WATER'S GONNA RISE: SEA-LEVEL RISE RISK PERCEPTION, COMMUNICATION AND POLICY-MAKING IN NORTH CAROLINA

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APRIL 2014

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ABSTRACT

Sea level rise is threatening coastal areas around the world with the loss of land, damage to personal and public property, ecological impacts, displacement of populations, and exacerbated risk associated with severe storm events. While the drivers of accelerated sea-level rise are global, it is at the local and regional levels that the most immediate impacts and responses occur. Planning for sea-level rise adaptation is occurring throughout the United States, but significant barriers exist, especially in places where political tensions concerning climate change science prevail. Observation of how people understand and perceive sea-level rise risk, comprehend information about their risk, and enter into processes to manage risk can provide us with better understanding of how risk can be socially amplified or attenuated, and strategies to overcome barriers to adaptation planning. To this end, this three-part dissertation investigates sea-level rise risk at multiple scales with the objective of characterizing the social dimensions of risk production and barriers to adaptation policy in northeastern North Carolina, a region with one of the largest areas of low-lying land threatened by sea-level rise in the United States, and with high social vulnerability to natural hazards among some resident populations. The first part investigates individual risk perception using an audience-driven, document evaluation methodology that assesses reader attention, comprehension, and attitudes. Comprehension difficulties confounded concern about sea-level rise hazard yielding fear, skepticism, and fatalism. The second part examines hegemonic

discourses of mistrust and fear that provide insight into barriers to adaptation planning and risk reduction efforts. Fatalistic risk perceptions and risk communication scarcity increase risk in the coastal hazardscape, especially among those with the highest social vulnerability. The lack of risk information and predominant risk perceptions reinforce uneven patterns of risk developed through the marginalization of poor populations and facilitation of land use by those with social and political advantages. The third part is a case study exploration of a public participation process that a local municipality used to confront the barriers to adaptation planning. The study enables an understanding of how mainstreaming can overcome political hurdles, and how bridging organizations help move low-capacity communities past resource limitations. The multi-scalar, risk perception-oriented approach to the examination of sea-level rise risk and policy development may provide further guidance for the study of other complex, politically-charged risks within local contexts.

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A DISSERTATION

PRESENTED TO THE FACULTY OF THE COASTAL RESOURCES MANAGEMENT PROGRAM

EAST CAROLINA UNIVERSITY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

APRIL 2014

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ACKNOWLEDGEMENTS

I would express my sincere appreciation to my advisor, Dr. Jennifer Brewer for her thoughtful advice and insight. She alternatively encouraged and challenged me to be my best throughout my experience in the Coastal Resources Management Program. I would also like to thank Dr. Donna Kain, my research partner, mentor and friend for her support and shared interest in research questions and approach. I am deeply indebted to Dr. Tom Allen, who provided tremendous support during my time at East Carolina University and never failed to show confidence in my potential as a research and outreach professional. I thank Dr. Jack Thigpen for giving me the opportunity to become involved in the North Carolina Sea Grant Plymouth project and continuing to encourage my research. I am also grateful to my other committee members Dr. Enrique Reyes and Dr. Burrell Montz, for their insights and guidance through the CRM program and in my research.

I thank the East Carolina University graduate school, the Coastal Resources Management Program and RENCI@ECU for funding my graduate education and research. I am grateful to Dr. Hans Vogelsong and Dr. Tom Allen for going the extra mile to make sure students have what they need to be successful. Also supporting this research was North Carolina Sea Grant, which funded the sea-level rise risk communication research through their mini-grant program.

I thank the people of North Carolina who participated in this research. I am grateful to Gloria Putnam and Jessica Whitehead of North Carolina Sea Grant for their cooperation, team work and encouragement. I also thank Doug Solomon, for his assistance in the risk communication project.

I am grateful to have the best husband I could ever ask for, Dr. Tim Kelley. His friendship and support over the years is unwavering and never fails to amaze me. I am also appreciative of the support of my family and the friends I have made here in Greenville, especially my CRM cohort, classmates and my coworkers at RENCI and the North Carolina Coastal Atlas project. Let's hope we all stay above the water.

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Chapter Summary

Global sea-level rise acceleration and high relative sea-level rise in North Carolina threaten large areas of land and many coastal settlements over the next decades. Policy action within the state has does not promote local adaptation planning, however. This dissertation examines sea-level rise risk and argues that in order to move people toward resilience, we need to better understand how people comprehend, perceive, and use discourses to evaluate the risk and ultimately take action to manage it. Decades of social science research into natural hazards has resulted in a shift toward acknowledgement of the fundamental importance of social vulnerability factors in producing risk, rather than an exclusive focus on predicting and controlling physical dimensions. Political ecologists have added scholarship that asserts the importance of power relationships and discourse in the social amplification or attenuation of risk. Risk perception and communication research point toward effective risk management practices, by providing insights into the ways people understand and respond to risk signals. The study of participatory governance processes provides analyses of ways groups can work together to manage risk. Ultimately, risk governance provides a policy framework for better understanding risk perception, communication, social vulnerability and participatory processes and their interactions, which can lead to better risk management. North Carolina's biophysical environment, social context, popular discourses, and risk management practices offer an important setting in which to study sea-level rise risk. The case study approach used in this dissertation aims to contribute to the further development of social science theory in natural hazards research, utilizing data that is firmly grounded in the unusually challenging decision contexts of North Carolina's northeastern region.

Introduction

Global sea levels are rising, endangering coastal areas. Sea-level rise is permanently flooding some low-lying areas, converting land to water and dry land to wetland (IPCC, 2013). More dramatically, higher sea levels threaten life and property by exacerbating storm surges associated with severe coastal weather systems (Parris, et al., 2012). With over 8 million people currently living in areas of high coastal flood risk in the United States, some groups are undertaking significant efforts to plan for sea-level rise risk. (Parris et al., 2012). North Carolina ranks third among US states in the extent of land area susceptible to sea-level rise, and sixth in number of housing units located within those susceptible areas (Strauss, Ziemlinski, Weiss, & Overpeck, 2012). The most threatened settlements include prosperous beach towns, with economies dependent on tourism and associated real estate development, and small, waterfront towns with struggling economies in rural counties. Nonetheless, despite this high exposure to the threat of sea-level rise and a well-developed scientific knowledge base, North Carolina has no state-wide policies that encourage planning for increasing risk to people and property. Most local municipalities are similarly lacking plans (Poulter et al., 2009). Without sea-level rise risk management, coastal populations are at greater risk for loss of property due to permanent inundation of land and flooding damage to buildings from storms. Understanding how people comprehend and manage those risks can mitigate losses.

This study aims to better understand how people in North Carolina perceive sea-level rise and the associated risk, comprehend information about the risk, use discourse to amplify or attenuate the risk, and enter into processes to manage the risk. It draws on a wide body of scholarship, particularly social science study of risk perception, hazards, political ecology, risk communication, public participation and policy-making. Here I argue that to reduce risks associated with sea-level rise and overcome the existing barriers to planned adaptation policy, we need to understand risk perceptions and the public discourses that drive them. We need to use techniques such as audience-driven risk communication, inclusive public participation and mainstreaming adaptation actions into existing plans to reduce risk. Qualitative analysis

of case study material from three northeastern North Carolina towns achieves the following objectives: (1) evaluate risk perception, attitudes, and comprehension among readers of science-based educational materials communicating risk-related information; (2) articulate factors driving the social production of risk, and associated barriers to policy action for risk reduction; and (3) convey lessons learned from a policy development process designed to reduce risk at the municipal level.

This dissertation asserts that understanding risk perception and how public discourses or policies amplify or attenuate risk is critical to creating effective sea-level rise risk governance. Risk perception relies on people associating an experience of a past harmful event with some unknown or potential future harm (Renn, 2010). Risk communication, information flows from the media, and popular discourses can amplify or attenuate risk perception depending on the social context in which they are experienced (Kasperson, Kasperson, Pidgeon, & Slovic, 2003). This study finds that barriers to risk reduction result from political advocacy and a lack of resources available to marginalized groups which limit their adaptive capacity. Sea-level rise is a multi-scale risk because it involves diverse actors, multiple stressors and multiple temporal and spatial scales. Using a cross-scalar approach, I examine the relationship between risk communication, public participation, and risk reduction activities within the context of the development of sea-level rise adaptation policy. The study moves from the examination of how people comprehend and perceive sea-level rise risk, to how municipalities work to cope with the risk, to how discourses and political power shape risk within the region. By crossing scales, the importance of audience-driven risk communication techniques, inclusive public participation, mainstreaming sea-level rise policy emerges. North Carolina coastal managers and those from other regions that face similar barriers to reducing risk within a contentious political environment can benefit from using tools that incorporate these techniques. This study also contributes to the emerging field of climate change risk research, a classical multi-scale problem, by incorporating risk perception and risk governance into the risk framework, a research gap identified by Adger (2006). This introductory chapter reviews scholarship in disciplines relevant to understanding sea-level rise risk, describes the socio-ecological characteristics and policy context of northeastern North Carolina, and presents the methods used to analyze sea-level rise

risk and response. The case study approach used in this research, combined with quantitative and qualitative methods, allows an in-depth examination of sea-level rise risk and response.

Literature Review

The review in this section introduces a cross-scalar approach to the examination of sea-level rise hazard, followed by a short summary of sea-level rise-relevant social sciences hazards research. I also review scholarship associated with the components of sea-level rise risk governance, including risk perception, risk communication and the policy-making process.

Cross-scalar Perspectives

Sea-level rise is a complex hazard driven by causal variables that cross global, regional and local scales, thus requiring a multi-scalar research approach. Environmental management in linked human-environment systems needs a better understanding of cross-scalar interactions to find more ecologically and politically sustainable solutions to difficult management problems such as sea-level rise risk reduction (Cash et al., 2006). Figure 1-1 illustrates how local impacts and responses nest within the regional and global context, with examples of impacts and responses at each spatial scale. For instance, climate change models indicate acceleration in sea-level rise on a global basis due to ocean warming, but the rates of rise vary regionally. Nonetheless, local residents and municipalities must adapt to the hazard with action at local scales. Global or regional responses can enhance local adaptation efforts. Regional informational campaigns or grant programs can influence the capacity of a local municipality or property owner to make changes by providing information, technical assistance or financial incentives. Regional or national discourses about sea-level rise in news media consumed in local communities affect local risk perceptions and attitudes. Temporal scales are also important in the consideration of impacts and responses. The longer-term threats are greater than those in the short term, and more likely to cause permanent ecological changes. Sea-level rise and storm action could, for example, cause new inlets or the degradation of the barrier island system, which would substantially change wave and salinity regimes,

threatening estuarine shorelines and settlements. Examining sea-level rise risk and adaptation response with attention to scale is important because issues, such as those related to power relationships, are often only evident when the local is scaled-up (Head, 2010).

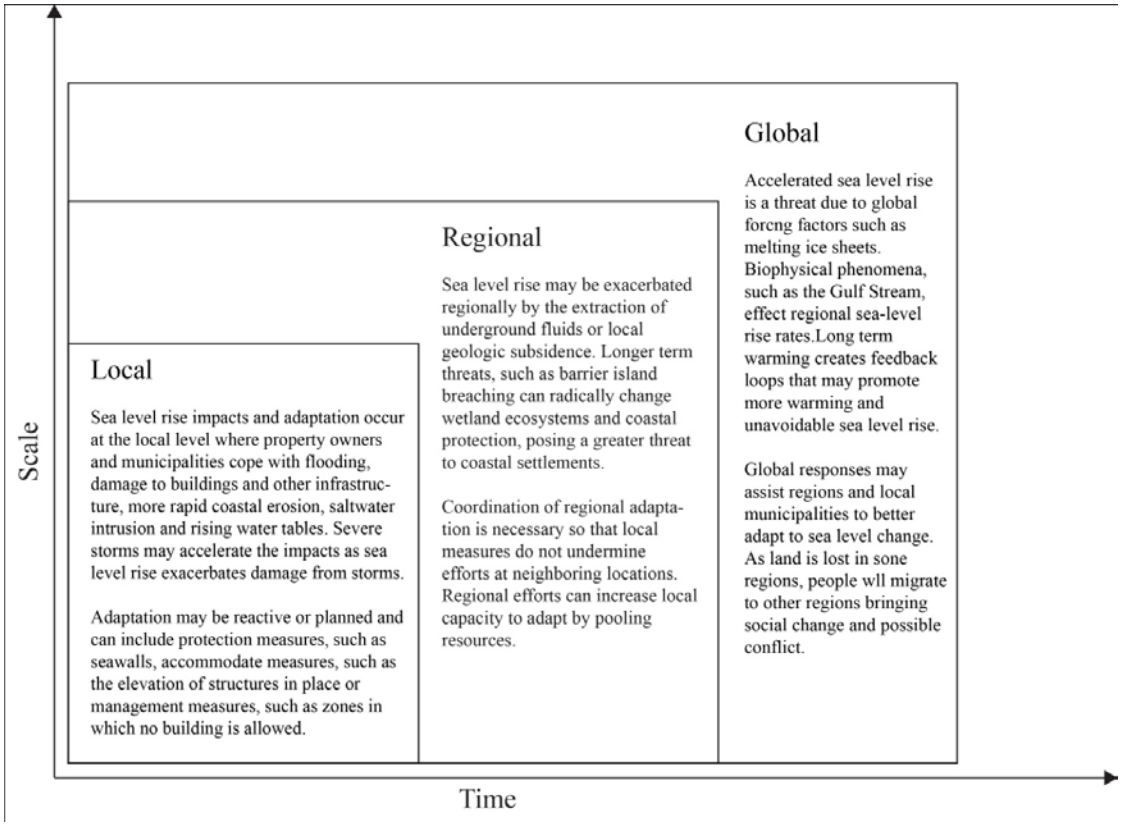

Figure 1-1. Sea-level rise scale of impact and response

A multi-scalar approach to the analysis of the social dimensions of sea-level rise risk can deploy quantitative and qualitative methods to examine how risk amplifies or attenuates at individual, group and landscape levels. This approach becomes necessary if we are to tease apart the multiple influences on perception and decision-making. At the level of the individual, a focus on the barriers to risk information comprehension, and individual risk perceptions allows an understanding of how people process and respond to information about sea-level rise risk. Individual risk perception is an essential part of the environmental decision-making process as is reflected in the way in which groups negotiate policies to respond to sea-level rise risk. The examination at the scale of the group exposes the influence of both

individual risk framing and the wider forces of the social production of risk. The planned adaptation decision and learning process is the focus of a case study of a town building strategies to respond to sea-level rise. In this case study, the municipality leadership folded sea-level rise adaptation plans into discussions about current management tasks. To overcome barriers to adaptation planning, leaders used mainstreaming and leveraged capacity through an organization bridging science and decision-making. Finally, at the landscape scale, the examination of risk falls within the context of the social and political influences on risk perception and response. The wider social context of power and access to resources acts upon individual and group decision-making to produce or reduce vulnerability to sea-level rise.

Hazards Social Science

For decades, social science has improved public understanding of why disasters occur, what makes people vulnerable, and how society accomplishes risk reduction. Hazards research, particularly as pursued by geographers and multi-disciplinary researchers in the 20th century, has evolved from an emphasis on discovering the geophysical processes that create dangerous environmental conditions to the integration of natural and social sciences. A rich scholarly tradition recognizes that risk is produced not only by biophysical hazards, but also by economic, cultural and social conditions that generate vulnerability (Montz & Tobin, 2011). The landmark work of geographer Gilbert F. White, *Human Adjustment to Floods* (1945), and subsequent scholarship (Montz & Tobin, 2011; Wisner, Blaikie, Cannon. Terry, & Davis, 2004; Wisner, Gaillard, & Kelman, 2012), changed the way that scholars and practitioners consider hazards and risk. Prior to White, public policy approaches focused almost exclusively on engineering solution such as dams, levees and channeling as methods to reduce risk (Macdonald, Chester, Sangster, Todd, & Hooke, 2012; Montz & Tobin, 2011). White's work changed hazards management throughout the United States and around the world by drawing attention to the centrality of human behavior in mitigating disaster, such as through land use decisions, emergency management, and relationships between perception and policy (Macdonald et al., 2012). Establishing a pragmatic scientific tradition, hazards scholars (such as Kates, Burton, Montz and Tobin) embraced

White's imperative that research should improve people's lives. By situating hazards research within the realm of public commitment to democratic governance, White foreshadowed the 1970s movement toward expanded public participation in US environmental management (Macdonald et al., 2012; Montz & Tobin, 2011). Later researchers built on this foundation by emphasizing it is not only by material aspects of social vulnerability that produce risk, but also political contexts and public discourses (Collins, 2009; Wescoat, 1992).

In the 1980s, hazards scholars started to focus on the underlying forces that lead to disasters and concluded that social and political forces are the factors most responsible for natural hazards risk, especially the uneven distribution of risk seen so often in developing countries (Robbins, 2004; Mascarenhas &Wisner, 2012; Macdonald et al., 2012). The "Pressure and Release" model (Figure 1-2) explores the relationship between risk, hazards and the underlying dynamic pressures and root causes of social vulnerability (Wisner et al., 2012). Authors defined root causes as the overarching social and economic structures, ideologies, history and culture, that interact with dynamic pressures, such as rapid population change, political conflict or poor governance to produce the fragile livelihoods and unsafe conditions in which people live. Dynamic pressures are the processes that connect the root causes with the unsafe conditions that lead to vulnerability. These dynamic pressures translate root causes into specific forms of insecurity in relation to the hazard. Unsafe conditions are the ways in which the hazard directly interacts with a vulnerable group through their unstable physical environment, fragile livelihood or other conditions. The Pressure and Release Model can provide an explanation about the underlying conditions leading to settlement in high hazard areas. For example, groups displaced by political conflicts may only be able to access that is susceptible to flash floods.

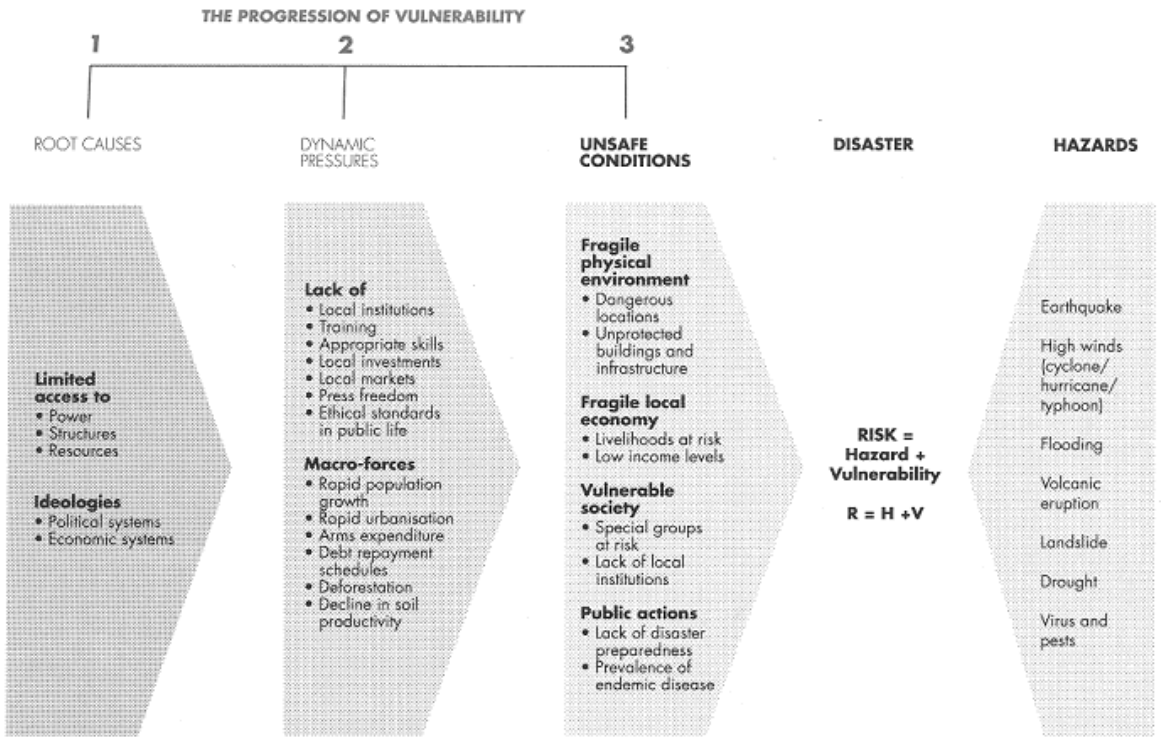

Figure 1-2. Pressure and Release model (Wisner, et al. 2012)

Scholars in the political ecology tradition conceptualize risk in an "access model" in which the underlying causes of vulnerability are only within social, economic and political factors (Forsyth, 2003; Wisner et al., 2004). "Access" refers to the ability of people or groups to use resources. Those without access to resources, due to their gender, ethnicity, or other status, have higher vulnerability and less ability to reconstruct their lives and livelihood after a disaster (Wisner et al., 2004). Resources can include those associated with the security of their livelihood, with self-protection or with protection associated with being part of a group (Wisner et al., 2004). People with low or tenuous incomes may also be limited in how they can protect themselves, such as with a safer dwelling or better location, and may depend more on social protection provided by family relationships, or governmental or non-governmental institutions. For example, political ecologists examining the risk of flooding and drought have found that the marginalization of populations through political, institutional and social mechanisms causes uneven patterns of risk (Collins, 2009; Liverman, 1999; Mustafa, 2005; Pelling, 1999).

Political ecology brings to hazards studies a central interest in how ecological change links to social dynamics of political-economic marginalization. The relationship between environmental change and the marginalization of the people with the least social or political power has been central to the development of theory in political ecology (Robbins, 2004). Most early political ecology studies were located in poor, developing countries, often with a history of colonialism. In these places, marginalized people live in the most dangerous locations such as floodplains or erodible land. The social and political elites controlling land use caused others to degrade the ecosystem, leading to more precarious livelihoods and less ability to cope with environmental change (Susman, O'Keefe, & Wisner, 1983). In developed countries, however, many social elites live in some of the most hazardous places, such as beachfronts or fire-prone forests, using the support of economic and social safety-nets such as insurance, emergency response and disaster relief. Collins (2008) has expanded the theory of marginalization to include facilitation, in which the privileged groups gain the ability to profit from the environmental resources in hazardous areas, while social safety nets insulate them from risk. Hazardous places may offer environmental rewards that social and political elites are able to exploit despite natural hazards, thus reinforcing existing social inequities (Pelling, 1999). In particular, many hazardous places, such as beaches, are places that are close to nature, an amenity that is highly valued by social and economic elites in the developed world. Facilitation is the mirror to marginalization and the process by which powerful groups use institutions to appropriate environmental amenities, producing a pattern of unequal risk (Collins, 2009).

To gain a more complete understanding of the risk associated with sea-level rise, it is important to understand both risk perceptions and how people interact with their local landscape. The idea of a "hazardscape", as conceptualized by Mustafa (2005), follows the landscape idea in cultural geography, integrating both the expert assessment of risk with its "lived reality." Mustafa (2005) differs in his use of the term "hazardscape" from previous works by Corson (1999) and Cutter, Mitchell and Scott (2000) in that he describes the multiple geographic factors that contribute to a single hazard in a place, rather than the suite of hazards that contribute to the biophysical and social vulnerability within a particular

geographic area. Included within the scope of a hazardscape are the biophysical properties of the hazards, the physical susceptibility of the place, and the vulnerability of people, with an emphasis on the socio-environmental system (Khan & Crozier, 2009). Using a hazardscape lens allows a focus on the relationships between the material realities of risk, including both biophysical and social vulnerability, with the perception and discursive formations of risk. The hazardscape concept incorporates consideration of how social and economic power can influence the attitudes that people hold about risk. Risk perceptions and discourse are critical to what the researchers described as the "production" of risk within an area. For example, the hazardscape approach has assisted characterization of flooding risk in Mexico, the Mexico-US border, and Pakistan (Collins, 2009; Eakin & Appendini, 2008; Mustafa, 2005). These studies examined how predominant discourses of experts, managers or decision-makers aggravated risk inequities, further endangering already-marginalized people (Collins, 2009). Discourses of government flood managers legitimized the marginalization of people by limiting their choices, especially when gaps existed between manager and resident perceptions of the hazard (Eakin & Appendini, 2008; Mustafa, 2005). Few studies have applied the hazardscape lens to climate change, but Yamane (2008) found that in Sri Lanka official government discourses portrayed farmers as victims of climate change, which perpetuated marginalization and hobbled adaptive abilities. Examining the institutional discourses of groups such as government managers, insurance companies, civic groups or elected officials is critical to understanding coastal hazardscapes and their relationships to sea-level rise.

Risk Perception

Risk perception involves judgments about activities or situations that might lead to negative consequences including personal or group harm or damage to property (Aven & Renn, 2009; Ropeik & Gray, 2002). Individuals make risk judgments based on their assessment of the probability of a harmful situation and their acceptance of the consequences should the harm occur. Risks are uncertain, so perceptions form based upon beliefs and associations with direct experiences. Perceptions are modified, amplified or attenuated by experience, information, values and the influence of others including the media

(Renn, 2008). Perceptions will differ depending on the risk type, the context in which the risk is likely to be experienced, cultural factors and individual factors. Risk perception is a major factor in determining whether individuals will ignore or prepare for a risk, although the relationship between perception and behavior is not straightforward (Bubeck, Botzen, & Aerts, 2012; Grothmann & Reusswig, 2006). Peer pressure and risk information modify the general disposition of an individual about risk to form risk perception, but personal protective action may depend more on one's ability to effective prepare (Wachinger, Renn, Begg, & Kuhlicke, 2012). Renn (2008) visualized risk perception as nested inside the four distinct contextual levels of information processing, cognitive-affective factors, socio-political institutions and cultural background (Figure 1-3).

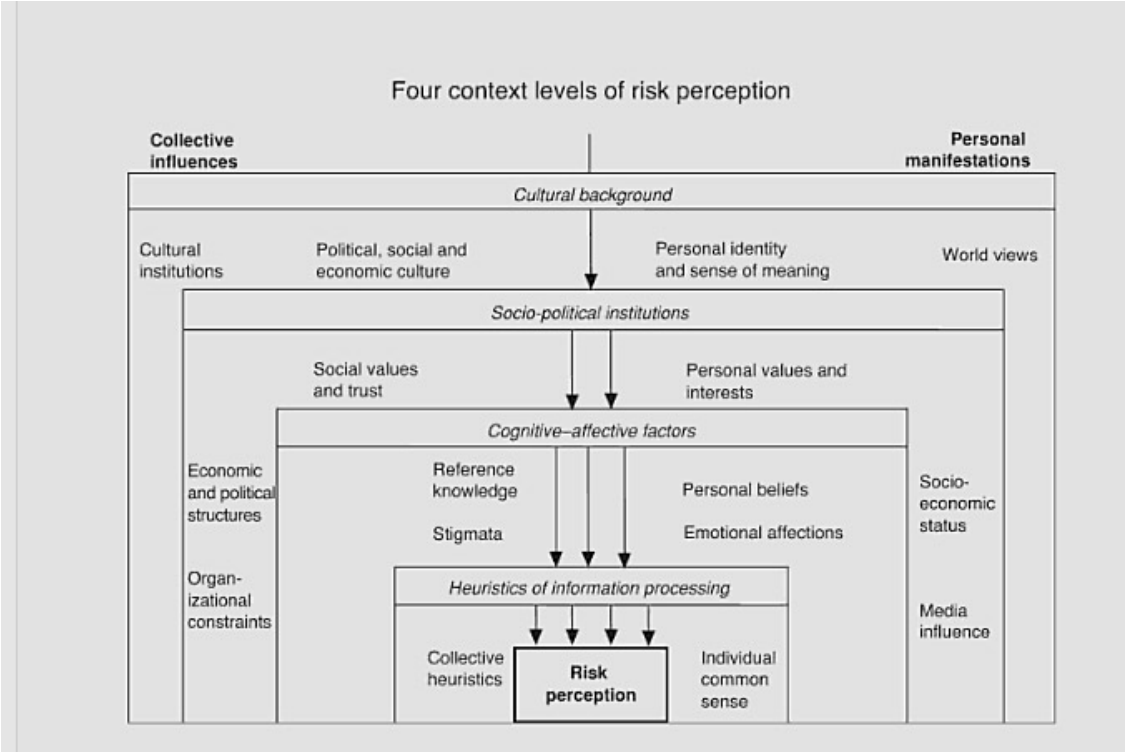

Figure 1-3. Four context levels of risk perception (Renn, 2008)

To gain a full understanding of risk perception, policy-makers and risk communicators should take into account all of the contextual levels. Information processing has its basis in risk appraisal, as separated from emotional responses. To apply reason and common sense, individuals must have access to

information and also possess the basic literacy and numeracy to understand it. Cognitive-affective factors apply what people believe to be true about a risk to the information they have received. Up 40% of risk perception variance is due to risk sensitivity, attitude, and specific fear (Sjöberg, 2000). Socio-political institutions, including government and the media, shape how individuals trust messages. Trust is an important factor in risk perception, especially when individuals have little experience or knowledge of the hazard (Wachinger et al., 2012). Finally, cultural factors and worldviews operate to influence each of the other contextual levels by providing a backdrop with a weak influence over risk perception (Brenot, Bonnefous, & Marris, 1998). Together these factors shape individual and group risk perception.

Although public risk perception of global climate change has been subject to intense research in the past decade, few scholars have specifically examined risk perception in reference to sea-level rise, particularly in the United States (but see Moser, 2005 and Moser & Tribbia, 2006). Several studies in Europe have examined flood risk perception related to changing climatic conditions including sea-level rise, particularly in reference to adaptation behavior (Koerth, Vafeidis, Hinkel & Sterr, 2012; Botzen, Aerts, & van den Bergh, 2013; Raaijmakers, Krywkow, & van der Veen, 2008). In a review of public perception studies in the United States and Europe, Lorenzoni and Pidgeon (2006) found that though there was widespread concern about climate change, it was a "back-burner" issue due to a lack of saliency in everyday life. People perceive climate change threat as limited to geographical separation and time delays (Lorenzoni & Pidgeon, 2006). In the United States, people living along the coast and at low elevations vulnerable to inundation due to sea-level rise, as well as those in areas with high fatalities from natural disasters, have a higher level of perceived personal risk due to climate change (Brody, Zahran, Vedlitz, & Grover, 2008). Socioeconomic and cultural factors may have an even stronger influence than physical vulnerability. For example, conservative white males in the United States are more likely than any other group to deny climate change and therefore perceive less risk of climate change and sea-level rise (Kahan et al., 2011; McCright & Dunlap, 2011b).

Greater scientific understanding, however, does not always lead to greater concern about risk because emotion, affect, and worldview play a large role in risk perception of climate change

(Leiserowitz, 2005). Ideology is also a strong indicator of climate change risk perception and more influential than education level or other demographic factors (Zia & Todd, 2010). Segments of the population have different opinions with respect to climate change risk perception and public policy preferences, indicating a need for the risk communicator to "tailor climate change messages to the needs and predispositions of particular audiences"(Leiserowitz, 2005; Leiserowitz, 2006). The landmark "Global Warming's Six Americas" study characterized six unique and highly disparate audiences in the United States with respect to their risk perceptions, underlying beliefs, attitudes and values (Leiserowitz, Maibach, Roser-Renouf, & Smith, 2011; Maibach, Roser-Renouf, & Leiserowitz, 2009). These groups have distinct behavioral patterns and policy preferences that inform their actions (or inactions) with respect to climate change. The disparities among audience groups interact closely with opposing positions in the public discourse of climate change. McCright and Dunlap (2011a) examined Gallup polls over the decade from 2001-2010 and found an increasing polarization of the public and politicization of climate change. They found that liberals and Democrats were more likely to align with the scientific consensus and express concern about the risk than conservatives and Republicans (McCright & Dunlap, 2011a). Sea-level rise risk perception has not received the same intense study as climate change risk perception, but has many features in common. In North Carolina, public discourse about sea-level rise has linked the risk directly with climate change, which impacts risk perception and policy-making.

Risk Communication

Risk management has long recognized a gap between expert assessments of risk and public risk perception, especially risk associated with climate change (Covello & Sandman, 2001; Morgan, Fischhoff, Bostrom, & Altman, 2002; Reynolds & W. Seeger, 2005; Sterman, 2008). Risk communications research developed to find solutions to bridge that gap, so that the public would embrace risk reduction activities. Scholarship on risk communication describe the evolution of the practice from a function of simple science translation to an interactive practice in which individuals, groups and organizations exchange information, opinions and attitudes (Covello & Sandman, 2001; Janoske, Liu, &

Madden, 2013; Seeger, 2006). Risk communicators interpret expert risk assessment information, help people cope with risk by suggesting behavioral changes, create confidence in risk management institutions and allow the public to be included in risk management solutions (Renn, 2008).

Multi-disciplinary research from psychology, cognitive science, marketing, decision science and communications informs risk communication practice. Communicators approach their task differently depending on the risk situation (e.g., crisis, building consensus, or health promotion) and their audience (Lundgren & McMakin, 2013). The National Research Council's efforts in their 1989 report and subsequent efforts such those suggested by Reynolds and Seeger (2005) and Simmons (2007) to improve risk communication have yielded an interactive approach that connects risk assessment to people at risk through a public participation process. These best practices assert that dialogue with the audience should start from the beginning of the risk management process. The key elements to effective risk communication are an audience-driven approach and transparency of risk information in order to build trust. The mental models approach focuses on a methodology using surveys and interviews with audiences to create a composite model of the way that a group thinks about a specific risk (Morgan et al., 2002). Researchers compare the audience mental models to an expert model representing the scientific opinion of risk assessment. Messages focus on key gaps or misconceptions raised in the comparison of lay and scientific models. The mental models approach to risk communication can help researchers gain a more accurate assessment of risk perception and therefore tailor communications to the audience's knowledge and needs.

Additionally, the risk communication approach of Peter Sandman (1987, 1993) focuses on the outrage component of risk representing an emotional assessment of the hazard by the public. Sandman uses the formula Risk = Hazard + Outrage to emphasize the importance of addressing the emotional response in risk communications. The typical result of this approach is outrage management, in addition to providing technical information about risk (Covello & Sandman, 2001;Sandman, 1993). This approach, using risk perception research in making specific recommendations for communicators, asserts that

effective communication recognizes all components of risk affect, including those driven by fear, such as questions of agency, fairness, trust and unvoiced concerns.

Risk communication research has focused on the areas of technical communication, building trust in management institutions, persuasion, and its role in deliberations about risk reduction (Covello & Sandman, 2001; Lundgren & McMakin, 2013; Palenchar & Heath, 2007; Renn, 2008). One approach to analyzing risk communication is to model the transfer of information among sources (Renn, 2008). In risk management, this analysis can yield insights into the relationships between messages, actions and outside influences (Figure 1-4). In this model, "physical signals" include the hazard or disaster event that is the

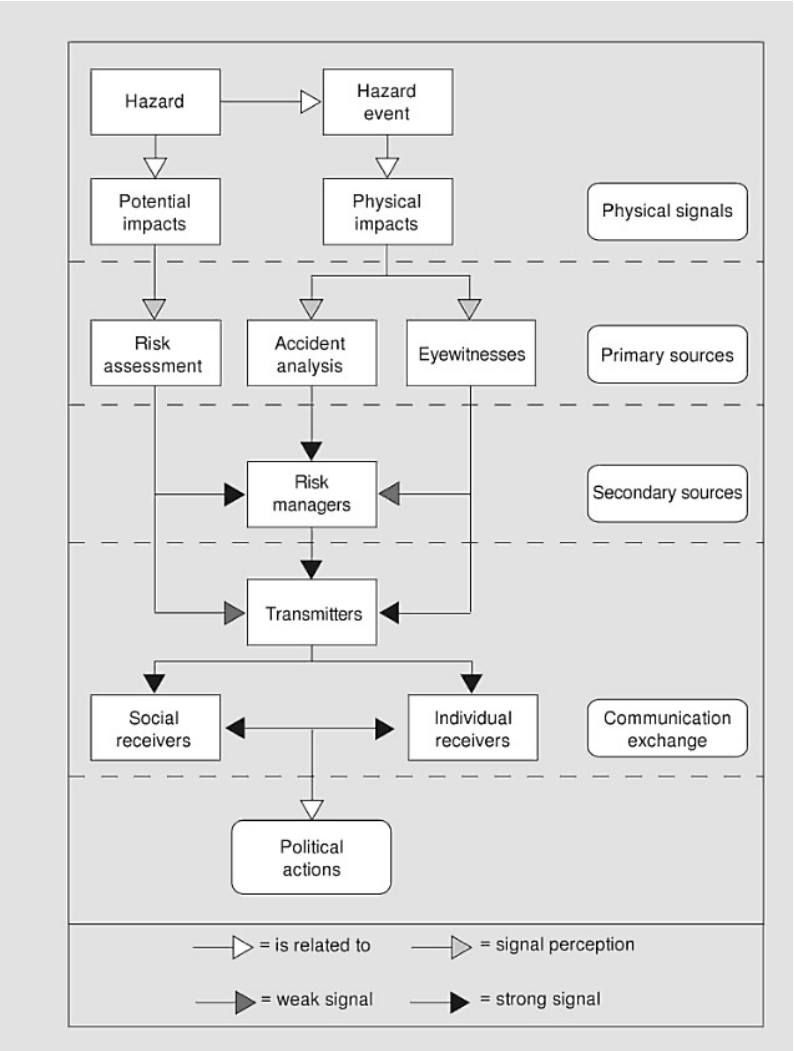

Figure 1-4. Signal flow model for risk communication (Renn, 2008)

focus. Scientific risk assessment is a primary source of information, which may include information about the natural hazard and related social vulnerability of the population at risk. Secondary sources of information include risk managers who can contextualize risk information and refine the meaning of risk within their purview. Finally, "transmitters" communicate risk to the public and media sources, which may then lead to the development of risk reduction policy.

Research based on the "transmission" communication model yields some important insights for sea-level rise risk communication. Firstly, communication takes place in an environment with many outside influences. The theory of the social amplification of risk holds that risk communication interacts with psychological, social, institutional and cultural processes in ways that will increase or decrease risk perception and behavioral responses (Kasperson & Kasperson, 1996). As risk messages permeate through society, each transmitter can affect the message by amplifying or attenuating risk perception, either intentionally or unintentionally. Risk communicators should understand the social and political dynamics associated with the risk within social contexts and address perceived risks with appropriate communication. Secondly, risks that are unfamiliar and complex are difficult to communicate, but communication about them should include information about ways that individuals can exert personal control or access resources to better understand and potentially reduce their risk. Research has also shown that communicators should build trust and credibility with an audience. Communication style, honesty and identification with their audience can help facilitate trust (Slovic, 1993). Therefore, risk communicators are an integral part of the stakeholder participation component of risk governance.

Public Participation in Risk Governance

Risk governance is a framework that describes the processes and structures for collective decision-making about risk that involves both governmental and non-governmental organizations (Renn, 2008). It includes risk assessment, risk management and risk communication, but goes beyond the conventional consideration of these as separate functions. Inclusive risk governance contextualizes a risk within its institutional, social and political culture (Renn & Klinke, 2013). The inclusive risk governance

structure emphasizes the importance of involving stakeholders and members of the public in the process of determining risk reduction strategies. Risk governance participation is particularly useful when risks are complex, uncertain, and politically contentious because the process helps bring forth a more complete description of vulnerability factors and the public is more likely to consider outcomes acceptable (National Research Council, 2008).

Federal agencies began instituting citizen participation and involvement in environmental decision-making in the 1960's when public criticism about environmental management began to influence the national agenda. In 1969, Congress passed the National Environmental Policy Act (NEPA), landmark legislation that required regulatory agencies to notify the public of pending regulations, and provide opportunity for public response (Simmons, 2007). Public participation in environmental decision-making serves to engage the public in the management process prior to implementation by a governmental agency or public-private collaborative. Citizen involvement processes, however, do not necessarily result in a final decision that reflects the views of the stakeholders (Yang & Callahan, 2007). The type of public participation used in a decision-making process can range widely from a meeting intended to pacify stakeholders to full citizen control (Arnstein, 1969). Public participation advocates suggest that public participation increases the quality and legitimacy of decisions and helps to increase the capacity of the group to engage in future decision-making (National Research Council, 2008). Positive outcomes depend on the process being inclusive of all stakeholders, involving the public early, and involvement such that each group makes substantive contribution.

Examination of the climate change adaptation planning process is a growing area of interest among social scientists (Fussel, 2007; Pearce, Ford, Caron, & Kudlak, 2012; Preston, Westaway, & Yuen, 2011). Planned adaptation, an adjustment in the socio-ecological system in response to or preparation for changes observed or expected, takes place at many different scales (Adger, Arnell, & Tompkins, 2005). Planned adaptation relies on climate change impact and vulnerability assessments to help create precursors to adaptation such as public awareness of the problem, availability of effective measures to adapt, and the capacity of the population to enact measures to create an effective process (Fussel, 2007).

First generation climate change adaptation planning in developed countries has yielded plans that are largely under-developed, with limited consideration for non-climatic factors, adaptive capacity and a participatory process (Preston et al., 2011). Public participation holds promise for overcoming some of the gaps evident in the adaptation planning processes, especially given the localized nature of vulnerability and appropriate responses. Public participation is particularly suited to sea-level rise adaptation planning because both expert and local knowledge may be incorporated, issues of fairness can be addressed within the process (rather than after decisions are made), and public involvement is more likely to facilitate plan implementation. Adaptation planning methodologies vary widely and although organizations and governments have developed a variety of adaptation planning guides and toolkits, few of the realized processes have been critically evaluated (Pearce et al., 2012). For effective and inclusive risk governance, and to build resilience in areas threatened by sea-level rise, such as North Carolina, planning units need effective processes and methods that involve the public in sea-level rise planning.

Boundaries and Barriers in Sea-level Rise Risk Governance

To summarize the sea-level rise risk governance structure, I developed the following model that builds upon the signal flow model of risk communication (Figure 1-4) and includes the nested context of risk perception (Figure 1-3). This process takes into account the characteristics of the hazard, risk perception, the social and economic vulnerability of a population, individual and institutional capacity to respond to sea-level rise and the policy framework for risk management, including adaptation planning (Figure 1-5).

Components such as sea-level rise science, expert risk assessment, risk communication, and the process used to make decisions about risk reduction policies are central to the development of inclusive governance structures. By placing risk perception at the center of sea-level rise governance, science links with policy through inter-group interaction. Sea-level rise science, therefore, becomes a "negotiated science," one that is informed by civic needs and management issues (Bäckstrand, 2003).

A bridging organization, sometimes also known as a boundary organization when its focus is on the science-policy interface and has structures for accountability, is a governmental agency, academic

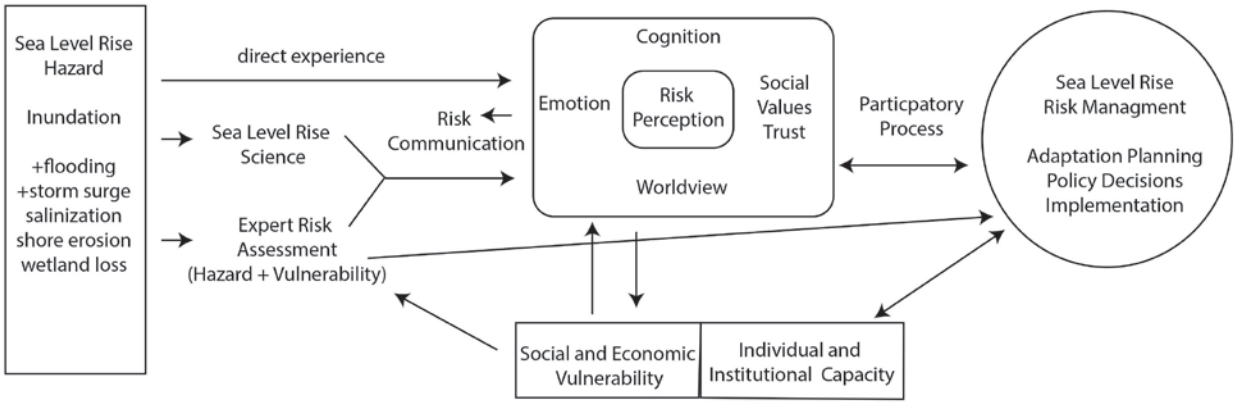

Figure 1-5. Sea-level rise risk governance components

unit, or non-governmental organization that serves as an intermediary (Crona & Parker, 2012; Guston, 2001). Boundary organizations exist at the frontiers of science and decision making enterprises, and can act as mediators to promote cooperation and collaboration across the two domain (Guston, 2001). These organizations may include university-based extension offices, non-profit groups, and government programs, spanning the boundary between scientists and decision makers. Boundary organizations help to translate research into action by facilitating communication and mediating conflicts caused by the use of different terminology and approaches to management (Cash et al., 2003).

Policy responses to sea-level rise, like those developed for climate change adaptation, exist at many different levels with different, but mostly complementary, objectives (Ostrom, 2012). Although climate adaptation planning activity is growing in the United States at the federal, state and local/regional levels, few policies have been implemented with meaningful impact (Bierbaum et al., 2013). In regions with significant political opposition to climate change planning discussions, mainstreaming climate changing adaptation into existing relevant policy areas such as emergency management and land use planning has been a successful way that local municipalities can sidestep political challenges (Kok & De Coninck, 2007). Mainstreaming and the associated use of ad hoc networks has served to allow progress in

North and South Carolina (Dow, Haywood, Kettle, & Lackstrom, 2013; Haywood, Brennan, Dow, Kettle, & Lackstrom, 2013). Among the key tools for sea-level rise adaptation are local comprehensive and coastal land management plans, regulations for shoreline development and floodplains, control of investment in public facilities and infrastructure development or redevelopment that incorporates resilient building design.

Although there are substantial benefits to sea-level rise adaptation planning, the barriers are also significant. These barriers are obstacles to adaptation that block, delay, or divert energy and resources from the planning process (Bierbaum et al., 2013). Adaptation barriers are associated with information, financial or other resources, divergent risk perceptions, and a lack of political leadership. Common barriers to the information or understanding phase of the adaptation process include identifying sea-level rise as a relevant problem, the availability and usability of information and defining the threshold of response need and workability (Moser & Ekstrom, 2010). If barriers to understanding are overcome and the adaptation process moves on to a planning phase, a second set of barriers, those associated more with process than information may be encountered, such as political controversy and a lack of local capacity to tackle a decision-making process that involves the public. A third set of barriers is associated with the implementation of adaptation plans, although reviews of adaptation activity suggest that few processes have moved into that final stage (Bierbaum et al., 2013). Leadership, availability of resources, risk perception based on values and belief, and risk communication are important in every stage of the adaptation planning process (Moser & Ekstrom, 2010). Close attention should be paid to existing risk perceptions, creating effective communications, providing relevant information and including a decision process that invites public involvement in overcoming adaptation planning barriers and build sea-level rise resilience.

Case Context

The following sections describe the ecological, social and policy context of sea-level rise risk in North Carolina. A brief overview of the impacts that sea-level rise is expected to have on the ecological

systems of the coast are followed by a discussion of the likely social and economic impacts on coastal populations. I then describe the development of state-wide sea-level rise policy, including the relationship to other coastal policy and the response to political controversy.

Socio-Ecological System

Coastal North Carolina has many features that make it an interesting place to examine how the biophysical environment, risk governance patterns, social context and popular discourses shape the coastal hazardscape. North Carolina is located in one of the regions most susceptible to sea-level rise in the US (Strauss et al., 2012). Sea-level rise threatens wetlands and the ecology of many North Carolina coastal habitats (Parris et al., 2012). In the future, it is likely that saltwater will infiltrate estuaries and affect agricultural fields. Municipal drinking water and wastewater systems, frequently located in low-lying areas near shorelines, are also at risk to storms and salt water. Even though sea-level changes have occurred throughout history, climate change will accelerate natural sea-level rise and exacerbate the risk of flooding in some areas (IPCC, 2013). At the same time that coastal populations are growing, many cities around the world are experiencing regional sea-level rise to the extent that global flooding losses are expected to reach $60-63 billion/year by 2050 (Hallegatte, Green, Nicholls, & Corfee-Morlot, 2013).

Sea-level rise and changing weather patterns can be synergistic factors leading to a greater impact of storm surge on ecosystems and built environments, shoreline erosion, increased saltwater intrusion into groundwater and a change in the salinity of the estuarine waters. Storm events can significantly change the dynamics of barrier islands and sounds in North Carolina, especially if new inlets are formed (Riggs, Culver, Mallinson, Corbett, & Walsh, 2009). Sea-level rise, increased extreme weather events and higher temperatures can interact with secondary impacts of shoreline erosion, increased storm surge and change in saltwater dynamics (in both surface and groundwater) to effect ecosystems, agriculture and forestry, and the built environment. The resulting complex interactions have social and economic impacts such as rising flood insurance costs or cost to repair roads which are likely to be the ways that most of the people in eastern North Carolina will experience climate change.

The predominant terrestrial ecosystems found in eastern North Carolina are intertidal salt marshes, cypress swamp forests, pine pocosins and upland pine forests. Wetlands provide important ecosystem services in eastern North Carolina including flood control, water storage, shoreline stabilization, storm protection, wildlife habitat (e.g., nurseries for fish) and recreational uses (Mitsch & Gosselink, 2007). Wetland ecosystems have been responding to changes in sea level and shoreline for millennia by migrating landward or seaward as necessary to maintain their elevation (Moorehead & Brinson, 1995). How wetlands in eastern North Carolina will respond to the predicted rate of sea-level rise is not certain but is highly dependent on local conditions and barriers to landward migration. Wetlands can develop vertically, as they trap sediments and grow root systems; and horizontally, expanding landward in response to sea-level rise. In the Albemarle-Pamlico estuary, the primary determination of the location of non-tidal marshes and swamp forests is the salinity of the water, which occurs on a gradient (Brinson, Christian, & Blum, 1995). If sea-level rise occurs so that vertical marsh accretion rates cannot keep up, the marshes will collapse and shoreline erosion rates will increase (Cahoon et al., 2009). If marshes can keep up with sea-level rise, it is still likely that they will expand inland, replacing the swamp forests and converting fresh water forested wetlands to salt marshes. The swamp forest is unlikely to be able to migrate inland because of barriers, resulting in a net loss of that particular habitat. Determining the vulnerability of specific wetland systems is difficult due to the lack of accurate predictive models available to natural resource managers (Mcleod, Poulter, Hinkel, Reyes, & Salm, 2010). The potential loss of wetland in eastern North Carolina may have an important impact on water quality, flooding, cultural resources and potentially, biodiversity as different habitats support different species.

Estuaries cover a significant area of eastern North Carolina and are important natural resources for commercial fisheries and recreation. Oyster reefs and seagrass beds provide habitat for many fish species that are commercially valuable as well as a number of other pragmatic and tacit values (Anthony et al., 2009). The estuaries in North Carolina are primarily barrier-lagoon systems that are particularly vulnerable to sea-level rise, especially as the barrier islands retreat landward. If the barrier islands are

separated by inlets, the estuaries will have radical shifts in salinity, which will change the species composition (Anthony, et al., 2009). In addition, deeper waters will reduce light penetration to seagrass beds, which will impact their sustainability. Even small increases in temperature associated with climate change can have cascading ecological effects in estuaries and other sensitive environments. Sea-level rise and salt water intrusion into surface and groundwater systems affect soils and irrigation of crops and forests. Most North Carolina agricultural fields are low-lying and ditched for better drainage due to frequent flooding. High precipitation events may exacerbate flooding, requiring farmers to deepen or widen canals. For low-lying regions susceptible to sea-level rise, these drainage canals may increase saltwater intrusion since storm surge may force salt water into the canals from the sounds (Poulter & Halpin, 2008).

The social and economic impacts of sea-level rise are extensive. One study estimated a loss of $10 billion due to the loss in property, recreation, and tourism due to sea-level rise inundation in just four North Carolina counties (Bin, Dumas, Poulter, & Whitehead, 2007). Episodic property flooding may represent a loss up to 28 times that of permanent inundation (Michael, 2007). Development and maintenance of infrastructures to provide drinking water, and wastewater treatment, transportation and other services are major functions of local municipalities. In many coastal North Carolina municipalities, these services are located near waterfronts vulnerable to sea-level rise and flooding associated with storm events. The counties in the northeastern region of North Carolina are among the most economically disadvantaged, some with declining populations and declining municipal income (NC Department of Commerce, 2012). With a majority of residents older than average and with high poverty rates, these municipalities have few financial resources to pay for the maintenance and replacement of aging community infrastructure (NC Rural Economic Development Center, 2013). Sea-level rise puts these populations at greater risk for loss of life and property due to inundation endangering human health, social values, and unique cultures.

North Carolina's Sea-level Rise Policy

The Coastal Zone Management Act (CZMA) of 1972 and subsequent reauthorizations establishes the federal mandate for states to consider their coastal areas differently than inland areas when managing natural resources and planning for development. North Carolina, in response to the CZMA of 1972, developed its landmark legislation for coastal management in 1974, the Coastal Area Management Act (CAMA), federally approved in 1978. This legislation established the Coastal Resources Commission (CRC), which is the primary rulemaking body and certifies local land use plans in the 20 counties designated as coastal. In 1990, the Coastal Zone Improvement Act amended section 302 of the CZMA to include the finding that sea-level rise will affect coastal states and section 303 mandates that states consider sea-level rise in their coastal management plans. The North Carolina statute was not amended to incorporate sea-level rise, nevertheless, sea-level rise may be implicitly considered in certain areas that are environmentally sensitive to coastal erosion because of their elevation, physical characteristics and relationship to water..

North Carolina's Division of Coastal Management (NCDCM), the state agency that enacts policies established by the CRC, has a several regulations that affect development along ocean and estuarine shorelines, none of which explicitly address sea-level change, but can react to some of the impacts. Property setbacks address shoreline erosion by changing in response to the local erosion rate, which may be affected by sea-level rise. Managers base erosion rates on aerial photography completed about every five years, so sea-level change is embedded within the rule, but future projections are not used (North Carolina Division of Coastal Management, 2010), The policy board established estuarine shoreline setbacks in 2000 and are 30 feet landward of the normal water level. Ocean and estuarine shoreline setbacks provide a measure of protection for new development by requiring buffers, but are based in either historic or existing shorelines and do not anticipate shoreline change. In 2005, North Carolina considered sea-level rise in the Department of Environment and Natural Resources' Coastal Habitat Protection Plan. That plan identified sea-level rise as a threat to wetlands and warned that coastal property owners should be aware of potential loss (Street, Deaton, Chappell, & Mooreside, 2005). At the

same time, the CRC demonstrated an increasing amount of interest in sea-level rise adaptation due to several North Carolina-based research studies and increasing national interest (Poulter et al., 2009).

The CRC identified sea-level rise as a priority in 2009 and asked their advisory science panel, a group of North Carolina coastal scientists and engineers, to study the topic and make planning recommendations. In March 2010, the science panel released a report reviewing the scientific literature. They determined that a relative sea-level rise of 0.38-1.4 m by 2100 was expected, and recommended that an anticipated rise of one meter be adopted for planning purposes. In February 2011, the CRC released draft policy that included the one meter planning benchmark and suggested that land use planning guidelines for regions required to submit CAMA land use plans include this guidance. The draft policy received significant political opposition. The CRC removed the planning guideline in a new draft policy released in June 2012.

In the summer of 2012, the North Carolina General Assembly passed House Bill 819. The original form of the bill prohibited the use of scientific models to estimate future sea-level change, which drew attention from the national news media for its heavy-handed approach to management legislation and for being anti-science. The ratified bill imposed a four-year moratorium on defining rates of sea-level change for management purposes and required the CRC science panel to include specific information about the scientific uncertainty of models in their next assessment. The bill allows local governments to consider anticipated sea-level rise rates for regulatory purposes, but restricts the ability of other state agencies or divisions to consider anticipated sea-level rise rates for their purposes. The bill ratifications appear to be in response to concerns of limiting North Carolina coastal development due to sea-level rise.

Methodology

This dissertation takes a case study approach to the examination of sea-level rise risk in North Carolina. The objectives of using this approach were to accurately and specifically describe sea-level rise knowledge, risk perception, discourses and attitudes within the study areas to better understand how people manage the risk. A case study approach may yield a more naturalistic understanding of complex

phenomena and is particularly suited to a scale-sensitive examination of multi-scalar human-environment dynamics. Although generalization from case studies is sometimes difficult because of small sample sizes and temporally- and spatially-specific results, case material contributes to theory development so that a more accurate understanding of causation can emerge.

This study relies mainly on qualitative methodologies to better understand the perception and communication of sea-level rise risk in North Carolina. I used quantitative methods to understand factors that are measureable and to describe and compare features of the case study sites. I used qualitative methods to collect information concerning factors that are not easily counted or measured. Quotes included as part of the results and discussion sections represent typical responses of the participants. Some quotes reflect a majority viewpoint of the interview participants, while others may reflect a significant minority perception that drives risk perception. Appendix C contains tallies of quotes from document based interviews and tallies of comments from civic leader interviews in Plymouth can be in Tables 4-3 and 4-5. These methods represent an inquiry approach intended to gain a rich understanding of perceptions, attitudes and underlying forces shaping sea-level rise risk. This mixed-method approach allowed one data type to inform the other, thus overcoming limitations of each data type alone.

A grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998) informs the analysis of the interviews and observations collected over more than three years. Grounded theory is a systematic method that iterates among data collection, textual analysis and theoretical development to create a better understanding and conceptualization of the phenomena of interest. The process employs multiple stages of data coding and theme-building, seeking to develop theory through constant comparison of emerging data or concepts with prior analyses. A strength of grounded theory is its ability to assess and explain the complex and contradictory nature of human perception and decision-making. It is particularly useful in examining the development of natural resource policy, because it allows theory to develop within the dynamic and empirically-rich social realm of policy making.

The data set for this dissertation includes twenty-eight in-depth interviews with civic leaders from Dare, Beaufort and Washington, North Carolina Counties in 2010 and 2011; forty resident interviews

conducted in Dare County and Beaufort County in 2011; over 50 hours of participant observations collected between 2010 and 2012 both at the state capitol (Raleigh) and at public meetings in coastal meeting locations designed to engage elected officials and municipal managers from coastal areas, public comment from an open hearing on the sea-level rise draft policy proposed by the CRC and minutes of CRC meetings in which sea-level rise policy was discussed; county and city land use plans; minutes of meetings of the Coastal Resources Commission; and news media and electronic publications pertaining to sea-level rise policy in North Carolina. The method of selecting interview participants for civic leader interviews was different than the method used to select residents who participated in document-based interviews. Civic leader interviewees were community experts or key informants, individuals who because of their profession, social position or affiliations have an extensive knowledge of the opinions and activities of others within some larger group. Key informants interviewees included elected officials, former elected officials, municipal staff, non-profit staff and a religious leader. Document-based interview participants volunteered in response to a flyer advertising the opportunity. Volunteers were demographically diverse and roughly matched the gender, age, ethnicity and education characteristics of the two towns in which the interviews took place (see Table 2-2).

I selected the towns of Manteo, Washington and Plymouth as sites for this case study because they represent the range of economic and social conditions within the context of small coastal towns in mostly rural areas with waterfronts that are susceptible to flooding. Manteo is located in Dare County, home to the North Carolina Outer Banks and is typical of counties with extensive beach communities. Manteo, however, is located on the estuarine Roanoke Island, and has much in common with the other two towns that are located on estuarine rivers. Dare County is highly dependent on tourism, but also has commercial fishing and boat building industries. Beaufort County is more industrial, with mining and manufacturing making up much of their economy, but less economic prosperous than Dare County. Washington is the Beaufort county seat, located on the Pamlico River, and is the largest of the three towns. Plymouth represents a municipality struggling both economically and socially. Unlike Manteo and Washington, it has a majority African-American population and it home county, Washington, has a

quarter of its population in poverty. Each municipality has its unique concerns and context, yet together they represent a spectrum of conditions that help to illuminate the patterns of sea-level rise risk.

Outline

The following three chapters convey central empirical findings of this study. Chapter two focuses on the concerns of risk communication and perception. Using a qualitative, document-based methodology that allows a rich description of understanding, emotions and experiences of participants, information about both document design and responses to new information inform attitudes and perspectives that can often provide either barriers or opportunities to development of risk reduction policies. Risk communicators work to bridge the gaps between the scientific and public understanding of risk and provide a process to address the concerns of both. In sea-level rise risk communication, as in climate change communication, challenges include conveying unfamiliar scientific concepts, complexity and uncertainty; and the perception that impacts will be distant both temporally and spatially (Moser & Ekstrom, 2010). In addition, the politicization of science exacerbates conflicts of values and issues of justice (Gardiner, 2006; Sarewitz, 2004). Risk communications tested with their audience and designed to address predominant gaps in understanding offer an invaluable tool to help communities threatened by sea-level rise to develop planned adaptation policies.

The third chapter examines sea-level rise risk through the lens of political ecology, going beyond risk assessments that take into account probabilities of flooding and physical exposure to storms to examine the interactions between social vulnerability factors and discourses that erect barriers to risk reduction. On the North Carolina coast, many of the places most at risk for sea-level rise are in locations with highly valuable environmental amenities, such as waterfronts and waterviews (Bin, Kruse, & Landry, 2008). Facilitation (Collins, 2008) is used by social elites to minimize their natural hazards risk, while deriving economic benefit from the associated amenities. Systems, such as private and public insurance, mortgages and government disaster relief, transfer risks from individuals to the society at large. Discourses of fatalism- fomented by political ideologies that generate mistrust in sea-level rise science

and an aversion to regulations that might restrict places or ways in which low-lying property may be used- erect barriers to sea-level rise risk reduction. Scarce financial resources and a perceived lack of salience reduces the capacity for sea-level rise adaptation in underserved communities, while wealthier communities have an increased pressure towards the conversion of green infrastructure that provides storm protection into investment homes. Building capacity for adaptation in coastal communities involves not only the consideration of the built infrastructure; but an exploration of knowledge, perceptions and attitudes is necessary to understand how people can respond to sea-level rise hazards or periodic flooding from severe storms. Understanding vulnerability in all of its dimensions, including the contribution of discourse, can help build greater community resilience to sea-level rise.

A case study of one community confronting the challenge of developing strategies to adapt to sea-level rise is the subject of this dissertation's fourth chapter. To determine climate change risk and identify barriers to adaptation policy, public engagement is critical. Best practices in risk communication, public policy decision-making and planning all emphasize the importance of involving stakeholders early in the process (Turnhout, Van Bommel, & Aarts, 2010). Public participation, however, has a diversity of methods and power dynamics exemplified by the classic "ladder of participation" which ranges from forms of participation in which the public has little power to complete citizen control of policy (Arnstein, 1969). How public participation is managed, who is included, and how it is conducted is likely to have a significant impact on its success as measured by the participants and the community leaders (National Research Council, 2008). Both outcomes and process measures provide insight into "what works", but the approach will likely need to balance between goal and process objectives (Chess & Purcell, 1999). In the Plymouth case study, interviews provided insight that helped shape a public participation process facilitated by professional managers, but directed by municipal staff and elected leaders. The process promoted social learning and a tangible final product that utilized a mixture of expert and local "layperson" knowledge of the participants.

The fifth and concluding chapter summarizes and synthesizes the results of the three intervening chapters. It reviews North Carolina's response to sea-level rise so far and reasons why barriers to

adaptation have impeded planned adaptation efforts. It discusses some implication for building sea-level rise resilience, including the potential for effective risk communication and public participation processes to assist moving municipalities to sea-level rise risk reduction. Boundary organizations can assist low capacity municipalities in the adaptation planning process, which will help the region as a whole move toward a more resilient future.

CHAPTER 2: SEA-LEVEL RISE RISK COMMUNICATION: PUBLIC UNDERSTANDING, RISK PERCEPTION AND ATTITUDES ABOUT INFORMATION

Chapter Summary

One of the most significant challenges in addressing sea-level rise in many coastal communities is understanding and engaging with the variety of risk perceptions that exist among stakeholders. Many people involved in planning and decision-making do not have scientific backgrounds, yet scientists, planners and managers need to communicate complex information, such as projected rates of change and the potential for impacts to natural and human-built infrastructure that involve significant uncertainty. For effective risk communication, scientific information must be appropriately framed, visually compelling and take into account prevailing risk perceptions and diverse viewpoints.

Results of a study conducted in two small, low lying communities in coastal North Carolina identified problems that residents had in interpreting sea-level rise information. This research used a document-based evaluation approach to assess issue awareness, reaction to texts and images, and possible adaptation responses. Most people (88%) reported that they learned new information from documents, but they expressed substantial difficulty understanding information about sea-level rise. In particular, people had difficulty in interpreting graphs and maps. The inability to decipher and understand information in sample documents was exacerbated by attitudes and beliefs about environmental change including fear, skepticism, fatalism, and loss. People perceive the risks as both temporally and spatially distant, which creates a challenge for communicators and policy-makers trying to convey a sense of urgency. An empathetic, audience-driven communication strategy is more effective in promoting understanding and may make discussions of adaptation strategies more productive.

Introduction

In the latest draft assessment by the Intergovernmental Panel on Climate Change, scientists report that it is virtually certain that the rate of global sea-level rise has accelerated in the past two centuries and that rise will continue for many centuries with a strong regional pattern (IPCC, 2013). Although the risk of global sea-level rise acceleration due to anthropogenic global climate change has been known for decades (Barth & Titus, 1984), policy response has lagged. Scholars have explored explanations for the gap between the risk of impacts from climate change and response including political polarization (Guber, 2013; Kahan et al., 2012; McCright & Dunlap, 2010), psychological barriers (Newell & Pitman, 2010; Swim et al., 2011), individual cognitive errors (Sterman, 2008), discourses of fear (Hulme, 2008), challenges to ethics (Markowitz & Shariff, 2012), the impact of the media (Antilla, 2010; Carvalho, 2010; Sonnett, 2010), and lack of effective communication (Kahan, Crow, & Boykoff, 2013; Moser & Dilling, 2004; Moser, 2010; Spence & Pidgeon, 2010). Scientists, science communicators and risk communicators have struggled to find methods to convey complex and uncertain scientific concepts to the public, especially in what has become a politically contentious environment in recent decades (Kahan et al., 2013). A lack of communication about the potential threat of sea-level rise may be partly due to the reticence of research scientists to report scientific findings that may shock or frighten the public (Hansen, 2007). Alternatively, climate change and sea-level rise risk communication is particularly difficult, and was practiced for many years, without a foundation of research to determine its effectiveness (Moser, 2010). Nevertheless, the need for effective sea-level rise risk communication, which takes into account the awareness, understanding, risk perception and attitudes of local audiences is crucial for coastal communities threatened by accelerated sea-level rise, such as those in eastern North Carolina (Poulter, et al., 2008).

Scholarship examining climate change science communication and risk communication is emerging as a distinct field of study because of its unique combination of challenges (Kahan et al., 2013; Moser, 2010). Climate change risk communication takes place in a world of competing messages about

both the veracity of the science and the feasibility of a response (Hulme, 2009). Consequently, the challenge of communicating climate change risks to a diverse public audience includes difficulty in making the science accessible, relevant, and salient to people who may have already experienced contradictory and confusing information (Cash et al., 2003; Guston, 2001). Innovative approaches are needed, such as making use of people's existing intuitive and experiential knowledge by appropriately associating lesser known risks with more familiar ones (Moser, 2010; Renn, 2010). Emotional reactions to climate change, often ignored or excluded by communicators, may also be an important tool in helping people to understand and react to climate change information (Roeser, 2012).

Although accelerated sea-level rise is linked to climate change, the issue has not received the same level of attention in the popular media and is less familiar to the public. No organized statewide public campaign has taken place in North Carolina to create awareness of the risk of sea-level rise, although research programs and lectures have contributed to public education (Nicholas Institute for Environmental Policy Solutions, Duke University, 2010); web pages were developed by the North Carolina Division of Coastal Management; and exhibits exist at some museums, such as the North Carolina Estuarium in Washington, NC. Sea-level rise communication shares many of the same challenges as climate change communication including difficulties with translating the science because of the abstract nature of the phenomena, the invisible causes, temporally distant impacts, and uncertainty surrounding the timing and probability of impacts. In addition, sea-level rise risk communicators have the challenge of creating texts and images for people with a variety of worldviews and political outlooks that could result in unexpected interpretations of the information (Weber & Stern, 2011).

This study addresses the need for effective practices in sea-level rise risk communication by using an innovative document-based approach to assess the understanding, risk perception and attitudes of residents of two sea-level rise vulnerable municipalities in North Carolina. It finds that public audiences have difficulty comprehending information about sea-level rise presented using standard scientific tools, such as graphs and maps, and respond to these communications with fear, skepticism and fatalism. First, I briefly review the unique combination of challenges to sea-level rise communication, in particular those

associated with climate change perception, and risk communications practices to communicate complex and uncertain science. Then I describe the research setting of northeastern North Carolina, including the socio-ecological factors contributing to the vulnerability of the population to the impact of sea-level rise and the demographic characteristics of the study participants. Following a description of the document-based methodology used to assess knowledge, beliefs and attitudes, I present the study results. The discussion that follows focuses on how the lessons from risk communication research can improve sea-level rise communication to increase scientific understanding and address local risk perceptions. In order to develop sea-level rise adaptation policies acceptable to local municipalities, decision-makers need better information about local knowledge and risk perception. Effective risk communication can serve to start a dialogue among technical experts, local decision makers, other stakeholders and the public. Because people understand risks in localized ways, as embedded in social contexts and situated within the social experiences and interactions of individuals, groups, and institutions (Masuda & Garvin, 2006), information about sea-level rise risks and response options needs to be perceived as relevant to local communities. Approaches that allow communicators and policy-makers to grasp the understanding, perception and attitudes of the local community is a first step toward the difficult process of developing locally acceptable sea-level rise adaptation policy.

Sea-level Rise Risk Perception and Communication

Managing risk depends on communicating critical information for decision-making that will ultimately reduce risk for individuals or communities. But risk communication has significant challenges that include making the messages easily understood by the audience, fostering credibility in sources of information, capturing the audience's attention, and finding the best way to disseminate the information (National Research Council, 1989). Risk communicators are very often advised to "know your audience" and to tailor messages to specific stakeholders, but often do not have the detailed information about the diverse attitudes in a local community or an effective methodology to assess community perceptions. Public participation at the local level is critical in the development of risk communications methods,

which may also need to be treated as a kind of research design (Kasperson, 1986). Scientists, managers, or public officials who want to inform a community vulnerable to sea-level rise about their risk face this challenge with few resources and significant barriers (Fischhoff, 2011).

North Carolina is one of the three states with the most land area susceptible to sea-level rise (Strauss et al., 2012). Although policy and guidelines at the state level could help the state to determine adaptation strategies and provide guidance, planning and implementation of adaptation strategies will mostly take place at a local level. Thus, understanding how local residents and decision-makers in vulnerable municipalities think about and respond to information about sea- level rise may give insight into how similar places might respond in North Carolina and in other states. Ultimately, the question of whether or not people will prepare for climate change depends on public understanding of the risk, their perception, and community decision-making.

Although climate change risk perception has been an active area of research (Kahan, et al., 2012; Weber & Stern, 2011; McCright &Dunlap, 2011a; Moser & Ekstrom, 2010), sea-level rise risk perception has rarely been examined except as a component of a larger climate risk study (see Brody, et al., 2008). Studies of sea-level rise risk perception have been conducted informally or as a part of scoping surveys for state-wide policy initiatives. Previous research in the North Carolina coastal region includes three informal studies using different methodologies to gauge opinions about sea-level rise in 2008 and 2009. One survey found that while 71% of Outer Banks residents were concerned about sea-level rise, only 57% considered themselves "informed" (Barber et al., 2008). Focus groups around the Albemarle-Pamlico Sound area also reported that there was limited knowledge among the public and a need for more education and outreach (Brown, Campbell, Henry, & Robinson, 2008). In an internet survey conducted by the North Carolina Division of Coastal Management, 75% of North Carolina residents responding to the survey believe that sea-level rise is occurring and 51% of coastal property owners believe they will be affected (Miller, 2010). These studies, while helping to inform approaches that decision-makers can take toward sea-level rise adaptation policy, did not provide information about the community members' depth

of understanding of the risk of sea-level rise or the ways in which information has been delivered or received.

Risk Communication Practices

Risk is, by its very definition, uncertain (Aven & Renn, 2009). Because risk perception relies on the mental models of people associating their experience of harm with some future potential hazard, risk communication must balance different knowledge bases, values, and attitudes (Renn, 2010) . Risk perception depends on both objective measurements of the probability of harm and on "outrage" factors, such as the voluntariness, fairness, familiarity and morality of the hazard (Sandman, 1987). Emotions, personal values, and culture play a large part in the perception of a risk and the acceptance of messages about that risk (Slovic, 1999). Risk perception depends on a complex interaction of the physical properties of a risk with personal experiences, values and the social context in which these are experienced (Adger et al., 2009; Cutter, Mitchell, & Scott, 2000). According to the theory of the social amplification of risk (Kasperson et al., 1988; Renn, Burns, Kasperson, Kasperson, & Slovic, 1992; Renn, 2011), risk perceptions will be amplified or attenuated in predictable ways based on how information is communicated and how people respond. Since many risks are not directly experienced, information flows such as mass media, social media, and local talk are important to the ways people conceptualize a risk. Risk communications frame how people react to a risk and the resulting psychological or behavioral responses can create secondary impacts that may increase or decrease the risk itself (Kasperson et al., 1988). Some risks can also be "hidden" because of the elusive nature of a particular hazard, the social issues relating to ideologies or values held by populations, or because the hazard affects marginalized people whose interests are not well represented (Kasperson & Kasperson, 1996).

Effective risk communication requires more than just " getting the numbers right" or getting the message right (Fischhoff, 1995); it involves engaging with the population at risk to understand the perceptions, issues, and attitudes present so that personal or community decisions can be made based on the best available information about a risk (Leiss, 1996; National Research Council, 1989). The

assessment of a particular risk depends upon a variety of judgments, both those objectively measured and those informed by such factors as gender, race, political worldviews, emotion, affiliation and trust (Slovic, 1999). Risk perception is value-laden and also depends on culture and experience of place, which can increase or decrease risk perception (Masuda & Garvin, 2006). A sense of place in regard to landscape values also has an influence of perception of risk (Raymond & Brown 2011).

Challenges to Communicating about Climate Change and Sea-level Rise

Climate change communication research has received increasing attention and is emerging as a distinct field of research (Moser, 2010). Sea-level rise communication relates closely to climate change communication because sea-level rise and climate change are scientifically-linked and share characteristics of complexity and uncertainty. It is possible to discuss sea-level rise and its impacts without explicitly noting climate change, however, because local subsidence and coastal erosion can cause similar environmental impacts. Climate change communication presents significant challenges in science communication because of the abstract concepts involved in atmospheric modeling. Additionally, people often find it difficult to conceptualize the spatial and temporal scales of climate impacts. Polls assessing American's climate change knowledge have shown that 63% of the public understands that "global warming is occurring," but they do not understand why it is happening (Leiserowitz, Smith, & Marlon, 2010). Knowledge gaps were most significant in the understanding of how heat flows around the globe, the conceptual model of how climate changes, and the causes of global warming. One of the important scientific principles that is often misunderstood, even by highly educated adults, is the mass balance principle that governs the flow of greenhouse gas emissions (Sterman & Sweeney, 2007; Sterman, 2008). People typically do not understand that complex climate systems respond to changes much more slowly than might be expected, and that once the harm is evident, it may be too late to reverse the process. In fact, less than 20% of Americans understand that "on average carbon dioxide stays in the atmosphere hundreds to thousands of years once it has been emitted," and a majority (57%) incorrectly

believe that "the amount of carbon dioxide in the atmosphere would decrease almost immediately" if emissions from fossil fuels were stopped (Leiserowitz et al., 2010).

The wide ranges of scientific literacy and numeracy across audiences presents a challenge to broad public understanding of sea-level rise and climate change science. Currently, no unified theory of visual literacy exists to explain how people process visual information (Avgerinou, 2011; Trumbo, 1999). The range of visual representations may mean such a unified understanding is not possible. One study found that approximately one third of the population tested in Germany and the US have low graph literacy and low numeracy skill, which can affect understanding of complex scientific ideas and decision-making (Galesic & Garcia-Retamero, 2011). Diagrams and maps may have a higher correspondence to reality but depend on spatial reasoning as well as understanding of the conventions for those representations (Mennis, Peuquet, & Qian, 2000). Careful cartographic design can improve understanding of maps, but testing visual design with users is critical to the production of maps that effectively communicate risk (Hegarty, 2013). Similarly, individual learning styles also affect audience understanding of risk information. The concept of individual learning styles is not universally accepted and several dozen different models of learning styles have been proposed (Felder &Brent, 2005). Although models based in personality types have proven useful to increase student learning in some educational settings, learning styles have not been tested in the context of risk communication, so it is difficult to assess the impact of different learning styles on sea-level rise risk perception.

Another barrier to public understanding of climate change is the persistent uncertainty that is inherent to climate science (Morgan & Mellon, 2011). Although sea-level rise is one of the most certain outcomes of global climate change, the rate of sea-level rise in a particular location is difficult to predict, especially over long time periods. The uncertainty of future sea levels at a particular location results from uncertainties at both a global scale, such as the rate at which ice sheets are melting (Pfeffer, 2011), and at regional scales, where land subsidence and sedimentation dynamics manifest (Craft et al., 2009). How a particular shoreline will respond to sea-level rise will depend on global, regional, and local factors including human responses to the threat, such as the protection of the shoreline by armoring. Risk

communicators must grapple with the challenge of trying to convey the breadth and depth of the problem while being clear about the complexity and uncertainty of future projections and the many global and regional factors (Moser, 2010).

Public understanding is complicated by discourses that confer doubt about the veracity of scientific reports such as the IPCC assessments, and may also be limited by anecdotal comparisons of scientific findings against particular personal experiences (Newell & Pitman, 2010). Environmental values and political affiliations also color how individuals read media stories and can cause people to focus on uncertain, although relatively irrelevant details. Bias tends to be persistent in issues such as climate change where uncertainties exist and solutions are difficult (Etkin & Ho, 2007). Individuals may substitute familiar phenomena, such as weather, with phenomena that are unfamiliar, such as climate (Bostrom & Lashof, 2007). It is frequently difficult to experience temperature change due to global climate change directly because short-term extremes overwhelm the general trend (Weber & Stern, 2011). Recently, however, scientists have directly associated extreme weather events with climate change (Hansen, Seto, & Reudy, 2012).

Greater scientific understanding does not always lead to a greater public concern, in part because emotion, affect, and worldview play a large role in risk perception of climate change (Leiserowitz, 2005). A number of studies have attempted to measure how other factors affect the reception of information about climate change and sea-level rise. For example, in one study, political ideology had a strong effect on climate change risk perception and was more influential than education level or other demographic factors in determining concern about climate change (Zia & Todd, 2010). Another study found that some members of the public with the highest scientific literacy were among the most divided in opinion because their climate change risk perception aligns more closely with their personal or political affiliations than with climate science (Kahan et al., 2012). These studies have recognized a need to "tailor climate change messages to the needs and predispositions of particular audiences" (Leiserowitz, 2006). The "Six Americas" study describes distinct behavioral patterns and policy preferences that inform the action, or inaction, of these groups with respect to climate change (Leiserowitz, Maibach, Roser-Renouf,

& Smith, 2011). This study reveals deep divisions between ideologically different groups within the public, and argues that each group represents a different audience that will require uniquely tailored communication methods, messages and messengers (Maibach, Roser-Renouf, & Leiserowitz, 2009).

Additionally, trust in information sources can have an important influence on the public's understanding and acceptance of climate change and sea-level rise. Even though the public receives much of their information through the media, Leiserowitz, et al. (2011) found that the most trusted sources for information about climate change are scientific and government sources, such as NOAA. Among the group that denies climate change, only 25-30% responded that they trusted scientists and NOAA but still ranked them first among the 10 choices of information sources offered (Leiserowitz et al., 2011). This finding is in contrast to other studies that have found national governments are not necessarily seen as reliable (Lorenzoni & Pidgeon, 2006; National Research Council, 2009). One study found that more self-reported knowledge about climate change does not necessarily indicate individuals are more concerned or that information consistent with messages from sources with similar political affiliations is more likely to be trusted (Malka, Krosnick, & Langer, 2009).

Communicators "frame" information by selecting some aspect of their subject and making it more salient to their audience in order to promote a particular interpretation, evaluation or solution (Entman, 1993). Different frames may appeal to differing values or viewpoints; and audience analysis can provide a better understanding about why different groups disagree about climate change risk (Hulme, 2009). Because intuitive feelings are one of the principle ways that the people evaluate risk, in order to maximize communications effectiveness, researchers advise communicators to pay close attention to framing in sea-level rise risk communications and the emotions that frames invoke in audiences (Moser, 2007; Moser, 2010; Slovic, Finucane, Peters, & MacGregor, 2004). While the long-term and abstract nature of much climate science does not inspire the same concern in the public as it does in scientists (Weber, 2006), communications that inspire too much fear or guilt may cause emotional numbing and inaction (Moser, 2007). Spence and Pidgeon (2010) found that their study participants were more likely to say they would take action to mitigate climate change when the same scientific information was framed

in terms of gains instead of losses. On the other hand, the loss frames promoted a higher fear response, but a higher retention of information.

Risk communicators use a variety of graphics, such as photographs, illustrations, graphs and maps to illustrate scientific concepts and help audiences visualize the context or potential outcomes of the risk. Images that are local, placed-based and familiar can help reduce the sense of climate change as a distant phenomenon and better engage the audience (Nicholson-Cole, 2005). For sea-level rise communication, illustration of future scenarios can powerfully represent in a concise and concrete fashion the possible outcomes of climate change. Using tools that manipulate images to help people to visualize possible future landscapes has potential to demonstrate both sea-level rise and other phenomena, such as increased storm severity, which is more subtle (Sheppard, 2005). People connect their life experiences to a risk when the visualizations are of well-known local landscapes or familiar landmarks.. Nevertheless, illustrations of future sea-level rise conditions, and other images that inspire fear in audiences, can provoke unintended reactions. They can desensitize individuals to pending events, increase a sense of emotional distance and feelings of personal powerlessness, and thereby result in denial and apathy (O'Neill & Nicholson-Cole, 2009).

Using Risk Communication to Bridge the Gap

Public understanding of climate change and response options depend, in part, on the language used to describe it. For example, in a study by Whitmarsh (2008), the term "global warming" invoked more concern among residents of the south of England than the term "climate change". Human cultures have a historical relationship with climate in which narratives of fear, catastrophe and judgment have often dominated and these discourses shape how people read and interpret risk communications associated (Hulme, 2008). Although climate change and sea-level rise are familiar terms, much of the detailed information available to audiences uses specialized scientific language that may distance public audiences from both understanding and personal involvement (Lehtonen & Peltonen, 2006). To bridge the gap between science and lay understanding, "bridging metaphors" can help people understand complex

environment problems (Unger, 2007). For example, communicators described ozone depletion as a hole in the earth's protective shield allowing damaging rays to penetrate. A simple, easily visualized metaphor allows ordinary people to "play" with the idea, but no similarly effective metaphor has yet emerged for climate change (Unger, 2007).

Creating effective risk communication tools to overcome the significant challenges of climate science interpretation and barriers to climate change and sea-level rise response requires understanding audiences and carefully crafting messages and images. However, most of the risk communications about climate change and sea-level rise to date have not been planned in a comprehensive way nor has their effectiveness been evaluated (Moser, 2010). Sea-level rise risk communication is the focus of this study, but the results can also inform communications of other climate change impacts or environmental risk topics.

Research Setting

Participants recruited for this study were residents of the municipalities of Manteo and Washington, North Carolina or the immediately surrounding area. These towns are located in the northeastern region of the state, the area most susceptible to sea-level rise, and have coastal waterfront on the sound or adjacent rivers, exposing them to the threat of flooding (See Figure 2-1). The counties in the region are some of the most sparsely populated and economically distressed areas in the state. The North Carolina Department of Commerce ranks counties each year based on factors of economic well-being each year and assigns a 'Tier Designation' from 1 to 3. The 40 most economically distressed counties are Tier 1, the middle 40 are Tier 2 and the 20 least distressed counties are Tier 3. Within the 12 northeastern North Carolina counties, seven were Tier 1 and five were Tier 2 in 2011 (NC Department of Commerce, 2012). Manteo is the county seat of government for Dare County, which is a Tier 2 county that also includes beach towns with a different economic base than the inland sound front and riverfront municipalities. Manteo is located on Roanoke Island, between the mainland and the barrier islands where the Albemarle Sound meets the Pamlico Sound. Washington, the seat of Beaufort County was a Tier 1

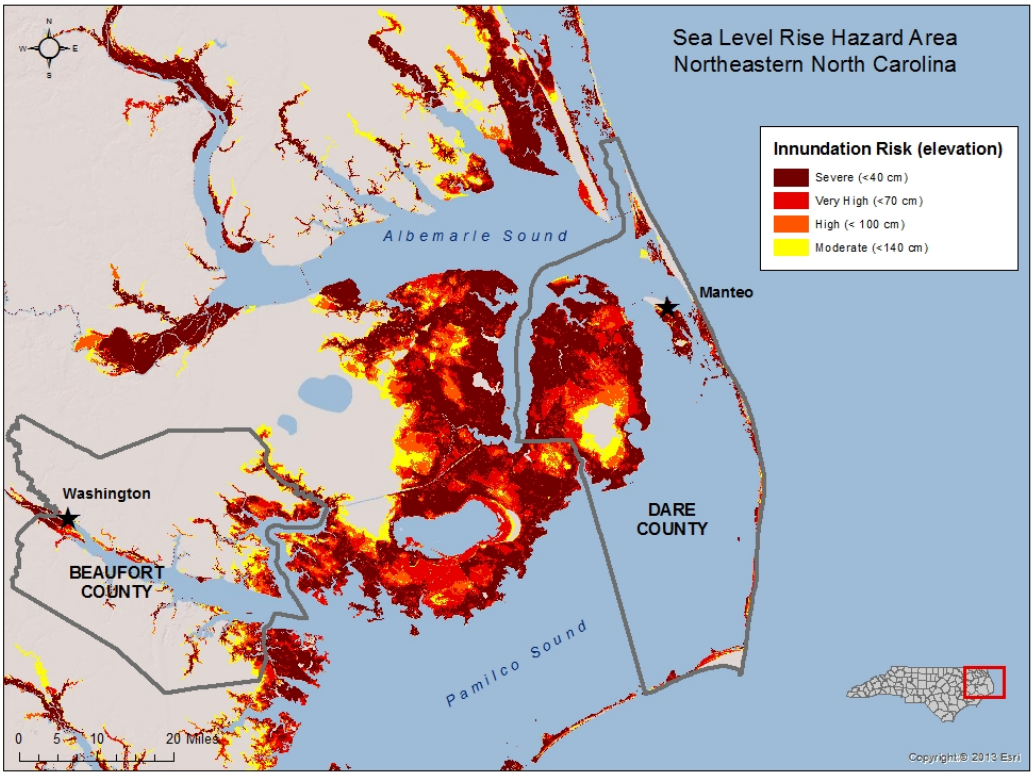

Figure 2-1. Map of the region

	Washington	Beaufort Co.	Manteo	Dare Co.	NC
Population	9,742	47,770	1,434	33,920	9,535,471
White	49%	72%	85%	94%	72%
Black	46%	26%	8%	3%	22%
Latino	6%	7%	9%	7%	9%
over 64	19%	19%	17%	16%	13%
Person/sq. mile	1,190	58	777	89	196
Socioeconomics					
Median household income	$26,352	$40,986	$32,365	$54,750	$46,291
Population in poverty	28%	19%	20%	11%	16%
Education (high school+)	76%	82%	92%	92%	84%
Education (BS+)	24%	19%	23%	32%	27%

Table 2-4. Demographic information for Manteo and Washington from the 2010 US Census

county in 2011 and is located on the Pamlico River about 25 miles from the Pamlico Sound. Both towns have demographic features characteristic of the county in which they are located, but both also have greater percentage of minority populations, lower median household incomes and higher poverty rates than their surrounding county (Table 2-1).

Study Participants

We collected demographic and attitudinal information about participants. The participants included 20 people in Washington, NC, and 20 people in the Manteo area. The study team recruited participants using flyers located in strategic locations (including public libraries, post offices, the North Carolina Estuarium in Washington, the College of the Albemarle and the Dare County Community Center in Manteo, and several local coffee shops in both target areas). The recruitment flyers did not specify the content of the documents, but rather indicated that the participant would read and discuss a fact sheet with information about their area. We conducted the interviews in several central, public locations in each area including the College of the Albemarle, the Dare County Community Center in Manteo, the public library in Washington, and the waterfront promenade in Washington. The participant sample was demographically diverse and represented the populations of the areas in which we conducted the study (See Table 2-2).

	2010 Census Manteo, NC	Our Study Manteo, NC	2010 Census Washington, NC	Our Study Washington, NC
Gender				
Female	55%	55%	51%	65%
Male	45%	45%	49%	35%
Age				
Range 18-29	16%	30%	17%	15%
Range 30-49	35%	35%	30%	50%
Range 50-64	31%	30%	28%	30%
Range 65-80	19%	5%	24%	5%
Ethnicity				
White	85%	52%	49%	65%
Black	8%	26%	46%	35%
Hispanic	9%	5%	5%	
other		16%		
Education:				
High School graduates	92%	95%	76%	100%
Bachelor's degree or higher	22%	35%	24%	30%

Table 2-2. Comparison of demographic features of Manteo and Washington with study participants

Methodology: Document Usability Testing

Researchers do not commonly distinguish sea-level rise knowledge and risk perception independently from that associated with climate change. Typically, researchers use mail-in, telephone, or internet surveys to assess climate change knowledge and risk perception. These surveys ask direct questions about the participants' level of knowledge, their concern about climate change and their willingness to respond to their concerns (Brody et al., 2008; Leiserowitz et al., 2010; Maibach et al., 2009; McCright, 2010; Zia & Todd, 2010). Other studies have used open-ended interviews in the mental models style to gain an in-depth understanding of how participants think about the topic of climate change (Bostrom, Morgan, Fischhoff, & Read, 1994; Morgan et al., 2002). But these methods, which gather data from large numbers of participants help to explain the predominant beliefs and attitudes that exist within the population of interest, may not go far enough to help communicators and policymakers understand the reasons why individuals hold their opinions.

Of particular interest to risk communicators is an understanding of the reasons readers pay attention to specific portions of a text and the ways in which readers interpret visual and textual information. Although public opinion surveys can give a broad brush of public knowledge and perception, collected in a particular time and place, it is useful to understand what methods of conveying information are most effective as public understanding and needs change. Communicators are particularly interested in what information audiences prioritize, choose to read or focus on, and what they consider important. Interpretation of textual and visual information depends upon reader evaluation of the material through deriving meaning from words, groups of words or images, and then measuring that evaluation against what audiences know and trust. Readers need to judge the credibility of the information, its relevance and salience, before they can respond. Information salience is the extent to which a text's features collectively facilitate audiences' abilities to effectively attend to, interpret, and understand a message (Albers 2007). These considerations suggest that the success of a message results from an

alignment of presentation and information with people's reading and critical thinking abilities, habits and preferences, as well as their knowledge of and reactions to an issue.

The approach in this study uses qualitative methods including document-based evaluations and semi-structured interviews to elicit audience understanding of information, attitudes, and risk perception. Other studies have used these methodologies to analyze audience interpretation of hurricane risk and preparedness information as well as information on other environmental and health risks (de Jong & Rjinks, 2006; de Jong & Schellens, 2000; Kain, de Jong, & Smith, 2011). Usability evaluation for audience analysis is a methodology developed for document design evaluation to learn more about audience needs and attitudes (Kain et al., 2011). The techniques serve the dual purpose of evaluating cognitive and emotional reactions to a specific text while also gathering information about risk perception including audience knowledge, attitudes, and policy preferences. The process promotes a dialogue between producers and users of information that results in better materials and promotes risk communications best practices.

The document testing methodology is used to research people's reception of information as well as their knowledge of and attitudes about sea-level rise. The primary purpose of the evaluation is to better understand how audiences attend to and interpret information about the topic, rather than to critique a specific document, though the latter can be an additional benefit. The primary goal is audience analysis, which establishes an intended audience profile, identifies actual target audience characteristics, or determines how representative audiences actually read and use documents.

Sea-level Rise Documents

The document testing methodology employed three different documents (See Appendix B). Each document was four pages and included graphs, photographs, maps, and similar textual information, grounded in the same scientific viewpoint. One document, "Sea Level Rise… What does it mean?", developed by Jessica Whitehead for North Carolina and South Carolina Sea Grant, provides information about sea-level rise effects to the southeast region. The regional document is set up in a question-and-

answer format with the list of eight questions on the first page and each question repeated with a textual answer on the following pages. Sidebar areas are used to place graphs and captions referred to in the answer paragraph and labeled as figure 1, figure 2, and so forth. On the first page, the sidebar area has a definition of sea-level rise and on the fourth page, the sidebar areas is used for contact information and a list of scientific sources of information.

Two new documents were developed specifically for the evaluations—one with locally-specific information about sea-level rise designed for residents of Manteo/Roanoke Island, NC, and one developed for residents of Washington, NC. The documents we localized included local photographs and maps that depicted the impacts of sea-level rise in area of the coast in which the reader's lived. The local documents made use of satellite images; photographs manipulated using CanVis to visualize a potential future water level on the community waterfront and used illustrations. The design of the document was similar to a magazine or newsletter, making use of colored boxes of text alternated with images.

Testing Protocol

Using a method described as "plus-minus mark-up," participants read and marked-up one of the three samples texts to indicate where they have positive and negative reactions to the information(de Jong & Rjinks, 2006; de Jong & Schellens, 2000; Kain et al., 2011). Participants were instructed to read the entire document and, as they are reading, to mark any content to which they reacted positively with a plus symbol (+) and to mark any content to which they had a negative response with a minus symbol (–). Research team members told participants that they could mark any unit of content from individual words and images to whole pages for any reason.

Next researchers interviewed the participants, asking them to explain the marks they noted on the guide. Researchers audio recorded the interviews for later review and partial transcription and made notes about participants' comments on pre-prepared forms that included areas for the various feature and sections of the document.

Participant interview. The document testing provided starting points for further discussion. We conducted extensive interviews to gather details about readers' comprehension of the documents as well as their attitudes about the issue and their perceptions of risks. After participants marked up the documents, interviewers asked first about overall comments or impressions. Then, the interviewer asked about each mark that the participant for the reasons for each mark that they made on the document. In addition, following the Morgan et al. (2002) mental models approach, we asked additional open-ended questions to further elicit participant reactions to the document and to any issues raised in the interview.

Post Test. To assess participants' understanding of the information, we developed a post-interview "test" about the information in the documents. At the conclusion of the interview, the participants completed the survey about concepts presented in words and/or graphical representations in the document. The survey consisted of multiple choice and open-ended questions about the facts presented in the documents. Participants could refer to the document to answer the survey questions. The purpose was to determine whether any particular information or presentation of information caused problems for audience understanding. Each participant session lasted between 60 and 90 minutes approximately.

Analysis of interviews. All interviews were digitally recorded and later transcribed. Transcripts were coded using an open coding technique in which themes were identified and grouped together using NVivo 10 software. Similar themes fell into categories and arranged in a hierarchal organization based on categories such as "comments about the design of the document" and "comments reflecting an attitude of fatalism about the issue". Some themes were collapsed into other themes when deemed similar. (See Appendix C).

Results

This section examines the responses of readers to the sea-level rise documents, their initial reactions, overall reception, and attention to text and images. The document-based interviews reveal the readers' evaluation of document design, comprehension of sea-level rise concepts, attitudes about the

information, and emotional reaction. By using a document-based method, we gain insight into how readers receive and understand information that may be unfamiliar, while also revealing local knowledge, beliefs, attitudes and values. Although the overall reaction to the document was positive, many readers did not understand the scientific information presented, especially the concepts conveyed in graphs and maps. Localized information and concrete ideas, such as experiences and photos, drew reader's attention better than more abstract text or graphs; however, these did not increase reader comprehension. Fatalism, skepticism, and fear result from the presentation of unfamiliar risk information without adequate information about possible individual or municipal responses. The analysis of interviews and marked documents demonstrates that to be effective, science communicators need to engage with audiences so that they can address local knowledge and attitudes, and that audiences need tools to think through the science and potential responses to sea-level rise.

Reader Responses to the Document

Overall Reception. Reader's overall reactions to the documents were more positive than negative (Table 2-3). In interviews with participants, most initial reactions to the documents and to learning new information were also positive with participants generally commenting positively. When asked about their overall assessment of the documents, most readers indicated that the documents were interesting, informative, and important. A mix of positive and negative comments was common, because although individuals had a positive reaction to learning new information in general, many had negative feelings about the effects of sea-level rise. For example, referring to information presented in a graph forecasting future sea-level rise, a reader said, "The plus in the description below is just because it is the same information [as presented in the graph], but the minus is because the information is alarming." Some acknowledged the importance of knowing the information, but indicated that they didn't feel affected or could not adequately respond to the threat of sea-level rise.

	Regional		Local	
Plus Marks (positive reactions)	166	61%	155	62%
Minus Marks (negative reactions)	94	35%	77	31%
Question Marks (confusion)	12	4%	17	7%
Total marks	272	100%	249	100%

Table 2-3. Document mark up

Despite an overall positive response, readers commented that the documents were too long and that they included some information that might be challenging or difficult to remember. One reader said, for example, "I thought it was good, but it has problems. I could understand the document, but I could see where the general public might have a hard time with it." Another indicated, "It seems mostly accessible. There were a few things that I didn't particularly understand, but I think I could figure it out probably." The topic did not seem particularly relevant to some readers, who considered the many issues competing for an individual's attention. As one noted, "I think sometimes when a new documentary or something like that comes out it is more talked about during that period of time, but it is like other things, it is out of sight, it's out of mind."

Reader Attention. A summary of the "plus" and "minus" marks people made on the documents, Table 2-4, suggests that readers paid about the same amount of attention to all three of the documents tested and that their overall positive and negative reactions to information were similar for all three. In looking more closely at how people marked up the documents they read, clusters of positive and negative marks, summarized in Table 2-4, identified areas for particular attention.

Readers paid most attention to the sections about exploring local options to responding to sea-level rise in all three documents. Readers made positive comments about the concepts that identified actions, such as "protect," "accommodate," and "retreat." Readers directed most attention in the localized documents at the sections describing techniques to protect shorelines, an adaptive response to sea-level rise. Other sections that readers responded to most were basic scientific information in the regional document including the definition of sea-level rise, projections of future sea –level rise and how much sea-level rise will affect the Carolinas. Introductory material on the first page of the local document garnered many marks, both positive and negative. Interviews revealed that the negative marks were associated primarily

with attitudes about the information, particularly concerns and fear. Only a few interviewees indicated that the negative marks meant that they didn't believe the information or thought it was wrong. People were most interested in locally relevant information and images and ways communities or individuals to respond to sea-level rise.

	Regional Document	Local Document
Most Marked Section	Paragraph entitled "What are some of our options for responding to SLR? " (12+, 5-)	Protecting Shorelines, bullet "Revetments" and "Sills" (10+, 2-)
Other sections with many positive marks	• Definition of SLR on front page • Paragraph "What does SLR mean?" • Paragraph "How much is sea-level rising in the Carolinas? • Bullet " How much carbon dioxide and other greenhouse….."	• Text page 1 • "Loss of Wetlands" paragraph 1 • Bullet "Accommodate" • Protecting Shorelines , bullet "Hard, vertical structures…"
Sections with many negative marks	"How does Sea Level Rise Affect the Carolinas?", • bullet "permanent flooding of many low-lying.." • bullet "expanded area…"	• Text page 1 • Paired waterfront photos • Protecting Shorelines , bullet "Hard, vertical structures…"
Specific Comments	• Pic used three times! • what does this mean for me? (refers to local communities), jargon?	• needs more historic examples, too short a time period • The paragraph before seems to point out the harm caused by bulkheads, therefore be honest and consistent with your message, only suggest "living shorelines", also manmade reefs

Table 2-4. Areas of the document that were most marked

Document Design

Some readers commented that they liked the colors, the overall layout, and images in the documents. Simple illustrations of concepts, such as the depiction of freeboard, posed fewer problems for readers than the maps and graphs. But readers also noted that some images seemed to only serve the purpose of adding visual interest and didn't add additional information or assist in comprehension, an attribute that they judged as a negative. Most readers liked information segmented into discrete, easily-read pieces. Some readers like the Q & A format of the regional document; for example one said, "The list of questions is a good breakdown of the sections." Other readers thought space was wasted. "The

formatting was strange. The document needs an introduction discussion before the list of questions. I put a plus by the first paragraph in the box on the left side of the page. That information needs to be more central—maybe put the questions in the box on the side and put the "meaning of the whole thing" in the center. Paragraph 2 in the box is repetitive…." Another reader was confused about the Q & A format and assumed that the readers needed to provide the answers. Readers of the local document appreciated a balance of text and visual information. One noted, "You need a good balance between the wording and the pictures to display your point. I like the key highlights because everyone is in a big hurry today and they don't read anything." The sidebar formatting in the regional document confused some readers. One commented, "I don't like the text in the side bar on page one. At first I thought that was answers to questions but then you realized it was just telling me what it was. It was a little bit of overkill."

Reader Comprehension

The document "post test" results indicate comprehension problems with particular types of information in all three documents. Table 2-5 lists the "post test" questions and results. Because both the regional and local documents covered the same general concepts, those questions were identical for readers of all documents, but the graphs, maps and terminology varied between the two types of documents, so those questions reflect the different information presented.

Graphs. Graphs are particularly difficult for many readers to understand. Half (50%) of the readers of the regional document could not correctly read the graph to answer a simple multiple-choice question correctly. Comments about graphs during the document interviews reflect the discomfort that many readers have with graphs in general and with the graphs used in the documents specifically. One reader commented, "I didn't understand it. I am not a graph person. I am not saying it is bad it is just not for me. I read some of it – especially the bullets to try to better understand the graph and I said okay, not for me."

Question	Number Surveyed	Percent correct answers
Graphs **Regional** - How much have global mean sea level increased since 1960 (according to Figure 1)? r0 mm r 50 mm r 100 mm r 200mm **Local-** How much is sea level expected to rise by 2100 if the warming trend in the ocean over the last century is considered (according to the figure "Future Sea-level Rise)? r0.38 ft r1.25 ft r 3.25 ft r 4.6 ft	20 20	50% 65%
Map **Regional-** Where along the coast of the Carolinas is the sea level rising the most (see Figure 2)? r Wilmington r Beaufort r Georgia Border r Virginia Border **Local-** Areas on the map shown on the front page that are red may be under water when the sea level has risen r0.38 ft r1.25 ft r 1.64 ft r 3.28 ft	20 20	60% 75%
Terminology A strategic action that is designed to accommodate for sea level rise is r an erosion prevention structure such as a sea wall r no permanent building allowed in the potential future flood zone r elevating buildings within the potential future flood zone r retreating from low lying areas	40	45%
Terminology Local- Marsh grass plantings that help prevent erosion are known as r bulkheads r seawalls r living shorelines r freeboard	20	95%
General Concepts Is sea level rising equally in all coastal regions? r Yes r No	40	75%
General Concepts Is it true that sea level rise can affect where flooding occurs during storms? r Yes r No	40	95%
General Concept (but not specifically addressed in document) Is it true that sea level rise can affect how much it rains? r Yes r No	40	55%
General Concept (open ended question) How do increasing global temperatures affect sea level?	40	70%

Table 2-5. Survey to evaluate document comprehensibility and reader retention

For the regional document, some specific comments demonstrated difficulty due to the size of the graph. One reader said, "The red on the graph is clear, but the blue and black you couldn't tell." Specialized terminology related to research findings informing visual such as graphs also prove challenging. The same participant commented, for example, "I did not understand the 90% confidence

level part." Though a number of readers commented favorably on the inclusion of graphs or did not comment specifically on problems with the graph, the results of the quiz indicate that people have more problems reading graphs than they are willing to admit and that some people don't take the time to review graphs carefully enough to interpret them effectively. One reader said," when I first saw it, my first instinct was to say, what does each of these lines mean, but I didn't read it at first. After reading it through I understand it. There are pretty pictures, I don't want to look at a graph."

On the other hand, some people understood and appreciated the inclusion of graphs. One said, "I liked the graph here. It shows how high the level is going. I like the whole graph. I do understand some of it… in 2000 it up high." Another comment, on a graph that includes a human figure to illustrate predicted sea-level rise, was that the figure makes the water level obvious—"like in 100 years is gonna be taller than you."

Maps. Readers were more successful in reading maps than reading graphs, yet only two-thirds (68%) of readers were able to answer a simple map question correctly. Some confusion about the map in the regional document may have been due to small print size, but several people did not understand the map or the information it was conveying. One person said, "I didn't know what the bottom right chart was about at all. It says change in sea-level rise along the Carolina coast but compared to what? Looks like they just kind of threw it in there as a filler." Other people liked the maps as visual references for the information, but felt more explanation was necessary in the local document. One person said, "The map needs to be one page with a commentary on it about what it is. Needs to be larger. The legend needs to be explained more. More explanation is needed."

Maps and graphs can be effective in conveying a lot of information and in illustrating relationships among data. However, reading maps and graphs accurately requires that people are comfortable with the genres and conventions enough to manage the cognitive tasks required to interpret them. Some audiences will simply ignore information in graphs, charts, and maps, as one participant's comment suggests:

> Map is a negative. It is unclear what it means and why it is there. I don't see what its purpose is. The graph didn't mean that much to me. The charts didn't mean that much. If this was something that I was really interested in, I would pay attention to the charts, but you know sea-level rise. I try to keep informed about things, but it is not on the top of my list. Or real gun ho about learning about. Some people may really get into these charts. I can't say it was a bad chart, but for me, it didn't really do much. The chart – you would have to be involved – charts are for the person in the business.

Terminology. Both documents introduce new terminology that is useful for a better understanding of sea-level rise, its consequences, and possible responses. Managers, in describing sea-level rise adaptation and shoreline erosion response, commonly use the terms "protect," "accommodate," and "retreat". Many readers responded very positively to the introduction of the concepts. For example, one participant said, "This is like the punch to get your attention. It is like okay, we have three ways to do this we protect, accommodate and retreat and it tells you what they are." Although the terms were welcome as concepts, most participants (55%) could not distinguish between the three terms when assessed. There was a difference in response to terminology between readers of the regional and local document. More readers of the local document were able to correctly define "accommodate" as compared to readers of the regional document (55% vs. 35%).

Readers had difficulty with the following terms and concepts used in the documents: altimetry, tidal gauge, re-nourishment, mitigates/hazards mitigation, inundation, linear trend, confidence interval, historical reconstruction, IPCC, freeboard, resilience, retreat, and revetment. One new term that readers successfully understood was "Living Shorelines," which was included only in the local document. Almost all readers (95%) were able to correctly match the term with its definition on the document survey. Though some people had trouble with the term "freeboard," indicating that they has never heard of it, didn't understand the explanation, or didn't know what it was, a number of others were interested in the benefits of freeboard as illustrated in a diagram. As one person commented, "I understood it and I liked the money figures that said if you take these extra steps, you will save this much." Benefits included safety as well as financial motivations, for example one participant said, "I like here where you talk about freeboard. Here again you can see how much it increases your chances. You can see how I only have to pay this much in insurance instead of almost twice as much."

General Concepts. The document survey tested the comprehension of several general concepts in both the regional and local document. The concept that sea-level rise can affect where future flooding occurs during storms was correctly answered by most (95%) of readers. Participants were less successful in answering the question "Is sea-level rising equally in all coastal regions?" Only 75% of readers correctly answered this question, with readers of the regional document more successful (85%) than readers of the local document (65%). About the same number of readers were able to answer a simple open-ended question, "How do increasing global temperatures affect sea-level?" Seventy percent of participants answered that ice melting and/or expanding water causes sea-level rise.

During interviews, participants' comments revealed other problems with their understanding of general concepts. Some problems with understanding stem from basic science misconceptions. For example, one reader said, "[sea-level rise] makes me think about global warming and hurricanes. We are having global warming because we are going too close to the sun." Another defined sea-level rise as "when there is a surge and there is water that comes and it is sea level, but it is a little above that."

Reader Attitudes about Information

In addition to the comments about the design of the document, the study team examined reader attitudes about sea-level rise information. To assess local knowledge, the study team asked interviewees about their previous experiences with the topic of sea-level rise, what new information they learned and if the document was missing key points that would assist understanding or interest. Although most participants claimed a familiarity with sea-level rise, most also learned some new information. Some readers felt that the documents were not specific enough about local conditions and potential adaptation responses. A summary of reader comments organized by category and theme, and enumerated is located in Appendix C.

Reader Familiarity with the Topic. Almost two-thirds of readers indicated that they were at least somewhat familiar with sea-level rise (see Table 2-6). The primary sources of information for the

people familiar with the topic included newspapers, television, and school, including their own or their children's' educational experiences as teachers or students. One reader reported:

> My grandbaby came home [from school] with something about the sea level and what would happen if this and stuff. . . . I had to go to the computer because I was dumbfounded because I really didn't know about it. I had to go and Google it because I didn't really know.

Several other readers also mentioned searching for sea-level rise information online, primarily to follow up on information they had heard or read. Some participants reported that they learned about sea-level rise from local talk about the issues while others said that the topic was not an issue of community concern and discussion. Of those who said that sea-level rise is discussed locally, several mentioned that they worked in, or had worked in, construction, real estate, or real-estate related business or government office, or that they had talked to someone else who was associated with one of those. A few readers identified dealing with, or knowing about, specific regulatory issues as the context in which they learned about sea-level rise, including CAMA regulations and the 100- and 500- year flood plain maps.

Are you familiar with this topic?		
Yes	16	40 %
Somewhat or a little	11	27.5 %
No	11	27.5 %
Unclear	2	5 %
Total	40	100 %

Table 2-6. Participant answers to the question "Are you familiar with this topic?"

New Information. Most people (88%) said that they learned something new from the document. For some people the entire topic was new. One reader said, "All of the information was 90% new to me." Others had heard of the issue, but either did not fully understand the phenomena, " I didn't know that the land raised up after the ice melted or that the land masses are sinking." Some readers acquired more detailed understanding than they held previously. One said, "I never thought about the other options - accommodation or retreat before, I guess because they only put out about retreat. " Other participants learned new terminology such as "freeboard" and "living shorelines. "

Many people were uncomfortable with unfamiliar concepts. One said "The minus was because I did not really understand the ice sheets compressing. It was something I never heard about." Sometimes this led to skepticism about the concepts due to a misunderstanding of the science. For example, one reader questioned the contribution of melting ice sheets to local sea-level rise, since there is no ice in the local area. Several readers had difficulty understanding and accepting the concept of land subsidence contributing to regional sea-level rise. One remarked that, "Maybe the geologic forces are beyond me."

Missing Information. Some readers reported finishing the document with the feeling that information was missing. Readers of the regional document commented that they were looking for more local information and photographs. When asked if any information was missing, one reader responded, "More numbers, I guess—more specific for my county—and something about whatever we're doing wrong that we could work on. Or the areas that are on the chart (map). What can we do to make a difference?" Another reader said,

> Overall it gave me a lot of information about sea-level rise, it truly did, but the local community part was lacking. I was hoping they would give me more specifics on just things in the local area: things I should be doing, what I should be looking for, more information about here.

Readers of the local document also wanted more information about the economics of sea-level rise adaptation. One reader said, "I don't know if there is a figure out there that is the cost. You know when there is a storm, [how much money] the federal government and state government spent and the cost of cleaning up from a storm. "

Reader Affect

Readers who participated in the study expressed many different attitudes, opinions, and beliefs about sea-level rise and the risk of impacts on the local communities. Among the emotions expressed were concern, no concern, fear and discomfort. Despite the primarily negative emotions expressed about the threat of sea-level rise, several people expressed optimism and that knowledge was a first step toward confronting the risk. Among the most commonly expressed attitudes were skepticism and fatalism, which

may be a response to a new, unfamiliar risk in combination with little information about ways an individual can counter the threat. Readers also expressed different beliefs as they thought about possible government or private sea-level rise adaptation responses. Some readers believed government should take action, while others feared regulation.

Concern. Readers generally expressed some level of concern, although 37% either showed a lack of concern, or gave contradictory or unclear answers (Table 2-7). Some readers admitted that their concern was superficial, and competed with many other life concerns that were more relevant. For example one responded, "It [concerns me] now, but it is not something I am going to lose sleep over". The temporal scale of sea-level rise allowed readers to feel the issue is not urgent. One reader said, "It is not scary to me, because I am not going to be around. I don't care. All I worry about is if my house will disappear in a hurricane. But for the water going up. I don't care about it. I am not going to live that long." Other readers had a mix of emotions. One explained, "I guess it is a concern for children and the next generation. I don't see that it is a concern as far as me being affected directly. But I mean you can't think like that, you have to think about the future of the earth. I can say it concerns me in that sense."

Does sea level rise concern you?		
Yes	24	60%
Somewhat or a little	5	12 %
No	7	17 %
Unclear	4	10 %
Total	40	99 %

Table 2-7. Participant answers to the question "Does sea-level rise concern you?"

Fear. One of the most common attitudes that readers expressed about sea-level rise was concern and fear. In some cases, readers associated fear specifically with and loss of property or land due to storm events, but in other cases, readers associated fear with anticipated economic impacts on individuals or the community. Many expressed fear upon learning new or more detailed information with implications for the future. One reader said, "I was surprised that there was that [much land] under 4 ft. It scares me that that much can be affected – that much low lying land." Another reader said, "This says the North Carolina

coastline and that makes it more of a threat to me. This could happen to me, so it is not one of those flyers that has nothing to do with me. They are talking about my neighborhood. I should read it."

Discomfort with uncertainty. Readers expressed a discomfort with the scientific uncertainty expressed in the document about possible future sea levels and their impacts on local communities. Some readers thought that new science and technology ought to be able to eliminate uncertainty. One participant said, "But if changes in sea level is a problem and difficult to predict, where did the figures come from? It should be easier to project with technology." Other readers did not think it was appropriate to express scientific uncertainty in an informational document and said, "Don't tell me you don't know. That's why I'm reading this."

Skepticism. Many readers expressed skepticism about some aspect of the information or the sources of information in the document. A typical comment that reflects a misunderstanding of how past sea levels are reconstructed was "They're guestimating… Nobody has records back from 3500 years." Other comments from readers that were not specific to this document, but in response to scientific material in general, demonstrated skepticism about science. One reader said, "I wonder who these scientists are. I don't give a lot of credit to it." Another said, "A lot of times you feel like people are making stuff up."

Fatalism. A common reaction that readers had to the information about sea-level rise was fatalism. Many readers felt that nothing can be done about the problems posed by sea-level rise. One reader said, "Talk about fixing this and fixing that… It is not possible… The damage has already been done." Other participants cast the impacts within their personal worldview, informed by their faith. One responded that "Whatever happens, it is God's plan. Nothing man does or think they can do. God's plan will not be thwarted."

Agency. Among the readers who discussed government and community responses to the future impacts of sea-level rise, diverse opinions exist about who should be responsible for dealing with the impact and these decisions might impact personal property rights. One participant said, "…I don't think we want to take away anyone's right to be able to build, or do with their property what they want to… On

the other hand, I question putting public money into anything on the water." Another reader said, "It is good that there is action to be taking. I like to know that there is action going on, planning for it." In fact, when the study team member asked if communities should be planning for sea-level rise, almost all the readers responded that they should plan. One said, "Prepare, no, plan yes."

Discussion

Communicating about risks, especially those that are unfamiliar, non-voluntary, scientifically complex and politically controversial, may be one of the most difficult tasks faced by scientists, managers and policy-makers dealing with adaptation to climate change and sea-level rise. While a majority of participants in the study had some previous exposure to information about sea-level rise, scientific understanding and an awareness of response options are lacking. These results are consistent with studies of the public understanding or self-reported knowledge of climate change in the United States (Leiserowitz et al., 2010; McCright, 2010; Moser, 2010; Weber & Stern, 2011). Sea-level rise shares with climate change many of the psychological reasons for misunderstanding: complex scientific causes, potential for misconception due to misleading personal experiences and worldviews, and conflicting information coming from a variety of media (Weber & Stern, 2011). When researchers introduced new information about sea-level rise to people in this study, many responded with discomfort, skepticism and fatalism. To overcome these problems in science communication, communicators, need to move toward a problem solving approach, rather than an information providing approach (Kim, 2012). Approaching sea-level rise as a challenge in which people can explore many options and decisions rather than a group of scientific facts people must understand may help overcome the attitudes of fear and fatalism.

In designing communications products, communicators need to be aware that many aspects of validity recognized by the scientific community are not equally valid to many public audiences. Items such as lists of references to peer-reviewed scientific literature, emphasis on methodology and measurement, and historical records are signals to scientists are unrecognized by most readers. What the public counts as valid is more likely to depend on their personal experiences, framed by their worldview

(Hulme, 2009; Moser, 2010; Weber & Stern, 2011). Non-scientists do not easily understand graphs, illustrations and maps designed for scientists. Graph literacy varies among people with high and low numerical skills, but it seems clear that significant portion of the population in the United States do not understand even simple graphs (Galesic & Garcia-Retamero, 2011). Maps are more familiar to most readers, but may also require some advanced skills if conveying complex information. Of all the graphics used, photographs, especially those depicting familiar images and experiences, seemed to resonate most strongly with readers (Kain and Covi, 2013).

In our study, readers understood basic concepts conveyed by the text and images, such as the idea that sea-level rise can affect where flooding occurs during storms. Readers also understood well-illustrated terminology and vividly descriptive terms like "living shorelines." They had difficulty distinguishing between similar terms, such as "protect" and "accommodate" on the document post-test (Table 2-5), but paid the most attention to this section in both documents (Table 2-4) indicating interest, but not complete understanding. Unfamiliar words caused confusion and frustration. For example, sea-level rise was associated with flooding by study participants, yet inundation, a word that a majority of readers did not understand, is conceptually different from the temporary flooding that is regularly experienced by residents of the study areas. Whether the distinction between flooding and inundation is important to communicate depends on the goal of the risk communication: increasing basic understanding or engaging with the issue and problem solving. One study (Harvatt, Petts, & Chilvers, 2011), which compared flooding and sea-level rise risk communication, suggested linking sea-level rise risk to flood risk in order to make it more tangible, which may indicate that this distinction is not important.

Participants in our study were concerned about sea –level rise, but not particularly concerned about their personal risk, which is consistent with other studies of sea-level rise and climate change in the area (Barber et al., 2008; Brown et al., 2008; Miller, 2010) and in the United States (Leiserowitz et al., 2011; Weber, 2006). People expressed a lack of concern for temporal reasons, spatial reasons, or because of competition with other risks or issues. While most people acknowledged some awareness of sea-level rise, only a few readers demonstrated knowledge of its causes and consequences. Sea-level rise itself is a

phenomenon typically without a personal direct experience, even by those who live on the coast. Because personal experiences and direct knowledge are much more likely to produce action than information provided secondhand (Whitmarsh, 2008), even those who understand the risk of sea-level rise might not act to reduce their risk.

The prevalence of comments indicating fatalism, skepticism, and a lack of concern or action to reduce sea-level rise risk in eastern North Carolina may be due to the "hidden" nature of the hazard. According to the social amplification of risk framework, some risks in our society are attenuated by their nature as "globally elusive" and ideologically hidden in a web of values and assumptions (Kasperson et al., 2003). Sea-level rise, like climate change, is globally elusive in that the causes are diffuse and out of individual control and no particular individual or group is entirely at fault or blameless. The risk can pass unnoticed, ignored in favor of ideologically enshrined private property rights that protect vulnerable, but highly desirable places like ocean-front property. Residents may have difficulty framing sea-level rise because of undetermined issues of agency and questions about responsibility for addressing inundation of land, salinization of water supplies, and more generalized ecological change. The prevalence of fatalistic attitudes may indicate the concern that residents have about their ability to continue to use and improve these threatened places.

Since climate change and sea-level rise are considered politically controversial topics, scientists have been advised to avoid an advocacy role (Fischhoff, 2007), so many of their communications about sea-level rise have emphasized underlying causes and geologic history of sea level. Readers in this study were more interested in solutions and personal or local action than the basic scientific information. Perhaps the role of the sea-level rise risk communicator would align closely with that of the scientific communicator as described in Kim (2012), that of engagement, education and collective problem solving.

Affect is a powerful force in forming opinions about new information and ultimately guiding decisions about action (Slovic, Finucane, Peters, & MacGregor, 2007) , so communicators need to carefully choose text and images that are engaging, yet credible, and that do not inspire dread. The experience of fear may cause denial, avoidance of the issue, or an inability to act, rather than the urgency

that communicators want to convey (Moser, 2007; Moser & Dilling, 2007). Overcoming fatalism and moving communities toward adaptation may be one of the most important challenges in sea-level rise communication.

Conclusion

Adapting to sea-level rise in North Carolina communities requires local capacity building that must involve a variety of stakeholders including local decision makers and the public. To inform and engage these diverse interests, effective communication about sea-level rise and adaptation is essential. This study demonstrates that the development of effective sea-level rise communication requires understanding the local knowledge, attitudes, and beliefs. Although most of the residents who participated in the study expressed some familiarity and concern about the threat of sea-level rise, many did not understand the scientific information presented in the document and did not feel at risk. To better convey sea-level rise risk, communications must use appropriate framing, compelling visual images, and accessible language for scientific information. Sea-level rise risk is a complex topic and the risk is difficult to communicate; but by employing a user-empathetic approach, that takes into account prevailing risk perceptions and diverse viewpoints, communicators can effectively promote a better understanding. Indeed, to move North Carolina coastal communities toward sea-level rise resilience, effective risk communication is necessary.

Sea-level rise risk communication is a small, but growing area of interest for coastal municipalities, state and federal governments across the US and beyond. Scholars of climate change communication have called for more studies of communication processes to better define the field (Moser, 2010). Risk communicators working in areas of health, hazards, and technological threats have techniques that can inform sea-level rise communications practice, while science communications experts can provide insight into best practices to illustrate scientific concepts. Risk communications is a key function that links every part of the risk reduction and risk management process. As more municipalities, states and regions grapple with a response to the growing risk of sea-level rise and its impacts, effectively

communicating the seriousness and urgency of the threat to the public and decision-makers is critical to building coastal resilience.

CHAPTER 3: SEA-LEVEL RISE RISK IN THE COASTAL HAZARDSCAPE: FATALISM, DENIAL AND BARRIERS TO POLICY

Chapter Summary

Despite the threat to the ecology and human settlements of the coastal region posed by climate change-accelerated sea-level rise, many of the most vulnerable areas are not actively confronting the risk. This study examines social factors that produce sea-level rise risk, in particular, the ways that social, economic and cultural factors that underlie vulnerability can be reinforced and even exacerbated by discourses of fatalism, fear and mistrust. Hazards research has explored the social production of vulnerability, and how social inequities and other root causes lead to unsafe conditions that combine with hazards to produce disasters. The hazardscape concept of Mustafa (2005) integrates the biophysical and social vulnerabilities associated with a natural hazard with the perceptual and discursive influence on human behavior to create a more complete description of the production of a risk. The case study includes interviews with residents and civic leaders in three small rural towns in northeastern North Carolina, collected in between 2010- 2012, participant observation at public meetings and the analysis of texts pertaining to sea-level rise policy in the region during the same time period. The study results describe the role of fatalism in the amplifications of sea-level rise risk. The feelings of powerlessness and inevitability conveyed by residents of the towns was associated with a lack of risk communication, a lack of resources to adapt to changing conditions and a culture of mistrust of science and coastal management. Fatalistic discourses help to legitimize municipal inaction and place sole responsibility for risk reduction with the individual. A better understanding of the relationship between discourse, perception and the social production of risk can inform the development of risk communications and other risk reductions efforts that can contribute to more resilient coastal communities.

Introduction

The human and ecological systems of low-lying coastal areas are constantly shaped by natural hazards such as coastal storms, shoreline erosion and flooding (Day, Gunn, Folan, Yáñez-Arancibia, & Horton, 2007). Climate change, sea-level rise and increased populations in coastal regions coalesce to elevate human risk (IPCC, 2013; Neumann, Hudgens, Herter, & Martinich, 2010; Nicholls & Cazenave, 2010). Sea-level rise is one among a suite of hazards that intersect with global climate change to exacerbate existing threats to natural and built environments. Associated flooding can cause changes to water bodies, shorelines, wetlands, and landward ecosystems. Although some governments around the world now recognize and attempt to address the impacts of sea-level rise through adaptation planning and sea-level rise risk reduction, others have not seriously considered such strategies (Poulter et al., 2009). This article presents the findings of a field study conducted in coastal North Carolina to understand the social production of sea-level rise risk, and factors that pose barriers to the reduction of the risk. These include economic inequity, fatalism, fear, avoidance, and repression.

When considering risk reduction, vulnerability is often defined as the susceptibility of hazard victims to suffer loss, injury or death and considers their resilience, or ability to rebound (Wisner et al., 2012). Here risk is understood as the outcome of the interaction between natural hazards, such as storms, flood or sea-level rise, the physical exposure of people to the hazards, and their vulnerability, which is closely tied to the underlying characteristics of the environment and society that makes damages and loss more likely (Ciurean, Schröter, & Glade, 2013). Vulnerability and resilience are largely shaped by social and economic factors, such as race and class, wealth, elderly status, Hispanic ethnicity, medically fragile and employment in service industries (Cutter et al., 2008; Dow, 1992). The factors influencing vulnerability become more complex as the focus shifts from single hazards to multiple, spatially and temporally dynamic hazards, such as those associated with global climate change and sea-level rise. Critical hazards geographers have increasingly described risk and vulnerability in terms of the joint social and ecological context of disasters. The social distribution of these risks has been explained as a result of

poverty, marginalization, hegemonic distributions of power, and modern governance systems (Collins, 2010; Martinich, Neumann, Ludwig, & Jantarasami, 2012; Mustafa, 2005; Pelling, 1999).

The framing of disasters or long-term hazards such as sea-level rise as "acts of nature" perpetuates existing social, economic and political inequities (Mascarenhas & Wisner, 2012; Wisner et al., 2004). The role of the public understanding and discourse in the social production of sea-level rise risk, however, has been largely unexamined thus far (Moser, 2009). Unequal distribution of power shapes vulnerability by controlling access to resources, capacities for resilience, and the public discourse surrounding the management of risk, a perspective familiar to political ecologists (Robbins, 2004). In fact, sea-level rise is a complex and uncertain biophysical hazard in which vulnerability depends on material factors such as geologic forces and social vulnerability (Cutter, Emrich, Webb, & Morath, 2009; Nicholls, 2004; Titus et al., 2009). The framing of scientific information about uncertain and unfamiliar risks such as sea-level rise has an important influence on risk perception. Public discourses that undermine trust in scientific information and generate fear of policies to address risks create significant barriers to the development of adaptation strategies and contribute to sea-level rise risk.

To fully understand how risk perception, framing of information, and public discourse interact in the amplification of sea-level rise risk, it is useful to place these within the coastal hazardscape. A hazardscape, as conceptualized by Mustafa (2005), uses the landscape idea in geography to go beyond the materialist aspects of biophysical and social vulnerability to include the discourses that construct the human experience of a hazard. Taking a different approach than Corson (1999) and Cutter, Mitchell and Scott (2000), who described the hazardscape as the suite of hazards associated with a particular geographic region, Mustafa's hazardscape idea takes into account how the expert or technocratic discourse about risk may interact with local discourses to shape risk perception within groups. Within the hazardscape, political conflicts can emerge about the way in which risk are represented and managed. Risk management decisions are made within the context of the predominant and minority discourses expressed in the public forum (Collins, 2009). These discourses reflect and shape divergent attitudes

toward the hazard. The resulting political conflict is often a proxy for underlying and on-going struggles for social justice or a voice in decision-making (Bidwell, 2009).

This study examines how popular discourses contribute to risk perceptions that create barriers to the development of risk reduction policies. It finds that fatalistic risk perceptions that develop as a response to a lack of information about the issue or a lack of resources to adapt to sea-level rise interact with discourses that undermine trust in science and foment a fear of adaptation policies to cause barriers to action. First, I briefly review how sea-level rise risk relates to theory in the areas of hazards geography and political ecology and how the coastal hazardscape is influenced by risk perceptions and shaped by public discourse. Next, I describe the case setting of North Carolina and the factors contributing to sea-level rise risk including its biophysical, social and discursive characteristics. Following a description of the methodology employed in the study, I present the results of interviews of residents and leaders in the region and the analysis of pertinent documents. The following discussion will center on how discourses that undermine trust in science and generate fear of new policies and regulation have promoted fatalistic risk perceptions. Ultimately, fatalism, a sense of powerlessness that inhibits action, paired with a lack of resources to reduce risk and a lack of risk communication, create a situation that paralyzes planning and contributes to the risk.

Hazards to Hazardscape

Hazards research, as pursued by geographers in the 20th century, has evolved from an emphasis on discovering the geophysical processes that create dangerous environmental conditions to a multidisplinary approach that integrates natural and social sciences in recognition that risk is produced not only by the biophysical hazard, but also by the economic, cultural and social conditions that lead to vulnerability (Montz & Tobin, 2011). In addition, hazards researchers have become more pragmatic, placing research within the realm of democratic decision-making, public participation in policy formation and examining how public discourse shapes risk (Collins, 2009; Wescoat, 1992). Scholars examining risk, especially in developing counties, found that social and political forces, rather than biophysical

conditions of the hazard, were factors most responsible for risk amplification (Macdonald et al., 2012). Researchers developed the "pressure and release" model to explore the social production of vulnerability and how root causes lead to unsafe conditions that combine with hazards to produce disasters (Wisner et al., 2012). To reduce disaster risk and release the pressure caused by the combined hazards and vulnerability forces, people must address root causes including ideologies and the distribution of power and resources. Sea-level rise is a long-term, gradual hazard, which can slowly affect an area directly through shoreline erosion and inundation, but also can exacerbate the impact of severe storms, a rapid-onset hazard. In evaluating the social production of sea-level rise risk, we must consider the social, economic and cultural systems of the people in areas susceptible to inundation, exacerbated flooding or storm events.

Sea-level rise risk affects people that live in low-lying areas in close proximity to marine or estuarine waters. Drawing on theoretical perspectives central to political ecology, many of the poor of the world are marginalized, living in places susceptible to hazardous conditions, and with livelihoods that are vulnerable to losses from which they may not be able to recover (Robbins, 2004). Conversely, in areas of economic wealth, environmental hazards can co-occur with amenities. These are desired place-based attributes, such as natural views, privacy, or access to a valued resource. Collins (2008) uses the term "facilitation" to describe the situation in relatively wealthy societies where powerful groups can minimize their vulnerability to risks through social institutions. This allows the use of otherwise hazardous areas, such as ocean fronts. Institutionalized protections such as private and public insurance, credit systems and government disaster relief policies transfer risks from individuals to the society at large. Marginalized people may not have practical access to these risk reduction opportunities because they cannot buy-in to costly protections or have difficulty navigating complex government processes. Without more equitable risk reduction programs, and without more equitable public participation in the development of risk reduction policies, the resulting distribution of risk is likely to be socially unequal (Mascarenhas & Wisner, 2012). Powerful groups, which can externalize their own risks while appropriating environmental rewards, often choose to legitimize the disparity of risk through the generation of politically strategic

strategic discourses. Coastal landscapes susceptible to sea-level rise risk are characteristic of places where this marginalization/facilitation frame is particularly useful in understanding how discourses are used to erect socially-embedded barriers to risk reduction.

In order to gain a more complete understanding of the risk associated with sea-level rise, it is important to understand both risk perceptions and how people interact with their local landscape. The idea of a "hazardscape," as conceptualized by Mustafa (2005) ,is inspired by the landscape idea in cultural geography. It integrates both the expert assessment of risk with its "lived reality." Included within the scope of a hazardscape are the characteristics of the hazards, the physical susceptibility of place, and the vulnerability of people, with an emphasis on the socio-environmental system (Khan & Crozier, 2009). Using a hazardscape lens allows a focus on the relationships between the material realities of risk, including both biophysical and social vulnerability, with the perception and discursive formations of risk. Hazardscapes allow the consideration of how social and economic power can influence the attitudes that people hold about risk, and therefore are critical in understanding the social production of risk. While few studies have applied the hazardscape lens to climate change, sea-level rise or other slow-onset hazards, an examination of policy and popular discourses is particularly useful because it can reveal how underlying social conditions affect climate change vulnerability and resilience (Adger, Barnett, Brown, Marshall, & O'Brien, 2012). Examining the discourses of government managers, civic groups, elected officials and residents helps us to more fully understand the processes by which sea-level rise risk is socially produced, and how barriers to action are erected and legitimized through these discourses.

Predominant discourses of sea-level rise track those surrounding climate change over the past thirty years. Scientific discourses, led by academic and government scientists, are concerned with the physical science basis of global climate change, the causes and impacts of change, and with mitigation or adaptation strategies (Adger, Benjaminsen, Brown, & Svarstad, 2001). Scientific discourses may take a managerial or technocratic approach towards climate change vulnerability and adaptation, primarily qualifying impacts and presenting engineering approaches to adaptation (Fussel, 2007; National Oceanic and Atmospheric Administration, 2010). Media and political discourses may interface with scientific

discourses, but often correspond more clearly with popular discourse, and with one another. While scientific findings generate news stories, research has found that media does not convey the science of climate change accurately and tends toward sensationalism (Hulme, 2008; Weingart, Engels, & Pansegrau, 2000). In the U.S., a particularly politicized discourse began to predominate in the media in the 1990, resulting in a bias that contributes significantly to a polarization of public opinion (Boykoff & Boykoff, 2007). The media discourse has been blamed for public risk perception that climate change is disputed and its impacts are distant and uncertain (Antilla, 2010; Doulton & Brown, 2009). Predominant political discourses have increasingly conformed to two opposing poles, one endorsing the scientific consensus and expressing concern for the future, and the other denying the science and seeking to prevent policy actions that might inhibit the accumulation of short term profits in the private sector (Guber, 2013; McCright & Dunlap, 2010; McCright & Dunlap, 2011a). These political discourses have shaped climate change risk perception and attitudes amongst public audiences, which in turn shape electoral opinions about whether a particular policy response is needed (Leiserowitz, 2006; McCright & Dunlap, 2010; Moser, 2009). Following this pattern, sea-level rise discourses in North Carolina have followed many of the trends observed in such national and international climate change discourses.

In the case study presented here, the discourse of fatalism plays a dominant role in exacerbating sea-level rise risk. Attitudes of fatalism develop through the lack of risk communication, lack of resources to prepare for sea-level rise, and mistrust of science or coastal management to provide accurate information and reasonable responses. Fatalistic perceptions often result when individuals recognize a risk and feel they have insufficient resources to lessen their vulnerability to the hazard (Harries, 2013). Feelings of personal powerlessness and the inevitability of future suffering increase in the absence of risk communication that is trustworthy and salient to the immediate location and circumstances, and that offers reasonable possibilities for personal or collective action (Renn & Levine, 1990). Mere awareness of a risk is not sufficient to stimulate risk reduction behavior. To build the capacity for response, people need access to financial and practical resources (Bubeck et al., 2012). Fatalism may also arise when scientific and managerial hurdles to preparing for sea-level rise are accompanied by political struggles to

suppress the use of scientific findings and foster inaction, such as through prohibitive local government proclamations and legislation. Moser (2010) described this political struggle as one in which "information and knowledge become strategic goods and tools" used by two sides that hold different beliefs. The conflict over the use of knowledge and information is not an expert versus local knowledge conflict. Rather, misconceptions and disengagement with the source of risk, along with a lack of direct experience, guide the debate. Since public views and values heavily influence risk perception and trust in information about risks, fatalism about sea-level rise risk can arise as a result of the political conflict over trust in sea-level rise science (Slovic, 1999; Slovic, 1993). As this study demonstrates, a discourse analysis framework can therefore support a more cogent analysis of the undergirding social development of risk, tracing the roles of fatalism and associated barriers to adaptation policy.

The Coastal Hazardscape of North Carolina: Socio-ecological and Legal Frames

Among U.S. states, North Carolina has the third greatest extent of land vulnerable to sea-level rise and the eighth largest population at risk (Strauss et al., 2012). The northeastern region of the state has a higher relative sea-level rise due to greater land subsidence and post-glacial rebound, with rise rates measured at up to 4.27 mm per year (Zervas, 2004) and expected to accelerate (Sallenger, Doran & Howd, 2012). In this region, much of the edge area between land and water at the coast is low-relief estuarine shoreline, fringed by coastal wetlands (Currin, Chappell, & Deaton, 2010) and susceptible to inundation (Figure 3-1). Erosion rates vary widely, but the shoreline has moved as much as 8.8 meters landward per year (Cowart, Walsh, & Corbett, 2010). Landowners often act to protect estuarine shorelines adjacent to residential or commercial structures by building hard vertical structures, though these actions often generate loss of nearby wetland vegetation and sediment. Shoreline erosion and the reduction of wetlands results in the loss of ecosystem services such as storm protection, waste water treatment and habitat for fisheries (Craft et al., 2009).

The economic driving forces in eastern North Carolina include the defense industry and the natural resource dependent sectors of agriculture, forestry, fishing and tourism. In several regions where

fishing and marine industries were critical economic drivers, activity has shifted to tourism and retiree development (Boucquey et al., 2010). The coastal North Carolina population is growing, but most of the growth is occurring in the more economically diversified southern counties, while some northeastern counties have declining populations. The negative economic impacts due to sea-level rise, just the loss of land due to inundation and greater impacts of storms, were estimated to exceed $6.9 billion by 2080 for four coastal counties in North Carolina (Bin et al., 2007). Other economic impacts include loss of public trust lands, access to recreational areas, potential salinization of water supplies and ecological impacts. The social impacts of sea-level rise will be wide-ranging, from changes in the sense of place to the loss of

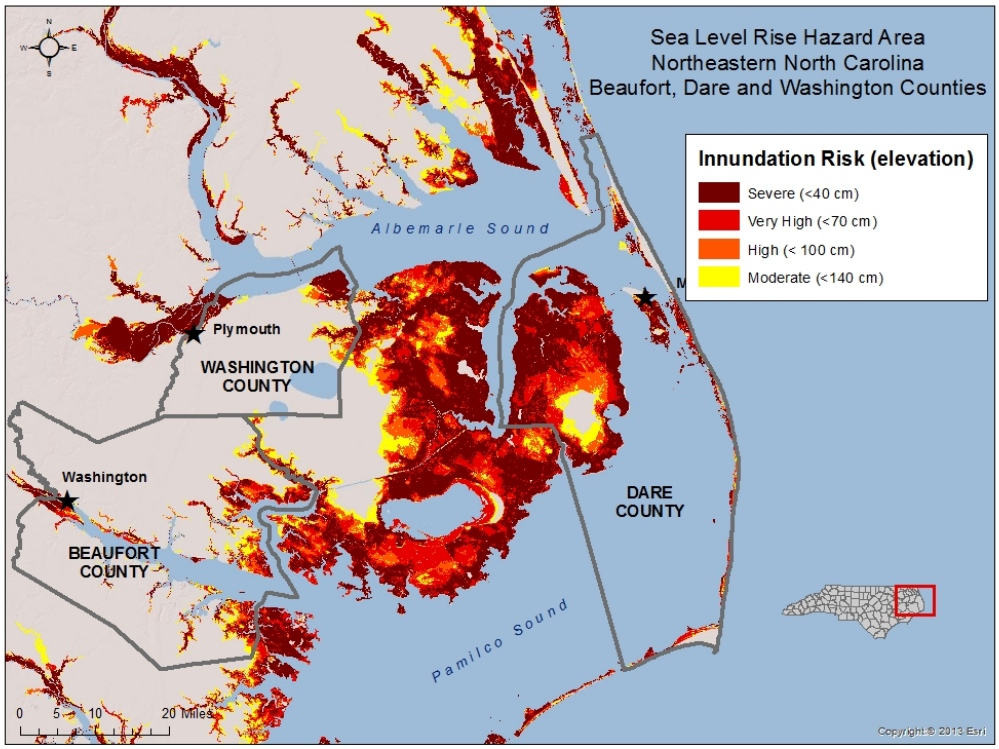

Figure 3-1. Sea-Level rise hazard area in northeastern North Carolina

entire communities, including their built environments and other artifacts of historical-material culture (Anthony et al., 2009). Due to interwoven economic networks and migration streams, social and economic impacts of sea-level rise are likely to extend far beyond those communities most likely to be

physically inundated (Curtis & Schneider, 2011). Development and prosperity have uneven patterns of distribution in the North Carolina coastal region (Crawford, 2007; Crawford, Bradley, & Marcucci, 2011). Eight of the counties in the northern region are among the most economically distressed in the state, while many of the counties with beach tourism are the most prosperous (North Carolina Department of Commerce, 2012). People pay substantial premiums to own property at the beach, despite the flood risk (Bin et al., 2008). However, economically disadvantaged residents in areas susceptible to sea-level rise are likely to be disproportionally affected, and are also unlikely to receive shoreline protection because their property is less valuable (Martinich et al., 2012).

The development of a statewide policy to encourage municipalities to plan for sea-level rise in North Carolina stalled in 2012 due to action by the state legislature (see Figure 3-2). The state Division of Coastal Management (NCDCM) and its appointed policy board, the Coastal Resources Commission (CRC), have established regulations that affect development along ocean and estuarine shorelines, although none explicitly discuss sea-level rise. However, the CRC addresses sea-level rise indirectly by regulating shoreline erosion through setbacks. The CRC established ocean setbacks in 1979 based on the size of the structure and the long-term average erosion rates (North Carolina General Statues, 2009). Estuarine shoreline setbacks, established in 2000, are 30 feet landward of normal water level (North Carolina General Statues, 2007). Ocean and estuarine shoreline setbacks provide some protection for property by requiring buffers, but are based on either historic or existing shoreline contours, and do not anticipate shoreline change. The renewal of the Coastal Zone Management Act (CAMA) in 1990 included guidelines for land use plans to consider sea-level rise, and many of the municipal land use plans that were updated after 1990 include some mention of sea-level rise, but this inclusion did not lead to adaptation planning.

Interest in sea-level rise risk rose among the federal and state government coastal management community starting around 2005 with the distribution of several research studies in North Carolina, and increasing national interest (Poulter et al., 2009). The CRC identified sea-level rise as a priority in 2009 and tasked their advisory science panel, a group of North Carolina coastal scientists and engineers, to

study the topic and determine a rate for planning purposes. In March 2010, the CRC science panel released a report reviewing the scientific literature and recommending that an anticipated rise of 1 meter could be used for planning. In February 2011, a draft policy was released by the CRC reflecting the

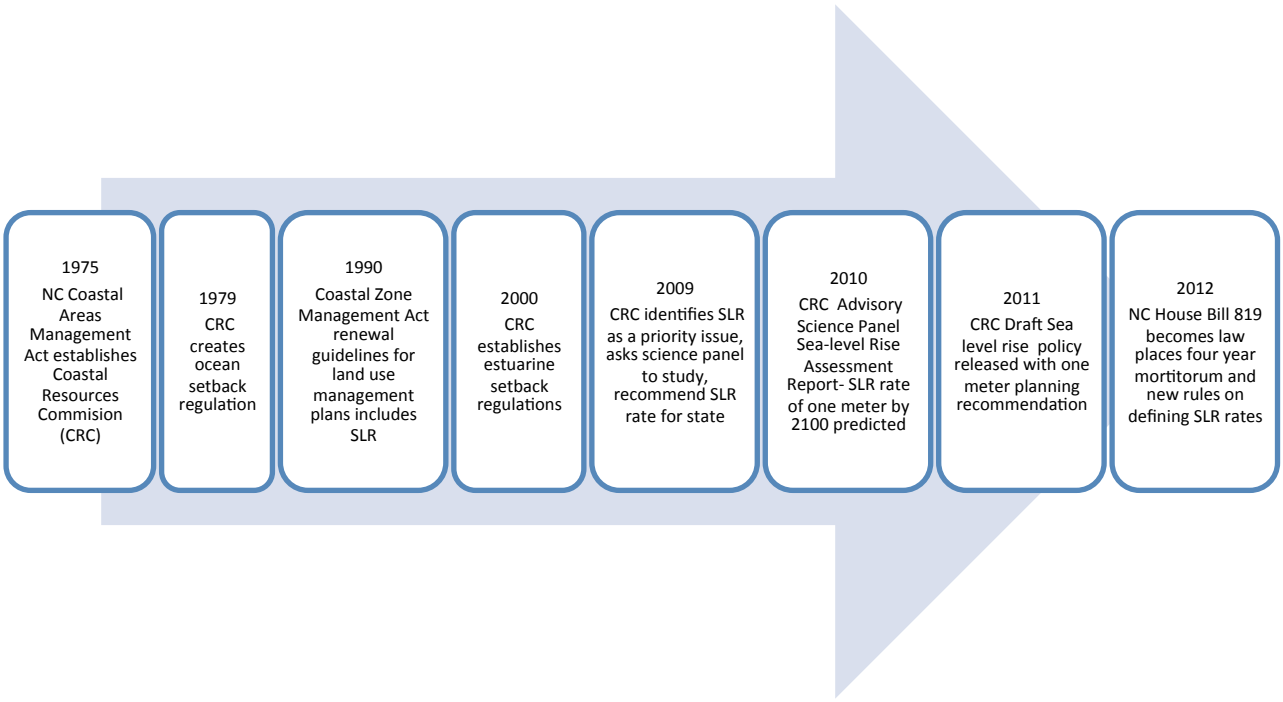

Figure 3-2. North Carolina legislature sea-level rise timeline

results of the science panel. Shortly, however, the draft policy caught the attention of NC-20, a group formed by several politically-active real estate developers, one that solicits participation from elected officials and municipal staff in their events. To defend their interests, NC-20 targeted the CRC science panel report with press statements, lobbied elected officials, and sponsored a symposium in October of 2011 featuring several speakers skeptical of climate change and sea-level rise acceleration. In 2012, NC-20 engaged the North Carolina state legislature in their efforts to suppress sea-level rise science, which resulted in the successful passage of a law imposing a two-year moratorium on determination of sea-level rise rates, and with new rules specifying how sea-level rise rates may be determined and applied (North Carolina Session Law, 2012). An earlier draft of the bill prohibited the use of scientific models to

estimate future sea-level change, thereby drawing attention from the national news media for the repression of responsible use of publicly available scientific information.

Case Study Sites

Within coastal North Carolina, the northeastern region is most susceptible to sea-level rise inundation and associated biophysical impacts and is also the most socially vulnerable (Figure 3-3). The present case study focuses on three locations that represent three distinct types in the region, each facing a similar sea-level rise hazard, but with different demographic and social characteristics (Table 3-1).

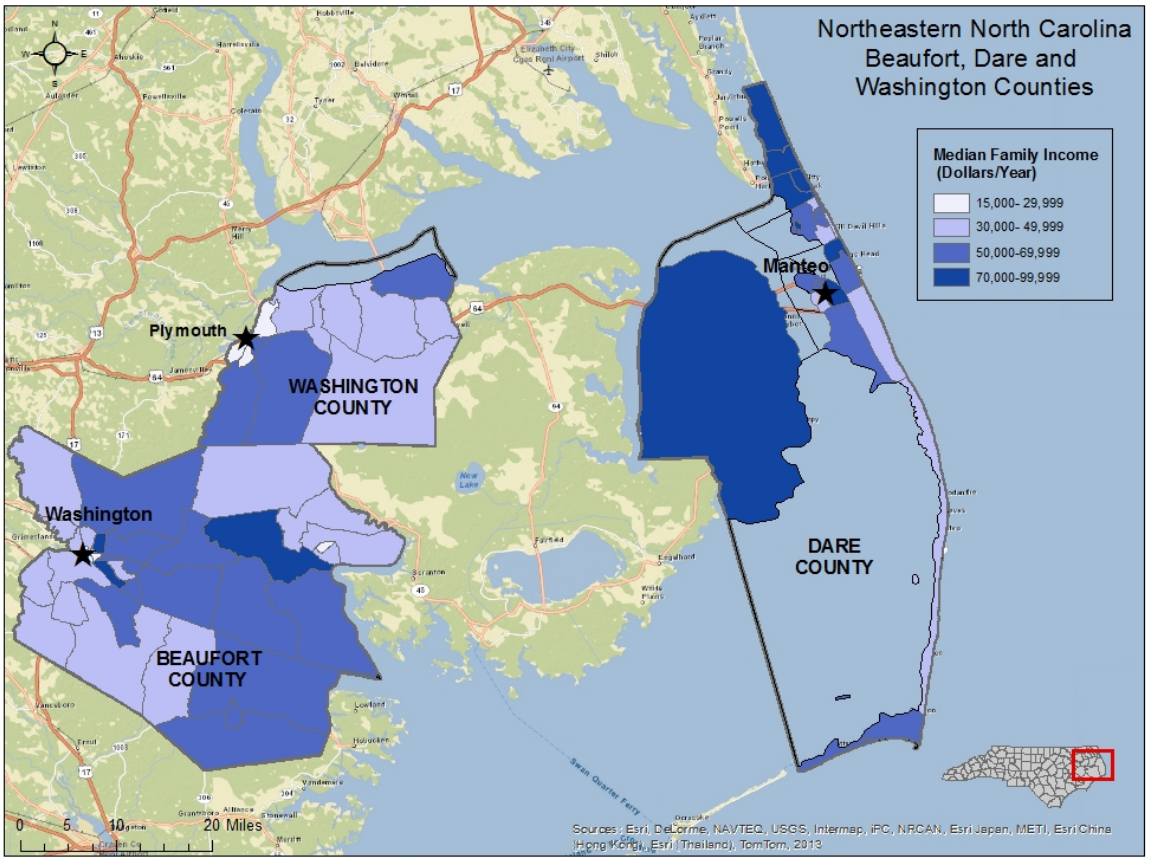

Figure 3-3. Distribution of income by block group in Beaufort, Washington and Dare County

Dare County encompasses most of the northern portion of the North Carolina Outer Banks. It includes 110 miles oceanfront on barrier islands, and extensive estuarine shoreline on barrier islands,

islands within the sounds (Roanoke Island being the largest), and the mainland. In this way, it includes several shoreline types that are also characteristic of other beachfront counties in North Carolina. The county is highly dependent on tourism, with a permanent population of less than 34,000, but a large seasonal population that swells to over 225,000 in June through August. Over 94% of the population is white, and the median household income and percent of population with high school and higher education exceeds the average for the state (Table 3-1). While Dare County has experienced a boom in tourism and economic development in the last two decades, nearby Beaufort and Washington counties have suffered from the decline of manufacturing jobs, placing these two counties among the poorest 40 of 100 counties in North Carolina in 2011 (North Carolina Department of Commerce, 2012).

Demographics	Washington Co.	Beaufort Co.	Dare Co.	North Carolina
Population	13,221	47,770	33,920	9,535,471
% white	48.2	71.5	94.2	72.1
% black	49.6	25.9	2.9	22
% Latino	3.8	7	6.6	8.6
% over 65	18.9	19.1	15.8	13.2
person/sq. mile	38	57.7	88.5	196.1
Socioeconomics				
median household income	$34,219	$40,986	$54,750	$46,291
% population in poverty	25.2	19.1	11.1	16.1
% education (high school+)	78	81.7	92	84.1
Housing				
housing units	6,498	24,881	33,639	4,362,740
median value of owner-occupied housing	$94,800	$113,600	$321,200	$152,700
% seasonal homes*2000		9 (Beau LUP)	56 (Dare LUP)	3.1

Table 3-1. 2010 Census data and Land Use Plan (LUP) data for the three case counties

Beaufort County has similar population size to Dare, but is an estuarine coastal county, with no oceanfront development. Beaufort County is typical of the estuarine counties that have had some success promoting their coastal amenities and have attracted waterfront development along the river and sound shorelines. One of their strategies has been to associate with the beach counties, known as the "Outer Banks," branding themselves as the "Inner Banks." Some areas in Beaufort County also serve as bedroom

communities for nearby Greenville in Pitt County, which has an expanding economic base. Beaufort County average incomes, value of housing, and education rates are all below state averages (Table 3-1).

The third location, Washington County, is the poorest of the three counties, with a small and declining population due to the loss of forestry and associated jobs in recent decades (these losses being primarily associated with the loss of a single principal employer). Median income is 38% lower than in Dare County, and the contrast in value of housing is even greater, with median value of housing in Dare more than three times that in Washington (Table 3-1). In these ways, Washington County is typical of North Carolina coastal counties with low socioeconomic status. Notably, each of these three counties studied has a county seat, which is their largest municipality, located on estuarine waterfront that is susceptible to flooding during storms.

Methods

To accurately describe the perceptions of people living and working at coastal locations vulnerable to sea-level rise, and to better understand the ways in which public discourses influence how people respond to risk, multiple methods of data collection and analysis were employed. Qualitative methods, while not providing a statistically random sample, provide detailed information about how participants use information and public discourse to shape their perceptions, and why corresponding social barriers arise to the taking of actions that might otherwise reduce risk. Data used in the analysis includes participant observation, civic leader interviews, resident interviews using a document-based protocol and review of archival documents. I conducted over 50 hours of participant observation between 2010 and 2012, both at the state capitol and in coastal locations. Observation focused principally on meetings designed to engage elected officials and municipal managers from coastal areas. These included workshops led by the North Carolina Department of Environment and Natural Resources focusing on sea-level rise and climate change in January and March 2010, and a meeting of an organization opposed to sea-level rise policy development in October 2011. I observed Coastal Resources Commission (CRC) meetings in 2011 and 2012. Throughout these meetings , I took field notes and wrote field memos as first-

order data analyses, later integrating these into coding and theme-building stages of second-order data analysis. Using a grounded theory approach, I subsequently incorporated these into the iterative development of interpretive-theoretical frameworks, combined with other sources of primary and secondary data, as described below.

To expand this iterated process of textual analysis, I also used public comments from an open hearing on the sea-level rise draft policy proposed by the CRC and minutes of CRC meetings in which sea-level rise policy was discussed. Other incorporated documents included county and city land use plans, minutes of meetings of the Coastal Resources Commission, and news media and electronic publications pertaining to sea-level rise policy in North Carolina. I collected and examined comprehensive land use plans associated with the counties and towns represented by interview participants. To determine whether these plans were representative of those of other coastal municipalities, I assessed a total of 47 plans and updates, approved or under review by the North Carolina Division of Coastal Management. I determined that the plans were remarkably similar, partly because many of the municipalities contracted the same consulting firms to write their plans. In addition, I collected media reports, electronic publications and reviewed websites reporting on the status of sea-level rise policy in North Carolina. I reviewed these various materials repeatedly throughout the process of textual analysis and theory-development.

This study also relies significantly on a total of 68 interviews. A research team conducted 28 in-depth interviews with civic leaders from Dare, Beaufort and Washington Counties in 2010 and 2011 (Table 3-2). To obtain a diversity of opinions, the team used a purposive, nested snowball strategy. Civic leader participants were selected to be knowledgeable and representative of the community across socioeconomic, racial and geographical factors. Participants were defined as leaders because each was involved in decisions with their local municipality, either through their profession or a voluntary civic leadership role. Interview participants included elected officials (both town and county), municipal staff, natural resources managers, and civic, religious, nonprofit organization and business leaders. The research team developed a list of potential participants by starting with municipal members known to be relatively

knowledgeable about local planning topics, such as mayors and planning directors. Purposive sampling provided several additional interviews to fill explanatory gaps. We asked these leaders about the environmental issues that were important in their town, about sea-level rise and flooding as hazards, and about policy efforts to confront these risks within the community (see interview instruments in Appendix B).

Civic Leader Role	Number of Participants
Elected officials or former elected official	10
Municipal Managers or Planners	8
Natural Resources Managers	4
Natural Resource non-profit staff/board	4
Religious leader	1
Economic development leader	1
Total	28

Table 3-2. Civic leader roles of interview participants

In addition to the civic leader interviews, the research team conducted 40 resident interviews in Dare County and Beaufort County as part of a risk perception and communication study (see interview protocol and testing documents in Appendix B). Researchers recruited participants for the resident interviews by posting flyers in strategic public locations, such as coffee shops and post offices and interviews were conducted at libraries and community centers. The participant sample was demographically diverse and was representative of the populations of the two areas in which the testing was conducted (Table 3-3).

	2010 Census Dare Co.	Participants Dare Co.	2010 Census Beaufort Co.	Participants Beaufort Co.
Gender Female: Male	51: 49	55: 45	52: 48	65: 35
Age (18-29: 30-49: 50-64: 65+)	16: 35: 31: 6	30: 35: 30: 5	16: 30: 28: 18	15: 50: 30: 5
Ethnicity White: Black: Hispanic: other	92: 3: 6.5: 5.2	52: 26: 5: 16	68: 26: 5	65: 35
Education: High School graduates Bachelor's degree or higher	 98 32	 95 35	 84 19	 100 30

Table 3-3. Comparison of demographic features of the Town of Manteo and the City of Washington with resident interview participants. All numbers are percentages

Researchers used resident interviews to evaluate the level of public understanding of sea-level rise science and to identify responses to an informational document provided to them about sea-level rise. Participants' sea-level rise risk perceptions and attitudes that cause barriers to actions that might reduce risk were assessed. All interview participants shared personal experiences of living in the area, including that of socio-environmental change and flooding due to storms. A total of 53 hours of interviews with 40 resident and 28 leader participants were digitally recorded and subsequently transcribed. Transcripts were coded using an open coding technique in NVivo software for qualitative data management and analysis.

Following relatively standard grounded theory techniques, I read and re-read the transcripts, searching for re-occurring concepts and ideas to code. I then reviewed persistent coding patterns, grouped coded text passages into categories, and assembled these into discursive themes. Themes included perspectives on sea-level rise science and information, and flooding and vulnerability, as well as personal experiences related to sea-level rise, comments revealing barriers to action, and attitudes toward policies or regulations. I examined and compared transcripts to better understand the origins and causes for common and contrasting themes. Iterative rounds of coding and grouping enhanced my ability to trace the social contexts of particular comments and general themes, and the elicitation of predominant discourses. In turn, these insights informed and supported the development of theoretical-explanatory frameworks.

Fatalistic Discourses and the Social Production of Risk

This section examines how risk is exacerbated and transformed through discourses that raise barriers to adaptation policy and have inhibited action to develop resilience to sea-level rise. By applying the hazardscape lens to sea-level rise risk in North Carolina, we can uncover some of the underlying amplifiers of risk within discourses that promote fatalism. As noted above, demographic factors are highly unequal across the three counties. Dare County is the most wealthy, highly educated, majority white and with much higher average property values. Washington County is the poorest county, with the lowest education rates, a majority percentage of African-Americans, and the lowest property values (see Table 3-1). While a greater percentage of land in Dare County is at physical risk to flooding and potential

sea-level rise, fatalistic discourses and patterns of marginalization/facilitation increase the exposure of Washington County residents to risk, and decrease their access to protective resources for risk reduction. The following analysis demonstrates a lack of risk communication, lack of resources to address the risk, especially in poorer counties, and discourses of mistrust of science and coastal management. It shows that these social barriers co-occur to produce and reinforce fatalistic attitudes of risk perception, thereby averting development of sea-level rise adaptation policies.

Fatalism and the Lack of Risk Communication

The dearth of sea-level rise risk communication contributes to the production of risk in the coastal hazardscape of North Carolina. The goal of effective risk communication is to provide information about risk in a way that an audience can understand, and that addresses the misunderstandings, worldviews and emotions that frame risk perceptions, so that action to reduce risk can proceed (Covello & Sandman, 2001). Sea-level rise risk communication has been ineffective in North Carolina to date because messages have not reached people, leaving gaps in public understanding, and generalized apathy about the risk. Unlike many other coastal hazards, such as flooding and shoreline erosion, sea-level rise is not readily recognized by non-scientists. People often conflate the contribution of sea-level rise to resulting hazards such as higher storm surges with other factors associated with storm strength and tidal stage at landfall. This leads to lay uncertainty about the relative impact that sea-level rise has on people, property and ecological systems. In this study, most interviewed residents (68%) had heard about sea-level rise, but few were knowledgeable about it. Forty percent of the resident interviewees were familiar with the topic of sea-level rise, while 28% were somewhat familiar and 28% were not familiar. When we asked residents to read and reflect on an informational sea-level rise pamphlet, as part of the document-based risk communication interviews described above, many found the topic to be new. In the words of one interviewee,

> It is new information to me because I have never totally thought about the sea-level rise. I thought more of erosion, but they both go hand in hand (Beaufort County resident).

Civic leader interviewees, such as municipal government staff, currently and previously elected officials, natural resources agency staff, and leaders of local organizations, were more familiar with the topic of sea-level rise than the resident interviewees. As sources of information, leader participants cited information state-wide public meetings and presentations made to county and city officials in each of the municipalities at a city or county board meeting by Duke University researchers in 2009. While the Duke research presentations raised awareness among municipal leaders, interviewees who attended these meetings said that the following discussions demonstrated skepticism about the science of sea-level rise among the meeting attendees.

Both resident and leader interviewees noted limited sources for information about sea-level rise, especially locally-relevant information. Leaders reported that the local news media were primary sources of information available within their communities..

> The only resource that I see of information is our local newspaper, and there has not been a lot. You know, the newspaper comes to the town council meetings and those types of things, but there aren't any dedicated stories that talk about waterfront recedence, those types of things. They get stories about if we get a hurricane and this area flooded, those types of statements might be embedded in a story. But there have not been any [dedicated] articles that I am aware of (Washington County leader).

Another leader, who was a member of a city municipal staff, suggested that his office might be a good source of risk information for the public in the future, but currently did not have any such material to distribute. At the time of the interviews, little sea-level rise information specific to North Carolina was available other than scientific reports that are largely inaccessible to the public.

Risk communication fails when information is not available in a way that meets the needs of the people at risk. Unfortunately, the North Carolina sea-level rise risk communication gap is persistent. In April 2011, just prior to the resident interviews, the North Carolina Division of Coastal Management launched a sea-level rise webpage, which was the product of a graduate student thesis (Dziuba, 2011). One might imagine that webpages should provide useful communicative venues, since seventy-five percent of resident interviewees said they would search the internet if they were looking for information, but existing awareness of the risk was low in this group, so it is unlikely they would actively search for

sea-level rise information. No interviews made mention of sea-level rise webpages. One interviewee noted that he would use the internet because he was unlikely to find the topic in the news media, but he had not conducted a search..

The sea-level rise risk communication gap and absence of adaptation planning by individuals or municipalities is also due to a lack of issue salience at the local level. For the small municipalities that make up the majority of the North Carolina coastal region, other immediate issues take priority and problems such as flooding or shoreline erosion are not associated with sea-level rise. The result of interviews with the leaders in Washington County revealed that only four out of eighteen participants associated sea-level rise with the urgent issue of flooding in the coastal region. When asked if sea-level rise is discussed among elected officials, one leader replied:

> Most of the time if it comes up, it comes up as a result of a storm that we had. Or we had a presentation, not necessarily someone talking about sea-level rise, but someone that has that scientific side of things. And it would become a discussion with the board at the point. But it is not a regular discussion point [because] half an inch a year is not that big of a deal right now, but when your grandkids have kids it will be a significantly different world (Dare County leader).

The temporal uncertainty of sea-level rise, coupled with the perception that it is an issue only for beach front properties, permits a "wait and see" attitude. Some interviewees reported a lack of concern because they did not own waterfront property. The perceived lack of personal consequences of sea-level rise and a mismatch of temporal scales led to a fatalistic apathy in some individuals.

> It is not scary to me, because I am not going to be around. I don't care. All I worry about is if my house will disappear in a hurricane. But as for the water going up, I don't care about it. I am not going to live that long (Dare County resident).

Other reasons given for sea-level rise risk apathy included a lack of available local information, a lack of practical actions individuals can do to prepare for sea-level rise and other competing interests. One leader said "people are just too busy making a living to live wisely." Issue salience can be a starting point for engagement on any issue that poses a threat to people. Once communicators achieve salience, information and understanding can become tools that provide options for response to the threat. In this way, risk

communication can empower people to act. However, if ineffective, communications can overwhelm people and lead to fatalism.

Risk and Resource Limitation

In order for governments to create policies to reduce sea-level rise risk, people within the municipality must have an interest in the issue and access to resources (Moser, 2005). The capacity of the municipality to develop policy is related to its resources, including finances, staff time, knowledge and experience with the issue, and the political will of the residents and leaders. Wealth and associated resources are unevenly distributed across the North Carolina coastal region. While some poorer municipalities search for resources to address flooding risk and crumbling infrastructure made worse by sea-level rise, wealthier municipalities reject sea-level rise planning because they believe it threatens their sense of place or economic real estate development potential. Existing inequalities in wealth and resources are reinforced by discourses that promote fatalistic, "do nothing" approaches, and a lack of investment in the built infrastructure (Collins & Jimenez, 2012).

Local governments often have a small number of staff and other resources, but still must provide a variety of services for their citizens, which stretches their capacity. Financial resources are a significant barrier for the poor, riverfront towns in the northeastern part of the state. Plymouth, a town in Washington County, one of the poorest in the state (North Carolina Department of Commerce, 2012), received external assistance to help them develop strategies to confront current flooding issues and future sea-level rise. The town proceeded with a planning exercise despite the apathy, lack of information and many other competing social problems described by civic leaders in interviews (see Chapter 3). When asked about building their government capacity to confront sea-level rise, one leader for Washington County commented, "The difficult part is funding. Funding is biggest thing. If you write me a check, we'll get it fixed." The inability to address sea-level rise risk is not just about money, however. In small coastal towns, needed repairs and upgrades to infrastructure strain capacity at many levels.

> I will tell you this about small towns, the infrastructure, particularly in our case. It's enormously expensive and also consumes a lot of personnel staff time. In a smaller community, that actually diverts the staff's time away from more fun things like parks and neighborhood beautification (Washington County leader).

Given the limited funds and municipal staff resources at the local level, it is not surprising that the small coastal towns have been unable to prepare for sea-level rise. Ultimately, a lack of resources engenders a fatalistic perspective among people who recognize sea-level rise risk, but are unable to respond either as an individual or a community:

> Again, with the topography the way it is, where do you go? Where do you go with it? With people's incomes the way they are here, they are not going to be able to afford to jack their house up a foot, so…I don't know (Washington County leader).

As the above quote suggests, a common reaction to the raised awareness of risk is to consider personal actions to reduce biophysical exposure to the hazard, but then feel defeated by the costs associated with the available solutions. Sea-level rise risk in Washington County is tied to a larger pattern of regional marginalization. A lack of resources increases risk, and the discourses that inhibit statewide policies to promote planning reinforce existing patterns of social vulnerability and marginalization.

In contrast to Plymouth, towns with more economic and social capacity are unable to reduce sea-level rise risk due to a resistance to planning. When more municipal resources are available, the decision to fund sea-level rise adaptation competes with other priorities. One leader commented that their town's historic character and aesthetics are more important to people than flood risk, and that "our town has made the decision that we would rather have our appearances than flood-proofing." In wealthier towns, individuals are more likely to have the personal resources to protect themselves from risk through protective mechanisms such as insurance and the ability to relocate. The sea-level rise risk discourse in the wealthier municipalities is primarily about personal risk, which shifts responsibility for risk to the individual, away from public policy arenas.

While in many respects, Washington and Dare Counties lie at opposite ends of the economic spectrum in North Carolina, both are economically dependent on natural resources in different ways,

which influences their sea-level rise risk discourse. Both Washington and Dare County have extensive national wildlife refuges and other federally-protected land located in close proximity to their county seat population centers. In Washington County, this land provides little direct economic benefit, with their declining employed population working in service and manufacturing. In interviews, some leaders expressed the value of green infrastructure in protecting their community from flooding, and discussed the role of wetlands in protecting buildings and absorbing flooding during storms. They were amenable to adaptation planning, but felt that little action would result due to constrained resources. In contrast, in wealthier Dare County, public lands are an amenity that draws tourism, their biggest economic engine. Some leaders commented that others consider public lands and protected wetlands to be limitations to the potential for real estate development. One said, "There's just no space to do things in." The comment suggests that at least when financial and risk protection resources are sufficient, the pressure is great to build in hazardous, natural amenity areas, such as the low-lying barrier islands that make up most of Dare County. Rather than view wetlands or other open lands as green infrastructure that could mitigate risk, a developer may focus instead on the regulatory restrictions that cut into potential profits. Fatalistic discourses legitimize barriers to planned adaptation, and reinforce existing risk patterns and inequalities in social vulnerability.

Discourses of Fatalism and Mistrust in Science

Leader and resident interviewees expressed both confidence and skepticism in sea-level rise science. Sources of skepticism included scientific uncertainty, disbelief in forecasting models and mistrust of scientists. Most of the residents accepted the science as presented in an informational document that they were asked to read, however some questioned its accuracy. Perceived scientific uncertainty was one source of skepticism.

> It is difficult to determine, the changes. It could be determined, but it was difficult to say how much it will rise as far as in the meters or feet. They say they have a technique to measure it, but they don't know the temperatures it will be as the time passes (Beaufort County resident).

Personal experience can also be a powerful force in the way that people understand sea-level rise science. Phenomena with spatial and temporal scales that exceed routine human experience can generate skepticism, because they are not readily observed. Such is the case in land subsidence, Descriptions of future conditions, such as the inundation of large areas of land, based in predictive climate models, may also generate resistance to risk information, especially when the conditions predicted by models are unlike the historic conditions. People may react with disbelief driven by their dread of potential impacts:

> More than 3 foot for change by 2100. That is a lot. I am not happy with that. Three feet is an awful lot. It was unbelievable. I don't believe it is going to do it, but if it does it is really bad (Dare County resident).

Trust in scientists was an important factor in whether interviewees judged the science of sea-level rise to be accurate, salient, or relevant to North Carolina. Some leader interviewees did not consider scientists associated with government, coastal management and sometimes universities to be credible. Some associated mistrust, fear, and anger with the sea-level rise science, as described by one leader.

> The sea-level rise thing has been cooking for so many years. And for whatever reason, it just seems to be in the scientific community, you know? Is it for real or is it a hoax? [Like] Y2K, whatever. People are just so mistrustful of the federal government right now and just government in general and just angry out there (Dare County leader).

As these quotes suggest, interviewees perceived sea-level rise science through a lens of emotion, and popular discourses of mistrust in government allow a dismissive attitude to prevail, inhibiting action.

Local land use plans are ostensibly intended to reflect the perceptions and attitudes of the people within their municipality and therefore provide insight into how people react to the risk of sea-level rise. Of the 47 reviewed land use plans and updates, 21 contained no mention of sea-level rise other than reprinting language used in a document intended to guide the planning process (Table 3-4). Fourteen plans included a minimal mention of sea-level rise, some indicating uncertainty and skepticism about the potential impacts of future sea-levels. For example, Dare County's land use plan included a passing mention of sea-level rise in their natural hazards section that conveys skepticism about the science of climate change and sea-level rise.

> Dare County believes the issues of global warming, sea-level rise and climate change are issues of international and national debate. Federal and/or State initiatives that may be forthcoming to address these issues will be reviewed as proposed with support or opposition offered depending on the impacts for Dare County (Dare County CAMA Land Use Plan)

The most common implementation actions listed in land use plans were the support of federal and state efforts to monitor sea-level rise, informing the public of risk, and a possible future review of ordinances. Although eleven plans contained a discussion of sea-level rise, only one, Manteo, had maps depicting areas at risk to sea-level rise and policies that suggested the adaptive action of avoiding development in the vulnerable zones. Subsequent to this research, Wilmington has developed a sea-level rise adaptation plan for their water and wastewater infrastructure.

Plan Type	No. of plans reviewed	No mention of Sea-level Rise	Minimal Mention of Sea-level Rise	Discussion of Sea-level Rise
County	15	9	3	3
Combined County/City	4	2	1	1
City	28	10	11	7
Total	47	21	15	11

Table 3-4. Review of North Carolina CAMA land use plans for the inclusion of sea-level rise

In interviews, three leaders referenced publicity and reports developed by NC-20, a civic group the focuses on regulations and insurance policies that may economically impact business and property owners in coastal North Carolina. At the October 2011 meeting of NC-20, the association president stated that scientists in North Carolina are not trustworthy and questioned the motives of climate scientists, suggesting that models projecting acceleration of sea-level rise assist in securing future grants funding, enriching the scientists (personal observation). NC-20 has stated the goal of preventing any regulation based on sea-level rise projections that include accelerated increase on their website and marketing materials. A key strategy has been to attack the science of sea-level rise by focusing on scientific uncertainties and making claims that preparations for potential rise would "irreparably damage the economy of eastern counties" (NC-20, 2012). NC-20 also works to influence the assessment of sea-level rise risk and made appeals to the NC Flood Mapping program, which aids the federal government in

determining the spatial pattern of flood risk. They call for low insurance rates, denying that coastal areas have greater hazard potential than other areas.

Discourse on Fear of Regulation

Discourse of mistrust demonstrated in interviews and public meetings extended from science and scientists to include coastal managers and regulation, creating a fear of precautionary action, and thus promoting fatalism. Three civic leader interviewees expressed a view, also held by NC-20, that a sea-level rise policy was the first step toward new coastal regulations that would inhibit further real estate development in the region. One described the popular discourse about regulation as "fear."

> I think the only concern, the only fear, the biggest fear that I hear that people have, is the over-regulation. That comes from a bunch of bureaucrats that are just trying to feather their nest (Beaufort County leader).

These leaders expressed the opinion that current regulations are restrictive to economic growth, expensive and inconvenient. State and federal regulations designed to reduce flooding and improve water quality restrict the way properties are developed. Leaders may express fatalistic attitudes when these rules make redevelopment difficult:

> So how do you, how do you, how do you take 100 years of development and change it? Well you probably need 100 years to change it. First of all is there the will to do it. Secondly, what do you do with everybody who's in the way, and thirdly, how do you pay for it? (Dare County leader).

While these leaders fear regulations, such was not the intention of the CRC, according to its chair, who refers to some "misinformation" published in a local coastal newspaper:

> The intent of the draft policy is not to regulate, but for the CRC to fulfill its responsibility to be aware of hazards to coastal communities, property, and the environment, and to work with communities and other stakeholders to stay informed as we make decisions for our future (Bob Emory in the New Bern Sun Journal February 26, 2012).

Despite reassurance from policy-makers and coastal management staff that their interests are being considered, NC-20 members fear the expansion of federal flood zone designations that require flood insurance for those property owners holding federally backed mortgage, which would cost people more to live in hazardous coastal areas (NC-20, 2012). Another Dare County leader suggested that the amount of land on which real estate development might take place in the county was highly restricted because the federal and state government own large tracts of property, up to 85% of the county land, including national seashore, national wildlife refuge, historic landmarks and parks. One resident described the dread that real estate developers have about the spread of information about sea-level rise:

> They've been talking about the global warming and sea-level rising, and it's kind of affecting the real estate market, and people are scared. People who might have bought property have showed some fear. Locals not so much. They realize that the tide comes up and down normally and it hasn't impacted the area much as of yet (Dare County resident).

A resident of Beaufort County said that her first concern was that she didn't think we should be taking away anyone's right to be able to build or do with their property what they want to do, but she questioned spending public money on waterfront projects. Some interview participants perceived sea-level rise adaptation as a personal choice and believed associated cost should be borne by the individual. Because of these questions of agency, several of our interviewees worried that nothing can be done:

> The problem is: what does an individual do? I know it is important, but we live on this island and we are going to be the ones who are flooded out. So if we stop, we make sacrifices and other people don't, and we are flooded out, it is like we have lost twice (Dare County leader).

As this quote suggests, preparing for sea-level rise in an area that is highly susceptible to coastal hazards may be cost-prohibitive for the individual property or business owner, which engenders a sense of inevitability and leads to fatalistic attitudes. Additionally, if the planned adaptation actions are not effective due to inaccurate estimates flooding, the regulations that might result from sea-level rise policy will incur an economic loss, and then the inevitable disaster will incur a second loss. The discourse of

regulation fear, that adaptation planning would result in regulations that would ultimately harm the local economy discourages the pursuit of solutions to reducing sea-level rise risk.

In summary, sea-level rise risk is produced in the coastal hazardscape when municipalities with areas susceptible to the hazard fail to plan for adaptation. The lack of risk communication, limited resources in poorer areas, and discourses of fatalism reinforce the existing uneven pattern of social vulnerability. Fatalistic discourses about mistrust in science and a fear of regulation legitimize inaction to reduce risk. These phenomena facilitate the ability of politically powerful social elites to use hazardous places to create personal wealth, such as in the development of Dare County real estate, while they marginalize residents of socially vulnerable areas, such as those in Washington County.

Discussion

The North Carolina coastal region is a hazardous place to live and make a living. Many coastal property owners in Dare County have chosen to live or buy properties in the county because of the beauty of the region and the opportunity to access the ocean and sounds. Institutional mechanisms, such as flood insurance, emergency aid and beach nourishment, reduce the sea-level rise risk, making ownership possible for many owners of second homes and investment properties in the region. In beach counties where much of the economy is driven by tourism, property owners are able to reap aesthetic and economic rewards while protected from coastal hazards. By contrast, individuals and municipalities in flood-prone areas away from prosperous tourism-dominated counties, such as those in Washington and Beaufort Counties, have less ability to afford risk reduction measures. People living in these counties have greater social vulnerability, and when this couples with high potential for sea-level rise-associated impacts, their risk is disproportionately high.

This disparity of risk among coastal residents exemplifies the twin processes of marginalization and facilitation as conceptualized by Collins (2008, 2009). The facilitation process favors economically and socially powerful groups by allowing access to the economic rewards associated with the waterfront areas, while insulating them from risk. Locations with high sea-level rise hazard also yield high property

values (Bin et al., 2008). The desire of people to live in or own property in the location, and the control of risk through insurance mechanisms, private property rights, and access to capital, facilitates the occupation of these hazardous places (Collins, 2009). Social elites, such as members of NC-20, exert their political influence to protect low property and flood insurance rates. Their lobbying efforts have resulted in a moratorium on the assessment of sea-level rise rates, shutting down progress that the NCDCM had made toward encouraging adaptation planning in coastal communities. If allowed to proceed, adaptation planning could help marginalized populations address existing vulnerabilities by increasing informational resources and in garnering outside funds, once adaptation needs are determined.

Fatalistic discourses help to legitimize the processes of marginalization and facilitation happening at the coast by reinforcing the existing disparities between groups that can afford to protect themselves from the impacts of sea-level rise and those that cannot. Like the hegemonic discourses found by Collins (2009) at the US/Mexico border and the technocratic discourses that Mustafa (2005) found in Pakistan, fatalistic discourses in North Carolina serve to protect the current state of uneven distribution of risk across the coastal hazardscape. The discourse of mistrust in science and fear of regulation shift the burden of preparing for sea-level rise from the government to the individual. Fatalistic attitudes reduce the capacity of local governments to plan for adaptation to sea-level rise by undermining the already weak political will that exists for problems characterized by high uncertainty and mainly long-term effects. Discourses of fatalism make sea-level rise risk seem beyond human control, much in the way hazards researchers have described the framing of hazards as "acts of nature" (Wisner et al., 2004). Framing risk in this way serves to relieve municipalities of responsibility. People then attribute risk to individual choices and municipal inaction is justified and reinforced by the fear that strategies to reduce risk may lead to drastic financial loses. The principle argument laid out by NC-20 against planning for sea-level rise is that acceleration of rise is "fake" and that actions taken to prepare would be harmful to the coastal economy. In their document, "How to Save $7 Billion Dollars: A Lesson in How to Protect the Coast from Overzealous Regulators," they admit sea-level rise is occurring in North Carolina, but they strongly object to science which models future acceleration of sea-level rise:

> The biggest problem with wildly exaggerated projections of sea-level rise was that preparations for such a drastic increase in sea level would irreparably damage the economy of the eastern counties. Perfectly good land would not be financed by banks for new homes, and insurance would increasingly become impossible to obtain.

The group was effective in codifying their position in state law that prohibits the calculation of sea-level rise rates for four years, requires the next CRC Science Panel report include a critique of predictive models, and requires an analysis of the economic impacts of sea-level rise policies. While nothing in the law prevents managers from providing sea-level rise risk communications materials, the political environment is such that state coastal managers are unable to encourage local municipalities to conduct adaptation planning. Given the limited ability of local governments to tackle long-term policy challenges, unless state or federal government facilitate sea-level rise planning, no action is likely to occur, leaving low-resource municipalities unable to tackle increasing flooding problems.

Discourses of fatalism about sea-level rise align with many of the media and political discourses that have been examined in the United States over the last thirty years. News media were the predominant reported source of sea-level rise information for interviewed residents, while leaders had access to additional sources, including expert information. Scientific discourses, promoted by NCDCM, Duke and other scientists, compete with political discourses, promoted by NC-20, among the civic leadership. NC-20 has framed sea-level rise as distant and uncertain, which closely mirrors with the way that climate change has been framed in news media and by political conservatives (Doulton & Brown, 2009; McCright & Dunlap, 2010). In the present study, interviewed leaders who expressed views that aligned with the NC-20 position, also expressed a fatalistic perception when asked about future action. Residents who had not heard about sea-level rise expressed similar fatalism, suggesting that generalized discourses about the inability of individuals or groups to take action to reduce these types of coastal risk circulate within the population. In this case, fatalistic risk perceptions result from discourses about mistrust of science and fear of regulation, along with a lack of clear risk communication that provides options for risk reduction measures. Even marginalized people may then accept these discourses and assume that risk reduction is too costly, and that they are therefore at the mercy of nature.

The lack of locally relevant sea-level rise risk communication is intimately linked with the lack of salience within municipalities. Information alone, however, even if communicated effectively, will not be able to overcome the other barriers to sea-level rise policy and planning. The discursive process leading to fatalistic risk perceptions creates a pattern of uneven risk that municipalities with few financial resources find difficult to overcome. The examination of the connection between discourse, perception and risk can contribute to a better understanding about how different discourses and risk communications can be used to reduce risk and address unjust patterns of risk.

Conclusions

The examination of sea-level rise risk within the North Carolina coastal hazardscape offers an opportunity to consider how the relationship between discourse and risk perception can work to create barriers to environmental planning and management. This case illustrates that fatalistic risk perceptions can develop through both the lack of information and municipal resources, but also through the active promotion of discourses of mistrust and fear by a powerful civic organization. Local municipalities grappling with diverse constituent needs are not able to take on sea-level rise adaptation planning unless it is recognized as salient. Until the necessity of adaptation is demonstrated either through a disaster that can be tied directly to sea-level rise, or in a mandate from federal or state government, it seems unlikely that progress will be made toward risk reduction in these local municipalities. Instead of facilitating planned adaptation, state law (North Carolina Session Law 2012-202) erected further barriers that increase the risk to communities by willfully ignoring potential future impacts of storms that are likely to hit the North Carolina coast. By aligning with a discourse which promotes a fatalistic attitude, local elected officials and municipal staff cannot substantially tackle this difficult, long-term but potentially high-impact problem. While it is true that no one can prevent sea-level rise, unless approaches to living with the coming rise are explored, municipalities risk the loss of public infrastructure to inundation or salinization, and potential disaster due to flooding from severe storms.

The inability of coastal municipalities to prepare for sea-level rise is not restricted to North Carolina. While large cities in the United States, such as New York City and San Francisco, have developed extensive sea-level rise adaptation plans, few small municipalities have been able to prepare, even in high risk regions, such as Louisiana (Schenk, 2012). Limitations such as funding, access to locally scaled information, and a lack of risk communications products can potentially be addressed by federal, state or non-profit partners. Addressing discourses of science skepticism and fear of regulation may be more difficult, especially when discourse advocates are politically powerful. Effectively designed risk communications, which specifically address local risk perceptions, may help to set up alternative discourses that support the scientific discourse. Without understanding the local risk perception and the full range of causes for vulnerability, it is unlikely that adaptation planning can move forward and sea-level rise risk will continue to increase.

CHAPTER 4: PREPARING FOR SEA-LEVEL RISE IN A SMALL COASTAL TOWN: A CASE STUDY IN PLYMOUTH, NORTH CAROLINA

Chapter Summary

Sea-level rise threatens cities on the US Atlantic coast with the potential for inundation of land and repeated flood damage associated with storm events. Many small, rural municipalities do not have adequate capacity to plan for sea-level rise impacts to property and infrastructure, especially in locales where physical and social vulnerability are greatest. Despite such challenges, these towns may be able to initiate adaptation planning by obtaining locally appropriate information and external assistance. If the topic of sea-level rise engenders political controversy, mainstreaming strategies can also help. This paper examines the case of Plymouth, North Carolina, a rural waterfront town in the impoverished northeastern portion of the state. Already experiencing increasing flooding problems, and with a limited capacity for conducting adaption planning, the town leaders engaged with university-based researchers and extension staff to develop strategies to prepare for future environmental change. Initial interviews with civic leaders helped the research team to better understand the local knowledge, belief and values of the population. A public participation workshop focused on flood management, and used a discussion visualization tool to promote social learning. Evaluation interviews revealed a high level of satisfaction with the public participation process, and indicated that learning had occurred. A comparison of the workshop diagram with that of a summary diagram of the interviews showed that the workshop addressed many, but not all, of the community concerns. Plymouth was successful in overcoming obstacles to adaptation planning by using a bridging organization to gain access to locally-scaled environmental risk information and public participation workshop facilitation expertise, by mainstreaming the adaption planning process into an immediate municipal management concern, and by using a public participation method to help build wider acceptance of decisions and capacity for future decision-making. Although Plymouth was not able to solve their immediate flood management problems, they began building a foundation for future resilience.

Introduction

Scientists have recognized for several decades that sea-level rise is a threat to coastal populations along the US Atlantic coast (Parris et al., 2012). Coastal areas are already experiencing recurring flooding and more severe storm damages, both of which promise to increase in the future (Karl, Melillo, & Peterson, 2009). Some cities and states have developed plans to prepare for sea-level rise, but many other locales at risk have not (Gregg, Hansen, Hitt, Kershner, & Hoffman, 2011). Although many reports assess impacts at regional or state levels, policy must accommodate local socio-ecological particularities (IPCC, 2013; Titus & Richman, 2001). Small rural municipalities encounter significant challenges in adapting to sea-level rise, especially towns where poverty and related social variables increase vulnerability (Wilson, Richard, Joseph, & Williams, 2010). This paper focuses on the feasibility of planning for sea-level rise impacts on municipal property and infrastructure, in a case where the vulnerability to sea-level rise is high and many barriers to risk reduction actions exist. The case of Plymouth demonstrates that small municipalities with limited capacities can develop adaptation strategies if they are able to obtain relevant locally-scaled information and help with facilitating a public participation process through outside sources, and are able to avoid local political controversy by mainstreaming sea-level rise adaptation policies into existing infrastructure plans and projects.

By involving citizens in environmental decision-making, the quality of information, the range of possible responses, and popular support for eventual solutions increases (National Research Council 2008). Public participation can also improve the group's capacity to deal with future decisions, as social learning changes the way they understand and engage with the socio-ecological system. Tools that increase the effectiveness of a public participation process, such as those that facilitate better understanding of risk perception and mainstream potentially-controversial decision processes, help organizations that bridge science and decision-making move municipalities past barriers to risk reduction. To prepare for sea-level rise, the process of developing adaptation plans can help municipalities to manage risk by involving a broad range of interest groups, eliciting information about the greatest

perceived threats, and identifying strategies to address those threats. Understanding how people think about risk and prioritize their concerns are important steps in the development of strategies that municipalities can implement effectively. As detailed below, a mental models approach to developing risk communications products (Morgan et al., 2002) can help elicit information to better understand how different groups think about a topic that is complex and controversial (Cone et al., 2013). Further, decisions made by incorporating substantive participation of the affected public are likely to be of better quality and legitimacy (National Research Council, 2008). Public engagement in decision-making can produce diffuse but long-lasting positive outcomes, such as the establishment of better communications between stakeholders and public officials (Beierle, 2000; National Research Council, 2008). Sea-level rise adaptation planning is most likely to be successful if the process includes a component of learning in which participants share knowledge and opinions in an effort to come to an agreement of goals and strategies (Blackmore, 2007). If scientific and management experts, residents, and decision-makers are included in a process that balances knowledge and power dynamics, the resulting plan is more likely to have better efficacy and acceptance in the community (Leys & Vanclay, 2011). Bridging organizations, those bring together science with local knowledge in service of decision-making, can use tools such as facilitated discussion and diagramming to summarize the knowledge and perspective of a community. These organizations can bring about a shared learning experience with the potential to move a group toward building adaptation strategies (Berkes, 2009).

A challenge in many small towns that are confronting climate change impacts such as the threat of sea-level rise, is to find ways to overcome the lack of locally-scaled information and other resources to plan for adaptation and resilience to sea-level rise. In many coastal areas of the US, vulnerable populations, including disadvantaged populations of color, live in areas of greater risk exposure which increases with the threat of climate change impacts (Wilson et al., 2010). Many small coastal towns in northeastern North Carolina, like small towns across the state, have impoverished and aging populations with declining populations (NC Rural Economic Development Center, 2013). Aging public infrastructure and a lack of municipal resources make confronting politically-charged topics like climate adaptation

difficult to address. Yet, as I found in this case study, effective ways to overcome barriers include techniques such as mainstreaming sea-level rise adaptation practices in existing plans and mobilizing resources from outside the municipality by partnering with bridging organizations. This study examines the case of a small town's efforts to address its vulnerability to the risks associated with sea-level rise; and how it was able to initiate a process to plan for adaptation despite having few economic, organizational, and scientific resources..

In the next section, I briefly review the role of public participation and social learning in environmental management and climate change adaptation planning, the context of their application in North Carolina, and how managers use mainstreaming to overcome social barriers to adaptation action. Next, I describe the sea-level rise threat in North Carolina and how that risk affects the population of Plymouth. I then describe the approach used to assess the knowledge and attitudes among Plymouth civic leaders, and the subsequent workshop process, including follow-up evaluations. The interviews reveal how the civic leaders mentally framed issues concerning the environment; identified barriers and opportunities involved in addressing environmental problems, and evaluated the adaptation planning process. The subsequent discussion focuses on how the Plymouth case demonstrates that bringing together key managers and elected officials with the addition of locally-relevant information forges better management coordination, and a product that can help the municipality create a sea-level rise adaptation action plan.

Public Participation and Social Learning in Environmental Decision-Making

Natural resources management, urban and spatial planning, and coastal zone management use public participation processes for environmental decision-making that have become a standard of practice in those arenas over the last twenty years (Burroughs, 2011; Kay & Alder, 2005). In some resource management venues, the degree of user involvement rises to the level of co-management when the government and resource users share knowledge, authority, and responsibility (Berkes, 2009). When the process is done well, the viability and legitimacy of management decisions are improved and the process

increases the capacity of both users and managers to better engage in future decision-making (Dryzek, 2009; National Research Council, 2008). A group deliberation process helps people to think differently about a problem, and may yield innovative ideas that may not arise otherwise (Dietz, Stern, & Dan, 2009).

Some experimental studies have demonstrated that when a deliberative process is used, stakeholders perceived that decisions were more fair and competent (Webler, Tuler, & Krueger, 2001). Other researchers have found that public participation confused decision-making, that small groups can co-opt the process, or that conflicts between viewpoints were exacerbated, thereby eroding the public's confidence in the decision-making process (Bora & Hausendorf, 2006; Lubell, Schneider, Scholtz, & Mete, 2002; Steelman & Ascher, 1997). Nonetheless, even when groups do not achieve consensus, the process can create new understandings within groups tackling unfamiliar and uncertain risk issues (Horick-Jones, et al. 2007). The international community has called for public participation in the development of climate change adaptation policy, but some researchers question the efficacy of applying deliberative processes to this politically-charged issue (Few, Brown, & Tompkins, 2007). At the local municipal level, however, the participatory process has proven valuable when the group focused on building their capacity to support a future climate adaptation decision and visualization tools provide a better understanding of the link between climate and action (Shaw et al., 2009).

Over the past 15 years, the evaluation of public participation processes has been an active subject of discussion among researchers (Duram & Brown, 1998; Filtcroft, Dedrick, Smith, Thieman, & Bolte, 2009; Lauber & Knuth, 1999; Webler & Renn, 1995). An effective decision-making process must attend to not only the science, but also the communications and participation processes (Blader & Tyler, 2003; Webler et al., 2001). Criteria of a successful process include measures of representativeness, fair deliberation, access to resources, transparency, independence, learning, and efficiency (Chilvers, 2008). Public satisfaction with a process often has more to do with perceived fairness and treatment of the public during the process than with the outcomes (Lauber & Knuth, 1999). Although there is no ideal formula for effective participation, successful processes have been inclusive, collaborative in both in problem

formation and the design of the process, transparent, and involved effective communication techniques (National Research Council, 2008). Since public decision-making processes are highly influenced by the perceptions, beliefs and attitudes held prior to the participation process, it is useful to implement a strategy to understanding a group's relevant priorities, interests and concerns.

Public decision-making processes also can change the way people understand and approach environmental resource problems. In the context of a management and policy development, social learning is a process of mutual, active engagement. When a group collaborates in the shared experience of public participation, the participants communicate their knowledge and attitudes, and thus learn from each other (Glasser, 2007). Social learning can encourage a convergence of goals among participants who may have different interests, and promotes the co-creation of knowledge that can build relationships and mutual understanding (Blackmore, 2007). A participation process that integrates social learning has the potential to generate new knowledge and increase the technical and social skills of the participants, as well as build relationships and trust among those involved (Muro & Jeffrey, 2008). Social learning has increasingly become a normative goal for natural resource management because it can provide a basis for a common understanding and collective action to address a planning or management challenge (Reed et al., 2010). As first defined by Argyris and Schon (1978), single-loop social learning does not change the participants' mental models, but can correct relatively minor errors, leaving routines and assumptions intact. Double-loop learning alters mental models when experiences and reflection reform values that underlie routines. Triple-loop learning challenges the social structures and governing norms, leading to transformative change (Armitage, Marschke, & Plummer, 2008).

An effective public participation process that promotes social learning and moves a group toward a solution to a management dilemma is often beyond the capacity of small municipalities because their staff do not typically have the appropriate training or the funding to hire sufficient expertise. A bridging organization, sometimes known as a boundary organization when its focus is on the science-policy interface and has structures for accountability, is a governmental agency, academic unit, or non-governmental organization that serves as an intermediary (Crona & Parker, 2012; Guston, 2001).

Whether the organization was formed to serve a bridging function, or has taken on the bridging role on in addition to pre-existing roles, such entities can assist the decision process by providing access to knowledge, facilitating participation across a science-decision boundary, and providing for the use of boundary-spanning objects, which can be maps, diagrams, or summaries that are co-produced by participants (Berkes, 2009; Cash et al., 2003). Bridging organizations can facilitate public participation processes to achieve goals of fair deliberations and unbiased process by incorporating values from multiple stakeholders to link their diverse within a workable relationship. Some bridging organizations establish long-term associations with particular stakeholders, and use social learning processes to increase the participatory capacity of resource users so that they can be involved in the management of that resource (Brewer, 2013). University-based boundary organizations must typically manage complex and dynamic decision environments, occupying a role in which science and policy intermingle, and with accountability to multiple types of stakeholders, including funding agencies and academic administrators (Parker & Crona, 2012). Because academically-tied boundary organizations have scientific research imperatives, many will integrate the testing or demonstration of new techniques into their plans for facilitation of a public participation process.

Public participation can take many different formats including public hearings, focus groups workshops, charettes, listening sessions, summits, town meetings, citizen juries, study circles and consensus conferences (National Research Council, 2008). Organizers of the public participation process use a variety of tools and techniques to manage interactions within these formats. Among the interactive formats designed to involve participants directly in decision-making are workshops that may include presentations and exhibits, but end with working groups using a particular tool to develop a tangible product that guides decisions (International Association for Public Participation (IAP2), 2005). Some participatory tools utilized in natural resources management include GIS participatory mapping using Google Earth to engage participants, and collaborative modeling using a diagramming process that assists visualization and synthesis of multiple perspectives (Etienne, Du Toit, & Pollard, 2011; Stocker, Burke, Kennedy, & Wood, 2012).

Public participation in sea-level rise adaptation planning involves the challenges of combining complex and uncertain scientific information with a politically-driven stakeholder process. The science of sea-level rise is often unfamiliar to the public, and the temporal and spatial scales of drivers and impacts extend beyond those of many municipal operations and electoral cycles. The geophysical models used to predict future sea levels yield results with uncertainties that limit the projection of impacts onto shorter time scales. Much of the predictive information is difficult to scale down to areas or time scales relevant to decision-makers at the municipal level where many adaptive actions must take place. The sea-level rise adaptation planning process in local municipalities must therefore proceed carefully to avoid the dangers of political polarization, reinforcement of existing social inequalities, or squandering the limited time and attention of citizens and public servants (National Research Council, 2008).

Sea-level Rise and Climate Change Adaptation Processes

A growing number of states and cities in the US are working to establish climate change adaptation policies. The Center for Climate and Energy Solutions reports that 15 states have completed climate action plans (Center for Climate and Energy Solutions, 2014). All of these completed plans are in coastal states, with an addition three coastal states now in the planning process. States such as Maryland, Massachusetts and Florida have developed climate action plans in part because of their exposure to sea-level rise and increased storm impacts (Executive Office of Energy and Environmental Affairs and the Adaptation Advisory Committee, 2011; Governor's Action Team on Energy and Climate Change, 2008; Johnson, 2000). Further, across coastal states, a wide variety of actions have arisen to respond specifically to sea-level rise. These include changes to land-use and building codes, incorporation of sea-level rise into planning processes, and incentives to elevate homes (Schenk, 2012). Large US coastal cities such as Boston, San Francisco, and New York also have climate adaptation plans and mayors are often more able to implement climate action policies compared to leaders of nations or larger regions (Rosenzweig, Solecki, Hammer, & Mehrotra, 2010). The New York adaptation planning process implemented a collaborative risk management approach that involved physical and social scientists

interacting with stakeholders from government and private industries that oversee municipal infrastructure functions (Rosenzweig et al., 2011). The resulting flexible adaptation plan uses scientific projections and local knowledge to locate infrastructure at risk to sea-level rise and higher storm surges on maps and develop policy solutions.

Despite the advances in climate change adaptation planning by states and cities, some investigators have found that small municipalities have few resources for structured planning processes (Brody, Zahran, Grover, & Vedlitz, 2008; Sheppard et al., 2011). There are, however, pilot projects in smaller coastal cities, facilitated by groups affiliated with universities, federal government agencies or non-profit organizations. These pilot projects develop locally-scaled risk assessments and test public participation techniques. In the New England region, four communities in Maine, New Hampshire, Rhode Island and Massachusetts are involved in the New England Climate Adaptation Project (MIT Science Impact Collaborative, 2014). These communities, eligible for funding because of their proximity to National Estuarine Research Reserves, are using role-playing exercises to build consensus among stakeholders about responding to climate change impacts. This research project included developing locally-scaled climate projects and social sciences data provided to participants based on surveys and interviews to gauge public perception about climate change. These consensus-building exercises reveal local attitudes and values, so that the solutions developed in the workshop have better chances of eventual implementation.

The municipalities in the New England project varied in population from 10,000 to 80,000 people, but projects in Florida and Oregon conducted similar adaptation exercises in small rural towns of about 1,500 people, which have different needs and limitations. In Florida, a research group from University of Florida conducted a pilot project at Yankeetown-Inglis, a twin town located in Levy County on the Gulf Coast (Frank et al., 2013). The Florida project used a scenario approach and conducted workshops to elicit public input, and although only 20 local community members participated, the local knowledge and concerns provided were included in subsequent planning analysis. The university-based team developed a list of strategies for adaptation that addressed relocation, redevelopment, and restoration

of key areas of the towns (Frank et al., 2013). The project in Oregon, although conducted in the same size of town as the Florida project, used participatory approach grounded in structured decision-making (Cone, Rowe, Borberg, & Goodwin, 2012). That community engagement approach used climate concept mapping and influence diagrams as visual representations of the way participants in the workshops thought about climate change and associated risks. Unlike the approaches in Florida, New England and New York, the Oregon team investigated local attitudes and knowledge in the workshop prior to the expert assessment, to better encourage two-way communication between experts and lay participants. Although this process did not explicitly generate adaptation strategies, the shared understanding developed among participants can assist future policy-making (Cone et al., 2012). These successful adaptation exercises are a part of a growing number of projects across the US, indicating that planning is increasingly occurring, but significant barriers persist (Bierbaum et al., 2013).

Barriers to public involvement in adaptation planning include both individual barriers because of practical, conceptual and psychological limitations, and societal barriers because of the lack of an effective institutional process for participation (Lorenzoni & Pidgeon, 2006). One way that planners and managers have been able to overcome some of these barriers is by using strategies that make adaptation actions salient through "climate mainstreaming" (Kok & De Coninck, 2007). Rather than explicitly address climate change or sea-level rise, adaptation actions are incorporated into existing management activities, such as hazard mitigation planning or developing water management strategies. Mainstreaming integrates climate adaptation goals into other policy areas so that action becomes more urgent. When plans can link climate adaptation actions to public health or air quality concerns they are more likely to become priorities (Kok & De Coninck, 2007).

In North and South Carolina, managers use mainstreaming to advance climate adaptation activities within a political environment that is hostile to climate policy (Haywood et al., 2013). Rather than try to develop a climate action plan, adaptation activities center on current issues of public concern. When managers put these actions into a larger context of multiple hazards, the benefits of adapting to climate change fold into a general approach to community sustainability and resilience (Wilbanks &

Kates, 2010). Mainstreaming has been a situation-specific process in which politically savvy leaders have moved climate adaptation planning forward, primarily through reframing issues and using clever communications (Haywood et al., 2013). Such framing is necessary to overcome the barriers to sea-level rise adaptation planning in many coastal small towns.

Sea- level Rise Risk in Northeastern North Carolina

The northeastern North Carolina coastal region is part of the area north of Cape Hatteras where researchers expect to observe a relative sea-level rise three to four times higher than the global average (Sallenger, Doran, & Howd, 2012). With an area of over 2,300 square miles of coastal land less than one meter above sea level, North Carolina is third in the nation in the extent of land area at risk to sea-level rise (Strauss et al., 2012). The Albemarle-Pamlico Sound system, located in the northern half of the state's coast, is the second largest estuary systems in the U.S. with 10,000 miles of freshwater rivers and streams, and over 2 million acres of estuarine waters (Albemarle Pamlico National Estuary Partnership, 2012). Located within the northeastern region, away from the tourism-dominated barrier islands, are primarily forestry and agricultural lands, public wildlife refuge areas, and small towns built on the banks of the sounds or estuarine rivers. Inundation, shoreline erosion and flooding during storms are occurring on town waterfronts, where many municipal and business assets are concentrated.

The counties in the northeastern North Carolina region are some of the most sparsely populated and economically distressed areas in the state. The largest cities in the twelve-county northeast area are Elizabeth City with a population of 18,000 and Washington with a population of 10,000. Twenty-four of the 37 towns have less than 1,000 people, however, with the remaining 13 having less than 6,000. Several counties have no incorporated towns whatsoever. Many of the small towns in this region have declining populations and persistently high poverty rates. Similarly, these towns have residents who are older on average than those in other parts of the state, and a majority of residents who self-identify as African-American, (NC Rural Economic Development Center, 2013). In addition to the economic challenges faced by their residents, these municipalities are also dealing with an aging infrastructure with few

resources to fund repairs, relocations, or new water and sewer systems (NC Rural Economic Development Center, 2013). Sea-level rise puts these populations at greater risk for loss of life and property through inundation and flooding during severe weather events, but also endangers their health, social values, and unique cultures (Anthony et al., 2009; Graham, Fincher, Hurlimann, Mortreux, & Waters, 2013).

Although the risk of sea-level rise in North Carolina has been known for many decades, policy development, planning and the implementation of adaptation strategies has lagged (Moser, 2005; Poulter et al., 2009). Although the North Carolina Coastal Habitat Protection Plan identifies sea-level rise as a major threat to coastal wetlands, and cautions coastal property owners to be aware of the potential for loss of wetlands and property, no state policy recommends the consideration of sea-level rise in local land use plans (Street et al., 2005). The North Carolina Coastal Resources Commission (CRC) has been unable to implement a sea-level rise policy that encourages municipal planning, because of political pressure applied by a NC-20, state civic group made up of coastal real estate and business interests. A few municipalities have participated in sea-level rise vulnerability studies, with assistance from grants through the United States Environmental Protection Agency, North Carolina Sea Grant, and the Albemarle-Pamlico Estuary Partnership (APNEP).

An APNEP-funded study conducted surveys and interviews in 2009 to determine capacity for climate adaption in five counties in the northeastern region. They found that locally-scaled information was a limitation, but that other urgent local priorities and disputes about the core concept of climate change also posed significant challenges to the commencement of adaptation planning (Nicholas Institute for Environmental Policy Solutions, Duke University, 2010). Informal studies of perception in the region in 2008 and 2009 found that people are concerned about sea-level rise and have a desire for more information, and that some believe they will be affected (Barber et al., 2008; Brown et al., 2008; Miller, 2010). As described in the previous chapters of this dissertation, a study of sea-level risk perception and attitudes among residents and civic leaders in the region in 2011 found fatalistic and skeptical attitudes as well as questions about what should be done to prepare and who is responsible for adaptation measures.

Study Site

In 2010, North Carolina Sea Grant Extension (NCSG) initiated a project with the municipality of Plymouth as part of a national grant program that funded climate change adaptation demonstration projects. The research team recruited the town for this study because of their exposure to future flood risk associated with sea-level rise, their problem of recurring flooding during high precipitation events and a municipal leadership willing to participate. Plymouth is a town of 3,878 people located on the Roanoke River near its the mouth at the Albemarle Sound in Washington County, one of 20 counties designated as part of the coastal management program under the North Carolina Coastal Areas Management Act (CAMA) (Figure 4-1). It is a small waterfront town, typical in many ways for the northeast portion of the Albemarle-Pamlico region. Plymouth has a rich history dating back to its establishment in 1787. Its riverfront location shaped the history of the town by providing an essential transportation route, also making it susceptible to flooding.

According to interviews, flooding was occasionally severe before the construction of a dam upstream in the 1950's. Although flooding from precipitation in the upper reaches of the watershed is no longer a problem, flooding because of local precipitation and strong oceanic storms with winds that drive water from the Albemarle Sound into the river has increased in recent years. These flooding events cause risks to public safety and human health, as well as economic burdens that are difficult for the municipality and many of the residents to withstand. For example, flooding makes it necessary to evacuate senior housing, and causes impassable streets that limit access for emergency services. Standing water due to poor or blocked drainage increases mosquitoes and associated health threats. Households and businesses that are already economically marginal do not have sufficient financial reserves to withstand flood-related income losses, even for relatively short recovery periods.

Plymouth's economy has declined over the last 150 years. During the peak of its prosperity before the civil war, the town served as a port for goods coming from nearby plantations and forests. It was the location of the last major Confederate victory of the civil war, a battle which largely destroyed

the town infrastructure in 1864. The major employer for Plymouth, a pulp and paper plant located in the adjacent Martin County, opened in 1937, but has been reducing its workforce in recent decades (Lewis, 2007). To counter the loss of jobs, the town has focused on growing small businesses and ecotourism with the assistance of funding from the state and private foundations (NC Rural Economic Development Center, 2013). Agriculture and forestry remain the principal industries in Washington County up to the present day (Lewis, 2007). Most of the people now living in Plymouth are descended from local merchant and farming families, from enslaved people, and from workers drawn to the area for a paper mill, mostly in the 1950s and 1960s.

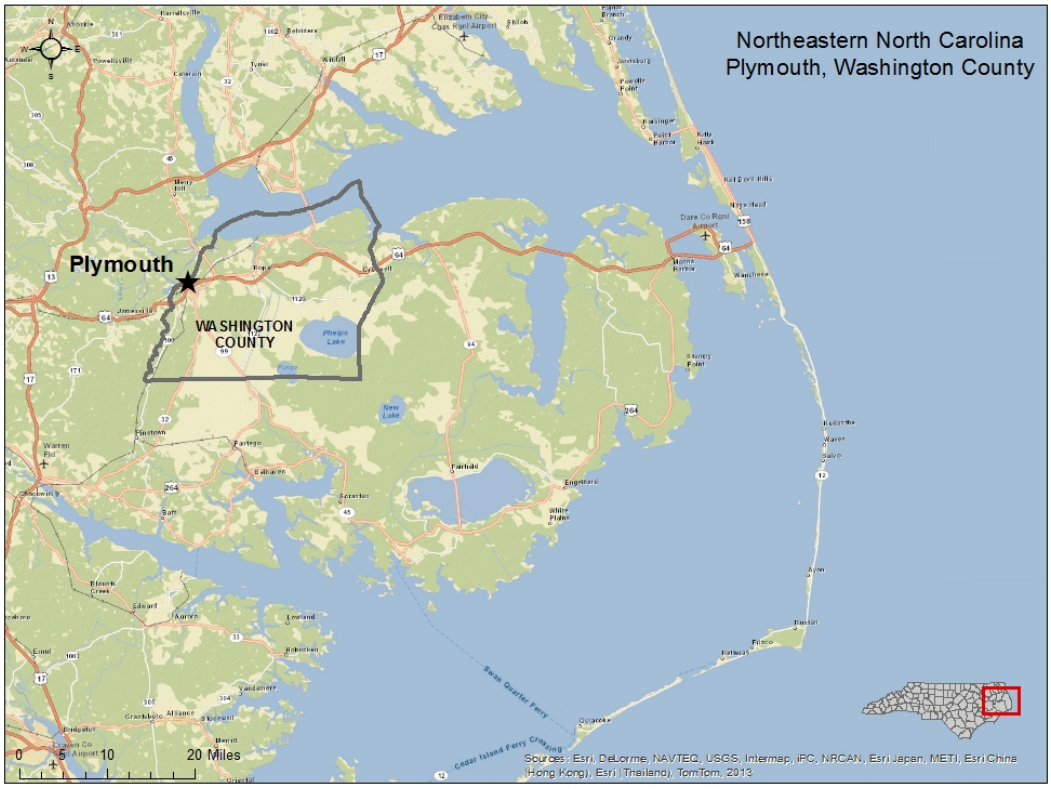

Figure 4-3. Location of Plymouth and Washington County, North Carolina

Plymouth has the demographic characteristics of a population with a high social vulnerability to environmental hazards (Table 4-1). Municipalities with high percentages of low-income populations,

minorities, women, and the elderly are often vulnerable because they lack social safety nets, have greater individual responsibility for family members, and find it difficult to move out of harm's way (Cutter, Boruff, & Shirley, 2003). Compared to North Carolina as a whole, Plymouth's population has a low median household income, a large minority population, and a high percentage of people over the age 65. Educational attainment is below average for the state and the US, with only 34% of adults having a high school education. Although the overall state population has increased over 18% in 10 years, during that same time Plymouth's population has decreased 5.5% because of the loss of jobs in manufacturing and little in-migration.

Demographics	Plymouth	North Carolina	United States
Population	3,878	9,535,471	308,745,538
% white	29	72.1	77.9
% black	68.4	22	13.1
% latino	1.2	8.6	16.9
% over 64	19.4	13.2	13.7
person/sq. mile	960	196.1	87.4
% increase in population since 2000	-5.58	18.46	9.7
Socioeconomics			
median household income	$25,248	$46,291	$52,762
% population in poverty	38.1	16.1	14.3
% education (high school+)	34.4	84.1	85.4
% education (BS+)	9.7	26.5	28.2

Table 4-5. Census data for Plymouth, North Carolina, United States

Methods

This study consisted of two distinct phases. In phase one, the goal was to gather perceptions, attitudes and priorities of civic leaders to better understand how facilitators of public participation processes and municipal staff might best approach a climate adaptation strategy development process. Interviews elicited the mental models of civic leaders in regards to the environment and flooding risk, and provided local knowledge and perceptions. Phase two involved a participatory process to develop strategies to address threats from climate change, called the Vulnerability and Consequences Adaptation

Planning Scenario (VCAPS) process. Participant observation took place during the VCAPS meeting and followed-up with evaluation interviews with the involved civic leaders. These methods follow a procedure developed by Cone, et al. (2012, 2013) designed improve engagement methods for climate change adaptation and were chosen as a systematic way to approach the dual role that the research team fulfilled of facilitation and evaluation. The empirical research to understand the knowledge, opinions and values of the community allowed the research team to appropriately implement the public engagement workshop. The following evaluation interviewed assessed participation objectives, such as salience and fairness, as well as social learning. Observation throughout the process allowed insight into the ways in which different leaders approached climate change adaptation.

Civic leader interviews

The research team for this study modified a mental models interviewing technique used by Cone, et al. (2013). The interview method was designed to elicit mental models that underlie the knowledge and opinions held by the interview participants. Mental models are cognitive representations of real or imagined conditions or situations. Each person relies on their unique set of knowledge, experiences, beliefs and attitudes to form their mental models. People also use mental models as short cuts that allow associations with familiar ideas to lead to conclusions (Kahneman, 2003). Participants in a decision-making process interpret information according to their own mental models. Under conditions of uncertainty, when learning and judgment are critical to an individual's interpretation of the environment, divergent mental models may arise due to differences in ideologies, knowledge and experiences (Denzau & North, 1994). Learning new information can change an individual's mental model, but it is slow and difficult for complex ideas such as climate change (Sterman, 2008). Nonetheless, use of an intentionally-neutral listening framework to gain understanding of the mental models of individuals involved in a public participation processes can yield important insights (Cone & Winters, 2011).

The participation of civic leaders in a small town can become difficult when faced with a topic that they view as unfamiliar and politically controversial. Since climate change and sea-level rise are

politically charged issues in North Carolina, and because the research team valued the participation of civic leaders with divergent opinions, we chose to not specifically elicit opinions about climate change per se during the interviews. Since the mental model interviews preceded the public participation process, the research team was concerned that opposition to a process associated with climate change would reduce potential participation in the later stages of the study. The interviews instead proceeded with questions eliciting information about leadership roles and time in the community, then open-ended questions about Plymouth and changes in the natural environment (See Appendix B). We asked specific questions about flooding, damages to infrastructure, how they received information about flood risk so that we could understand the extent of flooding problems, if those problems had become more severe with sea-level rise and to discover avenues for risk communication. We also asked about barriers and opportunities to action to address any of the problems that they had described.

To collect information about the location of local flooding, participants were asked to indicate their local knowledge of flooding problems on a locally-scaled map of the Plymouth area. Such participatory mapping exercises can help to facilitate the integration of local knowledge into risk assessment and management (Cadag and Gaillard 2012). In a group setting, this technique allows risk managers and citizens to engage in two-way communication of risk that heightens awareness. However, in this study, identification of flood areas was part of the interview and served to provide greater insight into the flooding problems later addressed in the community workshop. An aggregated digital map summarizes the local flood knowledge (Figure 4-4). The summary map can be used to compare local and expert knowledge of flood risk.

To initiate the interview process, researchers convened an advisory committee made up of the mayor, a county-wide natural resources manager and the city manager to create a list of potential interview participants for the study. The committee recommended potential interviewees based on their knowledge of the community and their leadership in local government, civic organizations, or their profession. Interview participants held a diverse knowledge set, including expertise in natural resources, town infrastructure, community-wide priorities, and the concerns of other residents. Participants were also

representative of the town residents across socioeconomic, racial and geographical factors. Eighteen civic leaders agreed to interviews. These included town and county elected officials; town and county municipal managers; county natural resource managers; and citizens, including civic, religious, nonprofit organization and business leaders (see Table 4-2).

Participant Role	Number of Leaders
Elected officials	4
Municipal Managers	4
Natural Resources Managers	4
Citizens	6

Table 4- 6. Leadership roles of interviewees

Most interviewees (61%) lived in the town of Plymouth and almost all (88%) lived within the county. Two individuals worked as managers in the town, but lived in adjacent counties. Many of the leaders had lived in the town or adjacent areas all of their life, or had been raised in the area, left for a time, then returned. Half of the interviewees had lived in the area 40 years or more and only four of the managers had been working in the area less than 10 years (Figure 4-2).

Figure 4-4. Years leaders have lived or worked in Plymouth

The study team conducted interviews between August 20, 2010 and September 10, 2010 in the offices of municipal staff and natural resources managers, in public areas, such as restaurants, and in one case in the interviewee's home. The interview team included two NCSG staff and one university

researcher. The university researcher was present at all the interviews and one or more of the NCSG staff attended 16 of the interviews. Each interview lasted between 30 and 112 minutes for a total of 18 hours of interviews. All interviews were digitally recorded and later transcribed. As noted in the previous chapter, transcripts were coded using an open coding technique in which themes were identified and grouped together using NVivo 10 software. Transcripts were read and similar themes were grouped together to examine patterns (see Appendix C). To summarize the mental models of the interviewees, I analyzed the themes associated with environmental change and developed an influence diagram (Figure 4-3), a graph that shows the key variables of the systems as identified by the interviewees and the direction of influence. Influence diagrams have been used in risk communication and risk analysis processes to provide a visual representation for thinking about risk (Morgan et al., 2002). The influence diagram provides a basis of comparison with the discussion visualization generated from the participation workshop.

Participation Workshop and Evaluation

North Carolina Sea Grant followed the initial interviews by conducting a workshop to involve Plymouth leaders in developing strategies to adapt to climate change. The advisory committee determined the focus, based on the priorities identified in the interviews. The advisory committee selected the Vulnerability and Consequences Adaption Planning Scenarios (VCAPS) tool to provide a way to visualize the facilitated discussion. VCAPS combines a structured discussion with an interactive diagramming tool as the means to promote interaction and learning among the groups. It was developed by the Social and Environmental Research Institute (SERI), the University of South Carolina and the South Carolina Sea Grant Consortium to help engage decision-makers in interactive discussion, summarize the community's knowledge, identify gaps, and stimulate the development of strategies to adapt to climate change (Tuler, 2011). The scenario-building process results in a diagram that represents a summary of the discussion and includes management actions that public institutions may take as well as individual responses (Tuler, 2011). During the workshop, a facilitator creates the diagram on a computer

and projects it on a screen to refine discussion. Decision-makers can later use the visualization of the group discussion to integrate adaptation responses into hazards mitigation plans or other initiatives.

A trained NCSG and SERI team facilitated the VCAPS process in Plymouth. The workshop took place over a two day period, October 4 and 5, 2011. Ten civic leaders were invited to attend, seven of who participated in the initial interviews. Seven leaders attended the first day of the workshop and four returned on the second day. Those invited to participate were involved in decision-making related to flooding including the mayor, town board members, the water utility director, the county emergency coordinator, the town engineer, the police chief and the soil and water conservation director. Discussion focused on storm water management and wastewater infrastructure issues caused by flooding. The VCAPS diagram (Figure 4-5) summarizes the content of the discussion.

To assess the VCAPS process, two members of the team who did not facilitate the workshop conducted post-interviews with five of the leaders, including four who attended both days, and one who participated only on the first day. Of the four leaders who attended both days, one was part of the initial interview process. The evaluation interviews took place within the week following the workshop. The research team digitally recorded and transcribed the interview. Subsequently, they coded the written transcripts for themes using NVivo 10 software. Although the number of evaluation interviews was small, coding provided a way to group themes that arose within the interviews allowing an easier comparison of answers to similar questions. Coding also allows the comparison of theses across questions, which helps analysis when interviewees' answers expand upon a topic or overlap with separate questions. Grouping and regrouping interview answers assisted the analysis as theory emerged.

Results

Our research in Plymouth provided a number of insights into civic leaders' understanding of flood hazards and risk perception, about the barriers to sea-level rise adaptation in small towns, and about the process used to develop solutions to address risk. Although the town has significant challenges associated with poverty and other socioeconomic issues, most of the leaders expressed optimism about

the future of the community. The mental models interviews revealed divergent ways leaders thought about the environment in Plymouth. When asked about environmental change, however, interviewees focused primarily on issues related to flood risk. The public participation process to develop strategies to address flooding yielded a visual tool that promoted a shared understanding and promoted social learning. A comparison of the influence diagram based on the mental models interviews and the VCAPS diagram developed during the public participation workshop demonstrates that the process represented a majority of the concerns of the community, however some key issues were absent. Leader interviews also provided insights into the barriers to adaptation action faced by small towns with limited resources, and some of the strategies used to overcome them.

Mental Models of Plymouth's Environment

Our mental models interviews aimed to reveal a complete picture of how each interviewee thinks about a topic through open-ended questions, followed by questions focusing on the specific area of concern, i.e. environmental change, flooding, and damage to infrastructure. Study researchers asked Plymouth civic leaders to speak about what came to mind when they thought about the local environment.

Responses diverged significantly in content. Most of the interviewees spoke about natural resources or pollution, while others first mentioned social problems, such as lack of housing and jobs in the area (Table 4-3). Three individuals spoke first about hazards. Leaders mentioned the natural resource amenities associated with the region. Pollution was a concern of leaders, particularly air and water pollution associated with the paper mill. Interviewees with professions in hazards management placed flooding and house fires in the context of the social vulnerability of the town's population. They described vulnerabilities as resulting from poverty, a declining population because of unemployment and few opportunities for youth. Interviewees made links between hazards, pollution and social issues, and spoke about competing municipal priorities. Notably, interviewees did not mention climate change or sea-level rise in open-ended questions about environmental concerns.

Category	Number of Responses	Example
Natural Resources	8	Biology and geology of the region Roanoke River, Wildlife Refuges, state parks Wildness and openness and beauty Waterfront and fishing
Pollution	7	Pollution is improving Paper mill- water pollution and air pollution
Hazards	3	Flooding House fires
Social Issues	5	Housing Jobs Shrinking population Opportunities for youth

Table 4-3. Leader's mental models of Plymouth's environment

When asked about environmental change, interviewees identified the impacts and causes of several natural hazards that they had experienced in the town including flooding, shoreline erosion, drought, and sea-level rise. An influence diagram (Figure 4-3) depicts a composite of the interviewees' answers to questions about environmental change. All of the participants spoke about flooding, past storm events, and the causes of flooding, and all identified places in the community that experience chronic flooding. Localized flooding was associated with storm surge, wind tides, and too much water for the creeks and canals to drain effectively. The impacts of flooding were crop damage, property damage to homes, flooding of roads, and sewage overflow from the town wastewater system, which results in fines. Six interview participants observed shoreline erosion, particularly at the downtown waterfront. They associated damage to waterfront infrastructure and loss of property with shoreline erosion. Leaders were unsure about the specific drivers of erosion in the downtown area, but river current and sea-level rise were noted as possible causes. Four out of the 18 participants raised sea-level rise as one a possible cause of increased flooding and shoreline erosion. Two interview participants referred to future sea-level rise making these problems worse, and making more drainage pumping necessary. Interviewees identified drought as a hazard, associated with changes in rainfall patterns. They were concerned that a lack of water in the river due to drought causes saltwater intrusion, exacerbated by sea-level rise. Salt in river water prevents the paper mill from operating normally, endangering the livelihood of many Plymouth residents.

One of the leaders feared that a combination of drought and transfer of water out of the river basin might completely stop the flow of the Roanoke River. He said, "The biggest risk to the river is the cities upstream taking so much water out that it would literally dry up."

An environmental changes influence diagram below summarizes the composite mental models of the Plymouth interviewees (Figure 4-3), and is modeled after community-composed influence diagrams in Cone, et al. (2012). Although the diagram does not include every detail from the Plymouth interviews, it provides a basis for comparison against a similar diagram developed in the workshop process that took place after the interviews (Figure 4-5). The initial diagram columns list the environmental changes, change drivers and impacts mentioned in the interviews. Arrows link items from causes of environmental change on the left to the impacts of change on the right.

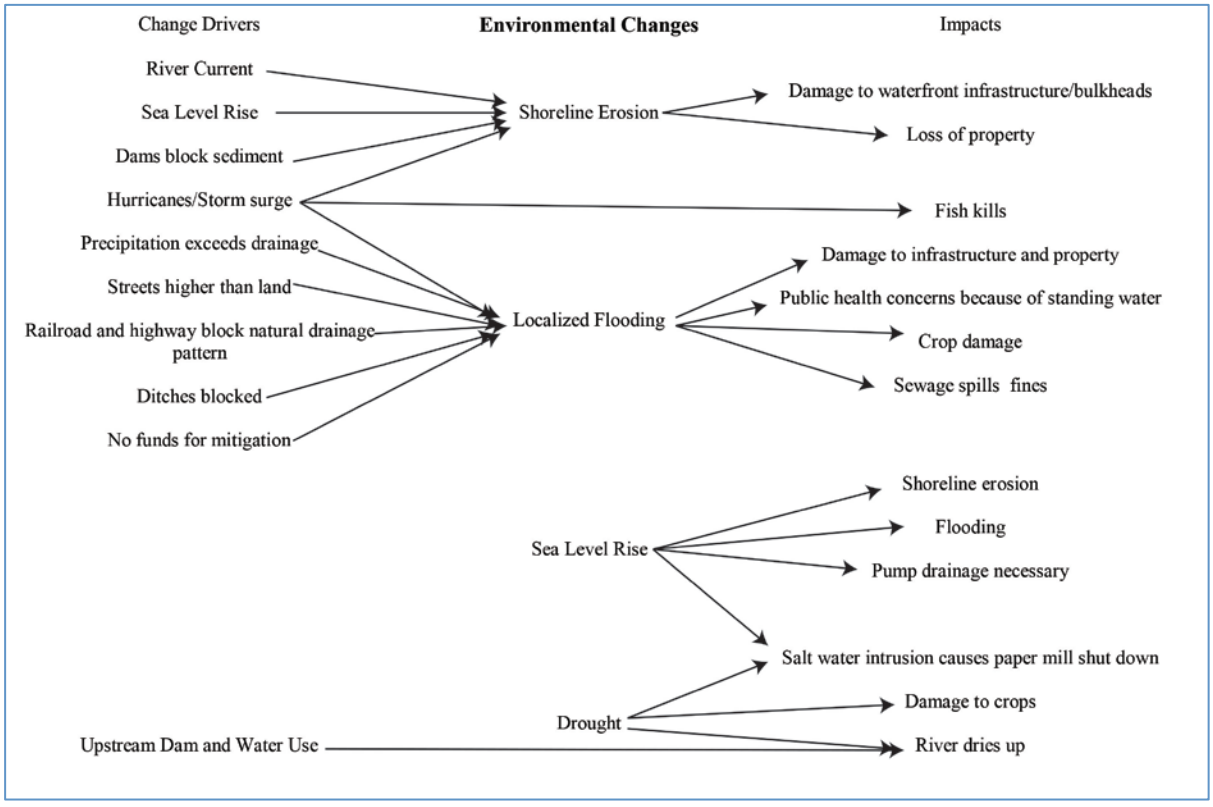

Figure 4-3. Plymouth environmental changes influence diagram

Each of the interview participants also made marks on a locally-scaled, commercially-available road map of Plymouth to indicate the areas that they had observed flooding. They were not asked to

specify the source of flooding, so flooding could be a result of wind tide, storm surge, heavy precipitation in the floodplain up river, or locally-intense precipitation. Their indicated flood regions were primarily low elevation areas close to water bodies.

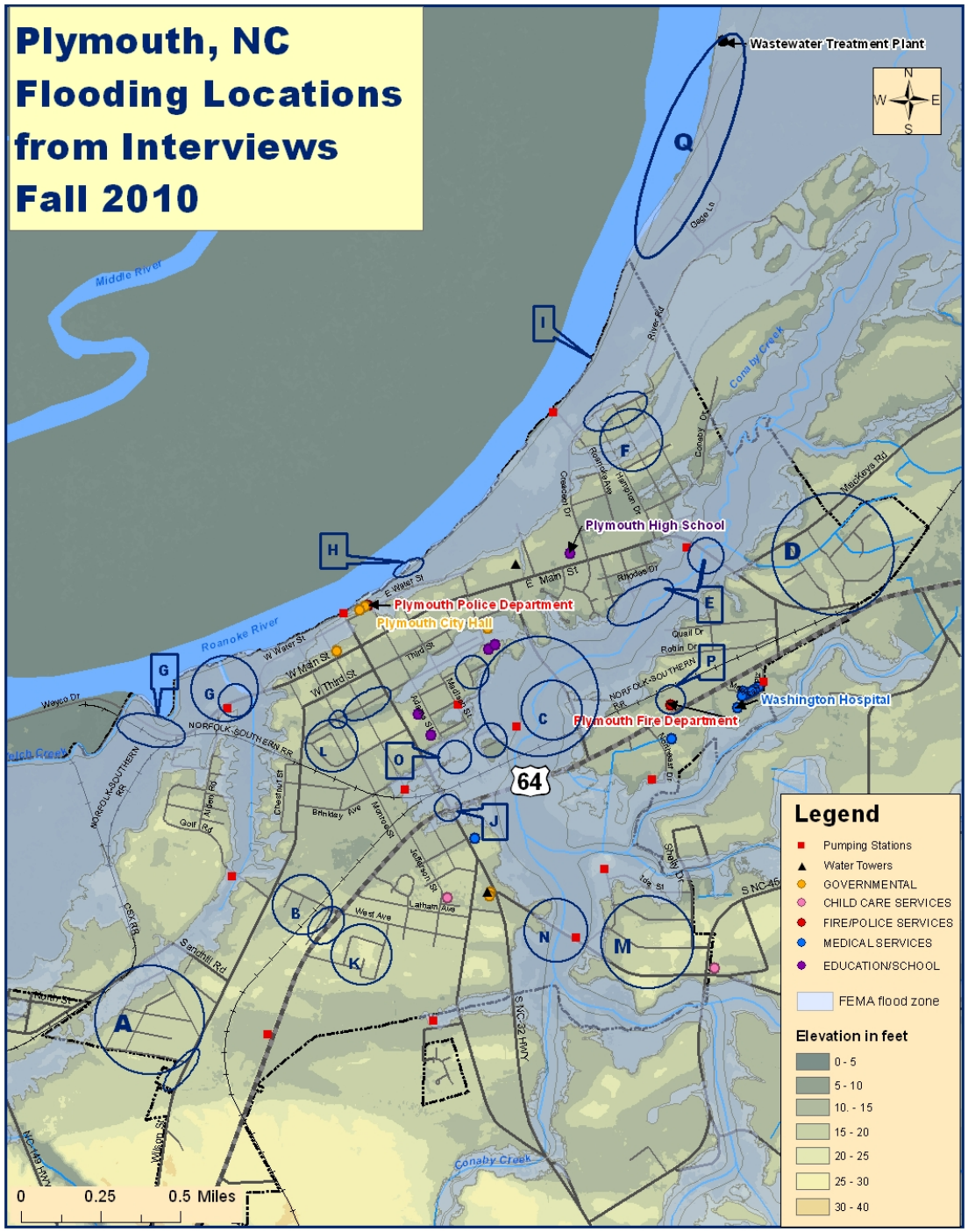

Figure 4-4. Combined flood areas from interviews

Location	Streets	Number of interviews that identified this location
A	Pine St. , Cranberry St, Cherry St., Oakford St., Park Ave., Campbell St.	4
B	Harvey St., Spencer St., West St., Truman Ave.	4
C	Rankin St. and Conaby Creek	4
D	Mackeys, Woodlawn Ter, Jackson Heights, Ridgeway, Gavin, Bradley, Patton Ct.	2
E	East Main St. and Conaby Creek	6
F	Riverside Dr., Kennedy Dr., Gen. Pettigrew, Matt Ransome, Hampton	2
G	West Main St.	6
H	Waterfront	2
I	Waterfront	1
J	Washington St and 64	1
K	Sterling Dr. , Anne St., Luvera St.	1
L	Winnsett Circle, Monroe St, Fourth Street	3
M	Old Roper Rd., Hazel St., Hillard St. ,	1
N	Old Roper Rd and Conaby Creek	2
O	Adams and Brinkley St.	1
P	Around Fire station	1
Q	Gage Lane to Wastewater Plant Roanoke Shores	3

Table 4-5. Flood areas identified during interviews

When the interview responses were then aggregated onto a single summary map, they corresponded closely with regions identified by a geospatial digital elevation model developed by RENCI at ECU to visualize potential inundation areas in Plymouth if local relative sea level reaches 4.5 feet (Figure 4-6). A majority of the few flood areas indicated by interviewees that did not match the RENCI model were located between an elevated railroad track and an elevated roadbed, or between two elevated roads. In these locations, infrastructure alterations of underlying topography worked like dams to impede floodwater from draining to lower areas.

Workshop Outcomes

As noted above, the NCSG and SERI workshop facilitators utilized the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) process, a set of participatory guidelines that use a diagramming tool to graphically depict the group discussion, which in this case focused on flooding and sea-level rise impacts on stormwater management and wastewater infrastructure (Figure 4-5). The workshop participants included two elected officials, the police chief, and four municipal managers with expertise in flood management and town infrastructure. The managers included the town engineer, the

town public works director, the county emergency manager, and the county soil and water conservation director. Workshop participants were asked to identify causes of flooding. At the suggestion of the mayor, the workshop facilitator who was composing the diagram grouped together the "climate stressors" components: sea-level rise, tropical storms, heavy precipitation upstream, and local storms, under the term "water-level rise." The mayor suggested using the term "water-level rise" to describe both the temporary flooding caused by storms and the permanent inundation caused by sea-level rise, to avoid raising issues of climate change, which might otherwise cause town elected officials to dismiss the discussion.

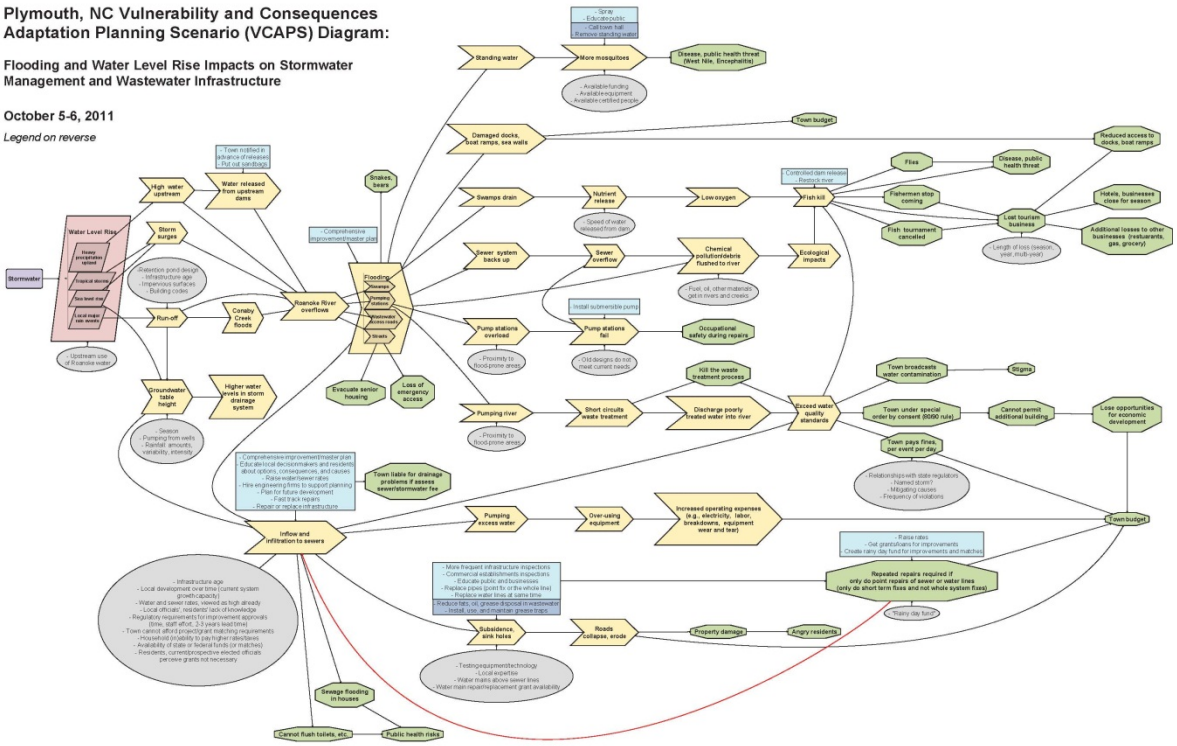

Figure 4-5. VCAPS diagram for Plymouth (NCSG and SERI)

The VCAPS diagram illustrates the facilitated discussion of factors that might increase or decrease the impact of flooding events, such as upstream dam management, infrastructure age, and building codes (Figure 4-5). Participants named actions that could mitigate the consequences of flooding, such as reducing sewer inflow and infiltration, installing grease traps to reduce land subsidence due to

sewer pipe failure, replacing or repairing other infrastructure, and creating a comprehensive improvement plan to deal with flooding, educating the public and decision-makers, and obtaining additional funding. A comparison of the environmental changes influence diagram with the VCAPS diagram demonstrates where the local knowledge, beliefs and values converges or diverges with that of the elected leaders and managers who participated in the VCAPS process. The match between the interview data and meeting diagram is imperfect, however. Standard application of the VCAPS process focuses on a specific management concern, so the resulting diagram omits several of the environmental changes observed in the civic leader interviews. The VCAPS diagram does provide a much more detailed understanding of the flooding impacts on the town, however, and includes many social impacts, such as public health concerns, economic loss, angry residents, and the effect on the town budget. On the other hand, key issues raised in the interviews, such as the social issues associated with housing and opportunities for youth, were not included in the VCAPS process. The VCAPS diagram does produce management actions and individual actions that municipal leaders could implement to create adaptation policies that were not broached in the interviews, when the project focus was more oriented toward understanding the complexity of existing attitudes and priorities than on generating workable action agendas for the future.

The study team conducted an evaluation of the VCAPS workshop to understand how the public participation process might have helped the municipality progress toward sea-level rise adaptation planning, determine if participants had learned new information, and assess participant satisfaction with the process. Opportunities for social learning built into the format of the VCAPS process helped decision-makers to learn about others' concerns and priorities. Although the mayor already had detailed knowledge of the impacts of flooding on the municipality, the other elected official who participated reported learning new information that allowed her to better understand the problem. Managers also reported learning new information from viewing the local inundation map produced for NCSG by RENCI at ECU using its digital elevation model (Figure 4-6):

> I think that a lot of the issues, the environmental issues, may have been known. I think that the town probably needs to do some homework and some thinking on how they want to manage or take mitigative actions to reduce those impacts. The new maps were telling of the environmental conditions. I think the town generally had an idea of where they are having problems but I think put that in graphical form certainly helped them.

Participants in the workshop commented that the participatory process was useful in allowing them to gain a more complete understanding of the flooding problem, its causes and impacts on the town. One participant noted that the visualization of the discussion using diagramming allowed him to understand the roles of each of the participants in the decision-making process. One of the elected officials noted that her understanding of the water infrastructure problem faced by the town deepened. She said, "Truly, I think that your council, your leaders, whether it is council, commission, whoever, should be more involved [in a participatory process] and they might understand [management issues] much better."

In evaluating their satisfaction with the VCAPS process, participants commented that the workshop was efficient and transparent. One participant said, "I think they did a very good job of bringing people from different specialties onto the room, but we all are stakeholders and we need to know what everybody else is thinking, so it was an opportunity to get everybody together and get information out on the table." Another participant said that workshop facilitation by an outside party was necessary so that there was a fair deliberation. Participants also commented about the quality of the scientific and engineering information provided by NCSG and the municipal managers. Researchers also asked workshop participants to evaluate the inclusion of important issue areas or individuals. Participants weighed the benefits and disadvantages of possibly including additional people in the process. Several said that involving others without expertise would make the VCAPS process less efficient and distract from the key management issue. Conversely, one participant said, "Where were the commissioners? Elected folks and business people could have been there, and of course the wildlife people should have been there."

Although the outcome of the process did not lead directly to a decision or action, leaders saw it as an intermediate step that built capacity in the community for future action to reduce current flooding and

future vulnerability. The VCAPS diagram included management and individual actions that decision-makers could incorporate into future stormwater management policies. One participant summed up the

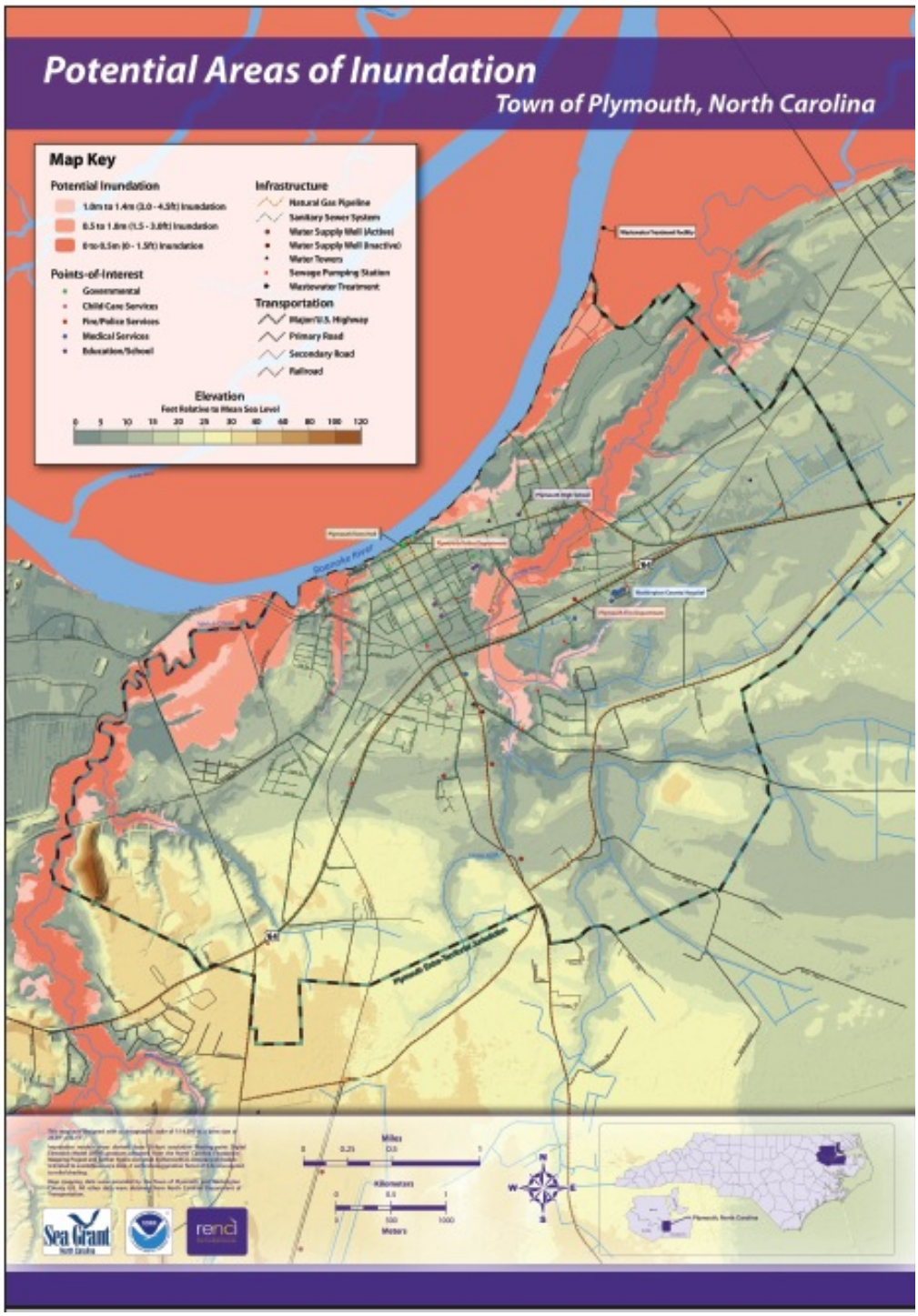

Figure 4-6. Sea-level rise risk map for Plymouth (RENCI@ECU)

process, “I think that the Town did a good job of identifying the outcomes. I think that they need to sit down and look at the response or preventive actions that they want to put in place.”

Barriers to Sea-level Rise Adaptation Policy in Small Towns

To better understand why sea-level rise adaptation policy development is difficult in small rural towns, the research team asked the civic leader interviewees to describe the barriers to addressing problems associated with the environmental changes observed. Interview answers also provided insights into the strategies Plymouth has used to overcome the barriers (Table 4-5). Lack of funds was the most commonly cited reason among interviewees for the inhibition of action to address environmental change impacts, such as flooding. When asked who bears the responsibility to address flooding in Plymouth, all of the interviewees agreed that it a municipality responsibility. To overcome the funding gaps, several interviewees mentioned grants from independent sources, but leaders described these as “scarce.” Most interviewees suggested that the federal government should help out, but another disagreed, “There is no free money. Are they going to take it from my right hand and give it to me in my left?” Another interviewee resisted the idea of loans and thought that individual property owners should be responsible for addressing flood issues.

Barriers to Action	Number of Responses	Strategies to Overcome Barriers	Number of Responses
Lack of funds	8	Increase economic base Grant money Fines as a motivating factor Storms bring funding	9
Lack of knowledge or awareness	4	Educate children Distribute information at the paper mill Remind people of storms	5
Lack of citizen involvement	4	Have a big community meeting Involve the youth	2
Political reasons	4		
Legal /Regulatory restrictions	2		
Poverty, lack of quality education, drugs and alcohol	2		

Table 4-5. Barriers to adaptation

Other barriers identified by interview participants included a lack of knowledge and awareness of natural hazards risk, and resistance on the part of elected officials to risk preparations. According to a member of the municipal staff, Plymouth suffers from a lack of education about risk, even among elected officials:

> Different places I've worked, county commissioners and town councils have been generally uneducated or not interested in any sort of environmental change or even hazard mitigation no matter what the cost or lack of cost. They are just not interested.

Four of the interviewees described political conflicts within the local government and a turnover in municipal staff leadership as barriers to addressing town problems. Interviewees also described ways to overcome barriers associated with risk awareness and community involvement. They had entrepreneurial ideas to alleviate unemployment in ways that protect the natural resources, such as the development of outdoor recreation on the river as a business opportunity.

Although the interviewees enumerated more barriers to action than mechanisms to overcome those barriers, the civic leaders' responses were optimistic and several leaders have been successful in overcoming the lack of resources by accessing outside sources of funding. For example, one of the interviewees founded an independent not-for-profit in order to obtain state grants to improve the waterfront area. Plymouth leaders have also overcome the lack of municipal resources by cooperating with university researchers and classes to bring expertise and tools that would otherwise be unavailable. In the case presented here, the mayor engaged with NCSG as a bridging organization to overcome the town lack of resources for sea-level rise adaptation.

Discussion

This case study yields several significant observations about the feasibility and process of adaptation planning in small rural towns with high socio-ecological vulnerability to sea-level rise and limited municipal capacity. Few studies of small rural towns undergoing adaptation planning projects detail the methods used to overcome planning barriers in addition to an evaluation of the public

participation process. In this case, Plymouth overcame obstacles to adaptation planning by mainstreaming the process into an existing problem to avoid political opposition, and by accessing resources through the use of a bridging organization. A comparison with other sea-level rise adaptation projects suggests that public participation processes, as outlined by the National Research Council (National Research Council, 2008) and as operationalized in the VCAPS workshop in Plymouth, are entering into standard governance practice. This study found such a process to be effective and valued by the participants, similar to findings in other communities using public participation for adaption planning (Cone et al., 2012). To limit political controversy, Plymouth municipal leaders use mainstreaming and connected adaptation activities to immediate municipal needs, not unlike other adaptation efforts in the Carolinas (Haywood et al., 2013). Bridging organizations like NCSG also contribute to resilience in Plymouth as they do in other regions (Crona & Parker, 2012), by providing locally-relevant data, and by providing a facilitated public participation approach that promotes social learning and increases municipal adaptive capacity.

Public Participation and Social Learning

The process used in Plymouth to develop strategies to adapt to sea-level rise followed guiding principles that have been previously observed by researchers to produce better quality and legitimacy in environmental decision-making (National Research Council, 2008). Participants in the Plymouth VCAPS process perceived that the collaborative process was fair and inclusive of all those in attendance. The method of graphically visualizing the discussion contributed transparency to the process, similar to "visible thinking" methods used by Cone et al. in Oregon (2012). The participants produced a detailed, thoughtful description of the flooding problem in Plymouth, and potential adaption actions. Participants reported satisfaction with the workshop, particularly its efficiency and transparency. Although this decision-making process took place on a much smaller scale than one developed in New York City, it shared aspects of the New York methods in that recruiting efforts focused on key managers responsible for city and county municipal functions, rather than on non-expert residents (who, by contrast, were

recruited in New England and Oregon processes) (Cone et al., 2012; MIT Science Impact Collaborative, 2014; Rosenzweig et al., 2011).

Successful processes depend on getting both the correct participants involved and the participation process facilitated correctly (National Research Council, 2009). The Plymouth workshop organizers used a recruitment strategy that was efficient, but not entirely inclusive of the civic leader priorities uncovered in prior interviews. A greater representation by the town council in the workshops could have achieved a wider range of input, the inclusion of additional management problems faced by the municipality, and a greater probability that decisions agendas emerging from the VCAPS process would be broadly accepted and implemented. Nonetheless, town infrastructure maintenance is a primary management responsibility of a municipality, and potentially affects all residents. If constructed strategically, future public participation process might connect the vulnerability of municipal infrastructure to flooding more concretely with other identified social priorities such as employment, declining populations, and quality of life for impoverished people. In this way, the VCAPS process can engender a second phase of incremental progress toward more climate-responsive public policy. One reasons that cities are leading many climate change adaptation efforts, even in states that do not yet have adaptation plans, is that they deal directly with the impacts of environmental change on their citizens (Rosenzweig et al., 2010). If Plymouth municipal leaders can tie adaptation to the more frequently-stated priorities of their citizens, and demonstrate that a resilient infrastructure underlies their success as a municipality where individual residents thrive, they can foster broader public acceptance and implementation of adaptation planning.

The VCAPS process built capacity within the municipality by providing an opportunity for double-loop learning that can improve the ability of the elected officials to understand the importance of funding infrastructure improvements, while managers uncover new options for action. Municipal staff who participated learned how their job related to the flooding problem, and how each staff position related to one another in this context. The VCAPS process helps connect short-term and long-term planning by embedding both within one management concern, and connecting their concern with a

"climate stressor." The discussion and diagramming activities promote learning by encouraging the group to think more deeply about the connections between events such as flooding, the context in which the event occur, the impacts of the events, and actions that can alleviate impacts. Although Plymouth is far from the triple-loop learning goal of transformative change, greater experience with public participation processes increases the capacity of the municipality to deal with environmental changes by strengthening communication between municipal personnel and creating better understanding and appreciation within the group. Unfortunately, many adaptation plans fail to go beyond assessment and capacity building (Preston, Westaway, & Yuen, 2011). To move toward resilience, Plymouth will need to take a next step of developing and implementing sea-level rise adaptation measures and confronting the barriers to action.

Overcoming Barriers to Action

Thus far, state coastal management in North Carolina has been unable to develop policy to encourage sea-level rise adaptation planning, despite apparent "policy windows" (Kingdon, 2010; Poulter et al., 2009). The mayor of Plymouth, however, used mainstreaming to side-step political controversies surrounding climate change and the causes of future sea-level rise. He coined the term "water-level rise" to mean flooding or inundation of areas, no matter the cause. Although some of the managers clearly accepted the threat of climate change-accelerated future sea-level rise, several others had difficulty, and elected officials were somewhat hostile toward the idea when it was raised. The mayor, as an advocate of the NCSG process, used mainstreaming to move past the controversy and address the town's current and most severe flooding issues. In a public meeting convened in 2013 to discuss public health implications of sea-level rise across the state, the mayor spoke about his need to avoid the use of word that trigger controversy unnecessarily. He said, "sea-level rise evokes a lot of stuff. I am an end-user and I just can't use that."

The VCAPS process stimulated discussion about potentially adaptive actions that Plymouth can take to develop policy, but the magnitude of the flooding problem is clearly beyond their means to control. Although participants in the VCAPS workshop did not raise environmental justice issues, the

Plymouth case is suggestive of dilemmas plaguing small, predominantly minority, coastal town governments that may or may not survive the pending challenges of sea-level rise (Anthony et al., 2009; Paolisso et al., 2012). Although the Plymouth leaders wish for a way to fix to their immediate flooding problems, no available physical engineering solution would address their additional suite of underlying social-economic vulnerabilities. Nevertheless, Plymouth was able to move closer to adaptation planning than other similar municipalities in North Carolina by engaging with NCSG as a bridging organization to access locally-relevant sea-level rise data and expertise, and launch initial stages of policy development.

Conclusions

The opportunity to examine a public participation process designed to help a small municipality develop strategies to adapt to sea-level rise provided an investigative window into the mechanisms that small towns use to overcome barriers when confronting difficult management problems. Small, rural and economically disadvantaged communities in low-lying coastal areas already experiencing flooding can expect their problems to become worse as sea-level rises. Developing sea-level rise adaptation responses using a public participation process promises to increase the viability and legitimacy of management decisions to address issues of flooding, and lay a foundation for corresponding policy development. Understanding the mental models and priorities of the civic leaders and involving them in a process in which they can learn from each other is an important step toward the implementation of adaption strategies that can protect lives, community investments and natural resources. The VCAPS process promotes social learning through illustrated, facilitated discussion, and produces a concise final product that captures the local and expert knowledge of the participants in a visual way that can be shared with constituents, other governance entities, and potential funding sources. Although this process is just a first step toward developing adaptive strategies, it can improve community resilience to climate change by encouraging relationships among participants that increase capacity for other types of decision-making.

This case study demonstrates that despite the challenges posed by living in a low-resource municipality that is at high risk, leaders try to find solutions that address multiple problems to improve

the quality of life. The challenge of funding specific infrastructure improvements to prevent further impacts from flooding remains unsolved. Although this study argues that leaders in Plymouth are using mainstreaming to incorporate sea-level rise risk into current flood planning, it is also possible that if leaders focus exclusively on current flooding concerns, they may distract public energies from meeting the greater challenges posed by future flood predictions. Such trading off of longer-term for shorter-term priorities becomes more likely if project funding becomes tied to state policies that continue to inhibit the development or implementation of more proactive plans.

CHAPTER 5: SYNTHESIS, CONCLUSIONS AND IMPLICATIONS

Chapter Summary

Despite increasing evidence of sea-level rise and confidence expressed by a majority of scientists about the risk of future impacts to coastal regions, many municipalities, especially small rural counties and towns, are not planning for adaptation. North Carolina, with its wide, low-elevation coastal plain, is one of the most vulnerable states in the US, yet the state General Assembly has stifled policies designed to encourage adaptation planning. This concluding chapter reviews the findings that sea-level rise risk is exacerbated by: (1) barriers to risk reduction caused by the absence of effective risk communication; (2) a lack of resources, such as locally-scaled risk information and capacity for adaptation planning in local municipalities; and (3) discourses that promote fatalism, mistrust in science and government and inaction. Insights into how municipalities might overcome these barriers was provided by the case of Plymouth, where civic leaders engaged with a bridging organization to access resources beyond their ability to provide and used mainstreaming to avoid potential political controversy. These results imply that to build resilience to sea-level rise, municipalities will need to overcome the barriers to adaptation by accessing effective risk communication, using decision-making processes that are participatory, and focusing on sea-level rise threats that overlap with immediate planning needs. Bridging organizations can bring the needed scientific, communications, and process expertise to the most vulnerable communities, and help preserve treasured coastal places .

Water's Gonna Rise: What Is North Carolina's Response?

The draft Intergovernmental Panel on Climate Change (IPCC) 5th Assessment report released in 2013 expresses even greater confidence than the previous report in the projections of accelerated sea-level rise due to improved models and better agreement about ice-sheet dynamics (IPCC, 2013). Reports examining the impacts of sea-level rise on the coast of the United States have found that sea-level rise inundation is already evident in areas of the Mid-Atlantic region, and that exacerbated storm surges pose

significant threats to public health, safety and employment in the coastal zone (Burkett & Davidson, 2013). At the time of this writing, the United States has no comprehensive, federally-coordinated effort to assess corresponding coastal vulnerabilities to sea-level rise. Rather, following the IPCC approach, federal, regional and local planning efforts have used scenarios of possible future sea levels to explore risk and support decisions depending on local needs and timelines. Using updated models, the 2012 National Climate Assessment report projects a high estimate of two meters average global sea-level rise by 2100, and a low estimate of 0.2 meters (Parris et al., 2012).

Accelerated sea-level rise is a new phenomenon, one not experienced by humans in the past. Though climate variability and sea-level change have both anthropogenic and non-anthropogenic causes, global climate and sea level have been relatively stable throughout human history, facilitating the growth of populations and complex societies (Day et al., 2007). Despite the threat, coastal population growth and urbanization is on-going, with more than 164 million US residents, over half of the national population, living in coastal regions in 2010 (Burkett & Davidson, 2013). In some locales, people are able to migrate landward to avoid inundation and storm risk. In the developed world, however, physical infrastructure, financial investments in private property, and associated social and political systems inhibit retreat from coastal settlements.

North Carolina has more than 1200 square kilometers of dry land less than one meter above mean high water at risk of inundation by 2100, making it one of most low-lying states on the U.S. (Strauss et al., 2012). Its northeastern region is a "hotspot" of acceleration with localized rise rates 3-4 times higher than the global average (Sallenger et al., 2012). Researchers recognized the state's vulnerability as much as 25 years ago, and diverse studies into the likely impact of sea-level rise to geomorphology, ecological processes and socio-economic systems of the region have been on-going (Poulter et al., 2009). Despite sea-level rise risk reported in scientific venues and the media, adaptation planning at the state and local level has lagged. In addition, state legislation in 2012 placed a four year moratorium on the determination of sea-level rise rates for purposes of planning or regulation. This action by the North Carolina General

Assembly seriously encumbers any first step in sea-level rise risk assessment, and subsequent risk reduction and adaptation planning efforts.

This dissertation provides insight into the ways in which sea-level rise risk is socially produced through the creation of barriers to planned adaptation. Risk perceptions, framed by hegemonic discourses that promote fatalism, reinforce existing social vulnerabilities, and amplify severe storm risk inequities. Lack of resources, including locally relevant sea-level rise risk information, inhibit the consideration of local impacts, and increase the perception that the threat is temporally and spatially distant. An audience-driven methodology examines comprehension of risk communications and attitudes about the information, gaps in understanding, and pitfalls in communications approaches. Knowledge of audience attitudes and competencies contributes to a better understanding of how people conceptualize information about complex and uncertain risk, and can facilitate better risk communication. The exploration of the process one town used to develop strategies to respond to sea-level rise allows insight into the techniques used in real-world situations to overcome barriers to adaptation planning. Mainstreaming sea-level rise adaptation into current management challenges, and leveraging the ability of a boundary organization to provide information and facilitation resources that are not locally available, allowed the town to move toward resilience, and provides a model for other similar municipalities.

Using a multi-scalar research approach allows the examination of sea-level rise risk at individual, group, and landscape levels. The causes of sea-level rise are global and regional, yet the risk is experienced at the local level, and adaptation will take place across many nested jurisdictional and social landscapes (Adger et al., 2005). The multi-scalar approach is particularly suited to sea-level rise risk research because it allows the integration of biophysical and social conditions within a socio-ecological context. The modern concept of risk governance goes beyond the jurisdictional boundaries and government entities to include diverse groups including non-governmental organizations, business, and civic groups (Boyte, 2005; Renn, 2008). Environmental management is a particularly complex type of governance due to the diverse scales at which physical and societal interact, making the response difficult, and requiring innovation and cross-cutting approaches (Meadowcroft, 2002). Attention to scale allows an

examination of the human-environment interaction with particular emphasis on the political or power regimes that influence both risk perception and risk management approaches.

North Carolina's response to sea-level rise will depend upon the attention drawn to the issue by the public as well as the response from elected officials and coastal managers. By understanding the relationship between risk perceptions, the social construction of risk, and the processes used to overcome the barriers to risk reduction, a more complete picture of risk response and the potential for building resilience emerges. This study provides a framework for examining risk governance and demonstrates methodologies to assess risk perception mechanisms and outcomes at multiple scales. Placing risk perception at the center of governance, and allowing those most affected by the risk to help frame policy-relevant research into risk, is a model that can apply to other complex human-environment governance regimes.

Risk Perception and Communication

Risk perception depends upon a personal judgment about the association of harm with a potential future hazard. In the case of sea-level rise risk, many people judge it to be distant, both spatially and temporally. To be an effective tool for risk management, communications must take into account the variety of knowledge bases, attitudes and worldviews of the audience. As detailed in the preceding chapters, sea-level rise risk communication faces significant barriers to conveying information about risk and response including difficulties with comprehension, discomfort with scientific uncertainty and complexity, and emotional responses that prevent people from being able to accept information as given. Barriers to communications are also barriers to risk reduction because individuals cannot take either personal or collective action if they are not aware of, or do not understand, the risk. Risk communicators use techniques such as bridging metaphors, framing, and visualization to move past barriers and provide information that can build resilience. The development of sea-level rise risk communication tools for northeastern North Carolina requires careful science translation and attention to addressing the attitudes and opinions of the audience.

The research design in Chapter 2 used a document-based methodology to assess reader comprehension, risk perception and attitudes about sea-level rise information. While two-thirds of people participating in that exercise were familiar with the issue of sea-level rise, only about half of the participants could correctly interpret information from graphs and maps that visualized details of the rate and geographic locations in which sea-level rise is taking place. Roughly half of the participants struggled with graphs and maps or incorrectly answered questions about them, and some didn't even try to interpret them. Localized information drew the attention of readers, but that did not necessarily increase their comprehension. While people were concerned about sea-level rise, they were not particularly concerned about their personal risk because they viewed the threat as temporally and spatially distant. The risk perception findings underscore the notion that sea-level rise is a hidden hazard, globally elusive and politically charged, so that people have difficulty framing it as one that they can address. Fear, skepticism, discomfort with uncertainty, and fatalism were among the risk perceptions evoked in residents when they read about projections of sea-level rise for their area. Questions of sea-level rise risk agency and governance arose. Specifically, people considered who should adapt, who is responsible for adaptation action, and how potential adaptation policies might affect local economic activities. Risk communicators serve an important role in negotiating issues of agency and developing sea-level rise risk governance strategies (Renn, 2008). This research suggests that to be effective, risk communicators must pay close attention to how they use visual representations of scientific findings and terminology, and how they address existing risk perceptions within their audience. The methodology presented provides a way that risk communication practitioners might engage in a dialogue with the public and contribute to the development sea-level rise resilience.

The Social Production of Sea-Level Rise Risk

As detailed in Chapter 3, natural hazards risk has been characterized as the outcome of the interaction between a hazard, such as fire, flood or earthquake, the physical exposure that a population has to the hazard due to their geographic location or ecological conditions, and the vulnerability of that

population due to largely social, economic and cultural factors (Wisner et al., 2004). The hazard component of sea-level rise risk is complex in that it not only causes inundation risk, it also exacerbates other hazards such as storm surge and flooding. In this case, existing social vulnerabilities are reinforced and increased due to the politically-charged nature of the predominant local discourses, which frame the hazard as an "act of nature," inevitable, and an inherent experience of life in a coastal community. Some people living in low-lying areas may be members of a marginalized population, susceptible to flooding due to their economic or social inability to move away from the hazardous area. Others may choose to live in hazardous areas to benefit from environmental amenities, such as water access (Collins, 2010). Chapter 3 revealed how fatalism is produced when people are made aware of a risk, but are confronted with a lack of information or a way to respond. Fatalism is also promoted discourses of mistrust of science and management.

In northeastern North Carolina, sea-level rise risk assessment and management is a contested issue. On one side, an organization that represents coastal real estate interests has promoted the mistrust of sea-level rise science, which models future sea-level and projects the inundation of large land areas. On the other hand, scientists, managers and others are concerned about the potential damage to both human and ecological systems, should the projected impacts come to pass. Instead of promoting sea-level rise resilience through adaptation planning, state law in 2012 codified barriers by restricting the ability of agencies to create planning targets and dampening the effort to create sea-level rise policy. Powerful social elites hold back the process of sea-level rise adaptation policy development in order to protect their ability to use hazardous places and thereby create personal wealth. Meanwhile, residents of socially vulnerable areas become further marginalized due to their inability to garner outside resources to support adaptive actions. The uneven distribution of risk within the coastal hazardscape is made legitimate through fatalistic discourses that circulate within and among these groups. To reduce risk, municipalities can nonetheless find ways to overcome barriers to adaptation planning by reframing sea-level rise risk to avoid fatalism and develop mechanisms to help socially vulnerable groups increase their adaptive capacity.

Sea-level Rise Hazard Policy-Making

As described in Chapter 4, public participation in environmental decision-making is an increasingly important way to improve the quality, legitimacy and relevance of decisions, especially ones that are potentially contentious (National Research Council, 2008). Policies developed through a process that involves stakeholder input have a better chance of successful implementation (Dietz et al., 2009). In addition, a facilitated public participation process is likely to increase the capacity of the community to engage in future collaborative decision-making. The Plymouth case study shows that understanding the risk perceptions within the municipal population allowed collaborating partners to frame a sea-level rise adaptation process that participants judged successful. Addressing all priority issues raised by the risk perception activities may not be possible, but focusing on the ones that connect to sea-level rise and have local relevance can move the process forward. Bringing key managers together with elected officials and having locally-scaled risk assessment information fosters learning, builds relationships, and increases the likelihood that the management strategies developed will achieve practical implementation.

Nonetheless, public participation processes aiming to find strategies to deal with sea-level rise risk depend on the availability of human and financial resources that are beyond the capacity of the northeastern North Carolina populations most in need. Some elected leaders in these areas are politically conservative, skeptical about climate change, and hostile toward environmental regulation. By mainstreaming sea-level rise adaptation planning into other activities, such as hazard mitigation planning, municipal managers are able to effectively side-step objections (Haywood et al., 2013). Plymouth leaders were able to overcome barriers to sea-level rise adaptation planning by using mainstreaming to avoid politically- charged controversies over sea-level rise science, and leveraged opportunities to work with North Carolina Sea Grant, which provided scientific expertise and facilitated their meeting for strategy planning. Although the town has not yet overcome the barrier of finding funds to implement a plan, the participatory process has moved them toward greater sea-level rise resilience.

Policy Implications: Building Sea-Level Rise Resilience

The concept of resilience arose within study of ecological systems to describe the capacity of a system to continue to have the same function and structure, despite disturbance (Holling, 1973). In common usage, coastal resilience has expanded on this meaning to include flexibility, adaptability, and durability for the region and its communities (Beatley, 2009). Resilience serves as a function of the capacity for adaptation, reduces vulnerability, and increases as a result of planned adaptation (IPCC, 2013). The concept of resilience also includes the idea that individuals or groups should not necessarily return to some state of existence identical to the time period preceding a disturbance or disaster, but should instead improve in ways that reflect continued adaptation to changing socio-ecological conditions and goals (Beatley, 2009). To build coastal resilience, municipalities need to think holistically and plan for the long-term. While leaders must confront political, economic, and practical obstacles to plan for sea-level rise resilience, the research presented here points to some possible strategies that can help move municipalities toward risk reduction. Sea-level rise adaptation planning promises to be a difficult and contentious process in North Carolina for many years to come. Building on this present body of research, however, I also see promise for success in the facilitation of planning activities as outlined in the next three subsections: by using effective risk communication, public participation techniques, and boundary organizations.

Effective Risk Communication

Effective risk communication is widely accepted by scholars as a key practice needed to move toward disaster-resilient communities (Renn, 2008). Goals for effective risk communication include raising awareness, educating, motivating action toward risk reduction, fostering agreement within a risk reduction strategy process, and building trust in the message and messenger (Rowan, 1991). To accomplish these goals, a risk communicator must make sure that the intended recipients of the message are able to understand it, that a level of confidence is built in risk management, and that the message

promotes change in behavior with respect to the risk (Renn, 2008). Sea-level rise risk is a complex topic that is difficult to communicate. Human exposure to sea-level rise is often involuntary, generally happens too slowly to permit direct human observation, and is perceived as temporally and spatially remote. Clear communication of appropriate scientific information is critical. It is also important for risk communicators to find new ways to describe scientific uncertainty. Risk perceptions such as discomfort with uncertainty can be addressed by using non-expert, rather than scientific terminology. Above all, it is important to make certain that communications meet the needs of the recipients' at their operant levels of scientific understanding. The use of visual information, such as photographs and diagrams, can be a key way to convey information, but only if people understand them. When scientific literacy and numeracy is lacking, communicators should seek alternatives to scientific graphs and terminology.

More information and better scientific literacy and numeracy, however, are not likely to change politically driven attitudes (Kahan et al., 2012). To address risk when there is cultural polarization, risk communicators may find it more strategic to focus on building trust in the message and use appropriate cultural frames to focus the message. Kahan, et al. (2011) found that individuals form risk perceptions that express their cultural values. To build trust in science among skeptics, messages that incorporate their cultural values, and use of messengers with trusted affiliations may be effective. Addressing fatalistic perceptions may depend on giving people options for both individual and collective action. Risk communication, effectively done, can create a dialogue between those managing sea-level rise and those most affected by it. The relationships formed as a result of sea-level rise risk communication and adaptation may also increase the capacity of groups to confront other human-environment issues.

Participation: Start to Finish

Involving the public in environmental decision-making, when done well, improves the perceived fairness and legitimacy of decisions, and builds trust and understanding between those involved (National Research Council, 2008). Sea-level rise adaptation planning offers the opportunity for engaging stakeholders in a process that can enhance not only the decisions about immediate problems, such as

frequent flooding and shoreline change, it also creates capacity for cooperative action when tackling other community issues or during a crisis. Relationships formed by cooperative decision-making can persist to ease collaboration through routine interactions and help bridge social barriers. Inclusiveness of participation, however, needs to be balanced with efficiency of process, so that the local knowledge and interests are represented, but scarce time and resources invested are not squandered. Outside facilitation can often help with time boundaries, keep the participation balanced and the discussion focused. To make decisions about complex issues such as sea-level rise adaptation, scientific and technical information, risk assessments, and vulnerability information must be communicated clearly to support engaged participation. When risk communication and public participation processes successfully reinforce one another, social learning can occur that moves groups beyond collaboration to shared action and reflection (Armitage, Marschke, & Plummer, 2008). Sea-level rise adaptation planning can potentially evolve into adaptive co-management, in which evaluation and iteration allow groups to find the most appropriate solutions to both existing and potential sea-level rise impacts.

The case study in Plymouth demonstrates that involving the public from the start can yield a process that has a greater potential for success. While Plymouth has only begun the process of adaptation, and is limited significantly by a lack of financial resources, they have succeeded in by-passing significant barriers to adaptation planning. Similar municipalities seeking to build their sea-level rise resilience might also use facilitated discussion processes that allow policy-makers, managers, technical experts and other stakeholders to fully understand the complexity of sea-level rise impacts and how management issues are interconnected. The participation of key individuals within a group is essential to the success of adaptation planning, and to accurately represent the knowledge and values present. When the values, perception, and power structures within a social group are represented through participation in the process risk governance, a more adaptable, resilient society becomes possible (Adger et al., 2009). Planning across all municipal management sectors, such as drinking water, waste water, emergency, and natural resource management, can encourage this resilience.

Overcoming Barriers to Adaptation

Although climate change adaptation planning is occurring at many scales of government, and within numerous private and non-profit sectors, implementation still lags (Bierbaum et al., 2013). While it is important that adaptation planning and support for resilience take place at multiple scales, much of the plan implementation ultimately occurs at a local level. Federal and state agencies are critical in providing resources not otherwise locally available, such as scientific information and financing for large projects. States, regions, and major cities such as New York City and Chicago have been able to create adaptation plans using their existing resources, including close relationships with the federal government. Smaller cities and towns in vulnerable regions do not have access to these resources yet still need adaptation planning.

For these reasons, bridging organizations, like Sea Grant extension, can serve several crucial roles in the local adaptation planning process. Cities and towns in special circumstances, such as those near federally-funded National Estuarine Research Reserves, have used their relationships to facilitate sea-level rise planning. First, as trusted brokers of scientific information, these organizations can provide sea-level rise risk communications to help raise awareness of the issue and provide basic educational materials to demonstrate the scientific basis for concern. Second, as an independent outside agency, they can facilitate a decision-making process that may be judged to be more fair than one conducted by those within the community. With both the scientific resources and expertise absent within local municipalities, boundary organizations are in a position to promote social learning and build capacity that will be retained within the municipality (Clarke et al., 2013). These organizations can also be efficient in their roles as conveners, because, experienced staff from the organization can move from one municipality to another, providing their expertise as needed. By taking the time to explore pre-existing risk perceptions of local community members, boundary organizations and municipalities can establish appropriate processes to advance sea-level rise risk reduction.

Final Comments

In 2008, Poulter, et al. suggested that the scientific, management, and political climate in North Carolina were such that sea-level rise adaptation policy had an opportunity to develop. Contrary to that prediction, by 2012 the state's political climate, legislation, and administrative priorities discouraged progress toward adaptation planning at the state and local levels. This dissertation has described barriers to adaptation planning, and explains some of the reasons that sea-level rise adaptation policy has been so difficult to advance in North Carolina. Sea-level rise risk is socially produced through fatalistic risk perceptions, gaps in the comprehension of risk communications, and discourses that promote mistrust of science and management. A better understanding of sea-level rise risk and the factors that amplify it may help coastal managers, municipal decision-makers, and boundary organizations to develop tools and techniques to address risk reduction.

Sea-level rise resilience is an important goal for all coastal regions to protect the natural resources, human lives, and economic livelihood of coastal settlements. While each coastal region will need to address its specific challenges, effective risk communication, and the use of public participation processes to incorporated local knowledge and attitudes into the adaptation process, are essential to success. Rising sea levels will not stop, and coastal regions will adapt, but by planning adaptation and building resilience, we may be able to preserve some of the coastal places, ecologies and cultures that we treasure. As J.R.R. Tolkien wrote in *The Hobbit*, "It does not do to leave a live dragon out of your calculations, if you live near him."

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APPENDIX A: IRB PERMISSIONS

UMCIRB #:

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UMCIRB

UNIVERSITY AND MEDICAL CENTER INSTITUTIONAL REVIEW BOARD
REVISION FORM

UMCIRB #: 10-0421 **Date this form was completed:** 10/27/2010
Title of research: Adapting to Environmental Change in Small Coastal Cities: Risk Perception and Communication in Plymouth, NC.
Principal Investigator: Michelle Covi
Sponsor:

Fund number for IRB fee collection (applies to all for-profit, private industry or pharmaceutical company sponsored project revisions requiring review by the convened UMCIRB committee). If you are a non-ECU entity payment is required at the time of submisison:

Fund	Organization	Account	Program	Activity (optional)
		73059		

Version of the most currently approved protocol: 7-30-2010
Version of the most currently approved consent document: 7-30-2010

CHECK ALL INSTITUTIONS OR SITES WHERE THIS RESEARCH STUDY WILL BE CONDUCTED:
☒ East Carolina University
☐ Pitt County Memorial Hospital, Inc
☐ Heritage Hospital
☐ Other
☐ Beaufort County Hospital
☐ Carteret General Hospital
☐ Boice-Willis Clinic

The following items are being submitted for review and approval:
☒ Protocol: version or date 10-27-2010
☐ Consent: version or date
☐ Additional material: version or date

Complete the following:
1. Level of IRB review required by sponsor: ☐ full ☒ expedited
2. Revision effects on risk analysis: ☐ increased ☒ no change ☐ decreased
3. Provide an explanation if there has been a greater than 60 day delay in the submission of this revision to the UMCIRB.
4. Does this revision add any procedures, tests or medications? ☐ yes ☒ no If yes, describe the additional information:
5. Have participants been locally enrolled in this research study? ☐ yes ☐ no
6. Will the revision require previously enrolled participants to sign a new consent document? ☐ yes ☒ no

Briefly describe and provide a rationale for this revision I am adding a scientific expert component to the study. I plan to interview experts that may have knowledge of the area, but do not live in Plymouth. My interview instrument is different for this group. (attached).

Michelle Covi — Michelle Covi — 11/2/2010
Principal Investigator Signature **Print** **Date**

Box for Office Use Only

The above revision has been reviewed by:
☐ Full committee review on _____ ☑ Expedited review on 11-3-10

The following action has been taken:
☑ Approval for period of 11-3-10 to 8-2-11
☑ Approval by expedited review according to category 45CFR46.110
☐ See separate correspondence for further required action.

Susan McCammon — Susan McCammon — 11-3-10
Signature **Print** **Date**

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building• 600 Moye Boulevard • Greenville, NC 27834
Office **252-744-2914** • Fax **252-744-2284** • **www.ecu.edu/irb**

TO: Donna Kain, PhD, Department of English, ECU, Mailstop 555

FROM: UMCIRB

DATE: April 25, 2011

RE: Expedited Category Research Study

TITLE: "Risk Communication and Perception of Climate Change and Adaptation in Northeastern North Carolina"

UMCIRB #11-0251

This research study has undergone review and approval using expedited review on 4.13.11. This research study is eligible for review under an expedited category number 6 and 7. The Chairperson (or designee) deemed this **North Carolina Sea Grant** sponsored study **no more than minimal risk** requiring a continuing review in **12 months**. Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The investigator must adhere to all reporting requirements for this study.

The above referenced research study has been given approval for the period of **4.13.11** to **4.12.12**. The approval includes the following items:

- Internal Processing Form (dated 4.8.11)
- Conflict of Interest (dated 4.8.11)
- Informed Consent (rec. 4.12.11)
- Grant Application
- Curriculum Vitae: Donna Kain, PhD & Michelle P. Covi
- Flyer
- Interview Draft/Questionnaire
- Sea Level Rise Information Packet

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

APPENDIX B: INTERVIEW INSTRUMENTS AND ASSOCIATED DOCUMENTS

Protocol for Document-based Resident Interviews

Sea-Level Rise Adaptation Document Usability Interview (D1)

Introductory Comments

Thank you for agreeing to participate in this interview.

This interview is part of a project to understand how coastal residents understand and respond to information about future sea level rise. The information that you provide will help us to improve our communications and better prepare our communities for coastal hazards.

This interview will be recorded so we can better understand your thinking. Your responses will all remain confidential and only be reviewed by our research team. The interview should take 60-90 minutes.

*Informed consent

Please read the brochure completely and mark with a plus any portion that you respond to positively for any reason, and mark with a minus any part that you respond negatively for any reason. You can mark any portion of the document from a word or color to sentences, paragraphs or whole pages. I will give you some time to read and then ask you some questions about your reaction.

After we finish with the interview, I will ask you to complete a written survey about the document and some general questions . Please use the document as a reference when completing the document survey questions.

Do you have any questions?

(Give the brochure to the participant to read.) Take as long as you need. There are no right or wrong answers—we're evaluating the document, not the people reading it! Please let me know when you are finished reading and marking the brochure.

Document Interview

Do you have any overall comments or impressions about the document?

Is this topic familiar to you? If so, where did you read or hear about it?

Plus-minus assessment

Now let's look at what you've marked. *(Work through section by section and make notes)*

Is there any information that you think is missing from this document?

If you were interested in learning more about this topic, where might you go to look for information?

Did you learn anything new from the document? What?

Is sea-level rise something that concerns you? Why or why not?

Do you think communities in eastern North Carolina need to prepare for sea-level rise? Why or why not?

Individual Information

I am a resident of r Washington area r Roanoke Island area

I live in a r storm surge zone r high risk flooding zone r neither r I don't know

How long have you lived in this location?

Have you lived in another location with storm surge or flood zone risk?

What is the highest level of education you have completed?

r some high school r high school r 2-year or vocational degree

r 4-year degree r graduate or professional degree

Annual income? r less than $20,000 r $20,000-49,999 r $50,000-74,999 r $75,0000-99,999 r $100,000+

Age? r 18-29 r 30-49 r 50-64 r 65+

Gender? r Female r Male

Ethnicity? r White/Caucasian r Black/African American r Hispanic/Latino/a r Other_____

Do you have experience with technical information such as given in the document through your work experience or as a student? If so, explain briefly.

_____ _____

_____ _____

Where do you get your news information?_____

Document Questions (D1- Sea Level Rise What does it mean?)

Please check the one best answer for the multiple choice and yes/no questions.

1. Is sea level rising equally in all coastal regions? r Yes r No

2. How much has global mean sea level increased since 1960 (according to Figure 1)?
   r0 mm r 50 mm r 100 mm r 200mm

3. Where along the coast of the Carolinas is the sea level rising the most (see Figure 2)?
   r Wilmington r Beaufort r Georgia Border r Virginia Border

4. During the last hundred years, global sea level has risen an average of about
   r half a foot per century r a foot per century r a foot and a half per century
   r two feet per century

5. According to figure 3, if the rate of sea level rise increases due to both warmer ocean temperatures and the melting of ice sheets, then global sea level will rise in the range of
   r 0.45-0.65 ft r 0 .6-1.9 ft r 1.6-4.6 ft r 2.6-6.6 ft

6. How do increasing global temperatures affect sea level? _____

   _____

7. Is it true that sea level rise can affect where flooding occurs during storms? r Yes r No

8. Is it true that sea level rise can affect how much it rains? r Yes r No

9. A strategic action that is designed to accommodate for sea level rise is
   r an erosion prevention structure such as a sea wall
   r no permanent building allowed in the potential future flood zone
   r elevating buildings within the potential future flood zone
   r retreating from low lying areas

10. How do scientists expect sea- level rise to impact our coastal communities?

Document Questions (D2- Sea Level Rise and North Carolina)

Please check the one best answer for the multiple choice and yes/no questions.

1. Areas on the map shown on the front page that are red may be under water when the sea level has risen r0.38 ft r1.25 ft r 1.64 ft r 3.28 ft

2. Is sea level rising equally in all coastal regions? r Yes r No

3. How much is sea level expected to rise by 2100 if the warming trend in the ocean over the last century is considered (according to the figure "Future Sea-level Rise)? r0.38 ft r1.25 ft r 3.25 ft r 4.6 ft

4. During the last hundred years, sea level has risen an average of about
   r half a foot per century r a foot per century r a foot and a half per century
   r two feet per century

5. Marsh grass plantings that help prevent erosion are known as r bulkheads r seawalls r living shorelines r freeboard

6. How do increasing global temperatures affect sea level? _____

   _____

7. Is it true that sea level rise can affect where flooding occurs during storms? r Yes r No

8. Is it true that sea level rise can affect how much it rains? r Yes r No

9. A strategic action that is designed to accommodate for sea level rise is
   r an erosion prevention structure such as a sea wall
   r no permanent building allowed in the potential future flood zone
   r elevating buildings within the potential future flood zone
   r retreating from low lying areas

10. How do scientists expect sea- level rise to impact our coastal communities?

Informational Documents Used in Resident Interviews

5 How much will the sea level rise in the future?

Predicting how much sea level will rise is difficult because changes in sea level vary over time and are not the same worldwide. There are many factors that influence SLR, and these factors and their interactions are not completely understood. Scientists must therefore make many assumptions and choices that influence the prediction of SLR. This leads to a wide range of estimates of future SLR. Whether SLR will follow the lower or higher rates shown in Figure 3 will depend upon several factors, including:

1. *How much carbon dioxide (CO2) and other greenhouse gasses are in the atmosphere.* More CO2 and other greenhouse gasses in the atmosphere will lead to greater global temperature increases. As the temperature gets warmer, ocean water will expand more, resulting in higher sea levels.
2. *How much temperature rises with increasing amounts of CO2 in the atmosphere.* The 2007 IPCC report estimates that temperature will rise 2°C-4.5°C (3.6°F-8.1°F) every time the amount of CO2 in the atmosphere doubles. Larger increases in temperature will speed up the rate at which glaciers and ice sheets melt, causing global sea level to rise faster.
3. *How fast the Antarctic and Greenland ice sheets melt.* Sea level would rise about 70 m. if all the glaciers, ice sheets, and ice caps melted. The rate of ice melt will depend on how fast temperature increases and many other factors affecting the movement of ice that are not well understood.

6 How does rising sea level impact the Carolinas?

Rising sea level may lead to significant economic and environmental losses, and threaten the safety to people living near the coast. The possible impacts are numerous, including:

- Permanent flooding of many low lying areas – leading to the loss of wetlands, wildlife habitat, and disruption of transportation infrastructure such as ports, railroads, and highways.
- Increased amount of salt within freshwater supplies – leading to possible contamination of drinking water supplies and harm to wetlands.
- Increased coastal erosion along many beaches – leading to more frequent damage to coastal property, higher demands for beach renourishment, and altered recreation and tourism uses.
- Expanded area vulnerable to coastal storms – leading to greater damages and safety risks.

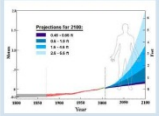


Figure 3: Estimated SLR from 2000-2100 based on four possible scenarios.

.45- .65 ft.
This estimate assumes that the rate of SLR for the next 100 years will be the same as the last 100 years.
Source: Church and White (2006).

0.6- 1.9 ft.
This estimate is from the IPCC. It assumes that the rate of SLR will accelerate, but this estimate does not include the rapid movement and loss of the Antarctic and Greenland ice sheets.
Source: IPCC (2007).

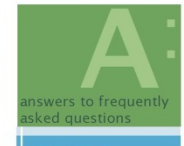
1.5- 4.6 ft.
This estimate is based on the historic relationship between temperature and sea level and future levels of atmospheric CO_2.
Source: Rahmstorf (2007).

2.5- 6.5 ft.
This estimate represents the high end of SLR by 2100. It is higher than the other estimates because it includes both acceleration of SLR and the rapid movement and loss of ice.
Source: Pfeffer (2008).

Modified image from Weather Underground (www.wunderground.com)

Sources:
Church, J.A., and N.J. White, 2006: A 20th century acceleration in global sea-level rise. Geophys. Res. Lett., 33, L01602, doi:10.1029/2005GL024826.
IPCC, 2007: Observations: Oceanic Climate Change and Sea Level. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
NOAA, 2010: Digital Coast: Digital Coast in Action. http://www.csc.noaa.gov/digitalcoast/action/hazards/images/chiflood.jpg. Accessed Jan 2010.
Rahmstorf, S., 2007: A Semi-Empirical Approach to Projecting Future Sea-Level Rise. Science 315 (5810), 368. (19 January 2007).
Pfeffer, W.T., J.T. Harper, and S. O'Neel, 2008: Kinematic Constraints on Glacier Contributions to 21st Century Sea-Level Rise. Science 321 (5894), 1340. (5 September 2008)
Weather underground, 2010: Dr. Jeff Masters' wunder blog. http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=1255. Accessed Jan 2010.

Publication of this fact sheet is sponsored by the National Oceanic and Atmospheric Administration (NOAA) through a grant administered by the S.C. Sea Grant Consortium, under Grant No. NA06OAR4xxxxxx.
SCSGC- G-11- 02
UNC- SG-11- xx
PUBLISHED APRIL 2011



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blogs.ncseagrant.org/coastalclimate

7 What are some of our options for responding to SLR?

As sea level rises faster, there are three general ways to react: *protect, accommodate,* and *retreat.* We could *protect* against the physical impacts of SLR by building hard structures like seawalls, but both North Carolina and South Carolina limit where such structures can be built. We can also decide to *accommodate* SLR through actions like elevating buildings, improving drainage, and preventing development in areas critical for the inland movement of marshes. However, when sea levels become too high, we may choose to *retreat* from threatened structures along the coast and inland wetland areas that are in danger of becoming inundated. It is very important for communities to weigh tradeoffs between the benefits and costs of each option; one community's solution may not be reasonable for a neighboring community.

8 How are people planning for SLR?

Planning for SLR requires efforts from many different sectors and organizations, including federal and state agencies, local communities, academic and scientific institutions, non-governmental organizations, and the private sector. The following are examples of resources in the Carolinas that can help with planning for SLR.

Federal agencies help coordinate planning across national, regional, and local levels. These resources include data and monitoring tools, funding mechanisms, and information to identify and assess local risks, vulnerabilities, and adaptation actions.

- NOAA Coastal Services Center:
  Digital Coast http://www.csc.noaa.gov/digitalcoast/
  Coastal Climate Adaptation http://collaborate.csc.noaa.gov/climateadaptation

State agencies assess statewide and local risks as well as develop consistent policies and best management practices to address shoreline changes.

- NC Risk Management Study http://www.ncsealevelrise.com/Home
- SC Shoreline Change Initiative http://www.scdhec.gov/environment/ocrm/shoreline_change.htm

Local communities develop community-oriented adaptation strategies to minimize risk to infrastructure, natural resources, public health, businesses and the economy, and ecosystems and the natural environment. These activities can be done through land use, hazard mitigation plans, or in collaboration with federal and state government, academic and scientific institutions, non-governmental organizations, and the private sector.

- Through our climate extension program, Sea Grant and the Carolina Integrated Sciences and Assessments (CISA) partner with communities to assess local needs and develop adaptation strategies and tools for decision making.
  http://www.cas.sc.edu/geog/research/cisa/SARP.html

Non- governmental organizations advocate the need for site specific projects to increase the resilience of ecosystems to SLR.

- The Nature Conservancy http://www.nature.org/wherework/northamerica/states/northcarolina/files/albermarle_fact_sheet_2010.pdf

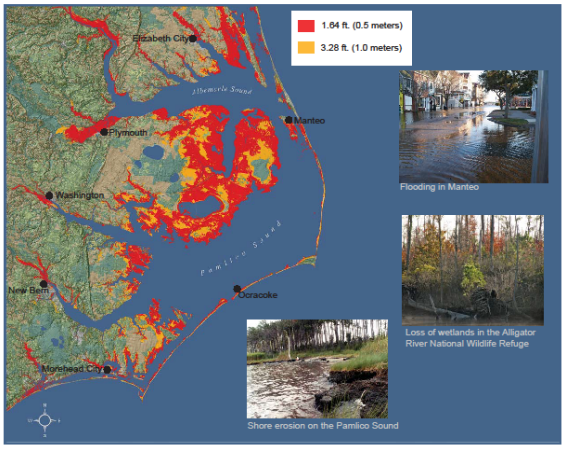
Sea-Level Rise and North Carolina
Preparing for the Future

We Must Understand the Risks and Ways to Respond

North Carolina's coastal region is one of our state's most spectacular resources with over 300 miles of beaches and more than 4,600 miles of shoreline along our sounds, coastal rivers and wetlands. These waters border over 2,000 square miles of low-lying land with elevations of less than four feet. The communities and natural resources in this area are threatened by sea level rise.

Northeastern North Carolina has experienced a one-foot increase in sea level over the last century. Many scientists expect the sea to rise more than three feet by the year 2100. Roads, buildings and community services are threatened. Sea-level rise over the next century will cause increased flooding, loss of wetlands, submergence of low-lying areas and shore erosion. Conservation areas and wildlife will be affected. Future impacts to property, public investment and safety can be reduced by considering sea-level rise in our community planning.

Potential Inundation in the Albemarle-Pamlico Region



Preparing for the Future

There are three general ways that we can respond to sea-level rise on coastlines that are developed.

- **Protect** our shorelines physically with either hard structures such as bulkheads or a strategy that uses native plants called *Living Shorelines*.
- **Accommodate** sea-level rise by designing buildings, roads and drainage systems for future water levels. Improving drainage and elevating buildings by increasing freeboard can prevent damage from increased flooding.
- **Retreat** from areas that are likely to be submerged. Low-lying areas that are already susceptible to frequent flooding can serve as vital protection for developed areas.

It is important to determine the costs and benefits of each option based on local conditions. Determining the option that is right for areas within communities will protect long term infrastructure investments.

Protecting Shorelines

Land along rivers and sounds in North Carolina is at risk to shoreline erosion due to waves, wind, boat wakes and sea-level rise. People who own these properties can choose to protect their shoreline by using

- Hard, vertical structures, such as bulkheads or seawalls. These walls reflect rather than absorb waves, so the wave energy tends to erode nearby unprotected land or marsh.

- Revetments, sloped structures that can be made from rock, concrete or oyster shells. These can include some marsh grass plantings as part of a *Living Shoreline*.

- Sills, made of rocks or oysters that are placed off the shoreline reduce waves so that *Living Shorelines* can grow. Marsh grasses then trap sediment and grow roots to protect the shore.

Freeboard is the height of the base of a building above the FEMA flood level that adds extra safety. FEMA recommends at least a one foot freeboard. Additional freeboard to accomodate for sea-level rise is a no-regrets planning strategy.

Building Resilience

Resilient communities are ones that can withstand difficult conditions, such as severe storms, and return to normal life relatively easily and quickly. Building resilience requires understanding possible future conditions and making plans. Many different people, businesses, organizations and municipalities will need to be involved to plan for resilience. Now is the time to determine the risk to our coastal communities. We can use tools such as hazards plans, land-use plans and local policies to reduce the risk. North Carolina's coastal communities are a vital part of our economic, cultural and social quality of life. We must prepare for their future.

For More Information

To learn more about sea-level rise in North Carolina visit
North Carolina Risk Management study
http://www.ncsealevelrise.com/
North Carolina Division of Coastal Management
http://dcm2.enr.state.nc.us/index.htm
North Carolina Climate Change Initiative
http://www.climatechange.nc.gov/

To learn more about Living Shorelines in North Carolina visit
North Carolina National Estuarine Research Reserve
http://www.ncoastalreserve.net/uploads/Living_Shorelines_tech_paper.pdf

Produced by:

Michelle Covi with assistance from Donna Kain and Doug Solomon. Cartography by: Matt Carey, Brent Gore and Travis Hill. Funded by: North Carolina Sea Grant and RENCI at East Carolina University

renci East Carolina University · Sea Grant North Carolina

Understanding Sea Level Rise

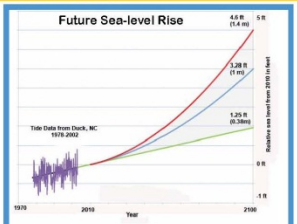
Sea-Level Rise: History and Future

North Carolina's coastline has a dynamic past that we understand from both historic records, such as maps, and physical evidence, such as the remains of ancient ocean creatures. We know that global sea level has been rising since the last ice age thousands of years ago. How much sea level changes at a specific location, however, depends on regional geology.

In North Carolina for the last 3,500 years, sea-level rise has averaged about 4 inches per century. In the 20th century, that rate increased to an average of more than a foot per century, as measured by both geologic records and local tide gauges. Since 1993, scientists also have used satellites to measure sea-level rise and provide a reference for tide gauges.

Will the rate of sea-level rise continue to accelerate? Most scientists believe that it will. Although it is difficult to predict the future sea level for a specific year, North Carolina scientists have determined that for planning purposes, a more than 3 foot (1 meter) rise is the most likely estimate for change by 2100.

Future Sea-level Rise



The chart above represents the range of most likely rates of future sea-level rise according to the North Carolina Coastal Resources Commission's Science Panel on Coastal Hazards.

- The green line represents sea-level rise at a rate based on current measurement only.
- The blue line includes an increase in the rate of sea-level rise due to an increasingly warm ocean based on the increase in ocean temperature in the last century.
- The red line adds the increase expected in sea level due to rapidly melting ice sheets.

Why Does Sea Level Rise?

Subsidence - the land surface in a region may sink due to geologic forces and the extraction of groundwater or oil

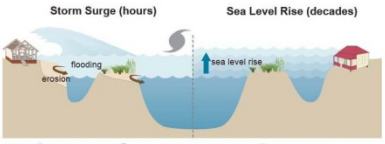
A Warmer Ocean - as the ocean becomes warmer, water expands

More Water in the Ocean - due to the melting of land-based ice

Recognizing Threats to Coastal Communities

Sea-Level Rise Makes Flooding Worse

During storms, higher waves formed by strong winds rise 20 feet or more above the normal tide level. Sea-level rise will increase wave height because the base level of the tide will be higher. An increase of 3 feet in sea level may cause an increase in storm damage of 102-200 percent. Flooding will become more frequent and longer lasting in low-lying areas as sea level rises because low areas will drain more slowly. Sea -level rise also causes increased shore erosion and permanent submergence of low areas. Damage from storms may be avoided by designing buildings for future higher sea levels and by directing building away from the lowest areas.



Flooding from strong storms, such as hurricanes, results in erosion and expensive property damage. Sea-level rise, which occurs over a long period of time, threatens to flood buildings in coastal areas. As sea level creeps up islands may disappear, and land will be lost.

Flooding from Hurricane Floyd drove tens of thousands of North Carolinians from their homes. Photo by Dave Gailey/FEMA News

Increased Risk of Storm Surge

Washington, NC is located on the Pamlico River in eastern North Carolina . It has been called the "Heart of the Inner Banks." Established in 1776, it was the first city named after George Washington. Flooding from severe storms, like Isabel in 2003, will increase for similar storms in the future.

Loss of Wetlands

Salt marshes in North Carolina are at risk because they are located within a few feet of sea level. These wetlands are economically important because they provide habitat for fish and shellfish that are harvested by commercial and recreational fishermen. Wetlands provide flood and shoreline erosion protection and also improve water quality.

Salt marshes can move to nearby areas if the sea level rises slowly enough, the slope of the land is low and there is no barrier. For example, in areas of the Alligator National Wildlife Refuge, freshwater swamps and low forests are already changing to salt marsh. This salt water intrusion eliminates habitat for animals such as forest birds and black bears. Wetlands may be lost entirely in developed areas because bulkheads are a barrier to the natural movement of marshes.

Beaufort County and Dare County Leader interview protocol

Introductory Comments

Thank you for agreeing to participate in this interview.

This interview is part of a project to understand how coastal residents understand and respond to information about future sea level rise. The information that you provide will help us to improve our communications and better prepare our communities for coastal hazards.

This interview will be recorded so we can better understand your thinking. Your responses will all remain confidential and only be reviewed by our research team. The interview should take 60-90 minutes.

*Informed consent

We interviewed 20 people in the Washington, NC area and 20 people in the Roanoke Island area to understand how they understand documents about sea-level rise, their perceptions and attitudes. As a leader in the community, we want to understand your thinking about sea level rise and your understanding about how others in the community think about and understand this topic.

First we would like to ask a few questions about you

1) How long have you been a resident or worked in this area?

2) What is your profession? Do you have additional leadership roles in the community?

3) What do you believe are the issues affecting this community related to sea-level rise?

4) Do you believe that residents and leaders of the area are informed about SLR? What kind of information do they get? Where do you think they get information?

5) Is this topic being discussed by local leaders and residents? If so, how is it being talked about?

6) Are there any local plans, policies or other decisions being made that pertain to SLR? What are they?

7) Are there any specific examples of places, such as wetlands or waterfront developments in the area that you feel are significantly affected by sea level rise?

8) Please take a look at these documents. Do you have any overall comments? Is there anything missing?

9) Who do you think are the most influential people in the local area with regard to sea level rise planning and policy? Who do you think we should talk to about this issue?

10) Anything you feel we should know about that we did not ask?

Washington County Leader Interview Protocol

Section 1

First, I'd like to ask you a few questions about yourself.

1) How long have you been a resident of Plymouth (or Washington County)?

2) What is your profession?

3) What are your leadership roles in the community? How long have you been in this/these role(s)?

Section 2

Next, I would like to know in general what you're thinking about a few topics. There is not a right or wrong answer to any of the questions we will ask.

4) What comes to mind when you think of living here in Plymouth especially as it relates to the environment?

5) What changes have you noticed in the natural environment of this town? What can you tell me about the natural environment of Plymouth in the past? How about in the present?

Section 3:

I'm going to ask you some more specific questions—if you feel you have already answered the questions, please refer to an earlier answer.

6) What changes have you noticed in things like roads, buildings, sewer lines, and water lines?

7) What role have you had in these changes? What role have you had dealing with these changes?

8)At times properties in the town —such as houses and buildings -- can be affected by the environment such as by flooding, heavy rainfall, or other local hazards. What changes (or damage) to property have you noticed that are caused by such environmental events?

9) What locations in Plymouth are more affected by these changes or damages? Could you please show me on this map? (Show Washington County Sheriff's map of Plymouth)

10) How has the community responded to these changes or damages?

11) Where do you get information about dealing with these changes or damages? What kind of information do you get?

12) What information do you get about other risks in the natural environment and preparing the community for these risks? Where do you get this information?

13) What about other residents in Plymouth—where do they learn about risks facing the community and how to prepare?

14) What is your role/level of involvement in providing or interpreting this information?

15) Compared to other problems or issues facing Plymouth—how important do you believe it is to deal with the kinds of environmental issues you've identified? Do you believe that this will change (increase/decrease) in the future?

16) What do you think should be done about natural hazards such as flooding and damage by weather events in Plymouth? Who should be responsible for taking these actions?

17) What would make it difficult to take these actions? How could you overcome these difficulties?

18) What kind of information or event would make you more likely to take action?

19) What have we left out of this discussion? Is there anything else you would like to say about Plymouth, its environment (both built and natural), or your role in the community?

APPENDIX C: INTERVIEW THEMES AND NUMBER OF COMMENTS IN INTERVIEWS

Document interviews

Category	Theme	Description	Number of Comments
Information	Lack of information	References to unavailable information in the community	9
	New information	Comments indicating reader learned something new	52
	Local Knowledge	References to their experience with impacts of SLR or storms or what they hear from other local people	69
	Information sources	References to potential or actual sources of information about SLR	78
Impacts of SLR		General Comments about the Impacts of SLR	5
	Specific places	References to impacts in specific locations	8
	Fishing		9
	Wildlife		22
	Flood		29
	Wetlands		44
	Temporal scale	References to the SLR timeframe of impacts	26
	Development	References to how SLR affects building or buying houses	62
Beliefs & Attitude	Optimism	Comments that reveal a positive attitude toward dealing with SLR and climate change	3
	power of knowledge	Comments about the importance of information and education to deal with SLR	5
	Uncertainty	Reference to the uncertainty in the issue and attitudes about uncertainty	8
	Fatalism	Comments that reveal a fatalistic attitude about SLR	22
	Agency	Comments about who is able to or should be able to make decisions about responses to SLR and its impacts (erosion, etc)	20
	Skepticism	Comments revealing disbelief or questioning of SLR information presented or responses.	30
	Fear	Comments indicating that the something about SLR or associated impacts scares them.	20
	Lack of concern	Comments indicating a lack of concern or apathy on the part of self or others.	23
	Concern	Answers indicating concern to the question "does this issue concern you" and other comments indicating a concern	29
Climate Change		References to Climate Change, global warming, greenhouse gases or other closely associated concepts	16
Local Action		Comments indicating the nature or importance of local action to respond to SLR	23
Planning		References to preparing or planning for SLR	33
Document design			108
Overall impression			46

Plymouth Leader Interview Summary of Responses by Topic

Erosion

1. Clearly our waterfront is progressively receding
   Evidence of significant shoreline erosion
   We have tree stumps in the river that once were on the shore. And we have some trees in the river but they'll eventually die off. The river is getting wider. .
2. Surprising that the biggest issue with the river front is the erosion. The river will erode away under parking lots, and underneath building foundations.
3. Erosion – along the waterfront. Also a lot toward the Albemarle Sound. Roanoke Shores in particular.
4. I tell people, especially farmers, to not spray their ditchbanks with weedkiller because it helps keep the soil in place and if they are gone severe erosion of ditchbanks can occur.
5. Two cottages at the beach, less than 10 years old, were gone. Beach erosion
   "But human nature is to keep on going until they have to leave."
   "Since the dams came in we don't have erosion."
   But the bulkheads are giving way. Where the lighthouse now stands used to be the train depot. It where it was, was actually wetlands, and they filled it in. And this has all been filled in, and this was the low end of town.
6. I can't say I've seen excessive damage. In downpours, when you all of a sudden get five inches of rains, you might seen erosion in some places along ditch banks where they've been sprayed with roundup and you'll see ditch bank wash there.
7. I think you can call it an environmental issues when you're dealing with a dirt roads that an ambulance can't get down. That's a big issue. You have water washing away dirt and people trying to fill in holes with god knows what. I've seen bricks and stuff put in holes just to try and even up the road.
8. The shoreline of the Albemarle Sound in this county I eroding, except for its bulkhead. And there are active shoreline erosion points that are not stable. And its not a slow process either. I mean, it averages long term a couple feet a hear. You might a few years and hardly notice, but you get a big storm and suddenly there goes 5-10 feet. I know historically islands have disappeared in the sounds, and the marshes down in (?) County have disappeared, you used to be able to walk from Manteo to mainland Tyrell County. You can't now. Its all gone.
9. If sea level rise accelerates, it will erode. It cannot adapt fast enough. It is a major concern with coastal marshes - if they can build themselves up with accumulations of organic trapped sediment fast enough to keep ahead of rising sea level. Cedar Island marshes are ones we are very concerned about.
   The dams have been up there since the 30s, there are still huge amounts of accumulated sediment in this river because erosion that took place during the 1700s and 1800s was immense. The river was full of sediment when they build the dams.

Localized Flooding and Stormwater Management

1. Stormwater is a problem in the entire county, and the northeastern part of the state. Its because you don't have tributaries and creeks and canals – there are not enough of them, and they can't hold the volume of water based on what's built today. The stormwater system in the town is adequate –but once it gets out of there and intermingles with the creeks and tributaries can't take it away, that's where there can be backups and flooding.

There have been some hydrological studies in the county and we have brought the issue as a regional concern to D.C.. But it would be expensive to address the issues and is complicated because an improvement in one county could harm another county.
From a crop standpoint in the county, flooding is an issue.

2. To me drainage problems are a non-issue. This is the Roanoke River delta; there is over 50 miles of shoreline within five miles of Plymouth. Have you seen the aerials of this area? So it's a very wide flood basin right here, as you go upstream it narrows and the banks get higher, and then five miles east of here you have the Albemarle Sound. The largest freshwater sound in North America, so what happens is you can't have enough rain that I've ever seen in my life, unless the dam breaks up are Kerr Lake or Lake Gaston, you can't have enough rain to flood Plymouth. The only time we have a flood, is a wind tide, because you've got this big bath. If you think of it as a bath tub, we've got this big bath tub out there – the Albemarle Sound – when you have high winds for an extended period of time blowing northeast in particular, it forces all that bath water up into the pipe, which is the Roanoke River, and it floods out of its banks and it spreads over this wide floodplain; the floodplain is so wide and can absorb so much water, that flooding has been a non-issue.
   I don't think there is a flooding problem. [But], When we think flooding, I'm thinking river. But let's go back and talk about heavy rains and the creeks and the pumping stations.
3. Plymouth is on a bluff so we don't get much flooding , and the floodplain is five miles wide here and its all on the other side of the river.
4. "What causes flooding in eastern NC is NCDOT [Department of Transportation]."
5. Most of the damage we have, except for a little bit, is from no maintenance on the drainage systems we have here.
6. Traditionally, sewer plants and low income people they get built in places of less desirable real estate so they get flooded.
7. It wouldn't surprise me if they had water in the living area of that housing project.
8. When the rivers up we get flooding. But longer term, real long term, depends on what the actual impact of sea level is.
9. We have drainage [problems?] at the end of Roanoke Avenue.
10. Plymouth doesn't flood as bad as other areas of the county do, like Creswell (mentioned several times by others also). Creswell mayor said that because of the slope of Hwy 64, it causes flooding in his town..
11. Crop damage is caused by wind damage, but also water damage from flooding or flood waters sitting in a field for 7-10 days.
12. I think people sometimes have the wrong concept about drainage. When you have a 50 year rainfall and get 8-10 inches in a matter of hours when it stops raining they expect it to be gone. That's not going to happened. But as for addressing the normal rainfall, the drainage is good.
13. We have real heavy rain for a day or two and you see water standing and people complain about it. But it doesn't happened but once every 2-3 years.
14. Going north from here there are four miles of swampland. That's what swamp land is for - to absorb flood.
15. And we're down at one foot above sea level in Hyde County and we had 12 or 14 inches of rain and it was up and then it was gone – the tide went out and we didn't have any trouble. I reckon we had somewhere for the water to go. And then you get up here where the rivers are, and I reckon the same thing could happen to Plymouth. Just a little west of here it could happen. And those whole towns, Tarboro and Princeville flooded out. That was weird, they are 30-100 foot elevation. How are they getting flooded, but there's nowhere for it to go – it gets backed up in those basins.
16. Basically it doesn't. There are a few sections that flood a bit during a heavy rain, but it runs off better now than it did before because of the town trying to keep the ditches and everything cleaned out. And one of the council members initiated back in June – Clean up Week, she took

different sections of the town and let the citizens clean up and put the trash out and gave them places to put the trash – and that cleaned out a lot of those drainage ditches and things of that nature. IT doesn't look like it, but it does in terms of beautification and better environment too.

17. Plymouth flooded before the dam was put in, 1937. Kerr Lake Dam. .
18. I can remember back in the 40s they built a dam up in the wilderness and we didn't have floods anymore.
19. In eastern NC, we have communities and agriculture that is under pump drainage.
20. "Well, you know, you can't have enough drainage." We've got good drainage.
21. The biggest problem that Plymouth has was from the river when it flooded. And when the river's up we get flooding now.
22. I've heard them say we're in the flood plain area but I don't see any evidence of floods. I'm not saying it won't come, but they're saying the ocean is moving inland all the time.
23. The plot where the fire station is located floods.
24. Some homes are below street level and have some flooding problems. I'm sure this has gotten worse over the years will all the pavement that's been added over the decades.
25. I don't' know what the regulators are doing to do to us. We are going to have a devil of a time complying with urban runoff regulations. Where is Plymouth going to put stormwater ponds?

Specific to Hurricanes

1. Isabelle was mostly wind damage.
2. We've never really had a hurricane come through this town. I've seen some trees pulled down, taken up. But never any real severe damage done in Plymouth from a hurricane.
3. Hurricane Isabelle really messed the river up – big time round here. Well it flooded the river bottom with the surge of water and when it came back out it sucked a lot of detritus with it, and we had a crash in oxygen, and since we overfish the river died. And this was I think in 93.
   The right kind of hurricane could push a big slug of water because this Albemarle Sound and the river system is funneled. This last hurricane off the coast, Earl, actually sucked out the water out – the water dropped here. The creeks here in PLYMOUTH the water level went down rather than up. But if we had the right fetch on the hurricane it could blow in a lot of water. PLY18
4. Plymouth was no impacted by Floyd at all. And the reason is that the Roanoke River flood plain from here to Roanoke Rapids is very narrow. It can rain, well Floyd was 30 inches, so it could rain 30 inches on that narrow flood plain, and Plymouth wouldn't even notice it. Because the flood plain here is five miles wide.
5. Hurricane Isabelle blew the water out of this lake and flooded the homes on this shore with three feet of water. It blew the water of the lake. If we get the right winds . . . .
6. From what I've read, if we had a Category 4 at high tides come directly into the Sound it could push back and Plymouth would have 3 feet for water.
7. If Floyd had happened another 50 miles further west, so that our reservoir had filled up and they had to turn that water loose down the Roanoke, the same thing could've happened in Plymouth that happened in Greenville.
8. Plymouth has been in a golden zone as far as a lot of hurricane damage.
9. There was some minor flooding from Isabelle.

Saltwater in the River

1. During drought, salt water can come in as far as Plymouth now. It can be a problem for the paper mill. They take water out of the river for their paper process. And in dry time, sometimes they have to barge water in or run a pipeline up the river.

2. We've had low flows here till we've had salt water back so far that the mill would have to go upstream to get water to go into the boiler. Because you can't have any salt in the mill. We've had dolphins up here. Last summer I caught salt water fish out at the mouth of the river.

Drought

1. The first and second year I was here we did have extreme drought like the rest of the state. Farmer survived because they had subsidy insurance programs out there.
2. In 2007 we had a drought and there was this big push for more conservation.
3. There is a big influx in irrigation this year. Farmers have been hurt in the drought.

Sea Level Rise

1. I've had some exposure to scientific information about sea level rise. Projected changes of future sea level and according to them this area could be covered again. Drainage ditches could be a way for water from the Albemarle Sound to move up and onto the land during hurricane or strong storms. There are drainage ditches that run behind various neighborhoods and the Georgia-Pacific site. The ditches are at sea level right now.
   I think water inundation from the Albemarle Sound, I think that is going to get worse – its clearly going to get worse. It has been for the last 100 years. Its been happening for a long time.
2. I'm one of those crazy people who think that sea level is actually rising. So if you live in a flat town, you need to be concerned that if you are near a river.
3. Because of rising sea level, the Roanoke at this location will become increasingly salty.
   I've been hearing in the news, the state has been starting a new push on how to deal with rising sea level, climate change, I say Lord, where have they been? We were we doing this 30 years ago.
   If you accept estimates by the Corps of Engineers and EPA – sea level has risen four feet since this area was settled..
   The sea level hasn't come up that much. Its only about a foot per century, people (engineers) are not interested in that. If they build something that'll last 15-20 years they think they've done a miracle. They should take into account the probability of flooding.
   They don't understand if you look out here and you see marsh grass and dead pine trees, that that means the salt has moved in far enough that it's killing pines. They don't interpret what they see – or they think its a single event: well, a hurricane did it. Well sure, but those pine trees got mature because it was not too salty, but now it is too salty.
4. I've seen Stan Riggs present and talk about sea level rise but did not note it as an issue of concern. The person later notes: "And it's never going to change because that's an island, it's wetlands, and behind that is another river, and then an island, and another river and creeks. And that's going to remain that way until it's absorbed into the sea some 100s of years from now.
5. The river is very deep due to rising sea level.
6. They are saying the ocean is moving inland all the time. I won't live to see it.

Weather Patterns

1. And with the changes in the precipitation patterns, and we had a really wet winter and can't really say warm winter is a predictor of the future, but if this area tends to be rainier in the future because of the weather shift then we'll have a lot of problems.
2. Fortunately this year, in particular, we had a dry spring. Dry springs you don't lose as many baby birds, rabbits, all wildlife – . . . If baby animals get wet, there's a high percentage of death. That's just the nature control of wildlife.

Groundwater

1. Our biggest problem with underground wells is irrigation – big farms. And there are also impacts from Texas-Gulf-PCS.
   I'm worried about the underground drying up. Because it has been doing that the last few years. The underground water level has been dropping, yes. Let's see Castle Hayne aquifer – that's the reason that the state came out in the last three to five years with some new laws concerning drawing water out of deep wells. I think more restrictions on irrigation can be put in place. Underground irrigation and drawing water up out of the river. I don't know exactly what the laws are now – but there's a lot more people using the river for irrigation than there was five years ago. . . . . the farmers are going to fight controls because they want an unlimited supply too. But we need to know how much is being used by farmers – now industry they know how much water."
2. Aquifer, we're right on the edge of the salt basin coming in from the east. And that's gotten to the bottom part of our aquifer. So what we've done in the past half dozen years we've abandoned some of our older wells and we've drilled new wells further south and further west to get into some better water quality. It is caused by overpumping but we just relocated the wells and change the pumping schedule, so we're drawing from a large area and pumping at a slower rate.

Roanoke River Flow

1. "The biggest concern for PLYMOUTH and all the towns on the river – is the river drying up. Most people can't imagine that, but right now the Triangle and Greenville both are looking towards the Roanoke River for a source of water. I have been to the Tar and Neuse River; places you can walk across in the summertime because the Triangle and upstream were drawing so much water out that they literally dried the rivers up."
   I was a bit concerned about the river, and the river drying up. A lot of people can't imagine that. I've been one meeting in Scotland Neck and one meeting in Roanoke Rapids – the Nature Conservancy, the power companies in the state, the people there talking about the river. When the river floods how it affects from Roanoke Rapids down. High water…if they hold the water back and let it flood at a certain level for so long, it'll kill the trees, and at one time they did that continuously, the power companies – I forget the, there's two or three power companies, they got a co-op where they control the lake levels. And they controlled it to their benefit, well, the people like Nature Conservancy had a gentleman there, said "we need to go on water-in-water-out." If you get a big volume of water in go ahead and discharge it. That is a natural process – that doesn't flood the trees for 30-45 days, it doesn't kill the trees. You go ahead and get the flood over with. You might flood a larger area, but you don't have the end result – the damage like you would in a controlled flood.
   Now I know of one instance in…in July they had…they were controlling water at a high level, then they cut the flow completely off, but in Williamston the river flow had backed the creek water up and we had hot weather and this water in the creek had come unusually hot. When they cut the river flow off it dumped all this water out of the swamps and creeks into the river. And it was dead and we had a big fish kill. And I saw that, in fact, I had a gentleman working at the mill, that I was taking on a tour and we saw rock fish floating down the river as a result of this fish kill.
2. The biggest risk to the river is the cities upstream taking so much water out that it would literally dry up. As you know in Georgia and Florida they had water wars this past year. Virginia Beach has got basically unlimited access to water that flows through here. OK – let Raleigh, Greenville, let them get in the door – there's only so many cubic yards coming down this river. It could dry up before it gets here.
3. Our reservoir and the others control the flow of the Roanoke most of the time. There is a continuing debate about the river flow. Plymouth used to go underwater in spring floods, it's common, that's why Carr Reservoir was built. So the river flow is not at all a natural flow – it's a

controlled flow; there are other factors that enter into it. They generate power and the power generator has a say in the flow; actually it goes through the Corps of Engineers, you can go on the internet and there is always something on there about the flow on the Roanoke.

Wetlands/Marshes

1. It's a major concern with coastal marshes if they can build themselves up with accumulations of organic trapped sediment fast enough to keep ahead of rising sea level. Cedar Island marshes are ones we are very concerned about.
2. 2. That's what swamp land is for – to absorb flood. Then as the water flows out, it filters it out.
3. We have some soggy areas called the bottoms, near Madison Street, Johnson lance, Johnson Court.

Infrastructure: Water and Wastewater Systems, Stormwater Ditches, and Roads

Sewer/Wastewater Treatment

1. We have a problem with groundwater that infiltrates into our sewer pipes, and it causes our pump stations to overflow because they can't handle the capacity.
2. The three sewage pump stations we have are located: the one downtown on the edge of the river we have concerns about when the water rises at Johnson Court Pump Station, and one at Connaby Creek called the Washington Street Pump Station. And then the East Main Street Station, we have problems with when Connaby Creek rises.
3. Because of the issues with the Roanoke River over time back pressure into the sewer system has started to be an issue. It influences the sewer system.
4. When it rains, the sewage treatment plant becomes an island. Its flood proof itself.
5. There has been a history of water and sewer problems in part because of clay tiles. And flood waters from rain has created a situation where the effluent from the pumping station is entering our estuaries. . . . there are three pumping stations that I'm aware of in downtown PLYMOUTH. One is on West Main, one on East Main, and one in right here on the waterfront at the end of Washington Street. I don't want to say it's a common occurrence, but it's not unusual during a heavy rain for alarms to go off at the pumping stations at the east and west ends of Main Street. The alarms go off and the red light flashes and you're sitting there wondering "I hope that somebody's doing something about this" but this is basically a situation as I understand it where the flood waters from the rain has created a situation where the effluent from the pumping station is entering our estuaries, Connaby Creek on the east end of PLYMOUTH and this drainage on the west end – I don't even know it has a name – my business adjoins it, but I've heard of a name applied to it.
6. Access to the treatment plant is an issues, and we have gotten fines recently for about sills from the pumping stations and exceeding our flow at the wwtp. We're working hard to get that under control.
7. This is a tough area for handling onsite septics due to the high water table.

Stormwater Ditches

1. Some houses were built in the 40s, 50s, and 60s at ground level. They were drained by ditches that were cut pretty deep. And we don't have any earthly way to go out and re-sculpt 150-200 miles of ditches in the town. We can't take care of ditches that run between people's property – it is on private land and trying to maintain them is difficult for many reasons.
2. Need to make sure the canal and ditches flow.
3. Connaby Creek has been cleaned from one end to the other. Every stream in the county was clogged after Isabelle – from trees. We have big problem in this county with alligator weed in the drainage ditches. This will completely stop, almost completely stop drainage in a ditch. It goes from bank to bank and just all debris that comes up it stops and just makes a dam. Especially if a

trees down across the stream it can lodge against the tree and it just keeps backing up. I can show you… we keep on talking I'll look. I get calls from homeowners about flooding and it would take them five minutes with a hoe to clean out the end of the culvert out. To get the Styrofoam cups and bottles and stuff out of the way so the way so the water could go through, or leaves.

4. We try to discourage any practice that we see that's going to cause erosion or adverse effects to the environment. Since Roundup has come out, that's been a very good tool for the farmer, but it's also been not a very good tool when you're talking the environmentally issue. Because of those ditch banks become bare. And I don't like to see people – you go by the yard and the front of the house and they've sprayed the whole – so you don't have to mow it. It looks awful. PLY08.
5. We haven't been maintaining the farm ditches for the last 30-40 years like we should have. They are starting to now but for many of them the cost to go in and clean them out now if prohibitive.
6. We've don't maintain canal clearances. But we don't have problem with flooding unless a big rain comes through (2-3 inches in an hour or two).
7. And, if you know anything about this area of the state, there are some elaborate drainage systems that have been dug, but unfortunately in terms of heavy storms and prolonged rains water can back up, and it's because it doesn't have tributaries and creeks and canals – there are not enough of them, and they can't hold the volume of water based on what's built currently today, so there can be moderate to severe flooding here, and most of the duration of it is that it's gone a day or less.
8. The town doesn't own ditches between houses – only responsible for maintaining those along roads. We don't' want ownership of them.

Roads

1. When it rains water pools everywhere and we have a number of roads that get shut down until the water recedes.
2. The vast majority of the water problems along Hwy64 because Hwy64 bisect the natural breadth of the water from here towards these major water basins. The essentially created a giant bowl right in between the two raised beds (between the hwy and the railroad line). The mom and pop single owner/single proprietor businesses simply flood – on the one side of the Hwy 64. .
3. Roads have gotten better. We now have four lanes and some are paved that were dirt.