Sea Level Rise and Housing Affordability in Small Coastal Communities: A Case Study in Maine

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Sea Level Rise and Housing Affordability in Small Coastal Communities: A Case Study in Maine

A Thesis Submitted to the Department of Urban Planning and Design, Harvard University Graduate School of Design by:

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In Partial Fulfillment of the Requirements for the Degree of Master in Urban Planning

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Nicholas Mitch [Student]

[Thesis Advisor]
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Land Acknowledgement

This thesis considers contemporary communities in Knox County, Maine, which was settled on the traditional territory of the Wabanaki Confederacy. The historic indigenous communities of Knox County are connected to the modern Abenaki Tribal Nation in Quebec and other Wabanaki Tribal Nations—the Passamaquoddy, Penobscot, Maliseet, and Micmac.

This thesis was primarily written in Cambridge and Somerville, Massachusetts, the traditional and ancestral land of the Massachusett People.¹

¹ The language of this acknowledgement was heavily guided by the land acknowledgements of the Harvard University Native American Program (https://hunap.harvard.edu/land-acknowledgement) and the University of Maine Darling Marine Center (https://dmc.umaine.edu/welcome/darling-marine-center-land-acknowledgement/).
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The Joint Center for Housing Studies of Harvard University

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The Environment, Energy and Natural Resources Division

of the American Planning Association

For supporting my education through their Student Fellowship
Abstract

Significant portions of the United States’ coastal housing stock are vulnerable to inundation in coming decades. This will cause a direct loss of housing, result in higher prices for homes that are not vulnerable to flooding, and require investment to protect flood-vulnerable housing. In the context of nationwide housing affordability challenges, this scenario raises equity concerns for those impacted both directly and indirectly. Planners employ community adaptation frameworks that primarily draw from highly-populated urban areas. While some center equity concerns, few consider the distinct, poorly understood challenges that small coastal communities face. Using four towns in Knox County, Maine, as a case study, I find (1) that likely inundation from sea level rise varies in extent by town, but the value of affected parcels is consistent in pattern and (2) that climate-induced housing challenges have a greater likelihood of being solved if addressed at a regional level.
Climate resilience planning seeks to enhance communities’ abilities to endure a variety of climate-related hazards with minimal negative impacts to the wellbeing of residents. Using four towns in Midcoast Maine as a case study, this paper explores the integration of housing affordability into climate resilience planning in small coastal communities through two overlapping investigations. First, it considers how the existing housing ecosystem is likely to be impacted by inundation from sea level rise by 2050. In this part, data from town assessors, the National Oceanographic and Atmospheric Administration, and the Maine Office of GIS is used to quantitively consider how sea level rise will impact the housing stock in each of the study communities. Second, it explores solutions to reduced housing affordability in these communities within four existing adaptation frameworks suggested by Brody et al. 2021: communicate, resist, accommodate, and avoid.²

A conceptual model of the potential relationship between climate related flooding and housing affordability guides this paper (Figure 1). This model is informed by existing research and observations on the relationship between various physical and behavioral dynamics of the housing ecosystem. Importantly, this model emphasized how inundation from sea level rise will cause both direct and indirect impacts. Of particular note in the context of housing affordability is the potential displacement of low-income households in non-flood-vulnerable areas by higher income households who formerly living in flood-vulnerable areas.

Housing is a highly complex system, affected by a wide variety of economic, legal, social, and cultural factors of which climate risk is only one. As such, exploration of the
housing ecosystem impacts of climate-related phenomena is inherently imprecise.

Nonetheless, it is an important task. Where and how people live is the foundation upon which communities are defined. For many communities, sea level rise and climate-related flooding represent two of the most acutely threatening impacts of climate change. As practitioners seek to support the development of widespread and equitable community resilience, housing must be a central consideration.

**Literature Review**

*Climate change is an indisputable reality.*

There is strong scientific consensus that global anthropogenic climate change is occurring.\(^3\) Two significant impacts of climate change are sea level rise and other climate-related flooding, both of which have “risen sharply” in recent decades and will accelerate in both frequency and intensity in the years to come.\(^4\) Although the foundational science of climate change and its global trends are well-established, local impacts will vary based on a variety of environmental conditions.\(^5\) Recent efforts have sought to improve the specificity of understandings and predictions of local trends.\(^6\) Responding to these improved scientific

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understandings, planners now must assist communities in understanding how trends are likely to impact residents in the context of local social and economic conditions. In this vein, understanding impacts to the housing ecosystem is particularly relevant.

*Sea level rise will have multifaceted impacts on local housing ecosystems.*

Many researchers have sought to quantify how many Americans will be exposed to sea level rise and related climate impacts in the United States’ vast and diverse coastal regions. This area is broadly defined as the location of physical, cultural, and economic interface between the terrestrial and marine environments; however, specific applied definitions vary greatly. To this point, the Coastal Zone Management Act – the guiding federal legislation for the management of coastal areas – allows each state to define its own designation of the coastal zone. A lack of a uniform definition of what constitutes a coastal place results in inconsistent statistics related to population size and demographics. Despite inconsistencies in exact statistics, the importance of coastal regions as a whole is clear. For example, 39-52% of the United States population lived in coastal regions in 2010 depending on the adopted definition. Even looking only at counties with a coastline, nearly 30% of the total United States population (94.7 million people) lived in coastal areas

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10 Ache et al., “‘The Coast’ Is Complicated.”
11 Ache et al.
in 2017. Further, at least 19 million people in the conterminous United States lived within one kilometer of the coast in 2009. Similarly, Neumann et al. (2015) estimated that 8.3% of the United States population (23.4 million people) lived in the “low-elevation coastal zone” in 2000 and estimated that would grow to 34 million people by 2030 and 43.9 million people by 2060. Population growth in coastal areas outpaces that of non-coastal areas. Correspondingly, this coastal population resides in millions of homes that collectively make up a substantial coastal housing stock.

Because of the large size of the coastal housing stock, there is significant popular and academic interest in understanding the impacts of sea level rise and climate-related flooding on coastal property values. Limited studies on this subject have revealed mixed impacts but suggest that properties at greater risk of inundation are beginning to be devalued at least in some areas. Bernstein, Gustafson, and Lewis (2018) found that “homes exposed to sea level rise (SLR) sell for approximately 7% less than observably equivalent unexposed properties equidistant from the beach.” McAlpine and Porter (2018) found that property values in Miami-Dade, Florida were decreasing as a result of sea level rise risk. Baldauf, Garlappi, and Yannelis (2020) also found that homes exposed to sea level

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15 Cohen, “About 60.2M Live in Areas Most Vulnerable to Hurricanes.”
rise sold at a 7% discount, but only in areas with high levels of belief in climate change.\textsuperscript{19} In the real estate and insurance industries, expansive proprietary efforts to improve property-level analyses of climate risk are underway.\textsuperscript{20} In February 2022, McKinsey and Company stated that “changes brought on by the climate transition will open new dimensions of competitive differentiation and value creation for real-estate players.”\textsuperscript{21}

*There is already a national affordable housing challenge.*

Any consideration of housing vulnerability and resilience must be situated within the nationwide context of a pervasive lack of affordable housing. Though complex, this condition is well documented by a robust collection of scholarship. In short, the supply of homes for both sale and rent is not keeping up with demand. The Joint Center for Housing Studies of Harvard University finds that, as a result, increases in home prices are outpacing increases in income.\textsuperscript{22} There was “an absolute shortage of 3.4 million affordable rental homes” in the United States in 2019.\textsuperscript{23} Further to this point, the Joint Center for Housing Studies of Harvard University found that in 2019 “nearly half of all renter households (20.4 million) and a fifth of homeowner households (16.7 million)” were housing cost

For the purposes of this paper, the concept of Naturally Occurring Affordable Housing (NOAH) is particularly relevant. NOAH refers to “properties that are affordable without public subsidy to low-income households” and nationally “constitutes the largest supply of affordable units.” Although semantic and substantive debate abounds regarding NOAH as a concept, it is nonetheless a relevant framing for the considerations of this paper. Because NOAH properties are by nature subject to market forces with no guarantee of affordability, as their relative scarcity within the market increases they are prone to price increases that reduce and potentially eliminate their affordability.

*Climate impacts will compound housing inequities in complex ways.*

The disparate impact of climate change on disadvantaged communities is well-established. Martinich, Neumann, Ludwig, and Jantarasami (2013) found that at least 20% of people likely to be impacted by sea level rise are “among the most socially vulnerable.” Ortiz, Schultheis, Novack, and Holt (2019) found that climate-related extreme weather events serve as an “affordable housing crisis multiplier.” Mickelson, Patton, Gordon, and Hammler (2020) describe how the needs of the lowest income households are often

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24 Joint Center for Housing Studies of Harvard University, “The State of the Nation’s Housing: 2021.”
27 Martinich et al., “Risks of Sea Level Rise to Disadvantaged Communities in the United States,” 177.
excluded from risk reduction planning and disaster recovery conversations. Camill, Hearn, Bahm, and Johnson (2012) emphasize how these needs have been especially understudied outside of the largest urban areas.

Scholars have sought to understand the complex ways that the impacts of climate change will affect housing affordability and resident displacement. Perhaps the most fundamental impact of climate change on the housing market will be the manner in which it strains existing housing stock by reducing the physical footprint of communities. Put simply, accommodating a steady or increasing population in a reduced housing stock will lead to decreased affordability within the local housing market.

Much of the exploration of the intersection of climate change and housing affordability revolves around the concept of climate gentrification which “refers to the ways that climate impacts and adaptations may contribute to changes in community characteristics and potential displacement of vulnerable residents through changes in property values.” Like gentrification more broadly, the term climate gentrification is often vaguely and variously defined such that it may refer to a variety of community conditions occurring at disparate moments in both the climate impact and climate adaptation processes. Keenan, Hill, and Gumber (2018) suggest pathways through which

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29 Sarah Mickelson et al., “Fixing America’s Broken Disaster Housing Recovery System” (National Low Income Housing Coalition, 2020).
31 Boland et al., “Climate Change Impact on Real Estate.”
33 Best and Jouzi.
climate gentrification may occur.⁴ These pathways include the displacement of low-income people in non-vulnerable areas by higher income people formerly living in vulnerable areas, low-income people not being able to bear the cost burden of living in vulnerable areas, and displacement as a result of increases in property values resulting from public investment in adaptation efforts. Morris (2021) describes how adaptation planning efforts must actively engage with the need for “permanent housing stability” including supporting the development of new, non-vulnerable units as part of broader adaption plans.⁵

**Scholars and planners are developing frameworks for adaptation.**

Responding to assessed risks, many scholars and institutions have sought to develop frameworks for adaptation and resilience building. Resilience can best be understood as “both a concept and practice” that seeks to enhance “the ability of a [community] to withstand or accommodate stresses and shocks such as climate impacts, while still maintaining its function.”⁶ The concept of resilience incorporates a number of related topics, including hazard mitigation, disaster recovery, and strategic retreat.⁷ Moser, Kaspersion, Yohe, and Agyeman (2008) explore methods for adaptation in the Northeast, emphasizing six adaptation needs including “increasing available resources and

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improving equitable access to them.”³⁸ Klima and Jerolleman (2014) suggest strategies for integrating work among risk reduction and sustainability practitioners to better achieve resilience planning aims.³⁹ Greer, Binder, and Zavar (2021) describe strategies for better integrating home buyout programs into comprehensive adaptation and resilience efforts.⁴⁰ Brody, Atoba, Highfield, Sebastian, Blessing, Mobley, and Stearns (2021) suggest a framework for climate flood risk reduction based on four mitigation categories: avoid, resist, accommodate, and communicate.⁴¹


Dickson and World Bank, Urban Risk Assessments, 21.

Camill et al., “Using a Boundary Organization Approach to Develop a Sea Level Rise and Storm Surge Impact Analysis Framework for Coastal Communities in Maine.”


Bresch, and Lin (2018) suggest a method that uses historical exposure to extreme weather events to estimate climate risk.46

There are a number of examples of adaptation models – both place-specific and generic – that seek to center equity. One such example is the guide for cities entitled “How to Tackle Climate Change and Inequality Jointly” developed by the World Resource Institute in partnership with the C40 Cities Global Climate Leadership Group. This guide seeks to equip cities “to advance climate action through an inclusive engagement and planning process that results in more equitable outcomes for all” by providing comprehensive guidance for development and evaluation from project initiation to implementation.47 This report suggests that “cities must design and deliver climate actions in an inclusive and equitable way to serve all city communities and groups without compromising on economic prosperity – a concept often referred to as a “just transition.”48 Applying similar principles, Oakland, California, is of particularly relevance as “one of the first cities to explicitly link evaluative criteria with benefits for disadvantaged communities when weighing climate policy choices.”49

48 Mahendra, King, and Hart, 7.
Small coastal communities need relevant solutions.

Non-urban communities are a significant portion of both the land and population in coastal areas, with 38.6% of the United States population in the low-elevation coastal zone residing in non-urban areas. Further, 85% of New England’s coastal census-designated, subcounty municipalities have populations of less than 50,000 people. However, a strong majority of studies on climate impacts and adaptation strategies – including nearly all those mentioned above in this paper – consider only highly populated urban areas.

However, less urban coastal communities face distinctly different conditions and challenges in the context of resilience and adaptation planning. Non-urban areas, for example, tend to have significantly reduced government operational capacity. Similarly, private resources and capital in these areas are also often more limited than in urban settings. Broader demographic and economic trends in these areas also differ from more urban areas with significant implications for climate resilience efforts. For example, a historic economic reliance on extractive natural resource industries and an ongoing decline in population in non-urban areas should inform resilience planning efforts.

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51 Camill et al., “Using a Boundary Organization Approach to Develop a Sea Level Rise and Storm Surge Impact Analysis Framework for Coastal Communities in Maine.”
54 Cutter, Ash, and Emrich.
56 Cutter, Ash, and Emrich, “Urban–Rural Differences in Disaster Resilience.”
This study fills gaps in existing knowledge.

This study builds on the areas of research described above through a case study, filling the need for better understandings of the impacts of climate-related flooding on coastal housing ecosystems in small coastal communities. It concludes by exploring the feasibility and efficacy of existing adaptation frameworks in small communities with particular emphasis on housing affordability equity.

Geographic Context

Knox County, Maine is a relatively representative context for studying the impacts of sea level rise on small coastal communities. Comprised of interspersed rural and small urban areas, it is home to approximately 41,000 year-round residents. Its economy is anchored by robust commercial fishing and tourism sectors. Knox County’s poverty rate is 9.5%, in line with that of the coastal portion of all New England states (9.5%) though
slightly lower than that of the coastal portion of all ocean-adjacent states (12.3%). Knox County’s unemployment rate (4.5%) is slightly higher than the national unemployment rate (3.8%), and its median household income ($57,794) is below the national median ($67,521). 

56 With guidance from local partners, four towns within Knox County were non-randomly selected for study: Camden, Rockland, St. George, and Vinalhaven. Approximately half of Knox County’s population resides in these towns. Significant variation in characteristics among the four study towns in Knox County captures diversity within the experiences of small coastal communities. Camden (Population 4,850, median household income $63,683) is a regional center for tourism. Rockland (population 6,936, median household income $44,156) is the commercial center and county seat and is highly engaged in the commercial fishing industry. St. George (Population 2,594, median household income $52,571) covers a rural peninsula with two small village centers – Port Clyde and Tenants Harbor – and is highly engaged in the commercial fishing industry. Notably, St. George embodies the rural peninsular community typology that is iconic in Maine and may also be observed in other coastal areas. Finally, Vinalhaven (Population 1,279, median household income $65,313) is an island in Penobscot Bay accessible only by ferry; it has a

60 NOAA Fisheries Office of Science and Technology.
small but notable artist community and high engagement in the commercial fishing industry.\textsuperscript{61}

The vast majority (78.6\%) of Knox county’s 24,579 housing units are owner-occupied single-family homes.\textsuperscript{62} Households are also relatively established, with 89\% of households living in the same house today as they did one year ago.\textsuperscript{63} The median value of owner-occupied housing units was $209,900 in 2019.\textsuperscript{64} The median gross rent was $855 per month.\textsuperscript{65} Approximately 21\% of housing units in Knox County are “for seasonal, recreational, or occasional use” (i.e. vacation homes).\textsuperscript{66}

As it is nationally, access to quality affordable housing has been a long-standing concern in the Midcoast Maine region including Knox County.\textsuperscript{67} Housing is generally considered affordable if occupants spend less than 30\% of their income on it; spending in excess of 30\% of income is considered a housing cost burden.\textsuperscript{68} Knox County has been unaffordable to households earning median renter income since at least 2001.\textsuperscript{69} In 2020, 63.5\% of renter households in Knox County were housing cost burdened for a 2-bedroom unit.\textsuperscript{70} Countywide, there are 690 federally subsidized housing units across 29 properties

\textsuperscript{61} NOAA Fisheries Office of Science and Technology.
\textsuperscript{62} U.S. Census Bureau, “U.S. Census Bureau QuickFacts.”
\textsuperscript{63} U.S. Census Bureau.
\textsuperscript{64} U.S. Census Bureau.
\textsuperscript{65} U.S. Census Bureau.
\textsuperscript{69} MaineHousing, “Rental Housing Facts and Affordability Index for Maine Counties” (Augusta, ME: MaineHousing, the Maine State Housing Authority, 2021), https://www.mainehousing.org/policy-research/housing-data/affordability-indexes.
\textsuperscript{70} MaineHousing.
comprising 2.8% of the total housing stock. Of these, 569 across 22 properties are in the four study towns: 192 in Camden, 352 in Rockland, and 25 in Vinalhaven. Because these represent only a small proportion of the housing stock, it can be inferred that NOAH is the primary provider of affordable housing.

Quantitative Analysis of Impacts to the Housing Ecosystem

Methods

In this part of the study, I conducted quantitative analysis to explore the likely impact of sea level rise by 2050 on the housing stock of the four study towns. Data was analyzed using ArcGIS Pro and Microsoft Excel.

The Scientific and Technical Advisory Subcommittee of the Maine Climate Commission – an entity of the Maine state government – recommends that communities in Maine “prepare to manage for 3.0 feet of relative sea level rise by 2050.” In line with this recommendation, layers depicting inundation resulting from 3.0 feet of sea level rise above the current mean higher high water (MHHW) level were downloaded from the National Oceanographic and Atmospheric Administration Office for Coastal Management’s Sea Level Rise Viewer for the western district of Maine.

Parcel-level assessed value data for residential parcels in Camden, Rockland, and Vinalhaven was sourced from the Town of Camden Assessing Department, City of Rockland Assessing Department, and Town of Vinalhaven Tax Assessor’s Office respectively. This

data was then joined with parcel shapefiles also sourced from these same respective town offices. Parcel-level assessed value data for all parcels sold in the previous 10 years in St. George was sourced from the Town of St. George Assessing Department. This data was then joined with a parcel shapefile sourced from the State of Maine Office of GIS.

Using the “select by location” tool in ArcGIS Pro, a count was conducted of all parcels in each of the study towns that would experience inundation by any amount at the considered Sea Level Rise scenario. Following this, the mean and median of the assessed value of impacted parcels was calculated and compared to the mean and median of the assessed value of all parcels. Finally, quartiles of the parcel value were calculated for the entire stock and then the number of impacted parcels in the lowest quartile and lowest half was identified. In Camden and Rockland, multifamily parcels were additionally noted and the proportion of both all parcels and impacted parcels which were multifamily was identified.

The Maine Constitution dictates that property be assessed at just value, which courts have interpreted to mean fair market value. However, municipal assessors retain discretion to assess properties in their jurisdiction higher or lower than fair market value so long as they do so uniformly.72

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Results

There were 2,552 residential parcels in Camden, 3.9% of which were multifamily. 207 residential parcels (4.2%) were inundated to some degree at 3 feet of sea level rise, 2.8% of which were multifamily. The mean assessed value of all residential parcels in Camden was $553,945 and the median was $397,450. The mean assessed value of impacted residential parcels in Camden was $2,097,926 and the median assessed value was $1,714,00. Among impacted parcels, 3.7% had an assessed value in the lowest quartile and 5.6% had an assessed value in the lowest half of all residential parcels in Camden.

There were 2,587 residential parcels in Rockland, 14.2% of which were multifamily. 17 residential parcels (0.6%) were inundated to some degree at 3 feet of sea level rise, 11.7% of which were multifamily. The mean assessed value of all residential parcels in Rockland was $192,525 and the median was $177,050. The mean assessed value of impacted residential parcels in Rockland was $531,218 and the median assessed value was $496,700. Among impacted parcels, none were in the lowest half of all residential parcels in Rockland.

There were 1,335 residential parcels on Vinalhaven; data on whether properties were single-family or multifamily was not available. Of these, 549 residential parcels (41.1%) were inundated to some degree at 3 feet of sea level rise. The mean assessed value of all residential parcels on Vinalhaven was $167,426 and the median was $64,254. The mean assessed value of impacted residential parcels on Vinalhaven was $324,125 and the median assessed value was $249,930. Among impacted parcels, 8.2% had an assessed value in the lowest quartile and 16.8% had an assessed value in the lowest half of all residential parcels on Vinalhaven.
Finally, there were 2,873 parcels sold in the previous 10 years in St. George; data on whether these properties were residential was not available. Of these, 1,113 parcels (38.7%) were inundated to some degree at 3 feet of sea level rise. The mean assessed value of all parcels in St. George was $373,898 and the median was $254,550. The mean assessed value of impacted parcels in St. George was $604,216 and the median assessed value was $513,400. Among impacted parcels, 2.5% had an assessed value in the lowest quartile and 4.9% had an assessed value in the lowest half of all parcels in St. George.

Discussion

The results of this analysis offer insight into potential climate dynamics on town and regional housing market conditions by 2050. In all four study towns, impacted parcels are of notably higher value relative to the entire stock. Homes valued in the lowest quartile and lowest half were disproportionately less directly affected. Similarly, in Camden and Rockland proportionally fewer multifamily residences are directly impacted relative to the stock overall. Further, the median household income of the towns most significantly impacted (St. George and Vinalhaven) are higher than that of one of the less-affected towns (Rockland). These results suggest that, contrary to what has been observed in studies of highly populated urban areas, in small coastal communities the most directly impacted households are not the otherwise most economically or socially vulnerable. However, this should not be construed to suggest that lower income and otherwise more vulnerable residents will not be negatively impacted. Rather, these residents are likely to be indirectly affected as more highly resourced impacted residents move throughout all four communities.
Indirect impacts are thus of particularly notable significance given the disparate proportion of parcels impacted between the four study communities. Previous research on the housing market of areas surrounding those directly affected by disasters offers insight into potential regional housing trends as inundation occurs.\(^7\) Synthesizing this research in the context of the study communities, Camden and Rockland are likely to receive residents as they migrate from St. George and Vinalhaven. This condition is likely, in turn, to result in increased scarcity within the housing market of Camden and Rockland as additional people seek housing within the existing stock. Increased scarcity coupled with the integration of climate risk into home prices could then result in a condition of reduced housing affordability in which those homes that are affordable are likely to be more vulnerable to climate hazards.

Though not a certain outcome, the scenario described above represents a plausible outcome based on current knowledge on local housing risks integrated with research on relevant housing market trends. A clear picture emerges of a scenario in which, despite being somewhat insulated from direct inundation by 2050, lower income households in all four study communities bear the brunt of climate impacts as housing affordability decreases communitywide and remaining affordable units are increasingly in climate vulnerable locations.

Beyond the scope of this study, additional quantitative research is needed to understand the likely housing ecosystem impacts of climate-related flooding and other climate hazards more fully. Of particular note, this study did not consider those parcels that

will not be inundated but will be cut off – permanently or intermittently – as a result of inundation on transportation corridors. Additionally, future studies should consider, for example, how intermittent tidal flooding, increasingly frequent and severe extreme storm and extreme heat events are likely to play out in this region. To facilitate these future studies, improved models of local climate impacts are needed. For example, it would be useful to understand the proportion of each parcel likely to be inundated but the inundation layer used in this study lacks the necessary granularity for this sort of analysis.

**Qualitative Exploration of Solutions**

Synthesizing the analysis of the previous section, two interrelated housing challenges emerge. In St. George and Vinalhaven, a direct reduction in housing stock will exacerbate affordability challenges. In Camden and Rockland, a relative increase in scarcity within the housing stock as a result of an influx of displaced individuals from adjacent communities will exacerbate affordability challenges. In this part, the study explores potential solutions to these challenges through the lens of four categories of adaptation, as described by Brody et al. (2021): communicate, resist, accommodate, and avoid.74 For each category, an example intervention is considered with emphasis on the likelihood of success in resolving identified challenges, community acceptability, and likely cost in the context of potential funding mechanisms.

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The choice of specific approaches is tied to a variety of social, cultural, and economic factors. In this context, the environmental histories of affected communities are particularly relevant. Deep connections to place through both economic and cultural practices, for example, are an inherent part of the study communities considered in this paper (Figure 3). This connection to place brings with it increased awareness of the complex natural systems in them, and makes the disruption brought both by climate change itself as well as potential adaptation measures particularly disruptive. Exact selection of adaptation strategies is highly context specific and will require extensive levels of community engagement.

<table>
<thead>
<tr>
<th>Social</th>
<th>Physical</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Camden</strong></td>
<td>Coastal location is core to community identity.</td>
<td>Location adjacent to Route 1 and the coast defines as a connection point.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grounded in tourism, including a popular state park.</td>
</tr>
<tr>
<td><strong>Rockland</strong></td>
<td>Location adjacent to Route 1 and the coast defines as a connection point.</td>
<td>Highly seasonal natural resource economy, grounded in tourism and fishing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Anchor” town with strong tourism element.</td>
</tr>
<tr>
<td><strong>St. George</strong></td>
<td>Variation in relationships to natural system across the varied landscape.</td>
<td>Peninsular location creates vulnerable “lifelines.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Both tourism and fishing are critical.</td>
</tr>
<tr>
<td><strong>Vinalhaven</strong></td>
<td>Deep cultural connection to natural systems among year-round residents.</td>
<td>As a small ferry-dependent island, Vinalhaven is inherent at greater exposure to natural systems.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Largely defined by the fishing industry. (Lobstering)</td>
</tr>
</tbody>
</table>

**Figure 3.**
Overview of the social, physical, and economic dimensions of each study town’s environmental history and connection. Understandings were drawn from a variety of sources, including site visits in February 2022.
Various climate risk communication schemes are the most widespread of the four approaches described by Brody, et al. Emerging from the broader field of risk communications, this approach seeks to shape individuals’ behavior – and in turn market behavior – through education on risk.\(^75\) In its most common form, various governmental and non-governmental entities have partnered to provide climate risk data in easily accessible formats.\(^76\) A public website, for example, often provides approximate information on the location of inundated properties at various levels of sea level rise with some sort of accompanying interpretation. Climate risk analysis provided through these portals may be useful to both municipal governments as well as individual property owners and residents. In a less common but potentially more impactful form of the communication approach, risk disclosure is mandated as part of the property sale process.\(^77\) With connections to the growing field of proprietary, property-level risk assessments, this communication strategy seeks to very directly impact consumer decisions within the housing marketplace.

In Maine, at least two high quality coastal risk communication web tools already exist. A collaborative project led by The Nature Conservancy, the Maine Coastal Risk Explorer features an accessible web interface and invites the public to “use this tool to explore how rising sea levels will affect roads in coastal cities and towns, see where road networks will be inaccessible to emergency responders, and how that relates to the overall

\(^{75}\) Brody et al., 16.
\(^{76}\) Brody et al., 17.
\(^{77}\) Brody et al., 17–18.
social vulnerability of the community.” Similarly, the Maine Geological Survey offers a web mapping tool that “approximates the potential inland extent of inundation from several scenarios.” Both of these supplement a similar tool provided for all coastal regions nationwide by the National Oceanic and Atmospheric Administration Office for Coastal Management. Knox County residents’ views on climate change reflect this abundance of accessible information, as they express concern and understanding of climate risks beyond national norms. Sixty percent of Knox County residents believe that climate change is happening as a result of human activities, and more than 40% believe that they will be personally harmed by climate change.

Mandatory communication of property-level risk is less tested, but potentially more impactful. Such mandated climate risk disclosure is in line with a rule proposed by the U.S. Securities and Exchange commission in March 2022 that would require registered companies to disclose the risk they face from climate change including on their properties. Similarly, in at least six states laws requires landlords to disclose flood risk to prospective tenants. Taking inspiration from these regulations, leaders and policymakers in the study communities could require all properties to include a property-level disclosure of climate risk as part of the sale process. A number of private firms increasingly offer this

sort of analysis.\textsuperscript{84} However, this approach is foundationally limited by only affecting properties going through the sale process. To the extent that long-term residents of a property are unaware of climate risk, such mandated communication of climate risk would do little to spur or support resilience building or adaptation activities for them. Since residents of the study area do not tend to move frequently, this is particularly limiting.

Although potentially valuable, communication approaches should be understood to constitute a shift of responsibility from higher levels of government toward lower levels (i.e. counties, towns, and villages) and eventually individuals. Providing data and related interpretation requires relatively little investment on the part of the participating government and nonprofit entities. Once the information is provided, the burden of more costly action is shifted toward local and individual actors.

This shift has significant implications for the housing market, specifically with regard to equity considerations. Awareness of property-specific climate risk potentially accelerates or deepens the emerging integration of climate risk into home values. Although this may initially seem positive, it causes worrisome ripple effects on the housing ecosystem in the absence of a coherent, place-appropriate adaptation plan for the affected community. For example, as awareness of climate risk grows and home prices increasingly reflect specific properties’ risks, it is likely that less resourced households will have no choice but to occupy at-risk (now cheaper) properties while higher resourced households seek less vulnerable locations for their homes.

Resist

After communication, the “resist” approach is the most common strategy for addressing both climate-related and non-climate related flooding in the United States. This approach does not seriously challenge status quo development patterns and market conditions, but rather ostensibly offers a path for their maintenance even in the face of significant challenges from natural hazards. In this approach, structures such as levees, storm surge gates, dams, and retaining walls serve as “armoring” to keep waters out of inhabited areas. Although this construction requires expansive context-specific technical expertise, it is not actually particularly innovative technology. In fact, the most expansive application of this approach in the United States occurred beginning more than a century ago. In the early and mid-20th century, the United States Army Corps of Engineers led the development of extensive flood control infrastructure across the United States both along coasts and in the flood plains of inland river valleys. Although these projects do not directly address climate-related flooding, they serve as a highly relevant example of flood control infrastructure.

While these projects can reduce flooding if properly designed, constructed, and maintained, they are not without complications. A few key criticisms must be considered. Flood control infrastructure of this type is highly expensive, and the opportunity cost of investing in them over other adaptation programs must be considered. Further, these systems require not only tremendous initial investment but a high level of ongoing

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maintenance as well. Additionally, flood control structures are not well suited to the highly
dynamic nature of aquatic settings and as a result often suffer from reduced efficacy over
time while causing a number of unintended consequences on both human and non-human
communities. In the context of climate risks, design of these structures is particularly
challenging given the uncertainty inherent in current prediction models. Though efforts
can be made to support these structures adaptation over time, there is limited evidence of
success.88 This point is especially important because of the way these structures can give
communities a false sense of security, facilitating continued development in vulnerable
areas. In areas protected by flood control infrastructure, even incomplete failure of the
infrastructure is often catastrophic.89

Although the most iconic projects in this category are colossal community-scale
pieces of infrastructure, resistance projects also commonly occur at the property level. In
the absence of government leadership and investment in community-scale projects,
property-level flood protection is increasingly common among individual homeowners. In
technical principal, these projects – often floodwalls – are essentially the same as larger-
scale ones but work to armor only a specific property from floodwaters.90 Placement of a
floodwall to protect one property can have impacts on the extent of flooding other
properties in the area will experience, potentially resulting in further injustice regarding
who within a community bears the burden of climate impacts.

In the context of the study communities, a resist approach could take the form of either property-level or neighborhood-level flood protection infrastructure. In all four study communities, vulnerabilities would be identified and appropriate projects developed to mitigate risk to the full extent possible. While property-level projects led and financed by individual property owners can be problematic as previously described, property-level projects could play a useful role as part of a comprehensive community wide adaptation strategy particularly in concert with subsidy schemes and risk communication programs.

If implemented equitably at a community-wide scale, projects that resist inundation have the potential to prevent or at least mitigate sea level rise’s exacerbating existing housing affordability challenges. However, because it intends mainly to preserve existing conditions, this approach offers few opportunities to address and resolve already existing challenges.

A resist approach would require extensive investment. While specific costs and siting would vary based on environmental conditions outside the scope of this paper, considering the cost of projects constructed elsewhere can provide insight into the likely cost of these projects. Projects of this type in the United States have an average cost of $28.8 million per kilometer, with ongoing annual maintenance costs of $150,000 per kilometer. For the purpose of this study, the construction along the entire coast of Vinalhaven and St. George and in the vulnerable areas of Camden and Rockland is considered. To do this would entail the construction of approximately 38 kilometers of protective barriers. This would result in a total upfront cost of at least $1.09 billion

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($69,609 per resident) and ongoing annual maintenance costs of $5.7 million ($364 per resident).

Since this approach builds directly from established natural hazard mitigation practices, funding sources are somewhat more readily available than for less conventional climate adaptation approaches. The high cost of this program requires funding from a variety of funding sources, with significant state and federal funds likely necessary. The significant, ongoing monetary cost as well as notable externalities of this approach should be taken seriously. While it is tempting to embrace an approach that demands few other changes in communities, other adaptation and resilience-building approaches offer potentially more equitable and cost-effective outcomes with co-benefits in the housing ecosystem.

**Accommodate**

In some ways, the accommodate approach can be viewed as an evolution of the resist approach. In recent years, adaptation projects have begun to explore how communities can thrive alongside dynamic coastal environments. This approach seeks to avoid building endlessly higher structures to simply keep water out and instead centers ecological understandings to create effective flood management strategies. A variety of large and small projects fit into this category. Some of the most prevalent examples include smaller scale "green infrastructure" for stormwater management like bioswales and green

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Increasingly, studies and cities’ experiences suggest that these approaches hold great potential to address challenges while providing abundant co-benefits in a cost effective manner. Perhaps the most significant example of the accommodate approach is the Netherlands’s “Room for the River” program which began in 2007. This program marked an important shift in approach from previous generations of Dutch “integrated flood risk management” programs, moving collective efforts from a resist approach towards one of accommodation. The “Room for the River” program included 34 projects along the Rhine, Waal, IJssel, and Nederrijn rivers with a goal “to increase the capacity of the rivers to cope with high water levels and simultaneously improve the spatial quality of the riverine area.” Although the Room for the River program did involve the relocation of some homes in line with an avoid approach, it primarily worked to eliminate flood risk through the construction of new adaptive infrastructure and land use regulations.

Embracing the mindset employed by “Room for the River” offers a compelling path forward for the study communities. One particularly relevant accommodate approach involves the adoption of sea level rise-informed building codes. By establishing and enforcing new design standards for flood vulnerable areas, community safety and continuity is assured. Communities elsewhere in the United States have adopted design standards and guidelines informed by coastal flooding risk. In Boston, for example, Coastal

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94 Odefey et al.
97 Verweij, Busscher, and van den Brink.
98 Sijmons et al., Room for the River.
Flood Resilience Design Guidelines were adopted in 2019 and Coastal Flood Resilience Overlay Districts were adopted into the zoning code 2021.99

The study communities already engage in Euclidean zoning managed at the town level. Further, they are empowered by the State of Maine to create overlay zones. Exemplifying this point, two of Maine’s largest cities are actively considering the implementation of overlay zones for resilience.100 Following Boston’s example, the study towns could implement a resilience overlay zone in line with the recommendations of the Scientific and Technical Advisory Subcommittee of the Maine Climate Commission.

Costs will vary significantly depending on the type and extent of renovations needed. Fully elevating buildings, for example, would likely cost between $19,000 and $194,000 per structure.101 In the context of this study, elevating all 1,786 structures identified as vulnerable to inundation in 2050 would cost between $33.9 million and $346.5 million (between $216 and $22,128 per resident).

As discussed in the resist section, some of the cost of these adaptation measures might be borne by private property owners. However, incentives and funding to support the adoption of the new standards on existing structures should also be implemented in order to be fully effective and equitable. Without community investment to ensure widespread adoption and thus equitable protection of existing structures, even the

adoption of best practice standards may provide only minimal mitigation at a community level.

**Avoid**

This adaptation approach can be summarized as “get out of the way.” In this way, it is perhaps both the most intuitive and most controversial in the context of sea level rise. Of the four approaches considered in this paper, avoid is the one that “most effectively eliminates risk.” Several overlapping approaches make up this category, including managed/strategic retreat, managed/strategic relocation, and managed/strategic realignment. Each term carries nuanced meaning, but exact definitions are inconsistent among the many researchers and practitioners engaged on this subject. For the purposes of this paper, the term managed retreat is used. This term refers to a cohesive government-led program through which community-oriented planning rather than market forces alone guide the relocation of flood-exposed households.

Extremely strong private property rights enshrined in the constitution make this adaptation strategy administratively challenging and extremely expensive in the United States. Further, popular opposition to relocation has so far hindered the development of such programs. Operating within these confines, most managed retreat in the United States...
States has occurred in the form of post-disaster property-level voluntary buyout programs without an emphasis on resettlement of the community.107 Since 1989, the Federal Emergency Management Agency has acquired 40,000 housing units in this context.108 More comprehensive managed retreat with an emphasis on community-scale resettlement has only been implemented in an even more limited manner.109

Managed retreat programs may be either voluntary or mandatory. Both have potential benefits and pitfalls. Mandatory managed retreat programs may more effectively eliminate risk, but they also face a multitude of procedural, legal, and financial hurdles in the United States. Though eminent domain is an established doctrine in the United States that could potentially be used to facilitate managed retreat, it is “costly, politically fraught, and can have the effect of marginalizing already vulnerable populations.”110 As such, voluntary programs are likely preferable. These programs face fewer hurdles because they engage only already interested parties. Thus, in the context of voluntary managed retreat programs it is important to consider the benefits that they provide to participants to ensure that even less-resources households are able to participate. Incentives may support an increased number of households’ participation. However, if not enough vulnerable households are interested, a voluntary managed retreat program may fail to effectively eliminate risk at a community level.

It is critically important to note that the absence of a managed retreat program does not mean an absence of retreat behavior. Abundant evidence suggests that in areas facing

107 Siders, "Managed Retreat in the United States."
108 Siders.
109 Siders.
repeated, severe disruption, residents will begin to “simply leave” as the cost-benefit balance of staying shifts.\textsuperscript{111} Unmanaged retreat carries a collection of negative consequences: abandoned homes, disrupted social networks, lost cultural heritage, untenable reductions in property tax revenue for local municipalities, and more. Further, it eliminates risk only for residents with the means to undertake an economically and socially expensive move, leaving less resourced residents in harm’s way.

In the study town, a managed retreat program might involve the relocation of vulnerable households from affected communities to less affected communities within Knox County. Of the four towns considered in this paper, this would mean the relocation of impacted households from St. George and Vinalhaven to unaffected areas of Camden and St. George. Because neither Rockland nor Camden currently has an abundance of vacant homes, retreat in this manner without the development of additional housing stock in the receiving communities would almost certainly result in increased housing costs, notably reducing affordability for both existing and incoming residents.

Space does exist in both Camden and Rockland that could accommodate the construction of new housing units to support the relocation of affected households from St. George and Vinalhaven, as well as the few affected households in Camden and Rockland. Development in this manner could support continued community cohesion and shared identity among relocated residents. To facilitate infill development, receiving towns should seek to subdivide large lots and allow for the development accessory dwelling units. However, additional development that expands the footprint of these communities would

\textsuperscript{111} Siders, "Managed Retreat in the United States."
likely also be necessary. Such development raises valid concerns of sprawl that must be addressed. Camden and Rockland are both relatively densely developed, for example, and surrounded by ecologically important natural areas.

Because there are few to no precedents of such a program being carried out, cost estimates are imprecise. Existing studies tend to focus only on higher-level state and national estimates. However, even imprecise estimates strikingly reveal the magnitude of public investment such a program would require. Based on the median assessed value of impacted homes and median new home price in Maine, such a program would cost the government between $381,000 and $819,000 per home depending on the proportion of the cost burden placed on the homeowner. The higher cost program would entail additional relocation and new home construction support for retreating homeowners. Such support would be necessary to mitigated negative housing ecosystem impacts. To accommodate all impacted households in the study communities, this would collectively mean a total cost between $680.4 million and $1.5 billion (between $43,451 per resident and $95,792 per resident).

A number of important equity considerations emerge in a managed retreat program. To this point, it is important to consider who the program is likely to serve and toward what outcome it directs participants. Particularly if the program is voluntary – as it likely would be – it could result in a scenario of “protection for the rich [but] retreat for the poor” in which only those residents without the means to invest in highly costly property-level

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112 Siders.
protection take part in the manage retreat program.\textsuperscript{114} While this would not necessarily mean the program is a failure – particularly in its housing affordability dimensions – it does raise important questions about who is afforded the privilege to remain in place as the program shifts individuals’ personal cost-benefit analyses. Perhaps more importantly, equity considerations also emerge related to the financial costs and investment of weathering the disruption that relocation requires. Efforts must be integrated into the program to minimize these negative impacts.

\textit{Funding Adaptation}

As discussed throughout the above section, government spending on adaptation programs – rather than leaving it to the private sector – has many advantages. These include the ability to maximize co-benefits and freedom from the market-driven need to “painstakingly monetize” all potential benefits.\textsuperscript{115} To this end, public funding of adaptation programs can ensure equity is at the center of adaptation planning efforts. However, funding meaningful interventions at scale poses a key challenge to any adaptation effort. This is particularly true in small communities as a result of significant higher per resident costs.

Municipal governments, alongside state agencies and special-purpose government entities, are the primary funders of infrastructure in the United States.\textsuperscript{116} The cost of every adaptation program proposed above greatly exceeds the current budgets of the study


\textsuperscript{116} Martin, 131.
communities both individually and collectively. In Fiscal Year 2021, Knox County’s budget had $12.6 million in expenditures, while Camden had $9 million, Rockland had $14.6 million, St. George had $3.3 million, and Vinalhaven had $7.9 million.\textsuperscript{117} To increase revenue for resilience projects, study communities could consider a variety of funding strategies that innovate on a foundation of well-established existing funding mechanisms. For example, special assessment districts with a resilience focus or new tourist and pied-a-terre taxes could increase revenue in a purposeful manner.\textsuperscript{118} If 20\% of properties in Knox County are “for seasonal, recreational, or occasional use” (i.e. vacation homes), a new 0.5\% property tax on pieds-a-terre could generate approximately $8 million in new annual revenue in Knox County.\textsuperscript{119}

However, given the large mismatch between existing budgets - which will remain necessary for other ongoing expenditures – and the cost of adaptation programs, it is not reasonable to expect or suggest that funding could come solely from town or county funding sources, let alone from existing revenue sources at these municipal levels in small coastal communities. Rather, some combination of state and federal funding will be

\begin{itemize}
\item \textsuperscript{118} U.S. Climate Resilience Toolkit, “Funding Opportunities,” U.S. Climate Resilience Toolkit, March 17, 2022, https://toolkit.climate.gov/content/funding-opportunities.
\end{itemize}
required to support essentially any adaptation plan the study communities might choose to pursue. This has important implications to the feasibility of such a program.

On the positive side, the State of Maine – particularly in the past several years – has demonstrated an interest and commitment to impactful climate action in line with research-driven best practices standards. However, federal funding is likely to be a necessary and significantly more challenging hurdle. For decades, most federal spending and programmatic focus related to housing in flood-prone areas has occurred through the National Flood Insurance Program (NFIP). Increasingly controversial and nearly insolvent, this FEMA-administered program subsidizes the risk-related costs of development in flood-prone areas but -at least in its present form - is for the most part logistically incapable of supporting adaptation programs outside of a post-disaster context. While recent changes to how the NFIP calculates flood insurance premiums are an important step forward in integrating climate risk into the program, they do little to alter the program’s post-disaster, individual-property focus. To this point, by nature “it is not possible to insure an event that will happen with certainty” so it is not possible to insure against inevitable inundation through sea level rise. As such, federal funding that might be directed to support managed retreat such as that considered in this paper

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122 Siders, “Managed Retreat in the United States.”
remains tied up in a program without a mechanism for funding community and regional-scale projects.

Although small compared to federal spending on the NFIP, another FEMA-administered program represents perhaps the most significant, reliable federal investment in more comprehensive community-scale adaptation projects. The Building Resilient Infrastructure and Communities program (BRIC) provides grants to “support states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards.” In its most recent round of funding, BRIC offered $1 billion to support adaptation programs.

In addition to FEMA through the NFIP and BRIC programs, the United States Army Corps of Engineers (USACE) is an important federal player in the development and implementation of adaptation programs. Building on their history of flood control measures, USACE has become increasingly involved in climate-related coastal flood mitigation programs over the past two decades. In 2016, USACE released a “Climate Adaptation Plan.” In 2021, USACE released a “Climate Action Plan” that expanded the scope of their involvement. A “Climate Preparedness and Resilience” community of practice within USACE leads their work “with [their] non-federal cost-sharing partners to plan, design, and construct projects to address our nation’s toughest water resource

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129 United States Army Corps of Engineers, 2.
challenges.” In line with their historical practice, USACE’s involvement has for the most part been limited to very large-scale, resistance projects in highly urban areas. In New York City, for example, USACE led the highly controversial study of a colossal storm surge barrier that would have cost $119 billion; the study has been tabled.

In the context of the study communities, USACE involvement could bring both challenges and opportunities. USACE has the potential to play a critical role in providing technical capacity and financial capital to the communities in this study. However, their involvement will likely necessitate the selection of certain potentially less desirable strategies (e.g. large-scale resistance) without investment to ameliorate broader housing concerns. Additionally, unless further shifts in USACE policy, they may be unlikely to engage in a project in small coastal communities where significantly higher per resident costs shift their cost-benefit analyses.

Finally, working to develop climate adaptation programs within the context of housing affordability could actually open additional funding opportunities for these projects. Programs that simultaneously solve multiple problems may be better able to make the case for funding to a variety of state and federal agencies as well as private philanthropic institutions.

As climate change continues to become an even more dire reality, funding sources will surely evolve. While this uncertainty makes planning difficult – particularly giving the

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130 United States Army Corps of Engineers, 1–2.
131 United States Army Corps of Engineers, “USACE Climate Action Plan.”
highly politicized nature of climate issues in the United States – it is the condition within which small coastal communities must operate as they seek to engage in meaningful adaptation efforts. Because even small-scale adaptation programs are relatively high cost, innovative revenue schemes are unlikely to be able to resolve communities’ funding needs. Collaborating at a regional scale creates better opportunities for the development of funding, but it remains clear that small coastal communities are financially ill-suited to carry out climate adaptation on their own.

**Conclusion**

The two analyses in this paper emphasize the scale and critical nature of the climate adaptation challenge. Considered together, key principles for climate adaptation in small coastal communities emerge.

First and foremost, a regional approach is needed in order to achieve meaningful and equitable outcomes. While efforts should be made to empower local decision-making as much as possible, the scale at which we “local” is defined is a critical question. Regions of small coastal communities are by nature made up of many small municipalities – towns and villages with distinct identities yet linked livelihoods. These linkages are particularly apparent in the housing ecosystems; one community for example may house lower-income workers who commute into a town with higher housing costs. The higher cost towns may in turn house the tourists and secondary residents who are an important part of the regional economy. Further, as demonstrated in the four towns considered in this study, these small municipalities are often internally relatively homogeneous but heterogenous in
comparison to each other. As such, defining “local” at the city, town, or village level may preclude planning that can effectively engage with system conditions and enhance equity. Applying any of the strategies suggested in this paper to only one town would significantly reduce efficacy or render them completely ineffective.

In the case of the study communities, planning at the county level could facility effective planning on climate issues. In Maine, county-level governance is relatively limited. However, precedents do exist upon which climate adaptation planning can build. Perhaps most significant, each county in Maine has an Emergency Management Agency that “maintains the county all-hazards Emergency Operations Plan along with many other contingency, mitigation and recovery plans.” The inter-municipal cooperation exemplified by county emergency management agencies can serve as a guiding framework for developing and carrying out countywide climate adaptation plans. In other coastal parts of the United States with stronger county governments, such an approach through county government may be even more readily adopted.

At the regional level, a combination of the four methods – communicate, resist, avoid and accommodated – should be implemented in a coherent and complementary manner. Together, these strategies advantages and disadvantages may be strategically managed to result in the most positive outcome. For example, the study communities could collaborate to develop a plan in which managed retreat of vulnerable households occurs in St. George.

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and Vinalhaven while nature-based protective structures that accommodate waters are constructed to protect the few vulnerable homes in Camden and Rockland.

No matter what suite of adaptation strategies is selected, funding remains a key barrier to adaptation programs in small coastal communities. Although funding is a ubiquitous obstacle in municipal governance for communities of all sizes, it is especially so in small coastal communities for two reasons. First, they currently have budgets that in full are orders of magnitude less than the cost of adaptation programs. Second, per resident costs are significantly higher in these communities. Third, innovative revenue development schemes are limited by the size of the community as well as its economic and social condition.

Finally, it is important to keep in mind that equity considerations remain important to adaptation programs in small coastal communities. Considering the characteristics of the homes (and their residents, to the extent possible) will be impacted affects how equity-furthering measures should be implemented into adaptation programs. As emphasized in this paper, though, that higher value homes or more highly resources individuals are more likely to be directly impacted by sea level rise should not be construed to suggest that sea level rise will not have important impacts on equity within the housing ecosystem of small coastal. Communities must center equity and adaptation considerations in the same planning discourse in order to achieve positive outcomes.

Climate change is a generationally defining challenge, both in major urban areas and small communities worldwide. Through wide ranging impacts like sea level rise, it has the potential not only to cause devastation of its own but also to amplify existing challenges
and crises like housing affordability. Unfortunately, significantly more investment remains needed to assist community leaders in developing and carrying out critically important adaptation programs. This paper should serve as a call to action among planners, emphasizing the leading role this profession in well suited to play in navigating complex situations such that worst case outcomes do not become reality.


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