

CULTURAL PERCEPTIONS OF CLIMATE CHANGE AND SEA LEVEL RISE
ADAPTATION STRATEGIES IN MARYLAND, NORTH CAROLINA,
AND THE BALTIC SEA COAST

by

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ABSTRACT

Climate change and sea level rise pose significant threats to both the natural and built environment. Thus, it is becoming increasingly important for coastal communities to develop strategies that facilitate adaptation efforts in order to reduce their vulnerability. This research, in conjunction with the work of our client, Ecologic Institute, and the Regional Adaptation Strategies for the German Baltic Sea Coast (RADOST) project, involved a comparative analysis of the cultural perceptions of climate change and sea level rise adaptation strategies in Maryland and North Carolina. Through the completion of a literature review and in-person interviews with key informants and public citizens, this project investigated how differences in local perceptions affect current efforts to plan for and adapt to sea level rise. The study employed a “total ecology” framework in order to determine whether differences in the existing biophysical conditions, social demographics, and institutional frameworks of our study areas influence local perceptions of climate change and its associated impacts and, subsequently, whether these differences in perceptions affect current and future adaptation efforts. Several important themes emerged from the literature review and interview findings, including 1) the range of beliefs regarding climate change and sea level rise science, 2) the uneven distribution of interest in climate change related issues, 3) the lack of resources to address environmental challenges, and 4) additional barriers to the development and implementation of adaptation strategies. Overall, our research supports the overarching hypothesis that differences in biophysical conditions, social demographics, and existing policy frameworks influence local perceptions of climate change and sea level rise and the community’s willingness to formally address sea level rise concerns. However, our findings suggest that the ways in which the total ecology of a region influences local perceptions is very complex.

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INTRODUCTION

Background

There is unequivocal evidence that sea levels are rising globally at an unprecedented rate due to the thermal expansion of seawater and melting of land-based ice sheets and glaciers, both of which are associated with global climate change (National Research Council, 2010). Based on tide gauge and satellite altimetry data, there is evidence that the sea level rise rate has increased from approximately 1.8 millimeters (0.07 inches) per year throughout the second half of the 20th century to upwards of 3 millimeters (0.12 inches) per year over the past 15 years (National Research Council, 2010). In 2007, the Intergovernmental Panel on Climate Change (IPCC) estimated that the rate of global sea level rise was an average of 1.7 millimeters per year throughout the 20th century and projected that an additional 0.18 to 0.59 meter (0.6 to 1.9 feet) rise would occur by 2100 (Mehl et al., 2007). However, these estimates did not consider contributions to future sea level rise from the melting of ice sheets on Antarctica and Greenland, and are therefore likely to be conservative underestimates (Rahmstorf, 2010). More recent studies have accounted for this caveat and suggest that global sea level may rise by up to 1.4 meters (5 feet) by the year 2100 (Figure 1; Vermeer and Rahmstorf, 2009).

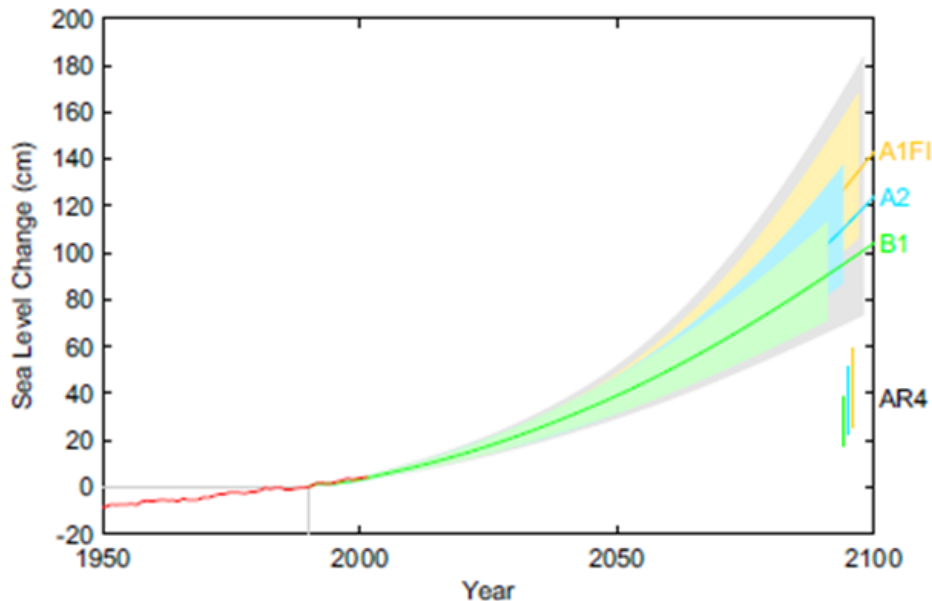


Figure 1. Projection of global sea level rise from 1990-2100 based on three IPCC emissions scenarios. Source: Vermeer and Rahmstorf, 2009.

It is critical to understand however, that sea level is not rising uniformly around the world. In regions experiencing local subsidence, the rate of relative sea level rise may be higher than the estimated global average, whereas relative sea level may actually be falling in areas where land masses are rising in response to glacial retreat. Regional variation in sea level rise has also been attributed to changes in the Earth's rotation speed as well as in the intensity of ocean currents (National Research Council, 2010). A recent report released by the US Geological Survey has identified a hot-spot of accelerated sea level rise along the US Atlantic coast from Cape Hatteras, NC to north of Boston, MA where sea level is rising at a rate 3-4 times the global average due to the slowing of the Atlantic Meridional Overturning Current (AMOC) (Sallenger et al., 2012).

Such ongoing and accelerated sea level rise poses several significant threats to both natural ecosystems and human development. Chief among these impacts include increased land loss due to the permanent inundation of low-lying coastal areas and intensified erosion; landward migration and eventual segmentation of barrier islands; loss of critical wetland habitat; increased frequency and extent of temporary storm-related flooding events; and salt water intrusion (Gesch et al., 2009).

Given these potential consequences, it is becoming increasingly important for coastal communities worldwide to begin designing and implementing adaptation strategies in an effort to reduce the vulnerability of both the natural and built environments. Whether and how communities will choose to adapt to these impacts remains to be seen, but sea level rise responses will likely be influenced by social perceptions of climate change and its associated risks (Moser, 2010). Understanding how people's values and beliefs shape decision making and thereby influence adaptive capacity is therefore critical for developing successful adaptation strategies.

Objective

Our research, in conjunction with the work of our client, Ecologic Institute, and the Regional Adaptation Strategies for the German Baltic Sea Coast (RADOST) project, involves a comparative analysis of the cultural perceptions of climate change and sea level rise adaptation strategies in Maryland and North Carolina, USA. In doing so, the project investigates whether differences in the existing biophysical conditions, social demographics, and institutional

frameworks (i.e., total ecology) of our study areas influence local perceptions of climate change and its associated impacts, and subsequently, whether these differences in perceptions affect current and future adaptation efforts. The results of this analysis will be used to assist both our client and coastal decision makers in developing a set of best management practices (BMPs) to guide adaptation planning worldwide.

Hypotheses

The overarching hypothesis guiding our analysis surmises that differences in the total ecologies of our study areas impact local perceptions of climate change and sea level rise, and thereby influence the formal adoption of relevant policies and adaptation strategies. This hypothesis is founded upon the three following assumptions: 1) an area's biophysical vulnerability to sea level rise and/or the extent to which an area is already experiencing sea level rise related impacts will make it more or less accepting of changing environmental conditions and proactive in developing relevant policies; 2) relevant stakeholders, population demographics, and economic drivers will influence a community's understanding of climate change and sea level rise and its willingness to adopt adaptation strategies; and 3) existing governance institutions directly influence a community's adaptive capacity and ability to adopt sea level rise policies and regulations.

In addition to this guiding hypothesis, we predict that attitudes will be different among county and municipal officials as well as across the different sectors represented by relevant stakeholders. In particular, we suspect that municipal officials will be much more willing to address current or future sea level rise impacts than county officials given their proximity and accessibility to constituents. Furthermore, environmental organizations will presumably be more accepting of the scientific evidence behind climate change projections and aware of the pending environmental impacts of climate change and sea level rise than development interests, who are likely concerned with their continued ability to develop coastal land in the face of sea level rise regulations.

METHODS

Our study was structured in order to uncover variances among sites in terms of differences in geographic location, levels of government, and across sectors. To do so, our research consisted of two parts: 1) a literature review and 2) in-person interviews with key informants and public citizens. The literature review formed the foundation of our research and provided an in-depth ethnography of each of research sites. This literature review serves as the background and context to the information gleaned from a range of stakeholder interviews at each site. In particular, in person interviews were conducted with individuals in the position to affect climate change and sea level rise adaptation strategies. The questions asked were derived from a previous survey put together by the Ecologic Institute for the RADOST project.

Study Sites

Research was conducted in the Chesapeake Bay region of Maryland and the region surrounding the Albemarle-Pamlico Sound complex in North Carolina. These regions were chosen by our client because they exhibit similarities to the areas that have been studied in the German Baltic Sea region as part of the RADOST project. Within these regions, we, in conjunction with our client, chose counties that included a mix of urban versus rural development, were socioeconomically diverse, represented a variety habitat and landscape types, and are located in different geologic areas in reference to either the Chesapeake Bay or the Outer Banks/Albemarle-Pamlico Sound complex. We specifically sought out these differences in order to assess how they might influence people's perceptions of climate change. In particular, Anne Arundel and Dorchester counties were chosen in Maryland, and Carteret, Dare, New Hanover, and Tyrrell counties were chosen in North Carolina (Figure 2, 3).

In order to explore the differences in perceptions between different levels of government, we chose to focus on one municipality within each county. The municipalities chosen were Annapolis (Anne Arundel), Cambridge (Dorchester), Beaufort (Carteret), Nags Head (Dare), Wilmington (New Hanover) and Columbia (Tyrrell).

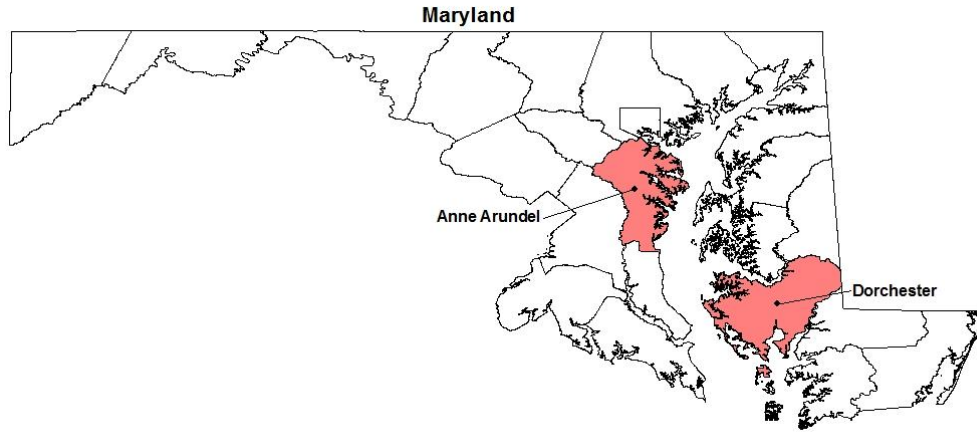


Figure 2. Maryland study counties.
 Source: Ducklow, K. (2013). Duke University, Nicholas School of the Environment.

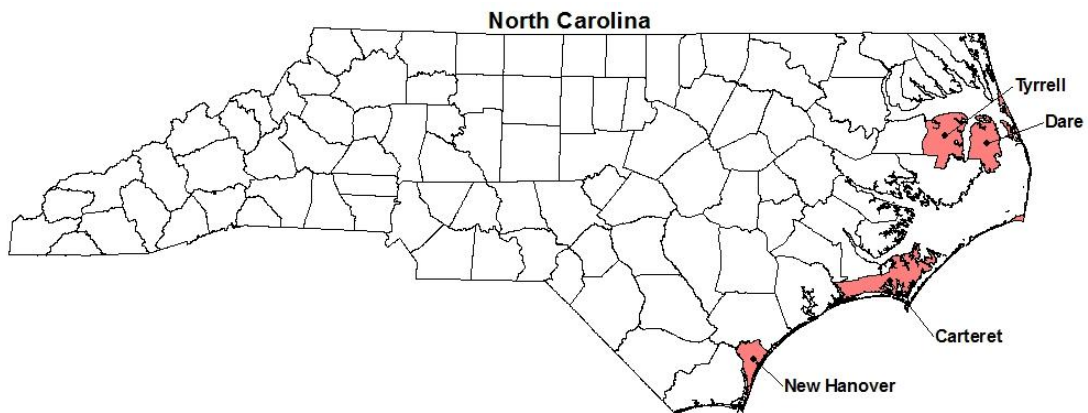


Figure 3. North Carolina study counties.
 Source: Ducklow, K. (2013). Duke University, Nicholas School of the Environment.

Total Ecology

Total ecology was used as the framework from which to understand and analyze differences in perceptions of climate change among different locales and people. Total ecology is a broad scale approach to analyzing environmental policy that seeks to understand the relationships and feedbacks among biophysical ecology, human ecology, and institutional ecology (Orbach, 2009).

The biophysical ecology of an issue is the set of non-human, biophysical resources and environments within a defined set of boundaries and the associated human-built artifacts of the system. Within each of our study counties, we assessed the various biophysical ecology characteristics that relate to climate change and sea level rise in an effort to understand what aspects make these counties more or less susceptible to the effects of climate change. These characteristics are important because differences across study sites will create differences in how each region will be impacted by climate change and sea level rise. It follows, then, that climate change perceptions and the adaptation strategies pursued in given areas may be influenced by these differences.

Human ecology is defined as the groups of humans who affect, are affected by, or are in some way concerned with the defined biophysical ecology. Put simply, the human ecology includes any and all of the stakeholders involved in some way with the environmental issue of concern. For our study, the human ecology included the citizens and interest groups in each county and municipality. Additionally, the associated population demographics and recent economic and political trends are important in understanding climate change perceptions.

The institutional ecology is composed of the governance institutions that guide the behavior of the relevant actors who are part of the human ecology of the system. These institutions include agencies as well as laws, regulations, and guidelines at the federal, state, and local levels of government. Policy development related to climate change adaptation strategies are influenced by governance regimes at all levels of government, and result in a mix of laws and regulations that govern how coastal areas design policies.

Literature Review

We performed a literature review in order to gather ethnographic data and information about each county and municipality. This was done so that we could build a foundation from which to understand and draw conclusions regarding the reasons for similarities and differences in perceptions of climate change and sea level rise adaptation strategies. In particular, we gathered data on environmental and biological aspects of the region (e.g. habitat types, important natural resources), demographics of the area's citizens (e.g. age, education level, median income), and economic factors (e.g. important industries, recent trends). In general, these factors impact how susceptible the study counties are to the effects of climate change (both in an

environmental sense and an economic sense) as well as how much importance people give to the issue of climate change. As such, similarities or differences in these factors across study areas help explain similarities and differences in how the counties/municipalities are (or are not) developing plans to adapt to environmental changes. We also looked into current county/municipality laws and planning guidelines to gain a sense of how they relate to current or future attempts to adapt to a changing environment.

Information on demographic indicators was gathered using U.S. Census Bureau data. In particular, data on county/municipality population, age structure, race/ethnicity, education level, and median income were taken from the 2010 national census. Information on the environmental, economic, and political/governance factors from each county were obtained from a variety of state and local government resources. Data of this nature was primarily obtained from county land use plans (LUPs). These plans were particularly important resources for this research because they are direct embodiments of what each county believes is important at the time of writing. In general, the LUPs included sections on the local environment, industry, recent economic, development, and population trends, and the primary threats and challenges to the county. The plans also included planning guidelines and goals for the future of each locality.

Interviews

Interviews were conducted using questions that our client, The Ecologic Institute, had previously put together for the RADOST project. The survey, named BALTEX (the Baltic Sea Experiment), is a “survey of the perceptions of regional political decision makers concerning climate change and adaptation in the German Baltic Sea region” (Bray & Martinez, 2011). This survey has been given to the heads of government in two German states and contains the questions we drew upon when putting together our interview guide to be given to stakeholders in the identified regions of the United States. We reviewed the questions and made amendments that would speak more to stakeholders on the East Coast of the United States. Our questions sought to a) identify local perceptions of climate change b) assess whether adaptation activities have been developed to address the potential impacts of climate change and sea level rise and c) to determine whether available sources of scientific information are useful and incorporated into local planning decisions (Appendix A).

Using county and municipality websites, we first identified key informants who are involved in, or who influence, the decision making processes concerning sea level rise and climate change at both the county and municipality levels. These positions include elected and appointed officials, government employees (planning and zoning departments, advisory boards, etc.), environmental organizations, and development interest groups from each of our study areas. Our goal was to speak with people across sectors and government levels.

After reaching out to a myriad of stakeholders we set up face-to-face meetings with these individuals to conduct our interviews. All three researchers had the same set of questions to ask. These were mainly multiple choice questions, but respondents were asked to elaborate on their answers. By meeting the participants face to face we were able to create a “participatory” element to our research from which we could gain knowledge from this short-lived “relationship” (Maxwell, 2005). In doing this we were able to gather more data on perceptions of climate change and sea level rise than might have been uncovered by solely analyzing the multiple choice answers to questions asked. Additionally, in many instances, our initial key informants gave us the names and contact information of others in the county or municipality with whom they thought would be important for us to talk.

In addition to our key informant interviews, we asked a subset of our survey questions to random residents in “on the street” interviews (Appendix A). This was done in order to obtain public perceptions of climate change and sea level rise. These questions came directly from the original list of interview questions, but include only those that asked about environmental changes they have experienced, whether or not climate change has been discussed in the community, and their perceptions of available science. We spoke to local business owners, parents at schools, watermen, and patrons of coffee shops, bars, and restaurants. We handed participants a survey, asked each to fill one out, and noted any additional comments they had.

Following our interviews, we qualitatively analyzed responses and summarized our results based on common themes that emerged across study areas. This process enabled us to examine commonalities and notable differences in climate change perceptions and adaptation strategies at the different study sites. We were able to discern what measures are already being taken, prevalent feelings concerning climate change and sea level rise, and possible directions of future decision making. We then related these findings back to our literature review results to

determine whether the total ecology of each of our study areas influenced local perceptions of climate change and current planning efforts.

RESULTS

Literature Review

BIOPHYSICAL ECOLOGY

Maryland

Maryland sits on approximately 4,000 miles of coastline on the Chesapeake Bay and Atlantic Ocean. Both Maryland study sites, Dorchester and Anne Arundel Counties, border the Chesapeake. The Chesapeake Bay is the largest estuary in the country and the third largest in the world, covering roughly 11,400 square kilometers. It is about 300 kilometers long, and has an average shallow depth of 8.42m (Colman & Mixon, 1988).

Winds, tides, and seasonal variability are driving forces in the Chesapeake Bay. Tidal surges can inundate low lying lands. The Chesapeake tidal flow is semi diurnal, it has two high tides and two low daily spanning 3 feet (Townsend, 2012). Seasonal variability effects wind speed patterns that are high in the winter and spring and low in the summer. Summer southern winds are at low speeds from the Bermuda High and push against surface currents flowing out (Xu et al, 2012). This process can be altered with climate and change and affect tidal surges. This, coupled with the Coriolis Effect which is responsible for the general direction of flow, can inundate low lying lands at a higher rate on the eastern shores of the Chesapeake (Chesapeake Bay Program, 2012). Figure 4 exhibits Maryland's current areas of sea level rise vulnerability.

Geological history of sea level rise is recognized in Maryland's current Climate Change Action Plan (MCCC, 2008). It is understood that sea level rise is a natural process in the region. According to the Conservation Fund, relative sea level in the Chesapeake Bay has risen roughly one foot, almost twice the global average. They anticipate that the relative sea level could rise between 1.3 feet (0.4 meters) to 5.2 feet (1.59 meters) by 2100 (The Conservation Fund, 2013). Coastal lands along the Chesapeake Bay experience a higher degree of sea level due to its

geomorphology (Anne Arundel County, 2011). Currently, the National Oceanic and Atmospheric Administration (NOAA) has reported that sea level is rising at 3.48 mm per year in Cambridge, MD and 3.44 mm per year in Annapolis, MD (NOAA, 2013).

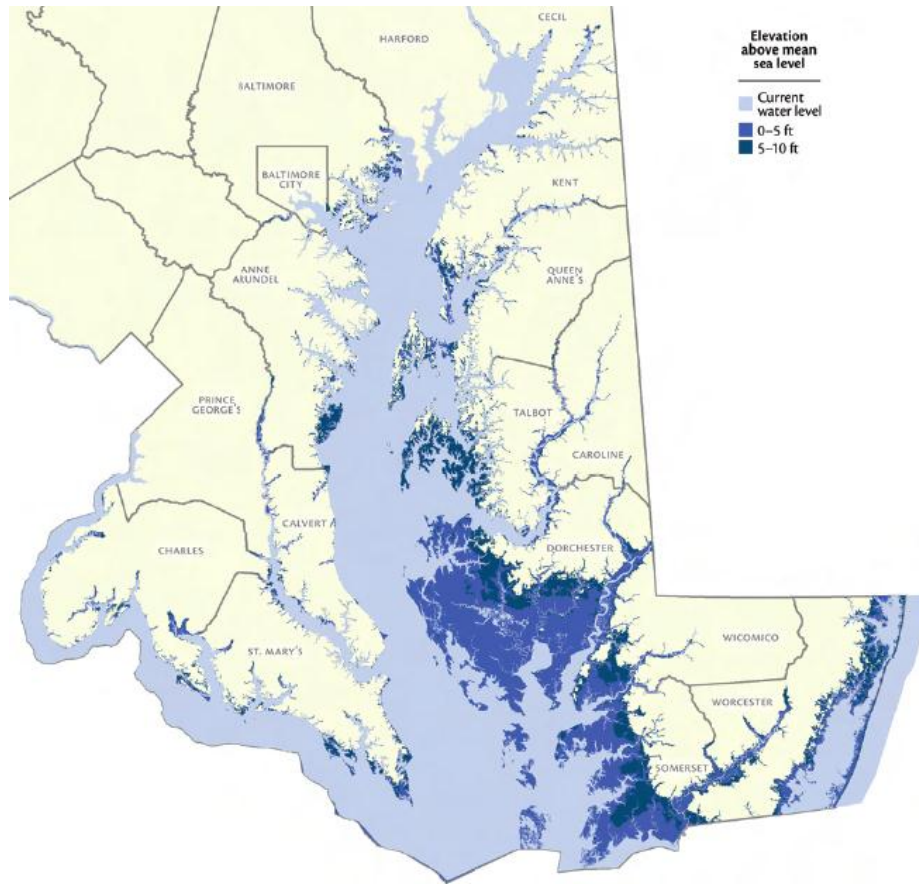


Figure 4. Coastal vulnerability to sea level rise along the Chesapeake Bay, MD.
Source: Maryland Commission on Climate Change (MCCC, 2008).

Anne Arundel County

Anne Arundel County is situated on the western coast of the Chesapeake Bay. It is almost completely surrounded by water. The northern boundary is on the Patapsco River, the western is the Patuxent and to the east is the Chesapeake, creating 533 miles of shoreline (Anne Arundel County, 2009). Anne Arundel lies along the eastern continental shelf. The shelf is continually

subsiding as a result of postglacial readjustment. In turn, the land slowly sinks relative to sea level (Anne Arundel County, 2011).

The County contains many suburban neighborhoods as well as a few, small, waterfront communities. The county is urbanized and, thus, densely populated. It lies within the Baltimore-Washington Metropolitan region. Within Anne Arundel is the city of Annapolis. Annapolis is not only the county seat, but also Maryland's capital. Annapolis has 17 miles of waterfront and takes up 7.2 square miles of Anne Arundel County (City of Annapolis, n.d.). A 2011 model done by MCCC found that, with IPCC predictions of sea level rise between 2 and 5 feet, as many as 2,400 structures in Anne Arundel County are vulnerable to the rising sea (Anne Arundel County, 2011).

The county also includes both state and federally owned parks. The Department of Parks and Recreation oversees both small and large park areas such as the Patapsco Valley State Park, Franklin Point Park, and the Patuxent Natural Resource Management Area, all state-owned, and the Federally-owned Patuxent Research Refuge (Anne Arundel County, 2009).

Dorchester County

Dorchester sits on the eastern portion of the Chesapeake. The majority of its land is low lying. The County is made up of long, slender peninsulas that include tidal marsh and non-tidal wetlands, tidal guts, creeks, ditches, and sloughs. Dorchester is also home to the Blackwater National Wildlife Refuge, which takes up 27,000 acres of mostly low-lying land in Dorchester County (Cole, 2008; USFWS, 2010).

Maryland deems Dorchester County as 1 of 3 counties most at risk in coping with irreversible damages due to sea level rise. As stated in the Sea Level Rise: Technical Guidance for Dorchester County report, "much of the County is already wet and getting wetter" (Cole, 2008). The Technical Guidance Report also lists that the mean high water mark is approximately 2 to 2.5 feet and the spring high tide is between 3.0 and 3.5 feet. About half of the County lies below 4.9 feet in elevation. Additionally, many properties in South Dorchester are flooded when the tide reaches 3.4 feet. Roads are flooded at 3.5 feet as well (Cole, 2008).

North Carolina

The North Carolina coast is incredibly varied, consisting of approximately 325 miles of ocean shoreline fronting a strip of barrier islands, 21 stable inlets, upwards of 5,000 miles of estuarine shoreline, and over 3,000 square miles of brackish water estuaries, including the Albemarle-Pamlico Sound, which constitutes the second largest estuary in the United States (Riggs et al., 2011).

The state is especially vulnerable to sea level rise and the ensuing long-term erosion of its shoreline due to its incredibly low-lying coastal plain. Many areas along the coast lie at an elevation of just 1.5 meters or less above sea level. In addition, while sea level is rising globally, coastal lands in the area are slowly subsiding, causing the current rate of relative sea level rise to be higher than the global average (Bin et al., 2007). In particular, extensive tide gauge and historical data for North Carolina indicate that relative sea level rise is currently rising at a rate of 16-18 inches per century, which roughly equates to 4—4.6 millimeters per year (Riggs et al., 2008). Furthermore, the NC Division of Coastal Management (NCDCM) 2004 ocean shoreline erosion report revealed that state's shoreline is already experiencing average annual rates of erosion of 1.6 feet per year, and close to 15 feet per year in some localized areas (Riggs et al., 2011).

Carteret County

Carteret County is situated on the central coast of North Carolina and spans 506 square miles across the state's mainland and southern outer banks, including Cedar Island, Harkers Island, Bogue Banks, Shackleford Banks, and Core Banks. Several Areas of Environmental Concern (AECs), designated by the North Carolina Coastal Resources Commission (CRC) are located within the Carteret County planning jurisdiction, including Estuarine and Ocean Systems and Ocean Hazard Areas (excluding Inlet Hazard Areas). In particular, the county is home to the water and shorelines of the White Oak, Newport, Neuse, and North Rivers and their tributaries; Core, Back, Bogue, and Pamlico Sounds; and the Atlantic Ocean bordering Bogue Banks. Extensive coastal wetland areas are also located within the County, particularly at Cedar Island, Brown's Island, the Middle Marshes, the North River shore, and Bogue Sound. In addition to these and other AECs, 176 natural heritage areas, constituting approximately 146,000 acres, have been identified throughout the County (Carteret County, 2009).

Dare County

Dare County stretches along 85 miles of islands along the Outer Banks bordering the Atlantic Ocean to the east, and includes land area on mainland North Carolina, with shorelines on the Albemarle-Pamlico sound system and the Alligator River. Thus, the county is characterized by two very different and important ecosystems: barrier islands and low-lying estuarine habitats. Within mainland portions of Dare County, the land elevation ranges between three and seven feet above sea level while sand dunes along the Outer Banks may be upwards of 100 feet (Dare County Board of Commissioners et al., 2009; NCDOT, n.d.)

The county also includes coastal wetlands, important estuarine waters, beach areas, ocean erodible zones, flood hazard areas, and maritime forests. Areas with natural resources include potential mineral sites, fish and game lands, and productive agricultural lands. Areas of special concern due to fragility and/or historical and cultural significance that receive special state or federal protection include Alligator River Wildlife Refuge, Buxton Woods Coastal Preserve, Pea Island National Wildlife Refuge, Jockey's Ridge State Park (a unique dune system in Nags Head), and Cape Hatteras National Seashore (Dare County Board of Commissioners et al., 2009).

New Hanover County

New Hanover County is located in the southeastern portion of North Carolina and borders the Atlantic Ocean to the east and the Cape Fear River to the west (New Hanover County Advisory Panel, 2006). The county ranges in elevation from less than 15 feet above sea level on the barrier islands and estuarine shorelines to upwards of 50 feet in the inland areas (New Hanover County Advisory Panel, 2006; North Carolina Department of Transportation, n.d.)

The county is dominated by several important ecosystems. The Cape Fear River basin is the largest in the state of North Carolina, and contributes many important resources to the county. The Atlantic coast beaches also contribute a great deal of natural and recreational resources. The county also includes swamp forests, pocosins, freshwater ponds, fresh and brackish marshes, maritime shrub thickets, and coastal wetlands. New Hanover also has a number of barrier islands, but unlike those in Dare County, these islands are significantly closer to the mainland, and thus experience a somewhat different set of impacts. Additionally, ocean erodible areas flood hazard areas, and inlet hazard areas are present. Important natural resources

in the area include prime farmland, forestry resources, limestone deposits along the Cape Fear River, and fish and shellfish resources (New Hanover County Advisory Panel, 2006).

Tyrrell County

Tyrrell County is located in northeastern North Carolina and is bounded by the Albemarle Sound to the North, the Alligator River to the East, and the Scuppernong River in the West. The County's topography is generally flat and low-lying with elevations from 15 feet above mean sea level in the southwest section to only 2 feet above mean sea level along the Albemarle Sound and Alligator River. As a result, 86% of the county's unincorporated land area is located inside the 100- or 500-year floodplain, while 100% of the Town of Columbia, the county seat, is located in a Special Flood Hazard Area (SPHA), as defined by the National Flood Insurance Program (NFIP) (Tyrrell County, 2009).

Tyrrell County and the Town of Columbia contain several AECs, including coastal wetlands, estuarine waters and shorelines, and natural and cultural resource areas. Notably, all of the County's surrounding water bodies are recognized estuarine waters, which support the local economy through the provision of fisheries and eco-tourism opportunities. According to the NCDCM 2003 coastal wetland inventory, 66% of the County's unincorporated area and 42% of the Town of Columbia were determined to be coastal wetlands. Additionally, 31.7% of the County's total area is designated as natural resource fragile areas, or "protected lands," in which development is prohibited, and 57% of the county's total acreage is classified as significant natural heritage areas (Tyrrell County, 2009).

HUMAN ECOLOGY

Maryland

As of 2010, the population of the state of Maryland was 5,773,552 persons, representing a 9% increase since the 2000 census. Persons 65 years of age or older represented 12.5% of the population and persons younger than age 18 represented 23.1% of the population. 61.1% of the population identified as white, 30.0% of the population identified as black, and 8.4% of the population identified themselves as having Hispanic or Latino origins (in addition to any specific race). Of those persons age 25 or older, 88.2% were high school graduates, and 36.1% had at

least a bachelor's degree. The median household income (2007-2011) was \$72, 419 and 9.0% of the population was below the poverty level (US Census Bureau, 2013e).

Anne Arundel County

Anne Arundel is steeped in American history and is the home of the historic city of Annapolis which has served as the State Capital since 1694. People come from all over the region, daily, to traverse its streets, and use its facilities. In 2010, the city housed 38, 394 residents with 5, 344.4 people living within one square mile (US Census Bureau, 2013a).

Population statistics from 2000 to 2010 indicate that the population of permanent residents in Anne Arundel County increased by 11% over the 10 year period, from 489,656 in 2000 to 544,403 in 2010. As of the 2010 census, persons 65 years and older accounted for 12.1% of the total population, while persons under the age of 18 years account for approximately 23.0% of the population. 77.1% of the population identified themselves as white, 16.1% identified as Black or African American. Of persons aged 25 years and older, 90.4% possessed a high school diploma and 36.3% had earned a Bachelor's degree or higher (US Census Bureau, 2013a).

One of the major driving economic forces in Annapolis is its tourism industry. The county of Anne Arundel houses many international businesses which aid county revenue. 50% of jobs in Anne Arundel are due to international businesses which settle in Anne Arundel because of its proximity to major east coast cities (Anne Arundel County, 2008).

Dorchester County

Population statistics from 2000 to 2010 indicate that the population of permanent residents in Dorchester County increased by 6% over the 10 year period, from 30, 674 in 2000 to 32,618 in 2010. As of the 2010 census, persons 65 years and older accounted for 17.9% of the total population, while persons under the age of 18 years account for approximately 21.7% of the population. 68.7% of the population identified themselves as white, 28.0% identified as Black or African American. Of persons aged 25 years and older, 82.2% possessed a high school diploma and 18% had earned a Bachelor's degree or higher (US Census Bureau, 2013d).

Dorchester has historically been Maryland's leader in crab processing. According to MD Sea Grant, Dorchester County holds 21 of the 30 active crab processing plants in Maryland State. This industry comprises a large proportion of the County's manufacturing base (2%), and of its

labor force (3.3%) (Lipton and Sullivan, 2002). If this industry were damaged in any way, including sea level rise impacts, Dorchester would face major economic losses.

North Carolina

As of 2010, the population of the state of North Carolina was 9,535,483, representing an 18.5% increase since the 2000 census. Persons 65 years of age or older represented 13.2% of the population and persons younger than age 18 represented 23.7% of the population. 72.1% of the population identified as white, 22.0% of the population identified as black, and 8.6% of the population identified themselves as having Hispanic or Latino origins (in addition to any specified race). Of those persons age 25 or older, 84.1% were high school graduates, and 26.5% had at least a bachelor's degree. The median income (2007-2011) was \$46,291 and 16.1% of the population was below the poverty level (US Census Bureau, 2013g).

Carteret County

Population statistics from 2000 to 2010 indicate that the population of permanent residents in Carteret County increased by 11.9% over the 10 year period, from 59,383 in 2000 to 66,469 in 2010. As of the 2010 census, persons 65 years and older accounted for 19.0% of the total population, while persons under the age of 18 years account for approximately 18.9% of the population. 89.3% of the population identified themselves as white, 6.1% identified as Black or African American, and 3.4% (of any race) identified as Hispanic or Latino in origin. Of persons aged 25 years and older, 87.5% possessed a high school diploma and 23.7% had earned a Bachelor's degree or higher (US Census Bureau, 2013b).

Carteret County's economy has grown steadily throughout the past twenty years and remains strong today (Carteret County, 2009). The median household income for 2007-2011 was \$47,403 and 13.1% of the population was below the poverty level for 2007-2011. (US Census Bureau, 2013b). Several sectors contribute to the County's economic development, including, but not limited to, tourism, retail trade, military, and commercial fishing (Carteret County, 2009). Table 1 shows Carteret County's major employment industries from 1970-2000.

Table 1. Employment by Major Industry in Carteret County for 1970-2000.
Source: Carteret County, 2009.

Total employment	Years				Percent Change			
	1970	1980	1990	2000	1970-1980	1980-1990	1990-2000	1970-2000
Agriculture, services, forestry, and fishing	529	1,291	1,222	1,329	144.0%	-5.3%	8.8%	151.2%
Mining	-	-	-	15	NA	NA	NA	NA
Construction	557	941	1,586	2,996	68.9%	68.5%	88.9%	437.9%
Manufacturing	1,650	2,268	1,795	1,945	37.5%	-20.9%	8.4%	17.9%
Transportation, communications, and public utilities	616	591	806	1,147	-4.1%	36.4%	42.3%	86.2%
Wholesale trade	549	803	791	996	46.3%	-1.5%	25.9%	81.4%
Retail trade	1,788	3,424	6,316	7,671	91.5%	84.5%	21.5%	329.0%
Finance, insurance, and real estate	455	1,113	1,901	2,710	144.6%	70.8%	42.6%	495.6%
Services	2,163	3,304	5,693	8,346	52.8%	72.3%	46.6%	285.9%
Total private employment	8,308	13,741	20,114	27,155	65.4%	46.4%	35.0%	226.9%
Federal Civilian	156	200	274	297	28.2%	37.0%	8.4%	90.4%
Federal military	410	533	624	367	30.0%	17.1%	-41.2%	-10.5%
State	NA	552	679	977	NA	23.0%	43.9%	NA
Local	NA	1,612	2,336	3,186	NA	44.9%	36.4%	NA
Total Govt employment	1,733	2,897	3,913	4,827	67.2%	35.1%	23.4%	178.5%
Non-Farm employment (private + government)	10,041	16,638	24,027	31,982	65.7%	44.4%	33.1%	218.5%
Farm employment	510	490	274	181	-3.9%	-44.1%	-33.9%	-64.5%
Total employment	10,551	17,128	24,301	32,163	62.3%	41.9%	32.4%	204.8%

Source: 1970-2000 Employment - Federal Agency Data: Bureau of Economic Analysis SIC, obtained from LINC March 2004
Source: 1970-2000 Government Employment - obtained from Bureau of Economic Analysis, Table CA25 (SIC) March 2004

Dare County

As of the 2010 census, Dare County had a permanent resident population of 33,920 people. This number indicates a 13.2% increase in population compared to the year 2000, which is likely a result of the County's popularity as a retirement location. Persons 65 years old or greater account for 15.1% of the population, and persons under the age of 18 years account for 20.7% of the population. 92.3% of the population identified themselves as white, 2.5% identified themselves as black, and 6.5% of the population identified themselves as of Hispanic or Latino origin (this identification was in addition to any race identification). Persons age 25 or older who have a high school degree account for 91.5% of the population, those with a bachelor's degree or higher account for 32.0% of the population. The median household income in 2009 was \$49,565, and 10.7% of the population was below the poverty level (US Census Bureau, 2013c). Population trends for Dare County place it as one of the most quickly growing jurisdictions in North Carolina (Dare County Board of Commissioners et al., 2009).

Importantly, Dare County has a very high amount of seasonal tourists. The highest influx of visitors occurs during the summer months but there are visitors throughout the year, such that the actual population in Dare County at a given time, while dynamic, is always greater than the stated year-round population number. For their land use planning efforts, Dare County officials estimate a peak population number based on a number of factors (e.g. the number of permanent

residents, the maximum occupancy of residential units and other accommodations, an estimate of daily visitors etc.). Using the formula, officials estimate that the peak seasonal population of Dare County is more than 6.5 times greater than the year-round population. This large number of visitors impacts the County in its need to provide services and infrastructure support. (Dare County Board of Commissioners et al., 2009).

Understandably, the economy of Dare County is mainly driven by the tourism industry. Local retail businesses, restaurants, hotels and other accommodations, all take in a significant amount of revenue from visitors to the area. Other important sectors include construction, real estate sales, boat building, and commercial fishing. Table 2 below shows the major employment sectors from the 4th quarter of 2006 (Dare County Board of Commissioners et al., 2009).

Table 2. Dare County Employment Sectors, 4th Quarter 2006.
Source: Dare County Board of Commissioners et al., 2009.

	Employees	Percentage
Total All Industries	18,670	100.0
Total Government	2,915	15.6
Total Private Industry	15,755	84.4
Agriculture, Forestry, Hunting	4	0.0
Utilities	101	0.5
Construction	1,444	7.7
Manufacturing	778	4.2
Wholesale Trade	427	2.3
Retail Trade	3,350	17.9
Transportation & Warehousing	190	1.0
Information	239	1.3
Finance & Insurance	415	2.2
Real Estate Sales & Rentals	2,216	11.4
Professional & Technical Services	558	3.0
Administrative & Waste Services	601	3.2
Educational Services	1,023	5.5
Healthcare & Social Assistance	831	4.5
Arts, Entertainment & Recreation	507	2.7
Accommodations & Food Services	3,742	20.0
Other Services (non-public admin)	537	2.9
Public Administration	1,641	8.8
Unclassified	139	0.7

New Hanover County

As of the 2010 census, New Hanover County had a population of 202,667 persons. This represents a population increase of 26.4% compared to the 2000 census. 14.2% of the population was over 65 and 19.7% of the population was under 18 years of age. 81.1% of the population identified as white, 15.0% of the population identified as black, and 5.4% of the population identified as persons of Hispanic or Latino origin (belonging to any race). Of persons 25 years of age or older, 89.5% had a high school diploma, and 36.1% had a bachelor's degree or higher.

The median household income was \$48,553 and 15.4% of the population was below the poverty level (US Census Bureau, 2013f).

New Hanover County has seen a steady increase in population throughout the last century. Importantly, both urban and suburban areas in the county have experienced growth. In 1960, 61.3% of the population of New Hanover County lived in Wilmington, but by 1980 this proportion had decreased to 42.5% as a result of suburban growth made possible by rural water and sewer service. This trend has varied in recent decades, though small town population growth has steadily increased since 1960 (New Hanover County Advisory Panel, 2006).

New Hanover County and the City of Wilmington have a diverse set of economic drivers including tourism, trade, pharmaceuticals and healthcare, manufacturing, and government. As the population continues to grow, the area continues to bring in a greater diversity of national companies. Tables 3 and 4 below show the top 25 employers and the breakdown of employment by sector in New Hanover County in 2003 (New Hanover County Advisory Panel, 2006).

Table 3. Top 25 New Hanover County Employers, 2003.
Source: New Hanover County Advisory Panel, 2006.

No.	Company	Product/Service	Employees
1	New Hanover Regional Medical Center	Hospital	4600
2	New Hanover County Schools	Education	3126
3	General Electric	Aircraft/Nuclear	1650
4	UNC-Wilmington	Higher Education	1627
5	New Hanover County	Government	1368
6	City of Wilmington	Government	1131
7	Progress Energy	Electricity	1100
8	Wall-Mart	Retail	1055
9	International Paper	Bleached Pulp & Paperboard	900
10	PPD	Pharmaceutical & Biotech Research & Development	900
11	Corning	Optical Fiber	800
12	Cape Fear Community College	Higher Education	648
13	aaiPharma	Pharmaceutical Development & Sales	630
14	DAK Americas LLC	Dacron Polyester	514
15	Louisiana Pacific Corporation	Laminated Veneer Lumber	300
16	KoSa	Chemicals	299
17	DEL Laboratories	Pharmaceutical and Cosmetic Manufacturing & Distribution	290
18	LL Building Products	Home Building Products	286
19	The Wilmington Star	Communications	255
20	Vision Air	Law Enforcement Software Development	197
21	Bedford Fair Industries	Women's Apparel – Mail Order	196
22	Chemtex	Engineering – Plant Consulting	185
23	Elementis Chromium LP	Sodium Bichromate	183
24	International Paper Carton Division	Paperboard Cartons	175
25	Sam's Club	Retail - Wholesale	165

Source: Greater Wilmington Chamber of Commerce

Table 4. 2003 New Hanover County Employment.
Source: New Hanover County Advisory Panel, 2006.

	Employment	% Total Workforce	Payroll (in \$ millions)	Weekly Wage/Employee
Agriculture, Forestry, Fishing, Mining	920	1.1%	5.5	\$458.78
Goods	16,062	18.3%	169.9	\$813.80
Manufacturing	8,974	10.3%	113.1	\$969.14
Construction	7,088	8.1%	56.9	\$617.14
Services	70,567	80.6%	492.3	\$536.60
Transportation, Communication, Utilities	3,976	4.5%	33.3	\$645.08
Wholesale trade	3,779	4.3%	36.2	\$737.85
Retail trade	21,079	24.1%	88.4	\$322.68
Finance/Real Estate	3,200	3.7%	30.7	\$738.01
Misc. Services	23,332	26.7%	173.3	\$571.40
Government	15,201	17.4%	130.2	\$659.03
Local	856	1.0%	10.5	\$946.29
State	3,649	4.2%	29.7	\$627.11
Federal	10,696	12.2%	90.0	\$646.93
Total	87,547		667.7	\$586.66

Tyrrell County

As of the 2010 census, Tyrrell County's permanent resident population was 4,407, which represents a 6% increase from 2000. In 2011, 16.4% of the population was 65 years old and over and 18.1% of the population was 18 years and under. 58% of the population identified as white and 37.7% identified as black. Persons of any race that identified as having Hispanic or Latino origin accounted for 6.6% of the population. Of persons aged 25 years and older, 10.1% received a bachelor's degree or higher and 71.5% earned a high school diploma for 2007-2011 (US Census Bureau, 2013h).

Tyrrell County has historically been below the state average for key economic indicators and has been assigned a Tier 1 designation, which includes the state's 40 most economically distressed counties (Tyrrell County, 2009; NCDOC, 2013). For 2007-2011, the median household income was \$34,071, which was 26% less than the state average of \$46,291. Additionally, a higher percentage of persons living below the poverty level was recorded for Tyrrell County (20.5%) than the state average (16.1%) from 2007-2011 (US Census Bureau, 2013h). According to the 2000 census, the county's largest employment sector is Agriculture, Forestry, Fishing, Hunting, and Mining (Tyrrell County, 2009). Table 5 shows employment by industry for the Town of Columbia and Tyrrell County in 2000. Tyrrell County's close proximity

to the popular vacation destinations along the northern Outer Banks has also contributed to an overall growth in tourism revenues (Tyrrell County, 2009).

Table 5. Town of Columbia and Tyrrell County Employment by Industry in 2000.
Source: Tyrrell County, 2009.

Industry	Columbia		Tyrrell County	
	# Employed	% of Total	# Employed	% of Total
Agriculture, Forestry, Fishing and Hunting, and Mining	21	7.6%	263	16.8%
Construction	18	6.5%	133	8.5%
Manufacturing	23	8.3%	124	7.9%
Wholesale Trade	13	4.7%	41	2.6%
Retail Trade	39	14.0%	173	11.0%
Transportation, Warehousing, and Utilities	4	1.4%	59	3.8%
Information	2	0.7%	27	1.7%
Finance, Insurance, Real Estate and Rental/Leasing	4	1.4%	50	3.2%
Professional, Scientific, Management	7	2.5%	44	2.8%
Education, Health and Social Sciences	42	15.1%	229	14.6%
Arts, Entertainment, Recreation and Accommodation	66	23.7%	188	12.0%
Other Services (Except Public Administration)	13	4.7%	102	6.5%
Public Administration	26	9.4%	135	8.6%
Total Person Employed 16 years or over	278	100.0%	1568	100.0%

INSTITUTIONAL ECOLOGY

Federal Framework

There are several main federal agencies, in addition to elected officials, that play a role in the management of coastal regions, and thus will be important actors in planning for climate change and sea level rise. These agencies include the National Oceanic and Atmospheric Administration (NOAA), the Federal Emergency Management Agency (FEMA), the Environmental Protection Agency (EPA), and the United States Army Corps of Engineers (USACE). Several key pieces of legislation and/or programs related to the management of coastal areas include the Coastal Zone Management Act, The National Flood Insurance Act, the Clean Water Act, the Coastal Barrier Resources Act, USACE permitting programs, and various laws in the Federal Tax Code. Several of these regulations are summarized below.

The Coastal Zone Management Act of 1972

At the present, the primary authority to address the challenges of sea level rise and climate change along the nation's coastline is vested under the federal Coastal Zone Management Act (CZMA) (16 U.S.C. §1451-1465). Enacted in 1972, the CZMA provides the foundation for all federal efforts to balance economic development and the conservation of coastal resources in the United States (Beatley et al., 2002). The Act, administered by the Office of Coastal Resource Management (OCRM) within NOAA, aims to “preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone” and assists states in this effort (16 U.S.C. §1452). Through the provision of various incentives such as cost-sharing grants, federal consistency, and technical assistance, the CZMA has established a voluntary, federal-state partnership that encourages states to develop and administer Coastal Zone Management Programs (CZMP) in accordance with the very general national guidelines set forth in the Act (Beatley et al., 2002). Conceived in this way, the CZMA is considered a “planning act” as it effectively delegates the responsibility of coastal zone management and land use planning to state and local authorities.

As amended by the Coastal Zone Act Reauthorization Amendments of 1990, the CZMA recognizes that “global warming may result in a substantial sea level rise with serious adverse effects in the coastal zone,” and calls for states to consider and start planning for the associated impacts (16 U.S.C. §1451(l)). In particular, Congress directs that it is the national policy for states to manage coastal development to “minimize loss of life and property caused by improper development in...areas likely to be affected by or vulnerable to sea level rise;” to provide for the “study and development...of plans for addressing the adverse effects upon the coastal zone of land subsidence and of sea level rise;” and to “encourage the preparation of special area management plans” to protect natural resources, life, and property, as well as provide for reasonable coastal-dependent economic growth in areas likely to be affected by sea level rise (16 U.S.C. §1452(2b);(2k);(3)). The Act does not specify how programs should carry out these provisions, thereby providing states and localities with ample freedom and flexibility in designing site-specific climate change and sea level rise adaptation policies.

National Flood Insurance Act of 1968

The National Flood Insurance Act of 1968 established the National Flood Insurance Program (NFIP). Administered by FEMA, this program offers federally funded flood insurance

to property owners who reside in flood prone areas and are unable to receive flood insurance through private agencies. Regions with a particularly high risk of flooding (greater than 1% per year, or 26% over a 30 year mortgage) are required by Congress to have NFIP policies (FloodSmart.gov, 2012).

In order to receive an NFIP policy, communities must abide by certain ordinances that reduce the risk of flood damages. Specific ordinances that communities are required to follow depend on the flood risk, and include guidelines such as elevating buildings above a defined Base Flood Elevation, ensuring that structures can withstand certain floodwater velocities, designating a floodway and prohibiting construction in this zone, and requiring permits for all construction projects within flood hazard areas (FEMA, 2002).

The NFIP incentivizes community activities that further reduce the risk of flooding and flood damage by allowing for the reduction of insurance premiums if communities go above and beyond the minimum requirements of the NFIP. Specifically, the Community Rating System (CRS) of the NFIP awards points for such actions as having more restrictive regulations; acquisition, relocation, or floodproofing of flood-prone properties; preservation of open space; the creation of accurate flood maps to ensure proper insurance rates; and promotion of awareness of flood hazards and insurance (FEMA, 2006).

In this way, NFIP and CRS regulations are de facto sea level rise adaptation strategies. Interestingly, because the NFIP is congressionally mandated for high flood risk areas, but the CRS is voluntary, future regulations related to flooding or sea level rise adaptation through these programs could come from the federal or local level.

Clean Water Act of 1972

The Clean Water Act of 1972 (CWA) (which amended the Federal Water Pollution Control Act of 1948) is administered by the EPA with the goal of regulating quality standards for surface waters of the United States (EPA, August 2012). Section 404 of the CWA addresses the management of development on, in, or near the nation's waterways, including wetlands, and calls for a permitting system to govern these activities (EPA, March 2012). EPA grants this permitting authority to U.S. Army Corps of Engineers such that USACE oversees all construction efforts in the nation's waterways, including wetlands, through its permitting program (United States Army Corps of Engineers, n.d.). As a result, any strategies to address sea

level rise that include construction or the deposition of materials on coastal wetlands and waterways are regulated by this program.

State and Local Framework

Maryland

Management of Maryland coasts are accomplished through state regulatory programs, an Executive Order mandating certain programs, and a Memoranda of Understanding between appropriate state departments. Additionally, Maryland has two main pieces of legislation that drive climate change policy: a 2007 Executive Order, and Maryland's Critical Area Law. (Rubinoff et al 2000; MCCC, 2008).

Executive Order 01.01.2007.07.

On April 20th, 2007 Governor Martin O'Malley established the Maryland Commission on Climate Change (MCCC). The Commission is chaired by the Secretary of the Environment and is comprised of the heads of 16 state agencies and 6 members of the General Assembly. The Executive Order established three working groups within the Commission: the Greenhouse Gas and Carbon Mitigation Working Group (MWG), the Adaptation and Response Working Group (ARWG), and the Scientific and Technical Working Group (STWG). The ARWG is responsible for developing a strategy to reduce Maryland's vulnerability to climate change, which emphasizes sea level rise and coastal hazards (MCCC, 2008).

The Order, aimed at developing a plan of action (The Climate Action Plan), emphasizes Maryland's particular vulnerability to climate change related impacts such as sea level rise, increased storm intensity, and increased wind and rainfall events. The commission is charged with establishing goals as well as timetables for the implementation of these goals (MCCC, 2008). MCCC recommends that adaptation plans should plan for at least a 1 foot rise in sea level by the end of 2050 and a 2 foot rise in sea level by 2100. MCCC goes so far as to suggest planning for up to 4 feet in sea level rise if the IPCC projections are accurate. (Anne Arundel County, 2011)

The Order emphasizes the need for collaboration with Maryland State and local governments. The Commission, specifically the ARWG, is responsible for building upon

recommendations put forth by organizations like the state’s Department of Natural Resources and the Maryland Coastal Program (MCCC, 2008).

Title 27, Critical Area Commission for the Chesapeake and Atlantic Coastal Bays

Maryland’s Critical Area Law was passed by the General Assembly in 1984 and created a commission to foster the welfare of the shorelines by limiting activities that could damage water quality and natural habitats. Under this law, a *Critical Area Commission* was created to provide local governments with guidelines and methods to establish, maintain and protect shoreline buffers. Local critical areas are required to have a “buffer” landward of the mean high water line. The law regulates land use within this “critical area”. Maryland’s Department of Natural Resources states that the law defines “critical area” as:

“all land within 1,000 feet of the Mean High Water Line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries” (Maryland DNR, n.d.)

“Buffer” is defined as:

“the area immediately adjacent to the mean high water line of tidal waters, the edge of each bank of tributary streams and the landward edge of tidal wetlands. It includes areas that are not naturally vegetated and may be developed or disturbed,” (Critical Area Commission, 2012).

It is important to note that the local government decides upon the interpretation of the term “critical area” and “buffer” (Critical Area Commission, 2012). In general, the hope is that the “buffer” will aid in removing sediments, nutrients, and toxins; and will minimize harmful anthropogenic impacts to the overall natural environment and, more specifically, riparian habitat.

Anne Arundel County

Anne Arundel County is composed of a legislative branch, which is led by the County Council, and an Executive branch that is headed by the County Executive. The County Council adopts ordinances and resolutions, while the Executive branch is responsible for overseeing the day-to-day operation of County Agencies and Departments as well as ensuring the observance of County laws and regulations.

Anne Arundel's 2009 General Development Plan (GDP) serves as the core of the County's land use planning program. The GDP framework of the counties plan establishes an "overall comprehensive plan" with recommendations and policies to help small area planners make decisions about development, resource protection, and the provision of infrastructure. The GDP program also provides:

- Sector Plans (development plans for specific regions)
- Functional Master Plans (focus on a specific functions of the county government)
- Facilities Plans and Strategic Plans (made for specific budgeting purposes)
- Development Regulations (the principal mechanisms used to implement the County's land use and development policies, as adopted in the General Development Plan) (Anne Arundel County, 2009).

Importantly, the 2009 GDP recognizes Anne Arundel's sensitivity to flooding from both non-tidal and tidal flooding caused by intense winds and heavy rains. Floodplains in the County are protected through the Floodplain, Subdivision, and Zoning ordinances. The Floodplain Ordinance defines the floodplain districts and requires a detailed description of the floodplain on development plans submitted to the County. The ordinance also prohibits new structures or substantial modifications to structures in the 100-year non-tidal floodplain.

In addition, Anne Arundel County is further divided into 16 small area planning zones, which create separate, more detailed, land use plans. These "Small Area Plans" serve as a guide for land use, zoning, and infrastructure development and identify areas for development and revitalization.

In November 2011, in coherence with the Maryland Commission on Climate Change and Anne Arundel's General Development Plan, Anne Arundel's Office of Planning and Zoning prepared "Sea Level Rise, Strategic Plan, Anne Arundel County." The study, conducted in partnership with Maryland's Department of Natural Resources, explores potential sea level rise impacts and develops adaptation strategies. The key goals of the project were to do a "vulnerability assessment to identify potential areas impacted by sea level rise and develop inventories of resources at risk", develop "a framework for interagency strategic planning," to develop "a strategic plan" and, lastly, to increase "public outreach and education to promote public awareness of sea level rise issues" (Anne Arundel County, 2011).

Dorchester County

Dorchester County is managed by five County Council Members, one representing each of the five county districts. One representative from the 5 districts serves as President of the council. This council also appoints the County Manager (Dorchester County, 2013).

Dorchester County has prepared five planning documents to guide the county's long-term growth and development, including a Comprehensive Plan; Educational Facilities Master Plan; Land Preservation, Parks, and Recreation Plan; Multi-Hazard Mitigation Plan; and Water and Sewer Plan. As of 2008, only the Multi-Hazard Mitigation Plan briefly addresses sea level rise. While this document provides information on several hazard mitigation strategies and associated costs of reducing future losses, it lacks details concerning the risk sea level rise poses to specific areas throughout the County (Cole, 2008).

Additionally, the Maryland Coastal Zone Management Program has developed a technical guidance report to assist Dorchester County in planning for sea level rise. Following the framework set forth in *A Sea Level Response Strategy for the State of Maryland*, the report addresses four planning strategies, including 1) vulnerability and planning assessment; 2) long-range and comprehensive planning; 3) regulations and development standards; and 4) public education and outreach (Cole, 2008). In doing so, the report provides specific recommendations to amend existing long-range plans as well as building codes, regulations, and development standards in order to address the future effects of sea level rise (Cole, 2008).

North Carolina

North Carolina Coastal Management Program

North Carolina's coastal management program (CMP) was approved in 1978 following the passage of the North Carolina Coastal Area Management Act (CAMA) in 1974. In an attempt to balance the preservation and orderly development of the state's coastal zone, CAMA established a cooperative coastal management framework between state and local governments throughout the 20 coastal counties (NCGS 113A-101; NCGS 113A-102). In addition, the Act authorized the Coastal Resources Commission (CRC), which is responsible for developing the program's coastal policies and regulations (NCGS 113A-104). The Division of Coastal Management within the North Carolina Department of Environment and Natural Resources

(NCDENR) serves as the program’s lead agency and is primarily responsible for providing staffing services to the CRC, implementing CRC policies and regulations, and administering coastal development (CAMA) permits (NC DCM, 2007). Two important aspects of North Carolina’s CMP that relate to sea level rise include its requirements for local land use plans and development permits in designated areas of environmental concern (AEC).

Land Use Plans

Pursuant to CAMA, the CRC mandates that each coastal counties must prepare a local land use plan (LUP) following the CAMA land use planning requirements set forth in North Carolina Administrative Code, Title 15A, subchapter 7B (NCGS 113A-110). In particular, CRC guidelines require that LUPs include the following elements: 1) community concerns and aspirations; 2) analysis of existing and emerging conditions; 3) plan for future; and 4) tools for managing development (15A NCAC 07B.0702; Figure 5).

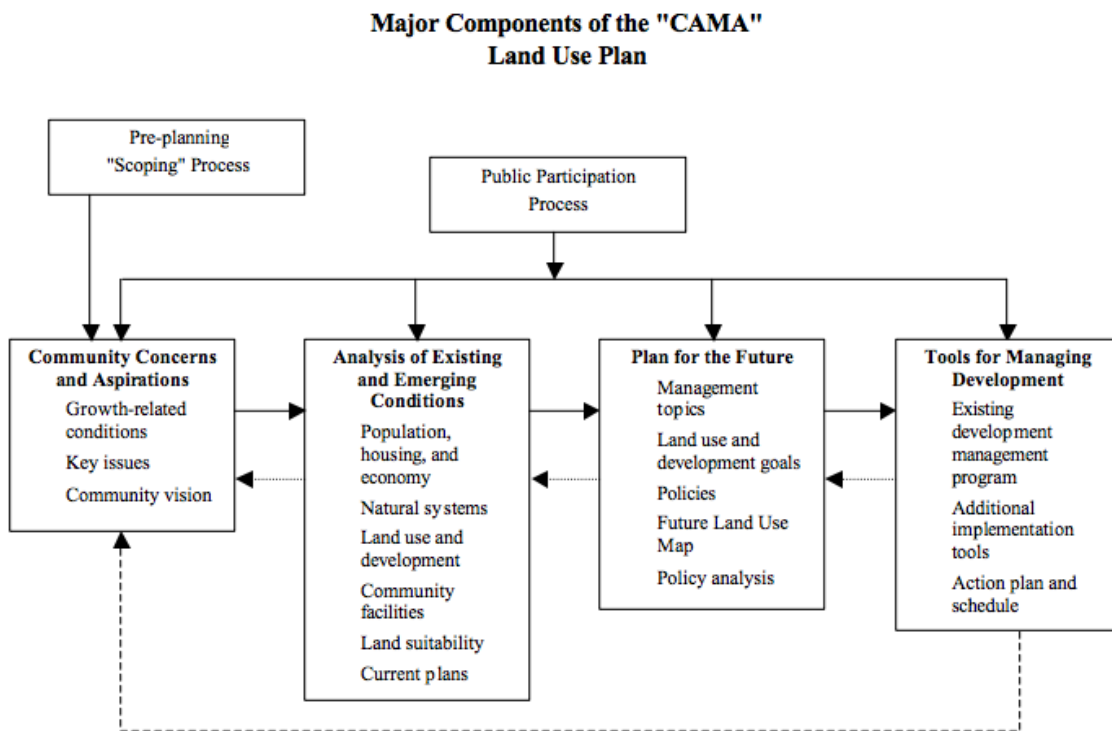


Figure 5. Major components of CAMA land use plans and their relationship to the planning process. Source: NC DCM, 2002.

Importantly, the “Plan for Future” must include local land use and development goals, policies, and a future land use map that are consistent with six Management Topics: 1) public access; 2) land use compatibility; 3) infrastructure carrying capacity; 4) natural hazard areas; 5) water quality; and 6) local areas of concern (15A NCAC 07B.0702(3)). While sea level rise is mentioned in the context of natural hazard areas, it is not addressed in DCM’s Technical Manual for Coastal Land Use Planning, which local planners use in developing their land use plans (NC DCM, 2002). As a result, sea level rise is rarely considered at the local level (see descriptions of land use plans below).

Areas of Environmental Concern

Additionally, the Commission also designates Areas of Environmental Concern within the coastal zone, including estuarine and ocean, ocean hazard, public water supplies, and natural and cultural resource areas (NCGS 113A-113). In an attempt to control development of these areas, the CRC requires all developers to obtain permits from the DCM to ensure that future development of AECs meets state standards (NCGS 113A-118). In addition to instituting coastal development standards in AECs, the CRC has devised strict rules and regulations for the implementation of several shoreline erosion response policies, including shoreline armoring, beach nourishment, and oceanfront development setbacks, all of which can be conceived as fully adaptable to sea level rise (15A NCAC 07M.0200; Klarin and Hershman, 1990).

Recent Sea Level Rise Policy Initiatives

The North Carolina DCM and CRC have initiated several efforts to evaluate and prepare for the potential impacts of sea level rise. Specifically, DCM conducted an initial scoping survey in 2009 to assess the public’s perception of sea level rise and its associated risks (NCDCM, 2010a). In March 2010, the CRC’s Science Panel on Coastal Hazards issued a sea level rise assessment report, in which they recommended that a rise of 1 meter (39 inches) by the end of the century be adopted for planning and policy development purposes (NCDCM, 2010b). Over the last two years, the CRC and DCM staffs have been actively developing a draft sea level rise policy. As originally written, the policy adopted the science panel’s recommendation that coastal communities begin preparing for a 39 inch, or 1 meter, rise in sea level by 2100. This enraged coastal developers, including the economic development interest group, NC-20, and resulted in

the introduction of a house bill that would prohibit state agencies from using accelerated sea-level rise projections in drafting coastal development rules, essentially making sea level rise illegal (NCGA H819 [Edition 3]). A revised version of the bill became law in August 2012 without the governor's signature and requires the CRC to study sea level rise further and places a moratorium on the implementation or use of official rates of sea level rise for regulatory purposes until July 2016 (NCGA S.L. 2012-202). Following the passage of this controversial legislation, the CRC draft sea level rise policy is a non-regulatory document lacking future projections and recommendations for adaptations. Instead, it clarifies DCM's role, allowing it to collaborate with other state and federal agencies to prepare educational outreach materials and conduct research on the issue (NC CRC, 2012).

Carteret County

Carteret County operates under a commission-administrator government structure with an elected Board of Commissioners and appointed County Manager serving as the lead governing bodies of the county (NACO, 2009). The Board of Commissioners is responsible for establishing County fiscal policy through its budgetary powers, enacting County ordinances, developing County programs and services, and appointing County employees, including the County Manager. The County Manager serves as the chief county administrator and is responsible to the board of directors for administering all departments within the county government, including the planning and inspections department and shore protection office, the latter of which is described in more detail below.

Several citizen commissions advise the County Board of Commissioners, including the planning and economic development commissions and the zoning board of adjustments. In addition, Carteret County is unique in that it is the only county in North Carolina to have a Shore Protection Office and Beach Commission dedicated to coordinating beach nourishment activity within the county. Specifically, the Shore Protection Manager and Beach Commission advise the County Board of Commissioners on strategies for beach nourishment and allocations of room occupancy tax proceeds dedicated for beach nourishment projects (Carteret County Beach Commission, 2006).

2005 Carteret County Land Use Plan Update

The 2005 Carteret County Land Use Plan update serves as the primary framework to guide short- and long-term development decisions throughout the county. It is important to note that although the plan was adopted by the Carteret County Board of Commissioners in April 2009, it remains to be certified by the Coastal Resources Commission. In addition, only the unincorporated Towns of Bogue, Peletier, and Cedar Point fall within the jurisdiction of the Carteret County LUP. All other incorporated municipalities have adopted their own individual land use plans (Carteret County, 2009). As such, only the land use and development goals and policies from the County LUP are described below.

Carteret County's land use and development goals are based on key planning concerns and direct the formulation of development policies that are consistent with the County's community vision for the future. While none of the goals explicitly relate to climate change, several, including those listed below, may be conceived as adaptable to future sea level rise response:

- "Land use and development patterns that are consistent with the capabilities and limitations of the County's natural systems, preserve the area's heritage and life styles, and promote sustainable economic growth."
- "Protect natural areas that have high biologic, economic, and scenic values."
- "Mitigation of risks associated with storms, flooding, and shoreline erosion."

In order to achieve its development and land use goals, the County has, in accordance with CRC requirements, developed comprehensive policies related to the CRC's six management topics (see *Land Use Plans*). Again, none of these policies specifically addresses sea level rise, but those that could affect adaptation efforts are outlined below.

Land Use Compatibility

- "Policy 2.3: Carteret County believes that 'Living Shorelines' may provide a better alternative to shoreline stabilization than conventional structures."
- "Policy 2.7: Carteret County encourages private acquisition of conservation areas by purchase or gift from property owners for the purpose of preserving these areas."

Natural and Man-made Hazard Areas

- “Policy 4.1: The County will implement the following measures to mitigate risks to development within flood hazard and ocean hazard AECs:
 - Carteret County will continue to enforce its existing zoning and flood damage prevention ordinances.
 - The County concurs with the CAMA use standards for ocean hazard AECs.
 - The County allows development and redevelopment within the 100-year floodplain subject to the provisions and requirements of NFIP, CAMA, the County’s Flood Damage Prevention Ordinance, and other local ordinances.
 - The County will finalize and implement the Hazard Mitigation Plan that addresses a broad range of natural hazards in the County.
 - The future location of public facilities and structures will take into consideration the existence and magnitude of natural hazards.
 - Carteret County is supportive of local beach nourishment programs, including the Carteret County Shore Protection Program.”
- “Policy 4.2: Carteret County will maintain or improve its NFIP Community Rating System (CRS) score to allow for continued discounted flood insurance rates for property owners.”
- “Policy 4.3: In order to mitigate risks for older properties and keep communities intact, the County will continue to cooperate with state and federal agencies and property owners to elevate residences and other structures above the base flood elevation.”

Local Areas of Concern - Economic Development

- “Policy 6.8: Carteret County will encourage the use of conservation easements to preserve important scenic resources such as coastal wetlands, pocosins, swamps, farms, and timberlands” (Carteret County, 2009).

These existing policy measures will undoubtedly influence how Carteret County will proceed in terms of developing future sea level rise policies. However, it is unlikely that the County will formally adopt any local adaptation strategies in the near future, especially considering the fact that the Board of Commissioners recently adopted a resolution concerning the development of sea level rise policies in North Carolina, in which they requested the “development of protocols articulating the precise methodology to how sea level is to be measured, recorded, interpreted, and reported” (Carteret County Board of Commissioners, 2012). In addition, the Board of

Commissioners resolved that state agencies delay developing and implementing any Sea-Level Rise policies until there is substantial scientific evidence to support accelerated rates of sea level rise and associated impacts to coastal North Carolina. It is important to note however, that the Town of Beaufort, NC did not sign off on this resolution even though the Town's core LUP highlights the difficulty in developing specific regulations based on uncertain sea level rise projections (Town of Beaufort, 2006).

Dare County

In Dare County, town mayors and members of county/city councils, boards of commissioners, and planning boards devise policies and guidelines that address both development and environmental protection goals for their respective jurisdictions. These policies and goals are defined in county and city land use plans. Additionally, departments and commissions such as Emergency Management, Environmental Planning, and the Shoreline Management Commission work with the city and county to address environmental concerns like those posed by climate change and sea level rise.

2009 Dare County Land Use Plan Update

The Dare County land use plan includes a description of the current conditions related to population demographics, housing, and the economy, an analysis of natural conditions and environmental resources, and land use and development, and a discussion of the vision of the county and the related policies that will guide how the goals will be met. The LUP also includes future land use maps that show how land should be used based on the policies designated in the LUP. The LUP addresses sea level rise only in reference to the continued debate surrounding the topic and notes that the Planning Board will reserve judgment on any policy initiatives that are a result of this debate (Dare County Board of Commissioners et al., 2009).

The stated vision of Dare County is to:

“Manage the growth and development in a manner that preserves the historical, cultural, and natural resources that make Dare County a desirable place to live, work and visit. Unincorporated Dare County should retain the characteristics typical of the entire County before the incorporated municipalities experienced urban-style growth. It is the goal of Dare County to shape the growth of the

unincorporated villages in such a manner that they retain their historical character,” (Dare County Board of Commissioners et al., 2009).

Policies statements are grouped to address the CRC’s six management topics (see *Land Use Plans*) and include implementing strategies. Several of the important objectives, policies, and strategies that relate to climate change and sea level rise planning are outlined and briefly summarized below.

“Management Topic #1: Public Access –

- Policy PA #1: support preservation and protection of right to access and use public trust areas and waters
- Policy PA #2: reserve right to review, advocate, or oppose Federal or state regulations that affect public trust waters or areas
- Policy PA #7: beach nourishment is the preferred shoreline management alternative along ocean beaches

Management Topic #2: Land Use Compatibility

- Policy LUC #8: redevelopment of older structures shall be done in accordance with current building codes and flood insurance regulations
- Policy LUC #9: siting of industrial development facilities should be evaluated based on impacts to environmentally sensitive areas
- Policy LUC #13: dune alteration activities should be minimal and meet standards to ensure erosion control

Management Topic #3: Infrastructure Carrying Capacity

- Policy ICC #4: wastewater treatment facilities that employ non-traditional systems should not be located in areas subject to storm surge or in designated flood hazard zones (identified in flood insurance maps)

Management Topic #4: Natural Hazard Areas

- Policy NH #1: oceanfront shoreline development should continue to be managed to protect and preserve the natural and recreational resources along the oceanfront
- Policy NH #2: estuarine shoreline development should continue to be managed to protect and preserve the natural and recreation resources along the oceanfront

- Policy NH #3: support the installation and maintenance of estuarine bulkheads
- Policy NH #5: supports the minimum standards, administration, and enforcement of floodplain management regulations of the NFIP
- Policy NH #6: use construction standards and regulations to mitigate the effects of storm surge, flooding, and erosion
- Policy NH #9: alternative locations for storm-damaged publicly-owned utilities will be considered
- Policy NH #12: federal and/or state initiatives that may be forthcoming to address issues of global warming and sea level rise will be reviewed

Management Topic #5: Water Quality

- Policy WQ #7: advocates existing state and federal programs for protecting and preserving coastal wetland areas
- Policy WQ #11: continued productivity of fisheries shall be fostered through restoration and protection of unique ecosystems on which they depend

Management Topic #6: Local Areas of Concern

- Policy LAC #11: recognizes the importance of the need for continued stabilization and protection of Oregon Inlet” (Dare County Board of Commissioners et al., 2009).

New Hanover County

New Hanover government officials that have responsibility and authority related to planning for climate change and sea level rise include town mayors and members of city councils, Boards of Commissioners, and Planning Boards. These officials design and implement policies related to how the county/city will be governed, managed, developed, and protected. The New Hanover County land use plan is described in detail below, but it should be noted that New Hanover County, and the City of Wilmington in particular, have several other guiding documents related to developmental and environmental concerns and goals for the future. These documents include such plans as “Wilmington Vision 2020: A Waterfront Downtown”, and “City of Wilmington 2010 – 2015 Parks, Recreation and Open Space Master Plan”.

Wilmington – New Hanover County Joint Coastal Areas Management Plan, 2006 Update

The 2006 New Hanover County CAMA Land Use Plan (LUP) forms the basis for decisions regarding development and protection of the region. This document includes an analysis of the current conditions related to population, housing, economy, land use, infrastructure, and natural resources, as well as a plan for the future that states the vision and goals of the county and the policies and implementation strategies that will guide land use decisions (New Hanover County Advisory Panel, 2006). The LUP also includes a brief discussion of sea level rise, but rather than the inclusion of any county-specific concerns or plans, this section only addresses the broad range of impacts related to SLR and the measures that any local government can take to address these impacts in a very general sense.

The stated visions of New Hanover County are as follows (italics are from the original):

“Wilmington and New Hanover County are rich in history, natural resources, and tradition. These are the characteristics that have formed our way of life and have made the area attractive to those who live and visit here. This way of life has adapted to changing times and to new people of differing ethnic proportion, customs, and background. The natural resources have contributed to the areas economic prosperity and beauty.”

“Our Vision is to continue to adapt to growth as we preserve the values that make our community a great place to live in harmony with the earth and the sea and give our people unique opportunities to make a living.”

“Thus, we combine the legacy of the past with the promise of the future.” (New Hanover County Advisory Panel, 2006).

The goals identified in the county LUP relate to government, infrastructure and transportation, housing and economics, education, and environment. Specific goals that relate to the topic of climate change and sea level rise adaptation strategies (and point to the potential trade-offs in the planning process for achieving these goals) include the following:

- “Wilmington and New Hanover County will be environmentally clean areas with a healthy economy,
- Natural resources including beaches, rivers, sounds, aquifers, natural vegetation, and tree canopy will be preserved and protected”(New Hanover County Advisory Panel, 2006).

The land use plan then goes on to address issues, policies and implementation strategies. Specifically, issues fall into broad categories including natural resources, land use and urban design, transportation, community infrastructure, housing, economic development, historic preservation, and storm and natural hazards. Each issue has a number of related policies which, in turn, include a number of implementation strategies. Several of the important issues and policies related to climate change and sea level rise are outlined and briefly summarized below.

“Natural Resources

- Issue 2: Open Space – preserve remaining natural areas; provide for the creation of additional public use areas, natural open space, greenways, conservation areas, and access to waterways
- Issue 3: Environmental Protection/Quality of Life – preserve and enhance the special qualities of the coastal environment and its natural resources; generate sustainable economic growth

Land Use and Urban Design

- Issue 4: Land Use Demand – enhance quality of the built environment while preserving and protecting the area’s natural environment
- Issue 5: Urban design and character – create more flexible and innovative development plans; allow higher development density where natural conditions will not be adversely affected to take pressure off more sensitive areas

Transportation

- Issue 7: Environment – strengthen environmental protection and mitigation of impacts during planning, construction, and maintenance of transportation facilities; consider design alternatives for road projects;

Storm and Natural Hazards

- Issue 21: Land Use and Safety – safeguard future population from development which may put increased numbers of people at risk in hazard incidents
- Issue 22: Government Response – appoint a recovery task force to direct reconstruction efforts after damaging storms” (New Hanover County Advisory Panel, 2006).

Tyrrell County

Tyrrell County's administrative government structure is overseen by a 5 member Board of Commissioners (Tyrrell County Chamber of Commerce, 2003). Columbia, NC is the county seat of Tyrrell County and is governed by an Alderman/Manager style of government, which is comprised of an elected Mayor and Board of Alderman as well as an appointed Town Manager. In addition, the Columbia Planning Board advises the Board of Alderman and Town Manager on development issues.

The Fiscal Year 2005/2006-2006/2007 Tyrrell County/ Town of Columbia CAMA Core Land Use Plan was adopted by the Tyrrell County Board of Commissioners and Town of Columbia Board of Alderman in 2009 and 2010 respectively (Tyrrell County, 2009). The plan, prepared according to CAMA and CRC requirements, is intended to guide the development and use of land in Tyrrell County and the Town of Columbia and includes policies and implementing actions that address the CRC management topics. Several of these policies and implementation actions that relate to climate change and sea level rise are outlined below.

Land Use Compatibility

- Policies - Conservation
 - “P.33: Except as otherwise permitted in this plan, residential, commercial, and industrial development should not be supported in natural heritage areas or coastal wetlands.”
 - “P. 34: Tyrrell County will support larger lots in conservation classified areas through the enforcement of the County's subdivision ordinance.”
 - “P. 40: Tyrrell County generally supports the efforts of state and federal agencies with regulatory authority to monitor and regulate development in areas susceptible to sea level rise and wetland loss, but reserves the right to object to amendments and/or changes to regulations and/or programs.”
- Implementation Actions - Conservation
 - “I. 22: In order to protect property and ensure public safety, Tyrrell County will implement the following:
 - Continue to enforce its Flood Damage Prevention Ordinance
 - Implement its Storm Hazard Mitigation Plan, as necessary.

- Continue to coordinate development within special flood hazard areas with the County’s Building Inspections Department, NC DCM, Federal Emergency Management Agency, and the US Army Corps of Engineers
 - Participate in the National Flood Insurance Program.”
- “I. 25: In order to monitor possible sea level rise, Tyrrell County will implement the following:
 - Rely on the NC DENR, DCM to monitor and regulate development in areas susceptible to sea level rise and wetlands loss.
 - Rely on state and federal agencies to monitor the effects of sea level rise and cooperate with local, state, and federal efforts to inform the public of the anticipated effects of sea level rise.
 - Consider updates or amendments to its land use plan policies as necessary to protect the county’s public and private properties from rising water levels Support bulk heading to protect its shoreline areas from intruding water resulting from rising sea levels.
 - Consider establishing setback standards, density controls, bulkhead restrictions, buffer vegetation protection requirements, and building designs which will facilitate the movement of structures, if necessary.”

Natural Hazard Areas

- Policies
 - “P. 67: Tyrrell County and the Town of Columbia support efforts to control estuarine shoreline erosion. Where possible, land owners are encouraged to use structures that will preserve wetlands and fisheries habitat and protect water quality.”
 - “P. 68: Tyrrell County and the Town of Columbia recognize the uncertainties associated with sea level rise. The rate of rise is difficult to predict. Thus, it is difficult to establish policies to deal with the effects of sea level rise. Tyrrell County and the Town of Columbia support cooperation with local, state, and federal efforts to inform the public of the anticipated effects of sea level rise.”
 - “P. 69: Tyrrell County and the Town of Columbia support hazard mitigation planning.”

- **Implementation Actions**

- “I.53: Tyrrell County and the Town of Columbia will continue to enforce its Floodplain Ordinance and participate in NFIP. It will rely on NC DCM to monitor and regulate development in areas up to five feet above mean high water susceptible to sea level rise and wetland loss. Subdivision regulations will be enforced requiring elevation monuments to be set so that floodplain elevations can be more easily determined.”
- “I.55: Tyrrell County and the Town of Columbia permit redevelopment of previously developed areas, provided all applicable policies, regulations, and ordinances are complied with.”
- “I.56: In response to sea level rise, Tyrrell County and the Town of Columbia will review all local building and land use related ordinances and consider establishing setback standards, density controls, bulkhead restrictions, buffer vegetation protection requirements, and building designs which will facilitate the movement of structures” (Tyrrell County, 2009).

Summary

A summary of the major differences in the total ecologies of our study areas that emerged from our literature review is provided in Table 6 below.

Table 6. Comparison of major county differences.

	MARYLAND			NORTH CAROLINA			TYRRELL
	ANNE ARUNDEL	DORCHESTER	CARTERET	DARE	NEW HANOVER		
BIOPHYSICAL	Landscape						
	Topography	Urban 0-300 ft above sea level	Rural 50% of land area lies below 4.9 feet above sea level	Urban/Rural Much of county is already located w/in flood hazard/storm surge areas	Urban/Rural 3-7 ft above sea level on mainland; 0-300 ft (sand dunes) on barrier islands	Urban 0-50 ft above sea level	Rural 88% unincorporated land in 100- or 500-year floodplain; Town of Columbia located in NFIP Special Flood Hazard Area
HUMAN	Habitat Types	Forests, wetlands	Narrow peninsulas, creeks, guts, streams, ditches, tidal/non-tidal marsh	Barrier islands, low-lying estuarine habitat	Barrier islands, low-lying estuarine habitat	Barrier islands (closer, inland), low lying estuarine habitat	Estuarine waters, coastal wetlands
	Other	N/A	Blackwater Refuge already experiencing permanent inundation	N/A	Federal/State Protected Areas; Ocean erodible areas; flood hazard areas	Ocean erodible areas; flood hazard areas; inlet hazard areas	Almost entirely surrounded by water; influenced by NE wind driven tides; conversion of forests for agriculture; existing ditching and drainage issues
HUMAN	Population (2010)	537,656	32,618	66,469	33,920	202,681	4,407
	Bachelor's Degree or higher (2007-2011)	36.3%	18.0%	23.7%	31.6%	36.0%	10.1%
HUMAN	Median Household Income (2007-2011)	\$85,690	\$46,683	\$47,403	\$54,750	\$48,893	\$34,071
	Persons below poverty level (2007-2011)	5.5%	15.0%	13.1%	11.1%	15.5%	20.5%
HUMAN	Economy	Defense contractors; Private Sector; Telecommunications; Retail; Distribution	Agriculture; Forestry; Seafood Processing	Services/Tourism; Military; Commercial Fishing	Services/Tourism; Boat Building; Commercial Fishing	Services/Tourism; Pharmaceuticals/Healthcare; Manufacturing; Government	Agriculture; Forestry; Fishing; Hunting; Mining
	Land Use Plans	<i>General Development Plan</i> recognizes county's sensitivity to temporary flooding events and includes recommendations to develop a strategic plan to avoid or reduce SLR impacts	<i>Multi-Hazard Mitigation Plan</i> briefly addresses sea level rise in terms of mitigation actions and costs.	N/A	<i>CAMA LUP</i> recognizes continued debate adm reserves judgement on resulting initiatives; No specific policies related to climate change/sea level rise	<i>CAMA LUP</i> section on sea level rise includes broad-scale EPA projections, potential impacts, and range of potential adaptation measures; No specific policies related to climate change/sea level rise	<i>CAMA LUP</i> addresses sea level rise in that it recognizes uncertainty with predictions and the resulting difficulty to establish policies; will rely on NCDM to monitor and regulate development in areas susceptible to sea level rise
INSTITUTIONAL	Other	<i>Anne Arundel SLR Strategic Plan</i> includes vulnerability assessment & identifies major planning issues related to SLR and recommends actions to minimize impacts;	<i>Sea Level Rise: Technical Report</i> includes vulnerability/impact assessment; recommendations to improve planning documents, codes, regulations, existing codes & regulations, and public outreach efforts;	County Resolution requesting development of protocols for measuring, recording, interpreting, and reporting sea level rise (not signed by Town of Beaufort); <i>Town of Beaufort LUP</i> recognizes uncertainties with SLR projections, which make it difficult to establish policies.	<i>Town of Hags Head LUP</i> states it is taking initiatives to mitigate sea level rise impacts, but nowhere addresses what those initiatives are.	<i>City of Wilmington Sea Level Rise Adaptation Report</i> assesses likely impacts of sea level rise and presents/evaluates adaptation strategies.	N/A

Interview Findings

In all, we conducted a total of 165 interviews with 39 key informants and 125 “on-the-street” citizens. Key informants represented a mix of municipal and county officials and government employees, environmental interests, and development interests. The breakdown by county and affiliation is presented in the table below (Table 7).

Table 7. Key Informant Interviews by Study Site and Affiliation

	MARYLAND		NORTH CAROLINA				Affiliation Total
	Anne Arundel (Annapolis)	Dorchester (Cambridge)	Carteret (Beaufort)	Dare (Nags Head)	New Hanover (Wilmington)	Tyrrell (Columbia)	
County Officials	1	2	4	2	3	1	13
Elected		2	1		1	1	5
Appointed/ Government Employee	1		3	2	2		8
Municipal Officials	2	4	4	3	1	4	18
Elected	1	1	2	1		3	8
Appointed/ Government Employee	1	3	2	2	1	1	10
Federal Employee	1						1
Environmental Interests			2				2
Development Interests	1		2				3
Other		1	1				2
County Total	5	7	13	5	4	5	39

It should be noted that variations in the number and affiliation of interviewees among the six study counties are a result of time constraints and inability to get in touch with some potential informants. However, we feel that we have gotten a good mix of viewpoints and an exceptional amount of information from those with whom we were able to speak. Moreover, the coding and analysis of our interview responses is ongoing; therefore, the findings presented below represent the results from our preliminary qualitative analysis and will later be supplemented by statistical data in a future appendix to this report.

That being said, we gathered an extensive amount of valuable information regarding people's attitudes towards climate change and sea level rise, how and why these environmental changes are being discussed, what types of actions have been taken so far, the role of science in decision-making, and beliefs regarding who should play a role in helping areas respond to the challenges associated with climate change.

When asked if they had experienced environmental changes since living in their community, the vast majority of interviewees responded that they had. Individual respondents noted a range of environmental changes, but in general, some of the most often noted changes included shoreline erosion and changes in summer and/or winter temperatures (mainly increasing temperatures, but there was variation on this response). Many also noted changes in storms and wind patterns, and some noted changes in habitat and wildlife. Responses in this line of questioning seemed to be very much dependent on how long the individual had lived in the community.

Responses in regards to whether or not climate change and/or sea level rise had been discussed in the community or if any actions had been taken were extremely mixed. Many said the issues had been discussed and they could identify the context of the discussions and who was involved. Others stated that the topics had been discussed but not in any formal manner. Still, others remarked that the topic hadn't been discussed at all aside from what they see on the national news. These responses are discussed in greater depth further below.

The questions on the understandability and use of science for decision-making also garnered a mix of responses. Many felt that each individual piece of science was understandable enough (at least the main point was, if not the technical details), but that the contradictory science was somewhat confusing and/or made the science of only little or some use for decision-making. Several respondents also pointed out that while they believe and understand the science, it is only one of many factors that they take into consideration when making decisions. Relatedly, the question regarding who interviewees trusted most turned out to be one of the hardest questions for people to answer. Many felt that being limited to one multiple choice answer was difficult because they either don't completely trust anyone, or they trust different information sources equally and consider them all when thinking about climate change. The topic of scientific uncertainty is also discussed in greater detail below.

Lastly, respondents had the most difficulty in answering what they believed to be the most appropriate source of resources to address the challenges of climate change and sea level rise, and this question seemed to be the most thought-provoking for many. The most common response seemed to be that everyone (all levels of government, NGOs, and private industry) has a role to play in helping local areas adapt to sea level rise and climate change. Some interviewees noted that the local level doesn't have any resources to address these challenges, so the upper levels of government need to help, while other interviewees stated that they didn't want to be told what to do by upper levels of the government and would prefer if local governments dealt with the problems directly. Somewhere in the middle of these two divergent opinions was the sentiment that resources should come from the federal government, but that states and local areas should be able to choose how to make use of these resources.

In addition to these findings, a number of interesting themes emerged throughout our interviews. These themes include 1) the range of beliefs regarding climate change and sea level rise science, 2) the uneven distribution of interest in climate change related issues, 3) the lack of resources to address these environmental challenges, and 4) additional barriers to the development and implementation of adaptation strategies.

Scientific Uncertainty

One of the most important sentiments we gleaned from our interviews is that there are a number of people who don't fully trust climate change or sea level rise science. Importantly, rather than a binary, believe or do not believe, set of responses, people's beliefs on the topic of climate change science fell across a very broad range. Some of the major categories of responses include:

1. Those who do not believe that sea level rise is occurring and/or those who do not think that sea level rise is or will be a concern for their county
2. Those who think that the climate is changing and sea levels are rising but rather than being human-induced, these changes are just one part of a completely natural set of global cycles
3. People who believe these environmental changes are occurring and that humans have influenced and/or caused these changes, but who have concerns with contradictory

science in terms of what the likely impacts are, and, perhaps more importantly, are troubled about the lack of data for what the localized impacts will be

4. Those who believe that humans have influenced climate change and sea level rise and are less interested in how the scientific debate surrounding these issues plays out but rather how to address the potential changes now and in the future.

It should be noted that these categories are not exhaustive of the range of people's beliefs, nor should it be assumed that these categories are completely rigid. However, these are important distinctions to make in order to understand the potential for the development and implementation of adaptation strategies. Indeed, perhaps not surprisingly, the category that a particular individual falls into influences what they believe their respective county should (or should not) do to respond to any potential environmental changes. Some of the commonly held perceptions on this topic are outlined below.

Among those who do not think that climate change and sea level rise will significantly impact their county, discussions regarding planning and adaptation strategies were, understandably, minimal. The primary example of this viewpoint in our research comes from Tyrrell County. In the interviews conducted in this region, the commonly held perception is that due to its more inland location, the county has less to fear from sea level rise and increased storm surge than it does from wind driven tides (from northeast winds in particular) and flooding as a result of clogged drainage ditches. As a result, beliefs regarding how to respond to climate change related challenges had less to do with planning adaptation strategies and more to do with addressing current flooding problems. For example, many individuals spoke of the high priority of gathering funds and assistance to clear and maintain drainage ditches to reduce flooding impacts.

Responses from those in the second and third categories regarding how best to plan for and adapt to sea level rise tended to be fairly similar in that they were largely against any specific plans at this point in time. One viewpoint that was particularly prevalent among watermen in Dorchester County is that the earth is always changing, whether or not this is from human causes, and people will address any problems as they come along as they always have done. This group of people seemed to be strongly against anyone (particularly the government at any level) telling them what to do and how they should adapt. It is also particularly important to note that

those in category three felt that climate change science just isn't yet mature enough to form the basis of policy decisions that may have significant short and long term consequences. In other words, it isn't that they don't believe efforts should be taken to adapt to these changes, but rather that additional research needs to be conducted in order to better understand the best approach to take.

Lastly, there is the group of people who believe that there is currently enough scientific data and research to begin planning efforts. These people believe that steps should be taken now to implement adaptation strategies, and may have even made some initial plans and/or completed projects or actions that include adaptation strategies. Discussions with these individuals regarding how to develop and implement adaptation policies focused instead on the barriers to this process including, but not limited to: lack of buy-in from decision-makers and the public, lack of knowledge for how to plan, lack of funding to support adaptation efforts, and a variety of political obstacles. Many of these factors are described further in the following sections.

Uneven Distribution of Interest

Second, we learned throughout the interviewing process that there seems to be an uneven distribution of concern for climate change and sea level rise related issues. One way this presented itself was in terms of differences between the municipal and county level. We found that on several occasions, those at the municipal level were more willing to address sea level rise, at least from a pragmatic, near-term standpoint, whereas those at the county level were much more hesitant or wary of planning any adaptation strategies. One prime example of this dichotomy comes from Carteret County and the Town of Beaufort. In March of 2012, Carteret County adopted a resolution that asked the state and relevant state agencies to discontinue the implementation of sea level rise policies based on what they deemed "unsound" science and requesting the development of a formal protocol for how sea level rise is to be measured. The Town of Beaufort, however, did not support or sign this resolution. This is a distinction that one Beaufort town official was very proud of and sure to emphasize.

Additionally, we found that, out of those we interviewed, there was often only one or two people in each county or municipality who were at all interested in the topic or concerned about climate change and sea level rise. In general, these individuals could speak at length and in great detail about any discussions in the county or municipality related to climate change or sea level

rise, the context of these discussions, who was involved, and what any results or follow-up discussions there were. These individuals could identify the people, by name, who have or might address climate change and sea level rise, could cite specific planning documents that were in any way related to the topic, and could speak with what is clearly a thorough understanding of the issues. On the other hand, those who were plainly uninterested in or unconcerned with these climate change and sea level rise couldn't really speak to any of these points. Their responses ranged from being entirely contradictory (for example saying that climate change and sea level rise hadn't been addressed in the county/municipality) to just unaware of the specifics (for example they knew for sure that the issues had been discussed, but not sure by whom, in what context, or what the results were). These types of responses were particularly interesting in many instances because these individuals had been named by others as having attended certain meetings in which these topics had been discussed.

Lack of Resources

One of the most often cited problems we heard related to the implementation of sea level rise adaptation strategies was that localities simply lack the resources to undertake any kind of planning efforts. In particular, as noted above, many interviewees remarked that a lack of localized data is a serious concern for beginning any planning efforts because they don't have a good idea or a good benchmark of what to plan for.

Not surprisingly, many people also noted that they lack the funding to start any initiatives. Importantly, this lack of funding plays into the first point regarding a lack local data because local governments can't afford to fund any local research in addition to the fact that they can't afford to implement any adaptations actions. A related point noted in Tyrrell County in particular is that given their small population and high poverty level, many people in the municipal and county government take on multiple roles. As a result, there simply aren't enough people to take on the additional role of addressing potential future environmental changes.

Lastly, there was a general lack of knowledge of how to start planning or what the planning process involves. In other words, even if decision-makers did have an idea of what to plan for and had the money to create adaptation plans, they are unsure of what steps to take first and what types of plans should be made.

Existing Barriers to Adaptation

The last major theme that we gleaned from our research is that beyond the lack of resources to address sea level rise, a widespread disinterest in climate change related issues, and a broad spectrum of belief (and disbelief) in climate change and sea level rise, there remains an even greater variety of existing barriers to the implementation of adaptation strategies.

Several of the most interesting examples of other types of barriers that we learned about in conducting our interviews came from the comments of an individual in North Carolina. We sought out this individual, in particular, because we knew that he would have a different point of view than we do as a result of the group he is associated with. In discussing his concerns regarding setting an actual sea level rise height for planning purposes, he noted that doing so would almost certainly bring with it a host of unintended consequences. One such consequence is that if we require roads to be built higher to account for a rise in sea level, they will likely be raised on platforms of fill (as opposed to roads lifted in the air like bridges) which will change hydrologic flow patterns in the surrounding area. These changes could actually increase flooding in certain regions rather than alleviate it. Additionally, this individual was one of the only people to point out specific social justice issues related to a sea level rise planning policy. He noted that if waterfront areas are labeled as places that will soon be underwater, the property values in those areas will immediately plummet, thereby creating very real problems for the poorest people living on estuarine shorelines.

Additionally, we heard in both Annapolis and Beaufort that there are historical preservation regulations which may actually inhibit efforts to protect some structures and areas. For example, regulations that don't allow the structure of a historical house to be modified in any way will make it even more difficult to raise or relocate it in the future. Somewhat similarly, we spoke with an individual involved with a church in Dorchester that is very threatened by the rising sea. The church group has been offered money and assistance to move the structure, but these resources have declined because it would mean leaving behind the historical graveyard and an area of cultural significance, which the group simply doesn't want to do.

DISCUSSION

Overall, our literature review and interview findings support our overarching hypothesis that differences in biophysical conditions, social demographics, and existing policy frameworks influence local perceptions of climate change and sea level rise as well as a community's willingness to formally address sea level rise concerns. However, our findings suggest that the ways in which the total ecology of a region influences local perceptions is very complex. For example, sea level rise studies have been completed for the City of Annapolis, MD and the City of Wilmington, NC, which are two of the wealthiest municipalities in our study areas. At first glance, this is not entirely surprising based on the assumption that these communities have more resources to conduct these types of extensive analyses (a "human" ecology trait). However, both studies received external financial assistance through existing institutions, namely the Coastal Zone Management Act of 1972 and Environmental Protection Agency (EPA) respectively (an "institutional" ecology trait). One could then speculate as to whether these communities have more at stake in terms of development and infrastructure than the other study areas (a "biological" ecology trait), which in turn has prompted them to act more proactively than areas that have relatively less to lose. It could also be that government staff in these communities wear only one hat, so to speak, and are therefore able to dedicate more of their time to exploring the resources available to assist them in their sea level rise planning efforts (another "institutional" ecology trait). This example shows how difficult it is to parse out the reasons behind certain actions. Additionally, it points to how certain aspects of an area's total ecology may be more influential than others within a particular county and that different aspects may be more influential than others across our study areas. As a result, our initial assumptions may or may not always hold true, as described below.

1 Biophysical Assumption: an area's biophysical vulnerability to sea level rise and/or the extent to which an area is already experiencing sea level rise related impacts will make it more or less accepting of changing environmental conditions and proactive in developing relevant policies.

Our findings suggest that areas that are more vulnerable to sea level rise from a biophysical standpoint (e.g., low-lying elevation) are not necessarily more aware of the potential impacts of climate change and sea level rise and/or willing to take action to address these

impacts. For example, given that both Dorchester County and Tyrrell County are similarly susceptible to even the slightest rise in sea level due to their low-lying coastal plains and extremely hydric soils, we assumed that they would be equally accepting of sea level rise projections and therefore equally likely to proactively address sea level rise impacts. However, it appears that climate change and its associated impacts are not a primary concern in Tyrrell County, whereas Dorchester has already taken initiative to address current and future sea level rise threats. This potentially points to the importance of the human aspect of an area's total ecology in driving perceptions and policy development.

2. *Human Assumption: relevant stakeholders, population demographics, and economic drivers will influence a community's understanding of climate change and sea level rise and its willingness to adopt adaptation strategies.*

Overall, our findings support the assumption that the human dimensions of a region play a significant role in influencing local perceptions and driving sea level rise adaptation efforts. In particular, people's beliefs and understanding of climate change and sea level rise science seems to greatly influence whether or not communities are ready to begin planning for and adapting to associated impacts. In general, distrust or questioning of climate change and sea level rise science will hinder adaptation planning efforts. In North Carolina in particular, the interviewees who felt the most strongly about the lack of data or contradictory science essentially stated outright that until there is "better" or more localized data, they will resist implementing any policies that have the potential to negatively impact their community in unintended ways. Relatedly, many decision-makers, whether or not they are comfortable with current climate change science, noted that without a higher degree of understanding of the potential impacts among their constituents, there simply won't be enough support or buy-in to even attempt implementing any broad-scale adaptation policies.

Additionally, our findings regarding the uneven distribution of interest in climate change related issues suggest that all else being equal, the presence of individuals who are more interested in the topic will make it more likely that actions are taken to address the challenges. There are a significant number of resources (e.g. grants, manuals, tools) that exist that are specifically designed to assist local decision-makers address the challenges of sea level rise, but if climate change and sea level rise is not on an individual's radar, they are unlikely to know about these resources. This could explain why Dorchester County has been more proactive than

Tyrrell County in seeking out financial and technical assistance to support their sea level rise planning efforts.

- 3. Institutional Assumption: existing governance institutions directly influence a community's adaptive capacity and ability to adopt or not adopt sea level rise policies and regulations.*

Overall, our findings suggest that existing sea level rise related policies and initiatives at the state-level greatly influence whether counties and/or municipalities are taking action at a more local level. Unsurprisingly, the presence of top-down directives ordering communities to begin planning for sea level rise impacts, like those present in Maryland (e.g. Executive Order 01.01.2007.07), are critical for initiating local adaptation efforts. Conversely, state-level legislation that effectively prohibits agencies from using projections of accelerated sea level rise in planning efforts, as is the case in North Carolina, clearly influences people's perceptions of the severity and immediacy of climate change and its associated risks, and therefore stifles the ability of localities to start adaptation planning from the bottom-up. One important caveat to note however is that localities may still fail to address sea level rise in their planning efforts even when state policies advise them to do so, as is the case in all of our North Carolina counties' land use plans. This points to the importance of having state-level policies that require counties to actually plan for, rather than simply acknowledge anticipated impacts.

- 4. Attitudes will be different among county and municipal officials as well as across the different sectors represented by relevant stakeholders.*

Our last assumption that differences in attitude will exist between county and municipal officials, as well as across different sectors, also seems to be supported by our interview findings. This likely stems from the fact that those at the municipal level are much closer to the problems at hand. We heard on multiple occasions from municipal officials that one way people in their town deal with flooding issues is to pick up the phone and call town officials to complain about water on the streets or on their land. Thus, it seems that municipal leaders hear about the problems on a much more daily basis whereas those at the county level are more sheltered from these problems. Relatedly, it is likely that municipal leaders are concerned with day-to-day business while county leaders are concerned with longer term planning efforts.

Additionally, we did find that environmental representatives and development interests differed in their perceptions of climate change and sea level rise and their attitudes towards the development and implementation of adaptation strategies. Importantly, the role that a specific interest group plays in the policy process is highly dependent on their visibility and power within a community. For example, NC-20, a group that represents development interests in coastal North Carolina, was able to successfully lobby North Carolina's General Assembly to stop them from adopting policies that would require coastal areas to begin planning for accelerated sea level rise. This further points to the importance of engaging all relevant stakeholders from the beginning when considering, developing, and implementing adaptation policies.

Based on this analysis, our findings suggest that there is still a lot to learn about how areas can best adapt to a changing environment. Moreover, there will likely be things that are learned along the way in implementing adaptation strategies so these processes will need to be adaptive. Additionally, while there are many existing barriers to adaptation, this does not mean that communities should not begin devising and implementing adaptation strategies, but rather that it is even more important to begin these processes now. It is critical that relevant stakeholders begin working together to break down existing barriers, address data deficiencies, and disseminate important information and resources in order to help localities develop site-specific adaptation strategies.

CONCLUSION

With unequivocal proof that the climate is changing and sea levels are rising, it is well understood that coastal communities are at risk of increasing land loss, loss of critical wetland habitat, increased frequency and extent of temporary storm-related flooding events, and salt water intrusion. As a result, it is becoming increasingly important to develop coastal management strategies that plan for the adverse effects of these environmental changes. Whether and how communities begin to develop and implement adaptation strategies and policies will likely depend on the perceptions citizens have related to the risk and immediacy of these impacts.

We hypothesize that adaptation to climate change is and will be affected by people's perceptions of climate change, which are based on the combination of and relationships among different "ecologies" – factors of biophysical properties, human characteristics, and institutional frameworks – in an area. Each site in this research has a different combination of these characteristics, which stands to affect perceptions of climate change and sea level rise and therefore the adaptation strategies that are put into place. As a result, we believe that differences in what actions a county has or is likely to take related to climate change and sea level rise can be explained by differences in people's perceptions of these issues, which are directly influenced by differences in the total ecology of a site.

Our paper brings attention to the different factors that seem to affect climate change and sea level rise strategic planning (or lack thereof) at the local level. Our literature review and interviews with key informants and public citizens sought to get to the core of how individuals think about climate change and sea level rise and whether or not they want to address their associated impacts. Important themes that emerged related to difficulties in developing and implementing adaptation strategies include scientific uncertainty, uneven distribution of interest, lack of resources, and existing barriers to climate change that may need to be reexamined. These themes are specific to our six study areas but, taken in a broader context, have the potential to be relevant to other coastal communities.

The purpose of our research is to bring to light complexities that exist, but may not be addressed, when developing adaptation plans to climate change and sea level rise. Many obstacles exist to implementing appropriate climate change and sea level rise adaptation strategies, and yet actions need to be taken now to address the potential impacts. We find that teasing through complex relationships among the biophysical, human, and institutional attributes of a region can help draw out the important factors that influence people's perceptions of climate change and sea level rise as well as identify existing barriers to adaptation and potential ways to overcome them. It is our hope that a greater understanding of these factors can help coastal decision makers break down barriers, involve relevant stakeholders, identify available resources, and bring communities closer to adapting to climate change and sea level rise impacts.

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APPENDIX A

Key Informant Interview Guide

CULTURAL PERCEPTIONS OF CLIMATE CHANGE AND SEA LEVEL RISE ADAPTATION STRATEGIES

Alexandra Donargo, Kelsey Ducklow, Nathalie Morison

1. What do you consider your primary affiliation?
 - a. Elected Official
 - b. Government Employee
 - c. Non-Government Organization
 - d. Private Citizen

2. If you identify as an elected official or government employee, what level of government do you represent?
 - a. Federal
 - b. State
 - c. County
 - d. Municipal

3. In your opinion, what is the main long-term problem that should be given priority in the area in which you live?
 - a. Economic conditions (e.g. development, taxes, employment, tourism, general economic activity)
 - b. Social conditions (e.g. education, health, human rights)
 - c. Environmental conditions (e.g. changes in water quality, forest cover, air pollution)
 - d. Other (please specify)

4. Have you observed environmental changes in your community since you have lived here?
 - a. Yes
 - b. No (If no, skip to question #6)

5. Which of the following environmental changes have you experienced? Select all that apply.
 - a. Accelerated beach erosion
 - b. Increased frequency and/or intensity of storms or flooding
 - c. Permanent water inundation
 - d. Warmer summer temperatures
 - e. Cooler summer temperatures
 - f. Warmer winter temperatures
 - g. Cooler winter temperatures
 - h. Stronger winds
 - i. Loss of wildlife
 - j. Loss of habitat (e.g. forests, wetlands)
 - k. Other (please specify)

6. Has climate change been discussed in your community?
 - a. Yes
 - b. No (If no, skip to question #8)

7. If yes to question #6, who in your community has discussed climate change? (Please identify specific individuals, groups, and/or organizations).

8. If yes to question #6, in what context was the issue of climate change discussed? Select all that apply.
 - a. Future development
 - b. Current or future weather conditions
 - c. Potential economic threats to your community
 - d. Potential threats to social welfare
 - e. Ecological/environmental issues
 - f. Other (please specify)

9. Has the potential for sea level rise been discussed in your community?
 - a. Yes
 - b. No (If no, skip to question #12)

10. If yes to question #9, who in your community has discussed sea level rise? (Please identify specific individuals, groups, and/or organizations).

11. If yes to question #9, in what context has the issue of sea level rise discussed? Select all that apply.
 - a. Future development
 - b. Current or future weather conditions
 - c. Potential economic threats to your community
 - d. Potential threats to social welfare
 - e. Ecological/environmental issues
 - f. Other (please specify)

12. What were the results of the discussions related to climate change (question #6) and sea level rise (question #9)? Select all that apply.
 - a. No results
 - b. A broader discussion in the community followed
 - c. An action plan was developed
 - d. Projects or specific activities were initiated
 - e. Other (please specify)

13. What major aspects have guided these discussions? Select all that apply.
 - a. Economic considerations
 - b. Social considerations
 - c. Environmental considerations
 - d. Religious considerations
 - e. Political considerations
 - f. Other (please specify)

14. What are the **principle agencies/departments/organizations** involved in considering climate change/sea level rise adaptations in your county/municipality? Please identify at each level.
 - a. At the local level (please specify)
 - b. At the state level (please specify)
 - c. At the federal level (please specify)
 - d. Within the private sector (please specify)

15. Who are the **principle individuals** involved in considering climate change/sea level rise adaptations in your county/municipality? Please identify at each level.
 - a. At the local level (please specify)
 - b. At the state level (please specify)
 - c. At the federal level (please specify)
 - d. Within the private sector (please specify)

16. What processes have or will influence the conceptualization, development, and implementation of adaptation strategies? Select all that apply.
- Precipitating events (e.g. hurricane)
 - Organized ongoing discussion
 - Official decision/action (e.g. permit approval)
17. What do people in your county/municipality traditionally do to minimize the problems associated with flooding and/or erosion? Select all that apply.
- Hardened structures (e.g. bulkheads, seawalls)
 - Soft solutions (e.g. beach nourishment)
 - Moving people, structures, or infrastructure out of harm's way
 - Environmental restoration (e.g. construction of oyster reefs)
 - Nothing
 - Other (please specify)
18. How much is the regional/local culture (i.e. people and their beliefs/values) considered when resolving coastal problems such as floods and erosion?
- No connection
 - Some connection
 - Strong connection
19. In your opinion, the scientific information available to inform your decisions is often:
- Not at all understandable
 - Somewhat understandable
 - Very understandable
20. In your opinion, the scientific information available to inform your decisions is often:
- Of little use for decision making
 - Of some use for decision making
 - Of great use for decision making
21. What source of information do you trust most:
- Scientists and/or scientific literature
 - Popular media (e.g. newspapers, television)
 - Friends and neighbors
 - Government published materials
 - Community or religious leaders
 - Other (please specify)
22. In your opinion, what is the most appropriate source of resources (e.g. funding, technical expertise) to help you address the issues of climate change/sea level rise?
- Local level (please specify)
 - State level (please specify)
 - Federal level (please specify)
 - Private industry (please specify)
 - Non-governmental organizations (please specify)

CULTURAL PERCEPTIONS OF CLIMATE CHANGE AND SEA LEVEL RISE ADAPTATION STRATEGIES

Alexandra Donargo, Kelsey Ducklow, Nathalie Morison

1. Where do you reside?
2. In your opinion, what is the main long-term problem that should be given priority in the area in which you live?
 - a. Economic conditions (e.g. development, taxes, employment, tourism, general economic activity)
 - b. Social conditions (e.g. education, health, human rights)
 - c. Environmental conditions (e.g. changes in water quality, forest cover, air pollution)
 - d. Other (please specify)
3. Have you observed environmental changes in your community since you have lived here?
 - a. Yes
 - b. No (If no, skip to question #5)
4. Which of the following environmental changes have you experienced? Select all that apply.
 - a. Accelerated beach erosion
 - b. Increased frequency and/or intensity of storms or flooding
 - c. Permanent water inundation
 - d. Warmer summer temperatures
 - e. Cooler summer temperatures
 - f. Warmer winter temperatures
 - g. Cooler winter temperatures
 - h. Stronger winds
 - i. Loss of wildlife
 - j. Loss of habitat (e.g. forests, wetlands)
 - k. Other (please specify)
5. Has climate change been discussed in your community?
 - a. Yes
 - b. No (If no, skip to question #7)
6. If yes to question #5, who in your community has discussed climate change? (Please identify specific individuals, groups, and/or organizations).
7. Has the potential for sea level rise been discussed in your community?
 - a. Yes
 - b. No (If no, skip to question #9)
8. If yes to question #7, who in your community has discussed the potential for sea level rise? (Please identify specific individuals, groups, and/or organizations).

9. What do people in your county/municipality traditionally do to minimize the problems associated with flooding and/or erosion? Select all that apply.
- Hardened structures (e.g. bulkheads, seawalls)
 - Soft solutions (e.g. beach nourishment)
 - Moving people, structures, or infrastructure out of harm's way
 - Environmental restoration (e.g. construction of oyster reefs)
 - Nothing
 - Other (please specify)
10. How much is the regional/local culture (i.e. people and their beliefs/values) considered when resolving coastal problems such as floods and erosion?
- No connection
 - Some connection
 - Strong connection
11. What source of information do you trust most:
- Scientists and/or scientific literature
 - Popular media (e.g. newspapers, television)
 - Friends and neighbors
 - Government published materials
 - Community or religious leaders
 - Other (please specify)
12. In your opinion, what is the most appropriate source of resources (e.g. funding, technical expertise) to help you address the issues of climate change/sea level rise?
- Local level (please specify)
 - State level (please specify)
 - Federal level (please specify)
 - Private industry (please specify)
 - Non-governmental organizations (please specify)