person, place, or system (Bedsworth & Hanak, 2010) at a variety of scales, some of which come into conflict with one another (Neil Adger, Arnell, & Tompkins, 2005). Case studies are important in providing insight to adaptation barriers and successes (Glavovic, 2000; Moser et al., 2005; Moser et al., 2008; Bassett and Shandas, 2010; Bedsworth and Hanak, 2010; Measham et al., 2011., Lyles et al., 2017). The literature has identified barriers to climate adaptation including: climate change information and decision making, with a focus on uncertainty; lack of resources to begin and sustain adaptation efforts, especially financial; fragmentation of decision-making, especially a lack of coordination; institutional constraints and lack of institutional flexibility; lack of political leadership; and divergent risk perceptions, cultures, and values (Bierbaum et al., 2013). However, the literature on how barriers to adaptation change over time is still new, and although generalized frameworks for idealized adaptation processes exist (Moser and Eckstrom, 2010), it is not known if barriers will follow the same processes identified in the theoretical literature.

Adaptation is implemented by a variety of actors who have different functions and capacity to guide adaptation (Adger et al., 2005; Bierbaum et al., 2013). Adaptation leadership at the state level is particularly important because it can

control development and adaptation initiatives at the scales within its boundaries such as counties and municipalities (Morsch & Bartlett, 2011) depending on what its own aims, objectives, and mandates are (Adger et al., 2005). For example, the state can choose to build adaptive capacity through funding of adaptation projects, or by passing legislative decisions that enable local adaptation decisions, or it can take a more active role through regulation and mandates to require adaptation action (Burby & Dalton, 1994). However, despite higher government's role in building adaptive capacity, most adaptation efforts and adaptation research to date has occurred at the local level (Gregg et al., 2011; Chu, 2018). Some mechanisms that local governments use to prepare for climate change include land use planning (Cuevas, 2016; Butler et al., 2016) provisions to protect infrastructure and ecosystems; regulations related to the design and construction of buildings; and emergency preparation, response, and recovery (Bierbaum et al., 2013). Additionally, states can manage local action through state-wide coastal management strategies (Grannis, 2011) and through state hazard mitigation plans.

Regardless of what scale adaptation is occurring, adaptation processes must grapple with uncertainty, “a cognitive state of incomplete knowledge that results from a lack of information and/or from disagreement about what is known or even knowable” (IPCC, 2014). Risk, on the other hand, “refers to the potential for adverse effects on lives, livelihoods, health status, economic, social and cultural assets, services (including environmental), and infrastructure due to uncertain states of the world” (IPCC, 2014). The ability of individuals and governments to respond to risk is often a function of their ability to define the probability, or their uncertainty, about the likelihood of an event. As the results of this research show,

uncertainty about future catastrophic events is changing the risk perceptions and as a result the willingness of residents to pay for coastal adaptation projects. Also, while uncertainty has entered the literature in regards to climate projections (Jones, 2000; Latif, 2011; Deser et al., 2012) sea level rise (Rahmstorf, 2007); there is less literature about uncertainty in human behaviors and social responses to climate change, or what Moser (2005) calls “social surprises.” This thesis will elucidate some such social surprises encountered at the local level.

One way the literature has addressed uncertainty is through the process of adaptive management, which argues that because climate change impacts difficult to predict, flexible strategies are essential for managing the potential stresses and opportunities (Lee, 1999; Folke, 2006; Hallegatte, 2009; Nelson, 2011). This process may also be more broadly a challenge of adaptive governance, which requires governance structures to be flexible across a variety of scales and with reasonable degrees of autonomy (Folke et al. 2005). Although strategies for adaptive management exist (Hallegatte, 2009), even a flexible process of adaptive management will encounter its own barriers (Stankey et al., 2005). One such barrier may be institutions themselves, which although often exist to reduce economic, social, and political transactional costs, can also be inflexible. This path-dependency can also act as a barrier because of how quickly environmental and social changes may occur. (Barnett et al., 2015). From an institutional design perspective, traditional institutional design for adaptation can include strong leadership and participation of a wide range of stakeholders for collective decision-making, but trade-offs and detailed complexity challenge the validity of this approach (Oberlack, 2015). As will be illustrated in the findings of this thesis, collective decision making does not just reduce

efficiency of decision-making but may result in recurring situations of 'the many vs. the few,' as described in section (iv).

Overall, this thesis aims to ground the literature on adaptation barriers in the local context of Massachusetts. While the lessons learned are geographically unique because of the political context of Massachusetts, the findings speak

more broadly to the societal changes that cities on the coast are facing. By highlighting this unique context, the research aims to contribute to a broader discussion on public versus private good and the role of local and state institutions in decision making and adaptive capacity.



*Coastal Development around Cape Cod, MA.
Satellite image from NASA, 2013: <https://earthobservatory.nasa.gov/IOTD/view.php?id=83749>*

An Analytical Framework for Climate Adaptation Barriers in Massachusetts

Massachusetts is facing a variety of impacts due to climate change. Winters are seeing an increase in overall precipitation as well as more extreme precipitation events, sometimes causing catastrophic flooding. By the end of the century, state temperatures could average up to more than five degrees Celsius higher, leading to concerns about summer heatwaves and droughts, which are also expected to be more significant and more frequent. The coast will also be heavily impacted by sea level rise, leading to many permanently inundated coastal areas, compromising both private and public land. Rising groundwater will impact essential freshwater aquifers, and storm surges can cause considerable damage to property and infrastructure (“Climate Change in Massachusetts and Its Impacts,” 2013). To preserve the coast as a cultural and economic asset, significant attention has been given to maintaining and managing the coastline. As of 2013, 27 percent of the ocean-facing shoreline in Massachusetts was armored by a private or public defensive structure. (Office of Coastal Zone Management, 2013).

As a result, the state has been undertaking massive efforts to educate citizens and local officials on future climate impacts, provide information on mitigation and adaptation strategies, and develop funding opportunities for implementation. In 2008, then Governor Deval Patrick signed The Global Warming Solutions Act, a comprehensive regulatory program to address climate change. In 2011, he released the “Massachusetts Climate Change Adaptation Report” (2011), which provides several strategic short and long-term solutions to both mitigate greenhouse gas emissions as well as reduce exposure to risks through adaptation planning. The same year, a group of researchers

from University of Massachusetts, Amherst interviewed 18 municipal planners in 14 coastal cities in Massachusetts and found that until then, communities had undertaken very limited adaptation efforts. No towns had an adaptation plan, three communities were planning to plan or mainstreaming technical adaptation strategies, four were expressing intentions of planning, six were addressing current hazards, and one town expressed no current adaptation efforts underway. In terms of barriers, at the time of the research, ‘local values/beliefs’ was cited by most respondents as the primary barrier to adaptation, but ‘leadership’ was cited by all planners as a barrier. Information was also cited by nine interviewees as a barrier to adaptation. Unfortunately, neither of these categories were sufficiently unpacked, and it is unclear what exactly the values and beliefs were, or whether leadership was lacking at the state or local level. Other challenges included private property rights, coordination efforts among different departments, equity about who should pay for adaptation, and lack of resources (Hamin, Gurran, & Emlinger, 2014).

Since that study, the state significantly increased its leadership on climate adaptation planning. In 2016, current Governor Charles Baker signed Executive Order 569: An Integrated Climate Change Strategy for the Commonwealth, which mandates the creation of a Statewide Hazard Mitigation and Adaptation plan, a State Climate Adaptation Plan, and support for municipal vulnerability assessments and adaptation plans. Municipalities now have a variety of reports and toolkits, including the Massachusetts Climate Change Adaptation Report; which provides a broad overview of climate change impacts and includes a coastal chapter with a range of potential strategies to address sea level rise and coastal storms; the Massachusetts Sea Level Rise and Coastal Flooding Viewer which highlights coastal flooding impacts; the Sea Level Rise: Understanding and Applying

Trends and Future Scenarios for Analysis and Planning document, which provides extensive background information about sea level rise trends and projects; and the resilient MA Climate Clearinghouse, which provides data and science on climate change impacts across the state as well as strategies for resilience projects and a resource database. Grant programs include the Municipal Vulnerability Preparedness (MVP) Grant Program; the CZM StormSmart Coasts Program; and the Coastal Resilience Grant Program. All of these serve to build the adaptive capacity of municipalities.

More recently, the series of nor'easters in March 2018 brought increased political urgency and attention to climate change, especially for the coastal areas. On January 04, 2018, winter storm Grayson hit record high tide gauge heights in Boston at 15.16 feet, breaking a previous record of 15.1 feet set during the infamous blizzard of 1978. Governor Charles Baker declared a State of Emergency for Winter Storm Riley, which lasted from March 1-3, knocking out power for more than 2 million homes and businesses. In response to two successive storms, Winter Storm Quinn and Winter Storm Skyler, on March 15, 2018, Governor Baker released a new piece of legislation: An Act Promoting Climate Change Adaptation, Environmental and Natural Resource Protection and Investment in Recreational Assets and Opportunity. The legislation, if passed, would authorize over 1.4 billion in capital allocations in projects. Of the 1.4 billion, \$300 million is allocated to climate impacts, and of that, \$170 million is for improvements and repairs to hard coastal infrastructure and other resiliency strategies; \$50 million to planning efforts through the Municipal Vulnerability Preparedness (MVP) Program; and \$60 million towards implementation of the Commonwealth's Integrated State Hazard Mitigation and Climate Adaptation Plan (Governor's Press Office, 2018).

The abundance of resources available for municipalities implies that coastal municipalities in Massachusetts should have enough information and political support to implement adaptation projects. But political leadership is not the only barrier. One other major barrier to adaptation cited in earlier studies is public or local values and beliefs. While it is difficult to know exactly what public opinion is within each individual municipality, a 2017 WBUR public opinion poll shows that concern about climate change has increased steadily since 2011. A more recent poll from March 2018 found that roughly two thirds of Massachusetts voters say climate change is bringing more frequent or severe storms, and 47% think that the state is only "somewhat prepared" (Swasey, n.d.). While these radio surveys cannot be considered a perfect representation of public opinion, they show a general trend in public opinion shifting over time.

Having found political leadership at the state level growing, available funding resources for adaptation planning, and an apparent increase in public opinion about the negative impacts of climate change, this research set out to understand whether barriers to adaptation have changed from the perspective of municipal staff in small coastal towns.

Research Design and Methodology

This research design begins with a few assumptions. The first is that climate impacts are being felt at the local level, which was illustrated by the news coverage of storms in January and March of 2018. The second assumption is that towns are likely undertaking climate adaptation strategies to respond to these impacts, and that they are likely encountering barriers to doing so. The third assumption is that municipal staff are the mostly like to know what is happening at the local level in terms of climate adaptation and that speaking with them, rather than conducting a survey, would provide greater insight into the specificities of their challenges. Semi-structured interview questions for practitioners were developed through a desk literature reviews of existing laws, policy documents, town reports and paperwork, and comparative studies in

the field. Case study towns were selected from news reports about considerable damage from the series of nor'easters in March 2018. (Young, 2018; Carr, 2018; Rios, 2018). While this reflects some case study selection bias, these cases present a reasonable starting point for investigation. That being said, it is possible that those towns with more pressing adaptation needs because of the storms are experiencing different barriers, which will be elaborated in the results section.

Semi-structured interviews were conducted with sixteen municipal staff in six towns: Hull, Scituate, Duxbury, Sandwich, Barnstable, and Chatham. Similar studies on climate change adaptation strategies that follow semi structured interviews include (Measham et al., 2011; Hamin et al., 2014, Rosendo et al., 2018). Rather than replicate the Hamin et al. (2014) methods, which only interviewed planners, interviews included Planning Directors as well



Governor Baker in Scituate. Wicked Local Staff/ Robin Chan

as Town Managers or Administrators, Directors of Public Works Departments, and Coastal Commissioners. The perspectives of other staff were included because while planners may deal with comprehensive physical planning and climate adaptation, other departments have their own unique considerations regarding adaptation implementation (Measham et al., 2011). Of the six municipalities listed, interviews with multiple staff occurred in four: Duxbury, Scituate, Sandwich, and Barnstable. Only one staff person was interviewed in Chatham and Hull.

Some interviews were conducted individually, and others were done in groups, depending on the preferences and availability of the interviewees. All interviews except for two were recorded. Individual interview responses were recorded and triangulated against responses in other towns. Responses in group interviews were triangulated against one another and then with other towns. Barriers identified were written in their original phrasing, ranked by primary, secondary, and “other” and then coded into categories, some of which were original, and some of which fit in the existing literature. Results were compared back to the literature to identify shifts, taking note of in which of Moser and Eckstrom’s (2010) phases of adaptation the barrier is occurring (understanding, planning, or monitoring).

Findings: Evaluating Changes Over Time

The findings suggest that funding is the most common barrier expressed by staff across all municipalities interviewed. Prioritization in this case includes lack of leadership or political will, although many of the staff I interviewed framed the matter as prioritization, rather than an explicit belief that climate change is not occurring. To compare to 2011, findings were grouped into the four cross cutting themes (leadership, values/beliefs, information, and resources) presented by Moser and Eckstrom (2010) and applied by Haman et al. (2014) for Massachusetts. Doing so made a longitudinal comparison in theory possible, but very difficult to interpret, because a significant amount of information about issues such as permitting and easements was lost, which were explicitly mentioned in interviews. →

A Critical Reflection on the Methods

Another challenge in comparing results is that Haman et al. (2014) do not provide a clear methodology for how they grouped their findings into the from Moser and Eckstrom (2010). For example, Haman et al. may have grouped issues

<i>To the right: WBUR public opinion poll. Percentage of Massachusetts voters who say effects of climate change will be felt</i>					
<i>Already begun to happen</i>		54%	57%	57%	69%
<i>Within a few years</i>		3%	4%	3%	3%
<i>Within your lifetime</i>		10%	10%	8%	7%
<i>Will affect future generations</i>		18%	17%	20%	15%
<i>Wil never happen</i>		12%	8%	8%	5%
<i>Dont know/refused</i>		2%	4%	4%	2%
		2011	2014	2015	2017

Source: WBUR poll of Massachusetts registered voters, June 2017

with permitting into the “leadership” category, although this may be categorically incorrect through a different interpretive methodology. For example, refusal to grant easements should be disaggregated from the values/beliefs category, which often encompasses both private property interests as well as a lack of prioritization around climate action due to a lack of felt impacts as well as belief that climate change is happening. But since these barriers are categorically different, the policy recommendations for each are different: one could possibly be overcome with more information and education, the other one will require more regulatory involvement to be addressed.

Although it is impossible to perfectly compare the results longitudinally due to a lack of information about explicit coding methods and lack of information about which towns faced

what barriers in the 2011 studies, barriers for these coastal municipalities do appear to be changing over time. Values/beliefs and leadership have both become less significant of a primary barrier, even when easements are included. Resources, and financial resources in particular, have become a more substantial barrier. Interestingly, information was also not mentioned as a barrier in any interviews from this study. Although some municipalities may still face information barriers, the significant decrease in reporting of “information” as a barrier may be a testament to the tremendous effort put forward by the state in the last seven years to provide information about climate change impacts and adaptation strategies to municipalities. This finding should show positive reinforcement for the state’s efforts to provide information about climate change, as it eliminates a significant barrier for municipalities. However, as this barrier is reduced, the state will

	Interview	Primary Barrier	Secondary Barrier	Other Barriers
Barnstable	<i>Planning Director</i>	Political Leadership	Funding	Regulatory Lags
	<i>Town Manager & Assistant Town Manager</i>	Education	Political Leadership	Easements
Sandwich	<i>Town Manager</i>	Permitting	Funding	Easements
	<i>Planning Director & Planning Assistant</i>	Permitting	Funding	Political leadership
Duxbury	<i>Town Manager, Director of Public Works & Director of Planning</i>	Public Beliefs	Easements	Funding
Scituate	<i>Planning Director & Town Manager</i>	Regulations and Permitting	Funding	Easements
	<i>Director of DPW</i>	Easements	Funding	Permits
Hull	<i>Conservation Commissioner</i>	Funding	Easements	
Chatham	<i>Planning Director</i>	Funding	Property	Permitting
	<i>Director of Coastal Resources</i>	Easements	Technical challenges	

Figure 2: Findings from interviews

now have to provide leadership and guidance on how to overcome new barriers.

While some trends emerge, it is impossible to draw a conclusive argument about how barriers are changing over time from the comparison of these two data sets alone for two reasons. The first is that a methodology for categorization was not provided in the previous study, which made it difficult to transform the data into a comparable study. Second, the previous study did not provide specific information about which municipalities experienced which barriers, so it is impossible to say whether barriers have changed in specific municipalities. Despite these limitations, the results do show interesting trends for the municipalities in question. They also provide useful methodological insights for facilitating further research on longitudinal comparisons of adaptation barriers over time.

The findings also highlight some of the broader methodological challenges in documenting barriers to adaptation throughout the adaptation process. Previous literature such as Moser and Eckstrom's (2010) framework may be derived from an assumption that all municipalities need to adapt is a plan, and that implementation will follow suit. As will be elaborated in the following sections, the implementation category outlined by Moser and Eckstrom (2010) may take for granted the challenges of implementation and should likely be divorced from monitoring and evaluation given its complexity. Recognizing the importance of resource and institutional challenges associated with implementation may elucidate some of the path dependencies and inflexibility of our current systems which are preventing climate change from occurring.

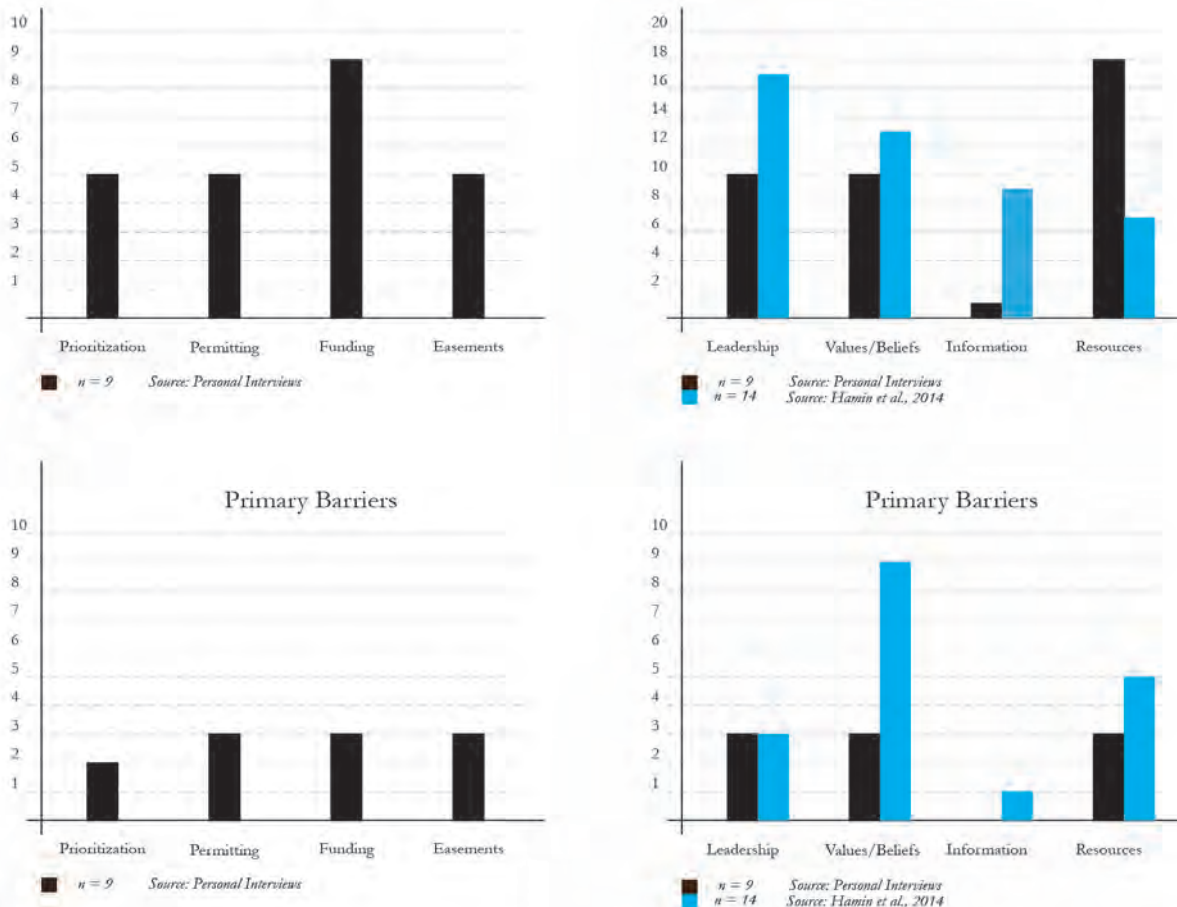


Figure 3: Comparing barriers between 2011 and 2014

Case Studies

The case studies presented here are not a comprehensive look at climate adaptation planning in the South Shore nor on the whole of Cape Cod. However, they provide some interesting preliminary insights into the unique challenges of adaptation at the local level.

The interviews also highlight that each municipal department has their own way of approaching climate adaptation and each staff person had their own insights, thoughts, and expertise. A result, the analysis in those towns with multiple interviewees is more comprehensive and nuanced, but even the single interviewee in Hull was able to provide information about the barriers faced. Patterns emerged in the language of different staff roles. Town managers had a much better understanding of municipal funding and revenue streams and were very concerned about annual and long-term budgeting constraints; the Public Works staff and Coastal Resource officers had a much more technical and straight forward understanding of implementation challenges, focusing their attention on costs of materials and also how to meet standards and criteria laid out in regulations; planners, on the other hand, were concerned with community feedback, the need for goal setting, and the possibilities of long-term transformational change. Additional interviews with other staff and other cities in the region would continue to add richness to this pressing topic.





Figure 4: Case Study Locations. Data source: MASSGIS

Hull

Interviews:

Chris Krahforst, Conservation Administrator

Climate impacts: Storm surge, erosion, sea level rise, exacerbated coastal changes

Primary Impacts:

Flooding, storm surge

Adaptation projects:

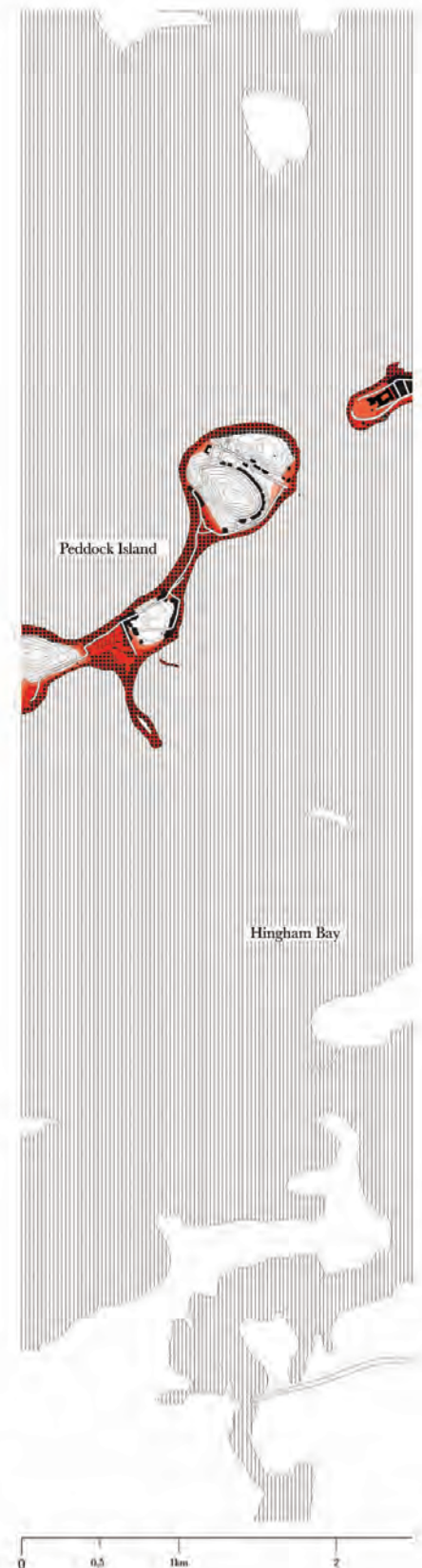
Beach nourishment

Barriers:

Funding, easements, technical challenges

Hull is the smallest town in Plymouth county, a narrow strip of sandy beach on the southern edge of the Boston Harbor. Despite its small area and vulnerability to coastal impacts, it has one of the highest population densities in the state, with 11,050 people, or just over 1400 people per square mile. Hull is made of a series of islands connected by sandbars called the Nantasket Peninsula, which was originally a significant trading outpost around the time of the city's founding in the early 17th century. Now, the series of islands include multiple estuaries that provide important habitats for fish and seabirds. Nantasket beach is famous for its fine sand and beautiful dunes, and the town derives significant economic benefit from tourism as a regional destination.

However, this serene beauty also puts Hull at elevated risk from sea level rise and its compounding impacts such as high tides and storm surge. One of the primary focuses of climate projects has been beach nourishment, as the beaches are not only a regional amenity and tourist attraction, but are essential, as they provide the only land-based form of transportation between the many islands. Hull has a well robust city-based dredging and sand management program, and the community currently continues to support beach nourishment programs, including \$450,000 for the first round of a two-year beach nourishment program for the public beach on Nantucket Sound.



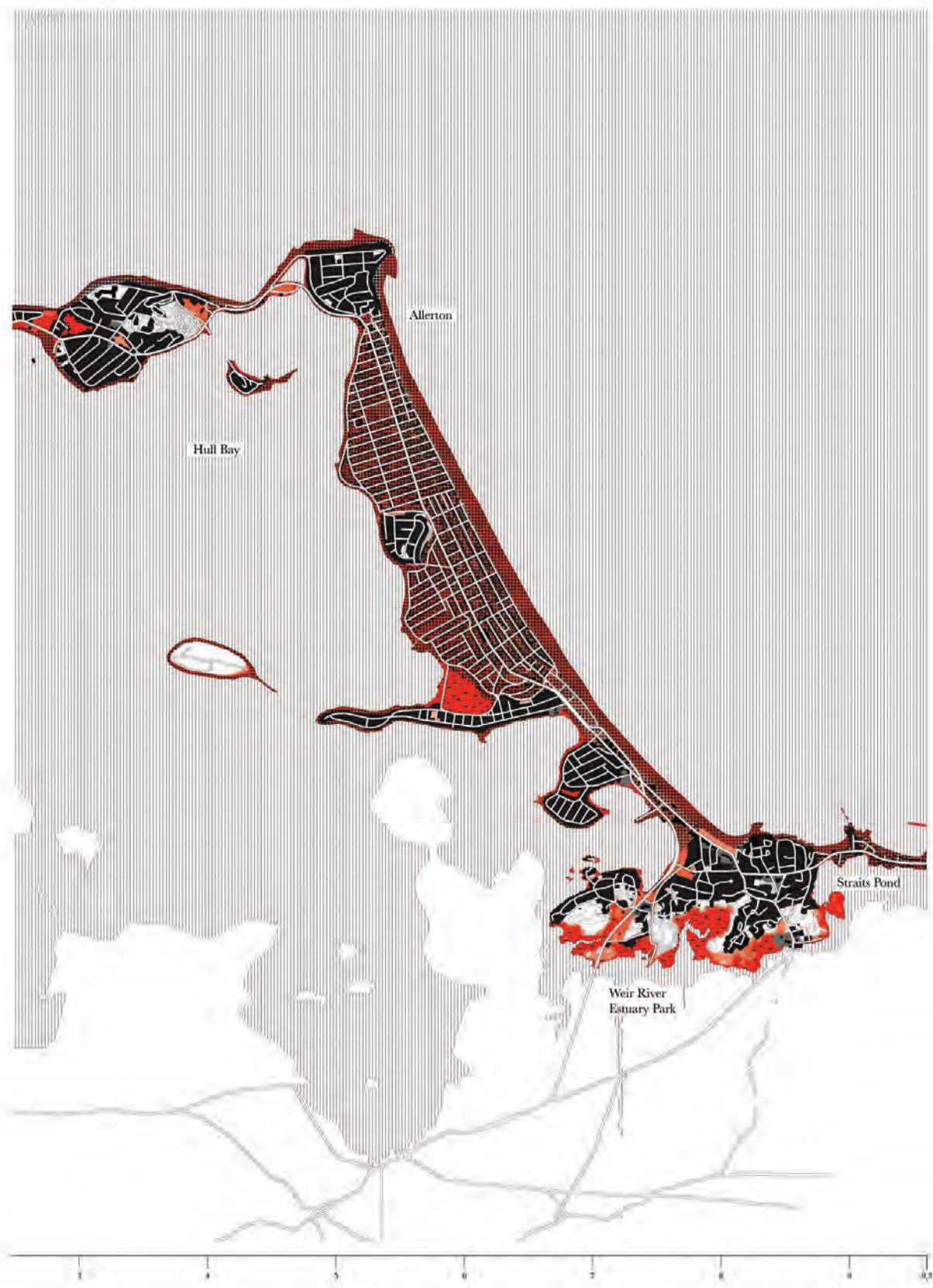


Figure 5: The Town of Hull. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Scituate

Interviews:

James Boudreau, Town Manager
Brad Washburn, Director of Planning and Development
Kevin Cafferty, Director of Public Works

Main impacts:

Erosion, coastal flooding, storm surge, ecosystem loss

Adaptation projects:

Beach nourishment, seawall construction

Barriers:

Permitting, easements, funding

Scituate is a town of roughly 18,000 people located midway between Boston and Plymouth on the South Shore of Massachusetts. Like many other cities in the area, the first formal settlement was established in the first decades of the 17th century and has always maintained a connection to the coast through maritime industries such as fishing. Today, the town is predominantly residential in nature. Geographically, Scituate is split in two as a result of the Portland Gale of 1898, which shifted the mouth of the south River northward and separated the Humarock peninsula from the rest of the town. Now Humarock can only be accessed through the neighboring town of Marshfield. Scituate is also a town meeting government and has a Community Preservation Act to maintain its historic character. This deep attachment to history has caused challenges for some of the climate adaptation goals of the city, especially coastal property owners who want to preserve their ownership of the coastline.

Scituate has been at the forefront of much recent climate commentary, as Baker appeared in Scituate to announce the filing of the legislation, “An Act Promoting Climate Change Adaptation, Environmental and Natural Resource Protection and Investment in Recreational Assets and Opportunity” after Winter Storm Riley on March 3 caused a fifty-foot breach in one of the town’s seawalls. Before that, in January, hundreds of people lost power to their homes after another break in the seawall flooded homes and businesses. Despite the threat of sea level rise, Scituate is committed to the rebuilding their coastal defense infrastructure to protect homes and the town from recurrent flooding. The Department of Public Works Director was proud to share hints about how to build a better seawall, including using galvanized steel rebar to preserve the metal and prevent rusting; increasing heights as high as homeowners will support; and driving the new seawall further into the ground to minimize the risk of erosion and undertow-driven collapse. Here, the strategy is to maximize upfront investment to replace the wall over a period of many years, prolonging the asset and the community behind it.



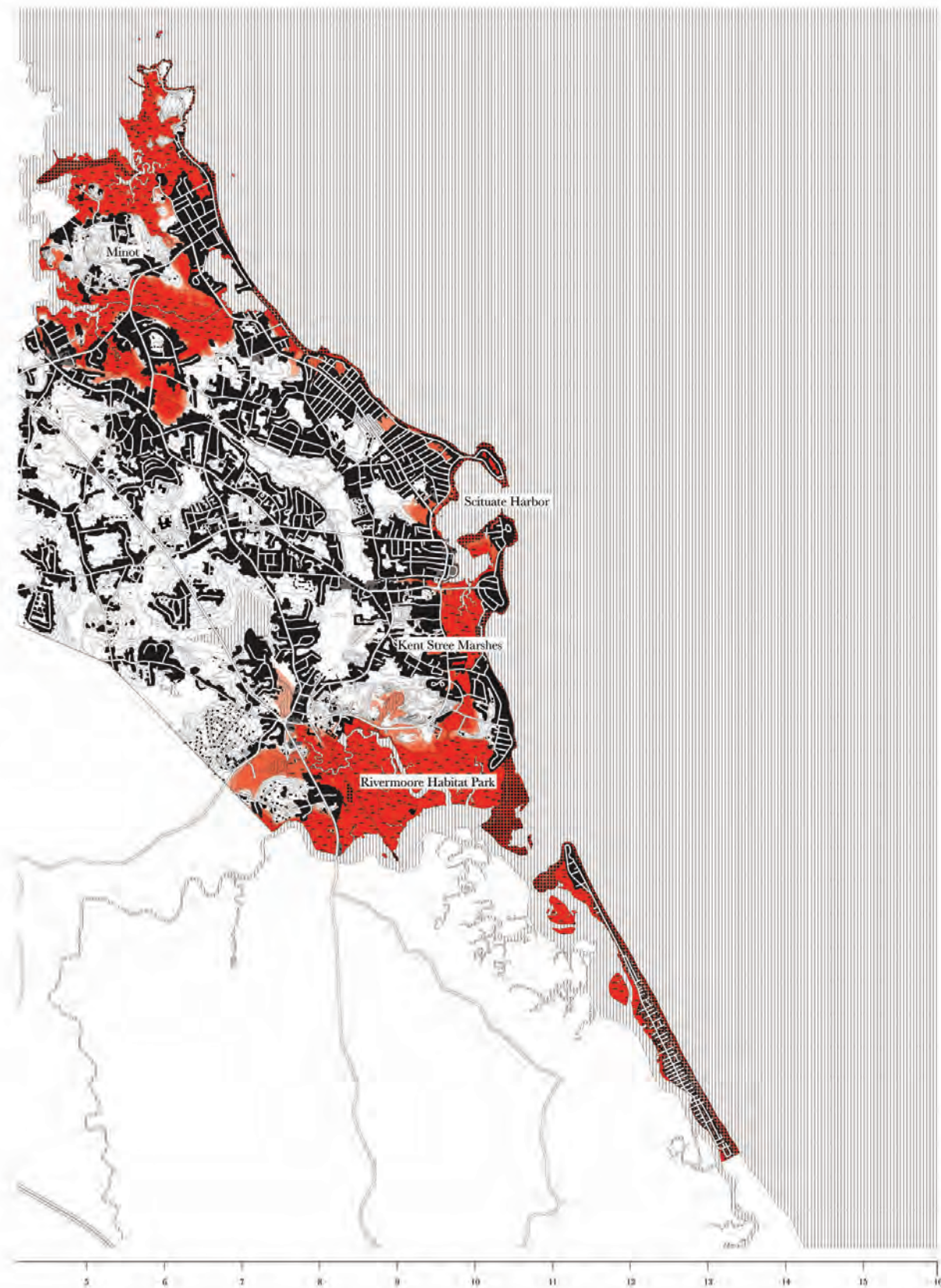


Figure 6: The Town of Scituate. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Duxbury

Interviews:

Valerie Massard, Director of Planning

Rene Read, Town Manager

Other staff (name withheld)

Main Impacts:

Storm surge, coastal flooding

Adaptation projects:

Seawall

Barriers:

Funding, public support, Easements

Duxbury, MA, population 15,000, is located on the Duxbury Bay, between the towns of Kingston and Marshfield on the South Shore. Like many other cities with Northeast facing land, Duxbury was hit hard by the series of Nor'easters in March 2018, with significant damage to the town's seawall, flooding throughout low-lying areas, and extensive power outages. Because of the town's unique geography, with a narrow strip of land called the Gurnet that protects the Bay from the Atlantic, the city faces two major challenges regarding climate impacts and sea level rise: the first is that the homes that are located on the Gurnet are becoming increasingly vulnerable to storm surge events, as the 50-year-old Seawall that protects them is starting to fail precipitously as the wave heights and intensity increase. The second concern is that the Duxbury bay, which otherwise provides pleasant opportunities for calm water boating and recreational activities, is also seeing impacts: although it doesn't face the same severe waves, waterfront properties are becoming increasingly vulnerable to tremendous storm surge events, with the water rising higher than ever before. The heightened flooding in the bay causes secondary problems for the homes on the Gurnet, which now face flooding from all sides.

The Duxbury seawall, built in the 1950s, is a concrete barrier protecting Atlantic-facing homes on the Gurnet from high tides and waves, spanning a total length of more than half a mile. Although the town has completed routine maintenance such as the sealing of cracks and armament in front, the structure is beginning to experience significant failure. While some of the maintenance issues have to do with time, the seawall also lacks a solid foundation because the entire Gurnet area is made of peat. The age of the infrastructure and resulting weak spots resulted in 700 feet of seawall either partially or completely destroyed.



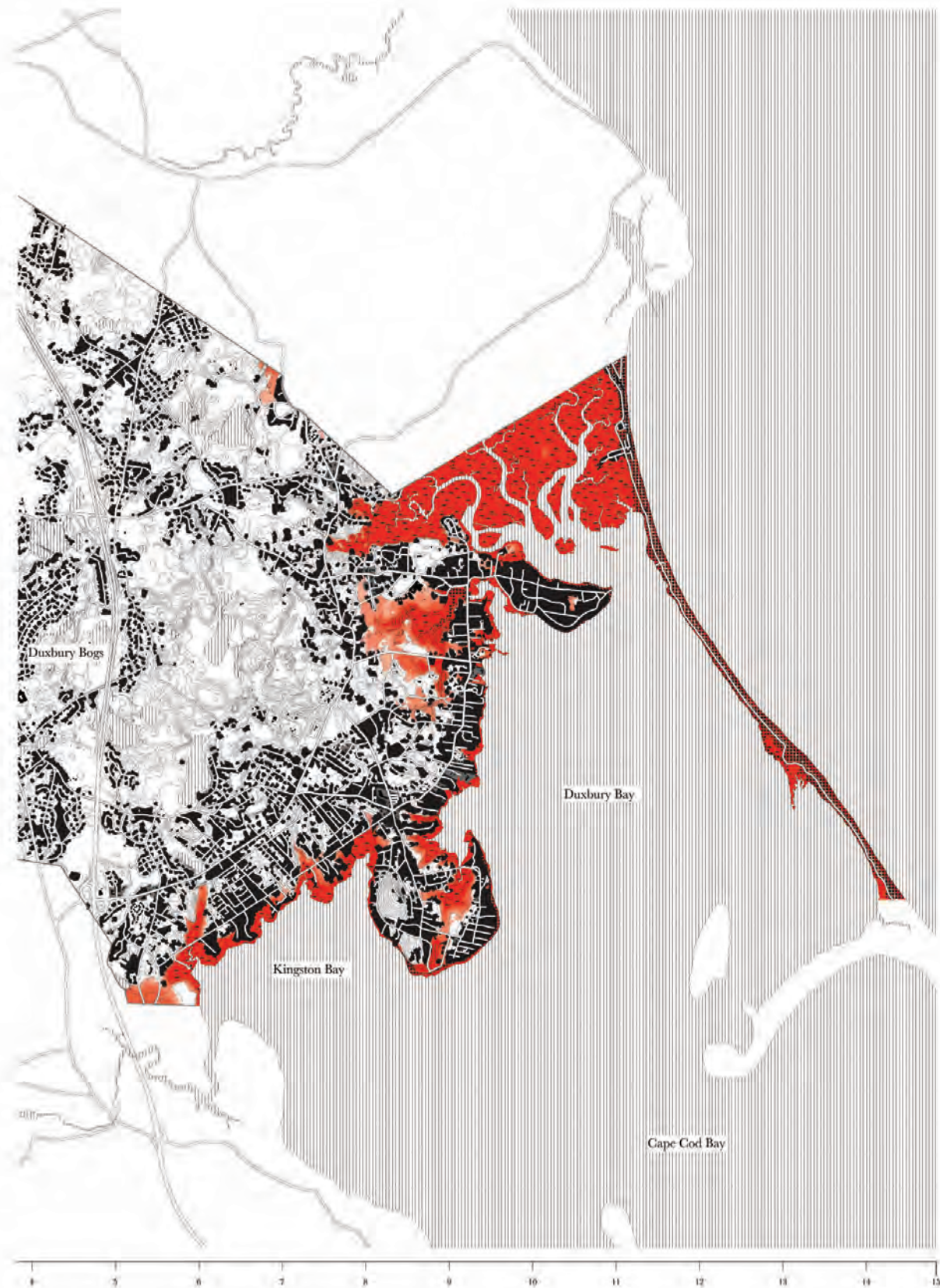


Figure 7: The Town of Duxbury. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Sandwich

Interviews:

George, “Bud” Dunham, Town Manager

Ralph Vitacco, Planning Director

Leanne Drake, Planning Assistant

Main impacts:

Erosion, coastal flooding, storm surge, ecosystem loss

Adaptation projects:

Beach nourishment

Barriers:

Permitting, environmental regulations, easements, funding, public support

Sandwich, Massachusetts was the first town established on Cape Cod in 1637. The Cape Cod Canal was completed in 1914 by private merchant firms, but was acquired by the federal government, who began work on it in 1928. While undoubtedly a historic landmark, the Cape Cod Canal today has many problems. The most pertinent is the issue of sand shoaling, a naturally occurring process that results in submerged ridges, banks, or bars. Engineers have made two significant efforts to minimize the amount of sand flowing into and through the canal: the construction of a jetty on the north end of the canal, and periodic dredging projects that take sand from the bottom of the canal and place it offshore. The jetty has prevented the natural littoral flow of sand from the northerly coast down into the town. As a result, Town Neck Beach has lost hundreds of thousands of cubic meters of sand. In addition to their regional tourism pull, the beach dunes act as a critical buffer between the sea and downtown Sandwich. The loss of littoral sand flow has brought the breakwater point closer to shore: in high tide and storm surge events, waves break extremely close to the dunes and cause massive erosion. As the dune height decreases, coastal flooding occurs more rapidly and threatens the historic downtown and homes. Additionally, the dunes protect a wetland marsh, a fragile ecosystem which also serves as a natural buffer. As the marsh's health is degraded from wave action and sand, it is unable to act as a secondary defense for low-lying inland properties.

Sandwich's predicament is a classic case of maladaptation: the construction of the jetty to protect the Cape Cod Canal from littoral flow has caused significant down-current impacts for Sandwich, increasing its vulnerability and limiting its ability to respond to the significant threats it currently faces. Because the impacts of the jetty have been felt for decades, the town remains mired in a regulatory battle with the Army Corps of Engineers to get the federal government to allow and pay for beach nourishment projects which would protect the seaside town for the time being. Unfortunately, because of sea level rise, the storm surges are becoming more intense, and for many in the town, the costs of perpetually funding such nourishment projects seems unfeasible. At the same time, the town is locked in battles with homeowners over the granting of public easements to allow the beach nourishment projects to move forward.



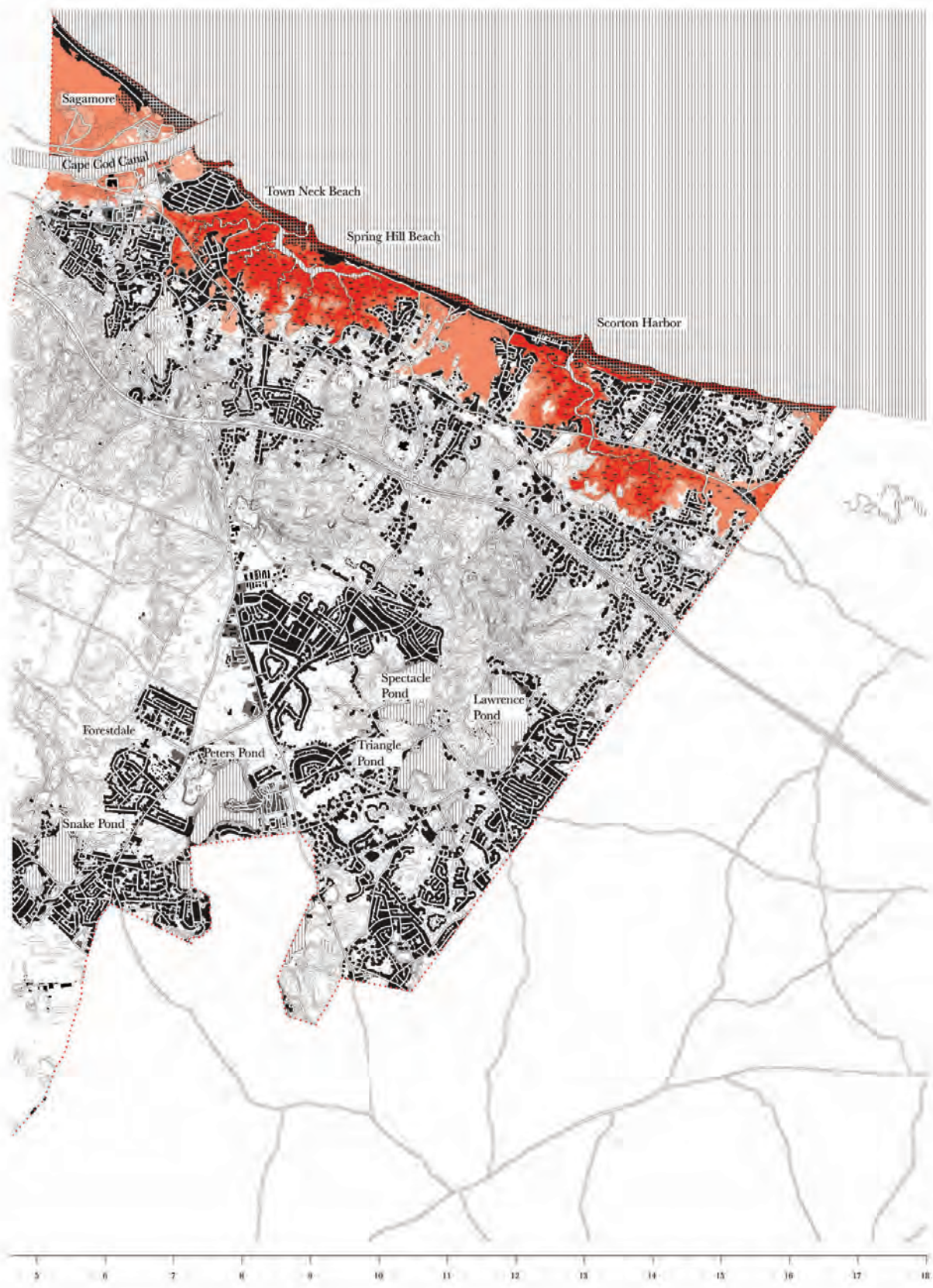


Figure 8: The Town of Sandwich. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Barnstable

Interviews:

Elisabeth Jenkins, Planning Director
Mark Ells, Town Manager
Andrew Clyburn, Assistant Town Manager

Climate impacts:

Storm surge, erosion

Adaptation projects:

Private sea walls

Barriers:

Education, funding, regulatory support

Barnstable is a collection of seven villages: Barnstable (including Cummaquid), Centerville (including Craigville), Cotuit, Hyannis (including Hyannis Port and West Hyannisport), Marstons Mills, Osterville, and West Barnstable. Barnstable was the second town founded on Cape Cod, behind its neighbor Sandwich, and was incorporated in 1639. The town of almost 50,000 people is well known for its picturesque coastline, beaches, and estates, which attract thousands of visitors every year. Like many other towns in this part of the county, Barnstable is deeply tied to its history. An April 2018 news article laments the loss of an old ship's captain home, a historic building, to be replaced by condominiums and redevelopment (Gould, n.d.). The challenges associated with changing planning objectives and low to no-growth strategies coupled with environmentally sensitive areas means that any project that impacts the natural environment is difficult to implement.

All of the staff interviewed agreed that the biggest issue facing Barnstable is water quality: both drinking water as well as the water that makes gives the multi-million dollar coastal properties their hefty price tags. Here, water quality is synonymous with quality of life. And if the water quality decreases, resulting in a lower quality experience, there is significant concern that property owners and tourists will go elsewhere. In addition to more frequent winter weather events, drought has become a significant issue for the entire Cape. Decreasing summer rainfalls and additional development mean that the aquifers which feed the drinking water supply are not being replenished as quickly as they are being depleted. Because the northern shores of Barnstable are primarily occupied by the Great Marsh and the Barnstable public beach, there are no homes affected by storm surge events such as in neighboring Sandwich. The relative protection that the homes on the southern coast of Barnstable face mean that storm surge and climate impacts are not felt as dramatically. Thus, the pressures of adaptation are not felt as acutely as in some of the other towns.



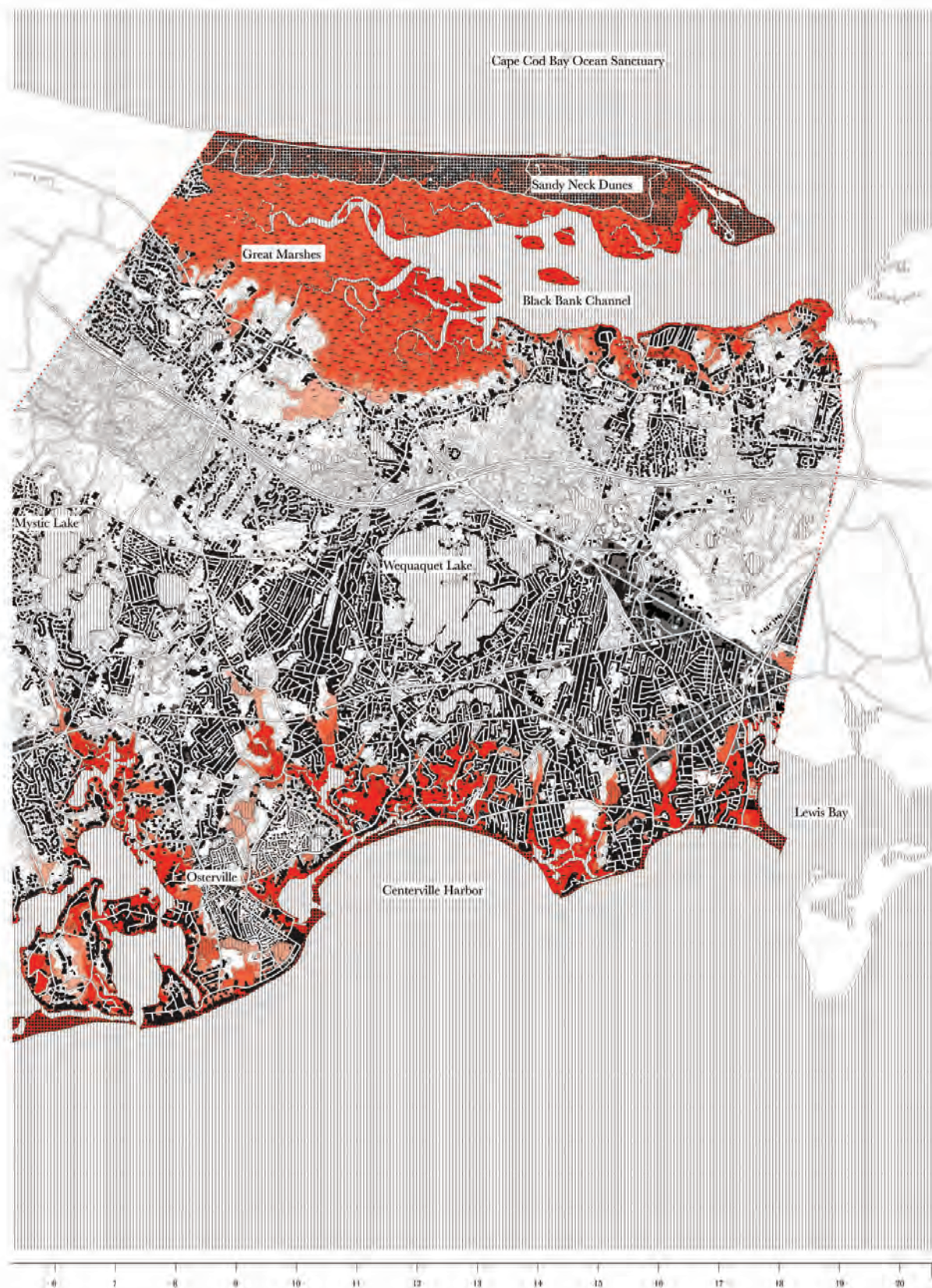


Figure 9: The Town of Barnstable. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Chatham

Interviews:

Aly Sabatino, Principal Planner
Theodore L. Keon, Director of Coastal Resources

Main Impacts:

Coastal flooding, exacerbated shoreline changes in beach and inlet systems, dune erosion

Adaptation projects:

Beach nourishment, dredging

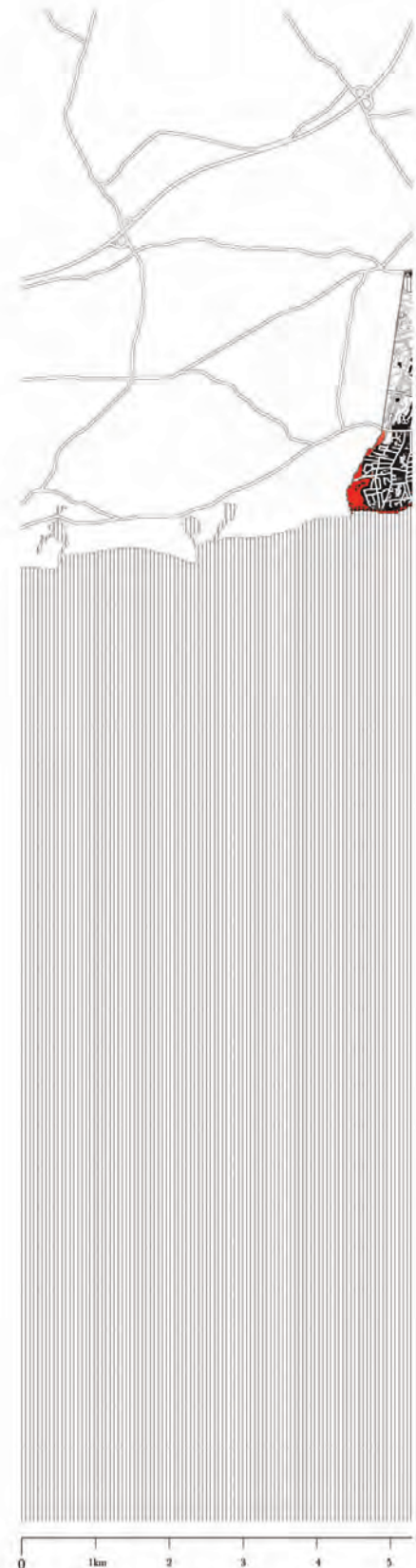
Barriers:

Technical issue, easements

Chatham, a small town of roughly 6,000 people, founded in the 17th century by English colonists, is located at the southeast tip of Cape Cod. The town has an extensive coastline and series of barrier beaches, and islands, many of which are lined by wealthy residential summer homes and properties. The town's character as a resort destination started in the 1800s and has grown steadily ever since, with only about one half of the town's 6300 housing units occupied year-round, although the population easily reaches between twenty and thirty thousand people in the summer months.

Chatham's main challenges are derived from its extremely close relationship with the water, characterized by several islands, including Strong Island, Tern Island Sanctuary, Morris Island, Stage Island, and Monomoy Island, home to the Monomoy National Wildlife Refuge. The area is used to constant shifts and erosion: an island named Slut's Bush vanished underwater in the mid-1800s, and although there is a recognition that climate change is occurring, there is also a long history of understanding and responding to natural shoreline changes. However, these impacts are being exacerbated by storm events and climate change, resulting in heightened coastal flooding, which creates major public safety hazards for residents and first responders during storm events as parts of the town become inaccessible.

Because of these unique geographic features, Chatham has its own town-wide comprehensive dredging and sand management program, which allows them to conduct an ongoing beach nourishment program. And overall, Chatham is just like every other town in that it is constantly managing the needs of a small community. One of the most significant is a local aversion to any densification, which limits other environmental and planning initiatives such as affordable housing, public water programs, and sewage. Most of the coastal challenges are managed through the natural resources department and the Coastal Resources office, but there are partnerships growing with other departments such as planning, especially those that require long-term visioning and planning, such as the Coastal Zone Management, Hazard Mitigation Plans, and Municipal Vulnerability Preparedness programs. Chatham's last comprehensive plan was done in 2003, meaning that it will probably be undertaking a new master planning process within the next five years or so.



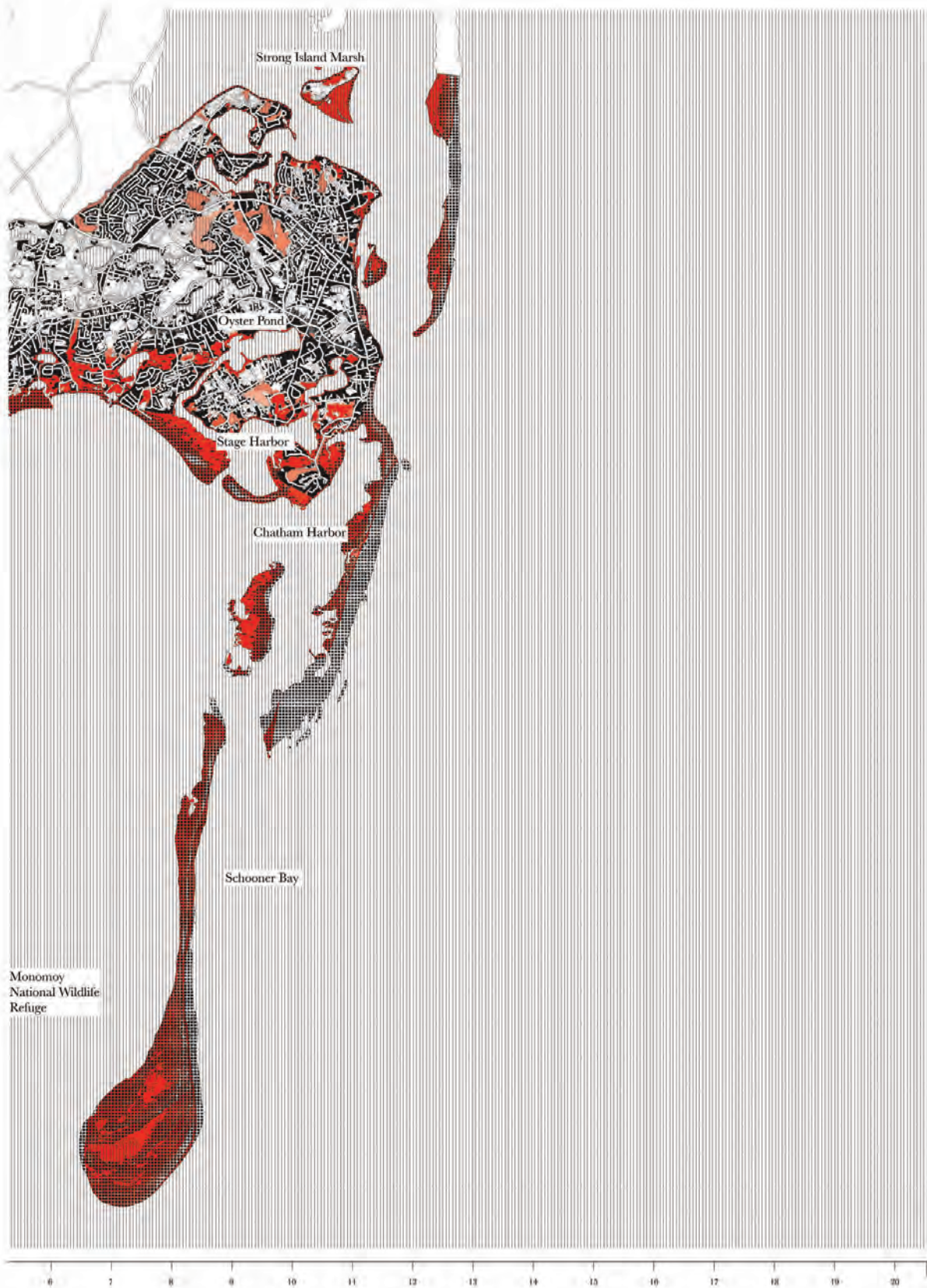


Figure 5: The Town of Chatham. Hurricane surge zones shown in red. Built up area shown in black. Data source: MASSGIS

Discussion: Cross-cutting Themes

While Moser and Eckstrom (2010) Identified four cross-cutting themes regarding barriers in the preliminary stages of implementation, this research has identified a series of new barriers for coastal municipalities attempting to implement adaptation projects. The first is that private property interests are a significant barrier because publicly funded adaptation projects require public easements on all property that benefits from public funding. Second, the potential of decreasing property tax revenue continues to be a concern for towns that rely on valuable waterfront property as a pillar of their municipal income. Third, the town meeting process illuminates many concerns about equity regarding who should pay for adaptation projects. Fourth, planners are aware of zoning and land use strategies for long-term adaptation, but just projects are still unpopular and unlikely to pass a town meeting vote. Fifth, uncertainty about damage caused by extreme weather events is more of a challenge to manage than slow-onset changes such as gradual sea level rise.

Private property Rights and Easements

In Sandwich, unanticipated challenges with easements brought a beach nourishment project to a halt, even after all other hurdles had been met. Because a small number of property owners did not grant the easements, the entire project funding fell through and the nourishment project became significantly more expensive.

The last time the canal was dredged, it was supposed to cost us one million dollars, because the feds said...they would pay 2/3 of the cost, and we'd only have to pay 1/3... but so, as you'd expect, there's federal, state, and local requirements and laws that require if they're going to put public money, and public sand on

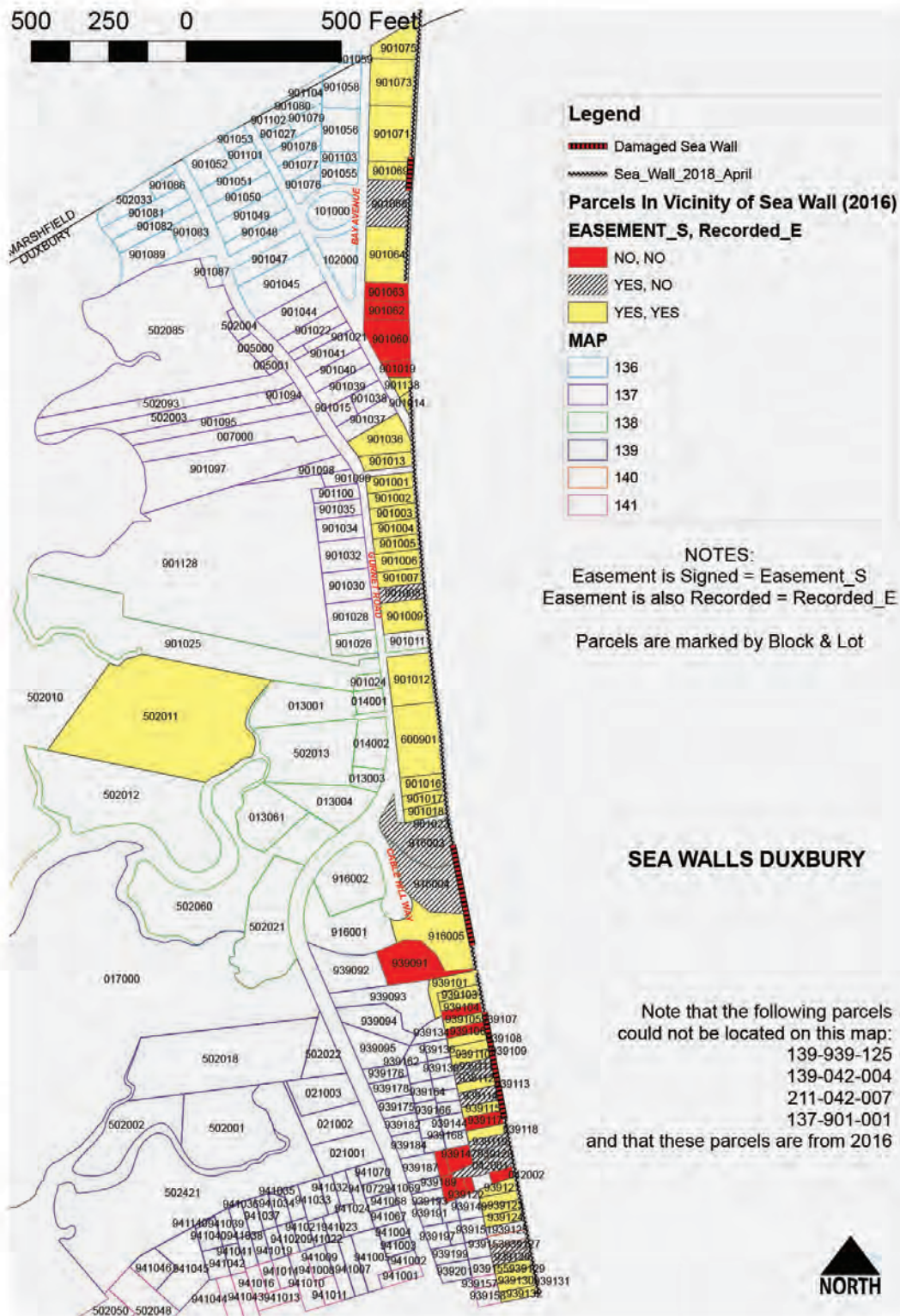


Figure 10. Property boundaries showing presence of easements and seawall. Source: Duxbury Municipality, 2018

private beaches, they need permanent easements. And believe it or not, these people who'd been crucifying us for over a decade, saying the worst things in the world about us, refused to give the easements. So we were like, completely dumfounded because now, instead of paying a million, which we had, we needed three million, which we didn't have." (Dunham, 2018)

In this case, the town decided to use the 150,000 cubic meters of sand to replenish the public beach, Town Neck Beach, instead. In response, the homeowners sued the town, saying they were doing the public replenishment project "out of spite" and requesting an injunction on the project (Brennan, n.d.). Although in the end the town won the lawsuit, they had to come up with the required money to still pay for the entire project: the lawsuit was only to keep the sand from being dumped back in the ocean. Although the holdouts inspired a decent amount of ire from their neighbors, some people were more sympathetic. The choice to grant easements may be emotional for some homeowners, which may have been in families for generations. Private beaches are also one of the main reasons why property values are high, and homeowners may have skepticism about the ability of the public sector to maintain these coastal projects over time, so some people would rather fund these defenses on their own.

"They felt 'well, this is my home, you know, and I don't want anybody having the right to hang out by my home...' and now, these people they get hit worse by the storm [and they] put the sand privately on their beach.... The easement, in their mind, cost more than the 10-20,000 dollars per year to put the sand [on the beach themselves]." (Vitacco, 2018)

In Scituate, the Director of Public Works provided a detailed analysis of the seawall program, which also included many challenges regarding easements. One of the problems with existing seawalls is that they often run through the middle of people's properties rather than along the edge. Some homes have even been constructed or expanded right on top of the walls or even overhanging the seawall, which makes the walls extremely difficult to maintain or repair when they fail. However, the town won't repair the wall without permanent easements.



Scituate



Figure 11: Humarock peninsula in Scituate. Data source: MASSGIS

“For us to spend public funds on it, we want clear and present ownership of the land that the wall sits on. So a lot of times we come back to people in these instances and we request easements... we typically have a three part easement; we request access to the wall at any time; we request an easement for the wall itself; and a public easement for use of the beach, because if you’re a taxpayer and you’re paying for somebody’s wall it shouldn’t be on private property that the public doesn’t have access to.” (Cafferty, 2014)

That the town requires public use of the beach in exchange for public funding to repair coastal infrastructure, is a matter of contentious debate, and not all property owners agree to turn over their rights. Cafferty explained that year-round homeowners are more likely to grant public easements than those owners who only use homes during the summer months. Year-round homeowners weather the storms throughout the winter and are more likely to appreciate and work with the public sector to protect their property. Those homeowners who only come for the summer months do not see the damage and are less likely to grant an easement.

Duxbury also has easement constraints with their seawall. The Duxbury seawall, a concrete barrier protecting Atlantic-facing homes on the Gurnet from high tides and waves, spans a total length of more than half a mile and was built in the early fifties. On Gurnet, the city requires easements ten feet on either side of the wall so that the department of public works can drive a tractor to bring boulders and material. Without easements, the town cannot drive across an owner’s property, potentially making it difficult to serve those homeowners who would otherwise allow the city access.

“Eminent domain is one possible strategy to address this issue. Cafferty described one case where the town used eminent domain to move forward with a seawall project, but it took a year and a half of litigation, which is both time consuming and costly. Eminent domain was also brought up by the Coastal Commissioner of Hull. He shared that the Hull Town Manager was discussing taking property rights through eminent domain to facilitate a complete beach nourishment project on Nantasket beach. Private property rights would be taken in order to create a continuously vegetated dune that some homeowners are resisting.” (Krahforst, 2018)

Although easements are a major challenge for some towns and a matter of contentious debate, other towns have developed



Chatham



Figure 11. Navigational channels in Chatham. Data source: MASSGIS

programs that appear to be more amenable for property owners. In Hull, for example, the town sees beach nourishment projects as more of a private-public partnership than a property rights challenge.

“There are two ways to do it. The first way is to do it on private property, and by state law, the owners are required to provide a “strolling easement” for the public, which means anyone has the right to walk along that shoreline. Or, if the private interests pay for the project, they can pay for it, and they don’t have to grant the easements.” (Keon, 2018)

This matter-of-factness is one way of approaching the easements challenge. Because the towns of Sandwich, Scituate, and Duxbury require full easements, they face more pushback from property owners about handing over their rights. While there may be some space for negotiation here, the strolling easements category may be seen by some as an unfair tradeoff for public dollars spent on private land.

The challenges associated with obtaining the necessary easements from property owners to unlock public funding may constitute what Moser (2005) describes as a “societal surprise.” While uncertainty of scientific climate predictions is a frequent topic of debate and study, less attention has been given to “societal surprises,” which describe uncertainty in human and social behavior, including significant shifts in public perception, potential economic collapse, property rights challenges, or innovative technologies (Moser, 2005). While practitioners may have taken for granted homeowners’ willingness to turn over their private property rights to undertake defensive projects such as beach restoration and seawall repairs, recent experiences in the towns described show otherwise. The tension elucidated is one where individual property rights come into direct conflict with the broader objective of public good. Without a doubt, private property debates and regulations regarding easements for publicly funded projects may put coastal property owners and municipalities at heads with one another. It is likely that litigation cases will become more common in the future and planners should prepare to act accordingly.



Sandwich

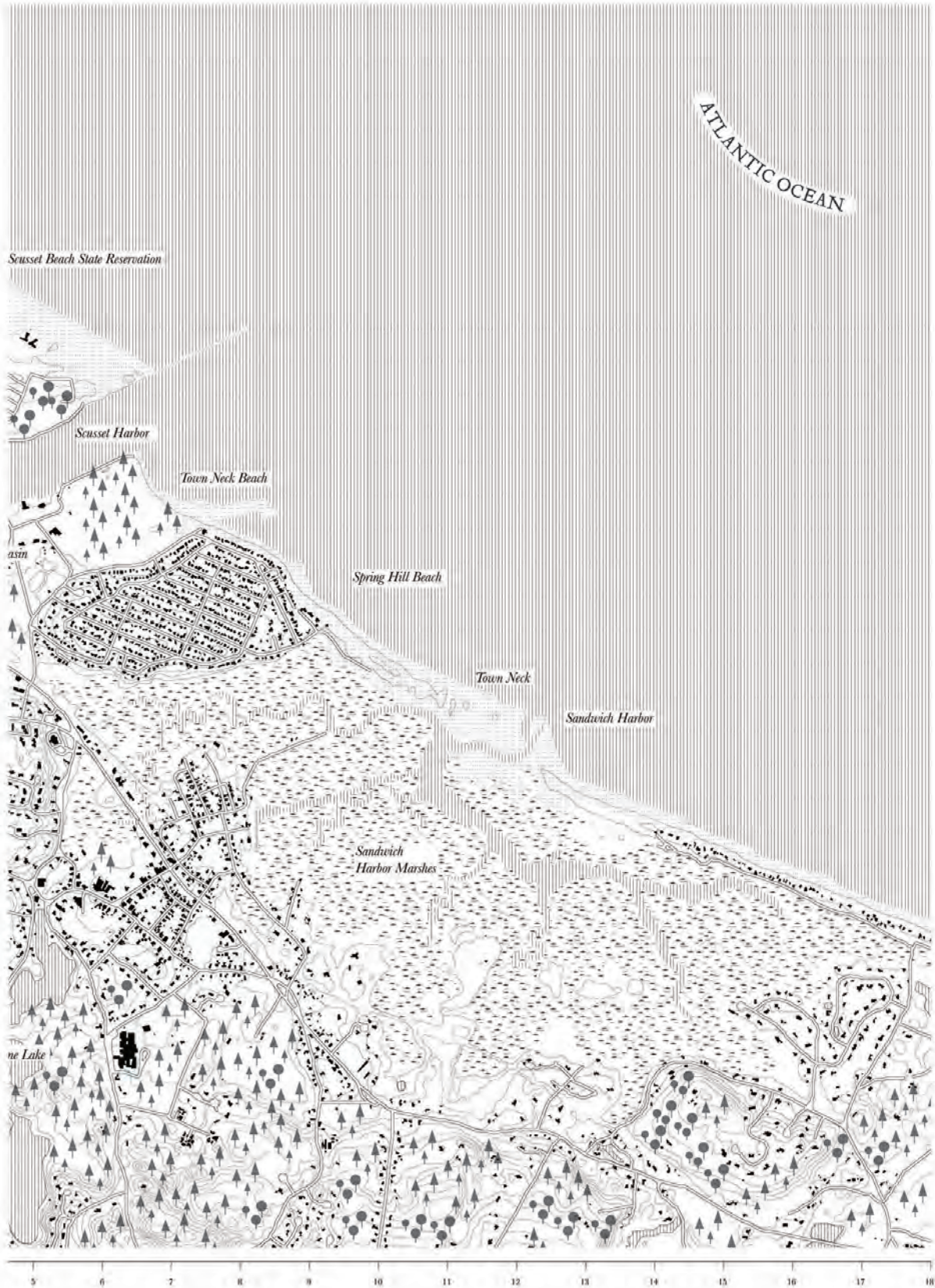


Figure 12. Town Neck Beach and marsh in Sandwich. Data source: MASSGIS

Risky Properties: A Threat to the Municipal Tax Base

Despite the challenges, the municipality still has a strong incentive to protect the homes because they bring in a substantial amount of tax revenue. Thus, staff are in a difficult predicament on how to address the need to get easements to implement publicly funded projects. One of the benefits of speaking with Town Managers and Town Administrators was the ability to learn about how finance impacts decision making at the local level. A good example of this is property tax revenue. Over the long run, many coastal properties will be lost to sea level rise and storm events, so municipal governments must strategize on how to manage their tax base. Do coastal properties in the town make up a significant enough portion of the tax base that it warrants the city taking excessive action to protect it? And when does it make more sense to retreat? The amount of tax revenue gained from coastal properties depends heavily on the town, but for some, such as Marshfield, shorefront properties can make up a substantial portion of the tax base. In the case of Marshfield, homes threatened by coastal flooding and storm surge make up thirty to forty percent of the entire tax base (Tiernan, 2018). But this is complicated by the ways that property tax revenues are collected. State law allows a certain pool of money to be collected, but it doesn't dictate where that money comes from. For this reason, from a municipal revenue standpoint, things won't necessarily hurt the town coffers, but may hurt residents' pocketbooks, because

"[T]he state allows you to raise [a certain] amount of money.... Say, 100 homes went away. It doesn't change the amount we can raise, it just reapportions who pays what... so the town doesn't get hurt by losing revenue, but the town gets hurt because all the other people now have to make up that difference. And you know, when there's 13,000 properties in town and 100 go, how much do you really see it?" (Dunham, 2018)

Although Dunham felt differently about Sandwich, any significant increase in property taxes was politically unfeasible in Duxbury, where 97% of the town budget comes from property taxes. While the Duxbury staff acknowledged that there was a lot of tax revenue currently on the Gurnet, they also recognized that property values were decreasing ("Some of these are in the multi-million-dollar range. Not today, but they were before March")(Read, 2018). Unlike other communities that may be able to attract investment or generate tax revenue from commercial or industrial activity, Duxbury is extremely resistant to change from its low-density, residential nature. As Rene said, "we're 97% residential, and people like it that way." (Read, 2018). The town is also almost completely built out, meaning there are little opportunities for new development. The home rule regulations for super majority votes on zoning changes also means that the likelihood of generating revenue through new development to compensate for lost properties is low.

"Nobody wants businesses here, nobody wants higher density homes. We're set. We're done... We're not going to have industry here, we're not going to have anything that resembles commercial other than what you see for retail. That's the vision everyone has here. So we're working with a fixed income." (Massard, 2018)

If the town won't pass zoning changes, towns will have to find other sources of revenue to make up for lost homes on the beach. But increasing taxes is too much of a burden, partially because many residents are home rich but cash poor.

"The other thing to keep in mind for this south shore region is that it is an aging demographic, and we have people that are on fixed incomes, and are house poor.... How much can you raise the taxes on the people that are on fixed incomes, retired in your communities?" (Massard, 2018)

Barnstable is not immune to these concerns as well, even though they aren't feeling direct impacts currently.

“Our tax base lines our shoreline. I mean when you look out to Wellfleet and Jerome we are starting to...lose real estate out there, it's a good moment to take a step back and think, what should we be doing in the long term? That's...why we have the mitigation plan, to be able to make some of those decisions about whether we should adapt or retreat or something in between.” (Jenkins, 2018)

The potential property tax revenue challenges are on the mind of many municipal offices, but it is not necessarily a front-burner issue because all efforts are going into rebuilding coastal defenses and preserving the tax base. At this time, staff are still considering ways to preserve the tax base because property values are still high, but this may not be the case for long. There is a growing academic literature (Byrne 2012; Nolon, 2012; Klein, 2015; Keenan et al., 2018, Bernstein et al. 2018), as well as increasing news coverage about potential impacts on property values in Florida (Urbina, 2016; Flavelle, 2017; Bolstad, 2017; Mafi, 2017), and more recently in Massachusetts (Conti, 2018). This uncertainty about episodic (disaster) v. chronic (gradual sea level rise) risk can turn coastal real estate into a “junk bond,” something that may initially increase in value, but which have a chance of going to zero. If property values plummet, there may be additional concerns for municipal budgets.

Even buyout programs will not necessarily solve the problem. Challenges with property tax revenue losses have been felt in places such as New Jersey after the Hurricane Sandy buyout programs. In these places, municipalities fought the state buyout programs because when land becomes public through acquisition, the state does not pay property taxes on the land, decreasing revenue (Flavelle, 2016). This can make cities hesitant to engage in buyout

programs that fundamentally challenge their ability to continue operations throughout the rest of the city.

Equity Concerns in Financing Adaptation

But these decisions do not rest solely on the staff alone. Massachusetts is a home rule state, meaning municipalities have (limited) autonomy about decision making through a citizen voting process called a town meeting. Article 89 of the State Constitution, also known as the Home Rule Amendment, was passed in 1965 to ‘grant and confirm to the people of every city and town the right of self-governance in local matters’ (Home Rule Amendment). Referendums are approved by town vote, but the limitations of referendums are set by the state legislature (Barron et al., 2006). Although Home Rule is relatively weak as it pertains to real decision-making power, home rule is a symbolic institution and system that communities have developed deep attachment to. Second, property rights will be challenged by sea level rise, and although current litigation cases are ruling on the side of municipalities in eminent domain cases, the real impacts of climate change on coastal property owners is currently unclear.

For those municipalities with a home rule charter, the annual budgeting process helps determine local priorities and policy objectives and is set every year at a town meeting. Increases on property taxes to finance additional projects, are governed through Proposition 2 ½, which determines the amount of increase on allowable property taxes every year through a debt exclusion (“Levy Limits: A Primer on Proposition 2 1/2,” 2016). If a debt exclusion is required for funding emergency projects, such as those after a storm, a general vote with 2/3 majority is required for approval. While many coastal projects have been funded this way, increasing severity and occurrence of events and rising costs of living, coupled with uncertainty about the future, have

made the financing of these projects increasingly difficult. The challenges are multi-fold: not only are there equity issues about who should pay, namely coastal property owners versus inland residents, but there are also equity issues about indebting the future for projects that may never stand to benefit them.

In Sandwich, home rule and town meetings have become a representation of tradeoffs between the greater good and a small number of homeowners who stand to benefit from the expensive coastal defense projects such as the sand nourishment at Town Neck Beach. (“How do you get the total residents of Sandwich, like our total public, to support a project that might only impact a small portion of our town?” (Dunham, 2018)) Although the coastal property owners experience major impacts from storm surge, flooding, and property damage, the town does not feel the impacts so acutely as the few homeowners who are located directly on the beach. As Town Manager Dunham says,

“Debt exclusion and override requires a lot of political courage and political leadership and, I’ll be blunt, sometimes they -cause they hear from every side , so they’re hearing from people here saying ‘please save my home’ and they’re hearing from all the people out here like ‘we fixed that three times in the last five years, are we throwing good money out to bat?” (Dunham, 2018)

Since the relative proportion of properties impacted compared to the total properties is so low, when coupled with expense and reoccurrence, these projects become increasingly untenable for most residents to support, especially with limited budgets.

Like in Sandwich, community buy-in is a tremendous barrier for Duxbury. The biggest concern is whether the majority of the town be willing to pay to protect the private residences that benefit from the repair of the seawall. Even if federal or state assistance comes in, the town still must front the money through the debt exclusion vote process.

“Well for the immediate part, FEMA came in here a couple days after the event...and told us they would consider... [reimbursing us] for it up to 75% [of the damage....once that happens... we have to come up with \$5.7 million, but we don’t have \$5.7 million sitting around. So what we have to do is go ask the voters for what’s called a debt exclusion, meaning its outside the levee limit, meaning that it will affect that taxes, of each tax payer in the town, to the tune of about \$225 (more) per residence, per house, and it’s probably for a 20 or 30 year note.” (Read, 2018)



Barnstable



Figure 13. Downtown Barnstable. Data source: MASSGIS

Although the \$225 might not seem like a tremendous amount, these additions will be compounded over time as additional project need funding. At a certain point, it is unlikely that voters will continue to approve these projects, because

“This wall affects 190 people plus or minus directly. The people who live inland, three miles away, don’t care about this wall. Half the town doesn’t even know where it is. So you have to educate them on where it is, why do I want it, and why should I pay for it?” (Read, 2018)

The challenges raised here are challenges of public versus private benefit. It is unclear at this time how and to what extent communities will support these nourishment projects without further concessions from private owners. Additional research will be helpful for better understanding why some communities support these projects compared to others (for example, length of coastline versus total area of the town), but in some cases, only time will tell.

Zoning and Land Use Strategies: Possible, but Improbable

The utility and challenges of traditional planning techniques are well-illustrated by the case of Duxbury. While rebuilding the seawall is a clear primary priority, limited funding for reconstruction efforts means that the planning department is also considering planning tools to guide development and reconstruction in a way that can minimize future risk. While zoning changes are impossible in the Gurnet due to limited land mass and low elevation, the Snug Harbor area of town has more opportunities for use of planning techniques. In this area, which is the historic “downtown” of Duxbury, Planning Director Massard has been looking at using zoning for retreat as an option to inform home and business owners about their possibilities of rebuilding.

“And so they’re like looking to rebuild, and when they rebuild, go up. And they’re asking, well where should I put it on my property?... [and] I’m saying, if I were you, I would talk to the neighbors who have a hill, and see if you can move it up there. And what can I do, as a regulator, to make that easier? Can I... take that little tiny area that’s zoned for that kind of use and re imagine it with no property lines for instance, or with zero setbacks, or a miniature TDR (Transfer of development rights)?” (Massard, 2018)



Duxbury

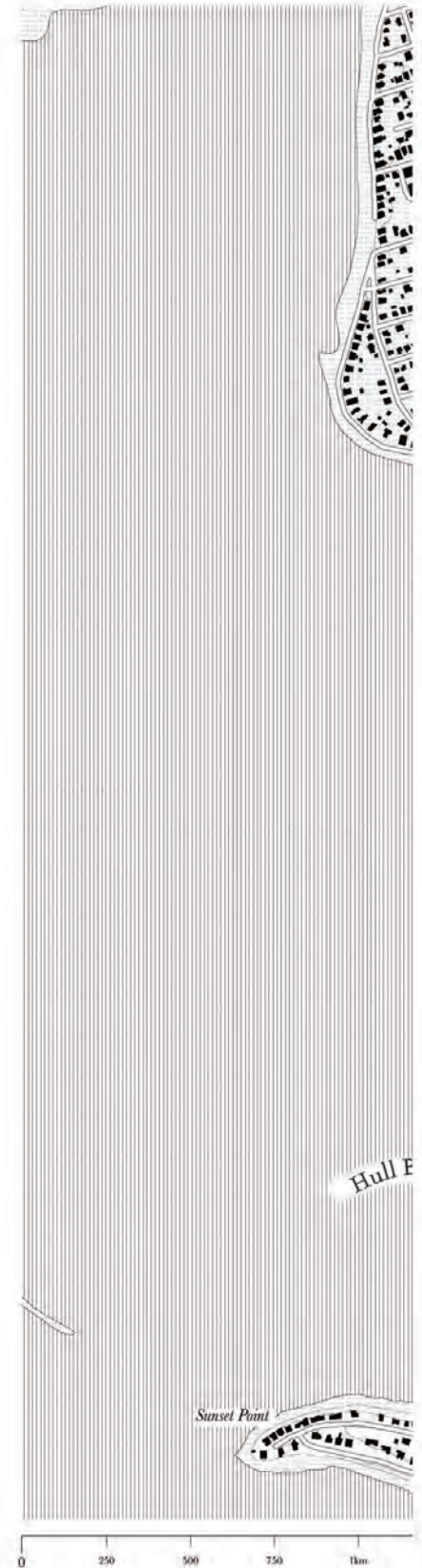


Figure 14. Gurnet and Duxbury Bay in Duxbury. Data source: MASSGIS

While in theory this process would allow homeowners and their neighbors to negotiate around architecture, design, and planning impacts to specific properties, any action to facilitate that would allow a town meeting vote, with a 2/3 approval to pass. This requires a significant amount of community resources, time, and buy in. Rezoning is a difficult choice for some communities to stomach, but such planning techniques don't require any cost except for time and permitting, compared to the massive infrastructure costs of coastal defenses and buyout programs. While planning options thus seem the least politically feasible in the short term, they have the potential to save towns a tremendous amount of time and resources in the future. Zoning for retreat is still a new strategy, and there are very few case studies of it being implemented with success. Since municipalities are not required to update their comprehensive plans under Massachusetts state law, many towns plans are out of date and do not include climate adaptation planning. Duxbury, although it is dealing with many immediate issues on the Gurnet, is also updating its comprehensive plan, and as Massard explains, this provides a window of opportunity.

“I think it’s great because we’re in the middle of doing a comprehensive plan. And phase two of the comprehensive plan is what are we going to look like the future? It’s rare that a town is in the middle of doing a comprehensive plan update.... It can be anywhere from 15 to 20 years before they do it again. So, we’re able to use a lot of this information and this bad storm -- the timing is good if there is a good time to have a storm – because it is on everyone’s mind, and I’m seeing people who I’ve never seen engaging in the planning process, from the business community and from the private sector. So, there’s at least some understanding of what we’re talking about when we say the ocean is going to rise and the storms are going to get worse and we’re going to have drought, because it’s happening. And unfortunately, it’s happening a lot faster than I think science anticipated.... And then when you ask, ‘is this the time for a framework to change?’ I think so.” (Massard, 2018)

Policy adoption is influenced both by planning capacity and commitment to address hazards (Burby & Dalton, 1994). While planners interviewed may have interest in adopting land use or zoning changes, their capacity is limited by home rule regulations and public buy-in. As Planning Director Vitacco said about Sandwich, just because zoning might be a good strategy doesn't mean it will happen if the public doesn't support it. This barrier is compounded by the fact that many



Hull



Figure 15. Nantastic Beach in Hull. Data source: MASSGIS

places are already built out and do not have the ability to shift development opportunities elsewhere through zoning changes due to a lack of community support.

“We have a town council, and they decide on everything....so every decision that is made has to go to town meeting. It’s like ancient Greece, every voter can if they want come and vote on it....so, we could put up the zoning and say, ‘the zoning will save the town’, and if less than 2/3 of voters say yes, then it will happen...if you get people that say ‘no, let’s just wait and see,’ then it’s not gonna happen.” (Vitacco, 2018)

State hazard mitigation mandates through the adoption of land use plans could be an effective way to force local land use planning changes because the responsibility can be shifted from local to state officials (Burby & Dalton, 1994). This type of hybrid mandate, which would require municipalities to update their plans but not determine exactly what needs to be done, could be an important way forward in terms of spurring on local action. The state should also provide more leadership in this mandate to pick a sea level rise projection that is responsible and consistent for the length of a comprehensive plan update, of at least 20 years out. The Coastal Zone Management “Recommendations for Addressing Climate Change Impacts to Stormwater Best Management Practices” is an online fact sheet which educates communities on how to update their coastal storm water BMPs. Their section on design recommendations already suggests using a 50-year planning horizon. A similar standard could be used for land use and zoning changes. While the government is providing numerous resources for communities, the truth is that these recommendations have no weight without regulatory backing or enforcement.

Extreme Uncertainty: How to Prepare for Stochastic Catastrophe

Interviews revealed a pervasive sense of uncertainty about the future among municipal staff. Uncertainty encompassed a wide range of conditions and considerations: in terms of financial feasibility of adaptation projects, the potential of future extreme weather events, and public support for implementation, whether it be short-term or long-term adaptation goals. While uncertainty referred to the likelihood of climate impacts, the challenges of uncertainty are aptly illuminated through discussions about municipal funding streams. Staff face concerns about the viability of expensive protective coastal defense strategies that can load current residents with debt far into the future without any guarantee that the protections will hold up past the next storm season. Also, there is an increasing skepticism that communities will be willing to fund projects through the traditional town meeting funding structure, as unaffected residents become resistant to pay large sums for projects that do not directly benefit them. Rather than slow-onset uncertainties such as sea level rise or temperature increases, uncertainty is predominately defined through the likelihood of major storm events causing significant destruction of coastal infrastructure.

“I think what scares us.... We could do a 10 million project, who’s to say in 5 years it is still going to be there, and we’re still paying debt on it for another 15 years? And that’s the depressing thing, when you really think about it.” (Dunham, 2018)

Compounding this issue is the immediacy of emergency repair projects, because the time required to educate the citizens about project funding may make it impossible to complete

the necessary repairs in time for the next storm season. The process is a simple race against the clock, with a lot of luck. These perspectives are important because they further complicate the ideas of uncertainty. Until this point, most of the literature around uncertainty in adaptation has more to do with slow onset challenges and making predictions about sea level rise impacts. However, sea level rise predictions usually establish a mean high tide prediction, and do not provide information on predictive storm surge modelling from extreme weather events as was experienced during the winter storms of March 2018. At this time, adaptation processes are often funded through emergency management funds or neighborhoods are rebuilt with the assumption that these events are highly unlikely to occur any given year, let alone multiple times a year. Because climate change is difficult to predict, it is impossible to know whether it is “worth it” to rebuild over and over. However, it seems that many households remain willing to take the chance for reconstruction as long as funding and insurance payouts are available to facilitate it.

The Gurnet unfortunately does not face impacts only on its Atlantic-facing side. The Southwestern part of the peninsula faces the marshes of Duxbury Bay, and the Duxbury Marsh is also seeing much higher flood heights. Trade-offs in different time scales flow through every decision that gets made. Although the staff are currently consumed by the constant deluge of short-term problem solving, there is profound knowledge about the challenges that will be faced in the long term. One of the challenges in any decisions to be made is the political willpower to plan for the future. At this point, there is enough information to allow decision makers to prepare for the longer term impacts of sea level rise, but it is difficult to make long-term decisions when

they are constantly in emergency management mode.

Barnstable is not as impacted by storm events as its northeastern-facing neighbors. Because As a result, decision-makers, at least the interviews, were committed to maintaining a positive relationship with the environment, living sustainably, and taking mother nature’s work in stride. Part of this comes through education about coastal issues.

“Massachusetts is a coastal community no matter where you live....We need to incorporate this into our learning process at a young age, if ultimately as responsible adults who reside in a coastal community, we’re going to understand this and how it’s going to fit into all that we have: as infrastructure, asset management, regulation, and then into policy.” (Ells, 2018)

While Barnstable faces less climate urgency from storm surge events, which hit northeastern facing towns particularly hard, climate predictions show significant challenges to Barnstable’s southern coasts. The time span for action here may be less immediate now, but one bad storm event could cause considerable damage. Town Manager Ells’s perspective on the state’s responsibility reflects a much slower timeline; rather than asking for money or immediate assistance, he is interested in seeing the state implement stronger standards to educate young students about climate change and its impacts, in the hopes that a future generation of people will be more likely to take dramatic action and make the difficult choices that are impossible to make in the present moment.

*Conclusion:
Confronting Barriers in Uncertain Times*

This thesis set out to understand how barriers to climate adaptation are shifting in Massachusetts given an increase in political leadership at the state level, an increase in informational and financial resources, and increasing frequency of extreme weather events. Interviews with sixteen staff in six municipalities revealed several findings. First, barriers do appear to have in fact shifted from 2011, which may be a positive reflection of both the Patrick and Baker administrations' leadership and efforts to provide resources and information for municipalities. Rather than the previously mentioned "values/beliefs" and "leadership" barriers municipalities now face new barriers such as funding for implementation and property easement requirements which were not as prominent as findings from Hamin et al. (2014). The research also uncovered that implementation may be a greater challenge than previously expected, requiring more elaborate analytical models for understanding, and that a new methodology for describing, cataloging, and reporting on barriers may also be necessary to understand how barriers in one locality shift over time. Lastly, rather than the cross-cutting themes identified by Moser and Eckstrom (2010) (value/beliefs, leadership, information, resources), new categories may be required for documenting barriers at the later stages of adaptation implementation, such as 'regulations', 'property rights', 'prioritization', and 'funding'. Throughout all these categories is the challenge of uncertainty, which is not a barrier that can be overcome with better or more elaborate scientific climate models but is more fundamentally a question of how society will grapple with a future full of change.

Institutions represent a stable world full of rules which allow us to act with a reasonable amount of certainty. As a result, some expect the public sector to be able to preserve and maintain a world that is fundamentally shifting because of climate change. ("The people who are most impacted by it, who chose to buy houses on the water, think we can control the weather and the tides, and we can't -- or where they buy their houses" (Dunham, 2018)). The government has a role in building the adaptive capacity of individuals by either enabling people to move and to leave these places behind, or by allowing them to stay at the risk of future damage and loss. Fundamentally, the tension speaks to the impossible challenge of preserving a changing world; should we shift around the world or should we struggle to prevent the world shift around us? After every disaster, can we strive to rebuild a world that no longer exists? These questions of adaptation move beyond the scale of the individual home. Individual property loss can have a resounding impact on municipal budgets and individual actions can cause damage to an entire neighborhood, revealing a significant lack of community cohesion, of which the implications are unclear. Longer-term strategies such as zoning changes and retreat options can help cities adapt for an uncertain future, but these options appear to be politically unfeasible at this time. The lessons showcased here highlight that municipalities still face significant barriers for implementing their adaptation plans and that additional research on implementation challenges is needed to facilitate responses to an uncertain future.

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