Enhancing Coastal Resilience: Perspectives on Valuing RI Coastal Lands

The Honors Program
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Student's Name: Kyle Nyskohus
Faculty Sponsor: Gaytha Langlois
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ABSTRACT

This paper discusses coastal resilience as an organizing framework for future policymaking, coastal planning, and insurance decisions, and explores the different perspectives of the value of ecosystems held by various stakeholders in Rhode Island's coastal communities. A grounded theory approach was used in an effort to abstract general insights from the substantive but isolated areas of coastal management and economics. Special attention is given to the perspectives of municipal decision makers, the National Flood Insurance Program, natural economists, and real estate developers. We have (1) conducted a statistical analysis of environmental spending of RI towns, (2) identified key models for ecosystem services valuation, (3) researched the major threats to coastal ecosystems, and (4) explored how the coastal resilience theme might shape the future of the coast. Elements of the study rely on the formulation and testing of hypotheses. However, the analysis was primarily a demonstration of the inter-disciplinary emergent thinking that this paper proposes will provide solutions for coastal communities' most pressing issues. The framing question is how social, personal, and environmental goals align when coastal resilience is enhanced, and how stakeholders can utilize these new decision-making tools to achieve increased communication and a more accurate understanding of the perceived value of ecosystem services.

INTRODUCTION

Coastal community development and infrastructure decisions are increasingly viewed through the lens of resilience. Resilience describes a community's ability to adapt to change and disruptions without altering the essential identity and structure of that community. The concept of resilience in ecological systems was first introduced by the Canadian ecologist C.S. Holling, who defined coastal resilience as,

> The capacity of a system to absorb and utilize or even benefit from perturbations and changes that attain it, and so persist without a qualitative change in the system's structure (Holling, 1973).

Optimizing the relationship between nature and social welfare is at the forefront of resilience. Techniques for optimization include economic valuations of ecosystem services as well as land-use and ecological factor matrices, along with spatial analysis and GIS mapping. If we are able to utilize land-use optimization techniques that take into account the various ecosystem services provided by salt marshes, dunes, eel grass, and coastal ponds, it will result in better coastal policy decisions and lead to smarter and more ethical use of coastal resources.

A 2007 study estimates that low elevation coastal zones, which are areas less than 10 meters above sea level, make up 2 percent of the world's land area but 10 percent of the world's population (McGranahan, Balk, & Anderson, 2007). Moreover, 13 percent of the world's urban population is concentrated in this area, encompassing many large countries with high population density. The United States has the third largest amount of land below the 10-meter

level, representing billions of dollars of real estate and infrastructure (McGranahan, Balk, & Anderson, 2007).

The amount of land being developed in high risk coastal zones, along with the population distribution in those areas, presents a number of challenges. The U.S. coastline is already vulnerable, and future sea level rise will increase the threat of flood damage. The dollar value of coastal assets in port cities at risk from a 100-year coastal flood will likely be $35 trillion by 2070, an increase of $32 trillion from 2007 (Beatley, 2009). The future of coastal economies is in jeopardy, and it will take careful planning to meet the challenges posed by climate change. Much of this planning will depend on the ability of policymakers to overcome personal bias and political uncertainty, and will necessitate integration of large quantities of data derived from many researchers in diverse fields of endeavor. We must turn to forward-looking coastal leaders on the municipal level that will guide communities toward resilience thinking. Because public sentiment about climate change is becoming more realistic, it is becoming easier for policymakers on the state and local levels to insist that sea level rise be taken into account in engineering and planning, and to raise the urgency with which these challenges are addressed.

An Incomplete Perspective

It could be argued that our preference for industrialization is derived from conclusions based on an incomplete data set. Ecological parameters are often excluded from economic analysis because they are problematic to pin down and abounding in complexity. Ecosystems generate value through routes that are not always immediate or observable. The interactions that take place within ecological communities among animals and plants and their physical

environment are made possible by incredibly intricate relationships. In many cases, valuable ecosystem services are byproducts from multiplying effects arising out of natural synergies. Some of these synergies are not fully understood, but they nonetheless occur when ecosystems are in balance. In other cases such as flood prevention by dune protection programs, the mechanism for the service is understood, but the scope of the chain of physical interactions is underestimated for particular regions.

Ecosystems are largely either ignored because of their long-term structure or simply written off as priceless. They are so precious that many people take umbrage at the notion of monetizing them. In a way, ecosystems are in fact priceless. After all, without them life as we know it would be impossible. The most familiar demand and supply curves do not adequately describe the actual or hypothetical market for ecosystem services. As the quantity of ecosystem services dropped to zero, prices would approach infinity. A consumer would literally pay any price for the last consumable quantity of oxygen on earth. Thus, realistically determining nature's costs and benefits only makes sense when limited to describing incremental changes. Measuring incremental change is the realm of marginal analysis and is firmly planted in the reality of compromises and tradeoffs that mark a healthy political process.

There is no question that when policymakers face decisions they are forced to make tradeoffs, and it is in problems dealing with marginal calculations that ecosystem services valuations make the most sense. We implicitly put a price on ecosystems by our decisions even if we do not state an amount. Policymakers might claim to have an immense appreciation for the environment and, at the same time, approve of actions that promote economic development to

the detriment of the environment. In this case, actions speak louder than words. A decision that favors unsustainable development involves an implicit calculus that places a relatively low value on natural services. Moreover, it is far easier to ignore environmental losses when there is no price tag associated with them, especially in times when municipal, state, and federal governments have been running persistent budget deficits.

Ecosystem Services

A major opportunity for public sentiment and political will to align is through increasing awareness of ecosystem services. A more resilient coastline can be justified in political terms and on economic grounds. Conserving and restoring ecosystems has tremendous benefit to society, and that value ought to be recognized. The services that ecosystems provide should be esteemed as contributors to the economic output and social welfare of a region.

Clean water and flood mitigation are examples of services that nature provides to mankind at no cost. Whether or not we use figures to describe the impact of the environment on our well-being, ecosystem services contribute to our physical and emotional health and have a direct impact on economic growth. Environmental balance is so vital for our future security and prosperity that we must take efforts to inform ourselves of its true worth. When it comes to valuation, the vernacular of policymakers and businesspeople is economics, and the relative worth of most goods and services is expressed in terms of the economic concepts of price, quantity, supply, and demand. The problem is that the traditional cost-benefit analysis, which is performed using a limited set of financial parameters, generally values unchecked development over conservation. Land use decisions based on inferences from these models tend to be unrealistic, inefficient, and irresponsible in the long-term. By comparison, natural

capitalism, which recognizes natural capital as an important foundational element of a capitalistic economic system, stresses the importance of valuing and managing natural capital as fervently as financial, infrastructural, and human capital (Lovins, Lovins, & Hawken 1999).

Valuing Coastal Lands

Translating the idea of a resilient coastline into a reality will involve invoking new patterns of thought and mindsets. This paper argues that economic valuations of natural capital are indeed valuable resources for making informed policy decisions. However, the utility of a tool does not supersede the need for a skilled craftsman. The environmental policy debate that takes place in every municipality is framed by a set of assumptions. These assumptions about the process of designing coastal policy can obscure the vision of the crafters of the policy.

Failed assumptions are manifested in the long-existing problems that characterize our coastal land use patterns. The mantra of "more houses in more places" that drove policymakers to capitulate to the demands (sometimes legitimate) of developers and landowners must be contextualized by an appreciation of ecology. For years, coastal cities and towns suffered the burden of demand for housing, at times severely artificially inflated by a financial environment favorable to speculation and prone to asset bubbles, with disaster impacts buffered by the availability of reasonably priced national flood insurance provided by the federal government. Nature's mechanisms for flood control—natural habitats, buffers, and dunes—were regarded as barriers to realizing gains on highly valued land.

The shortsightedness of this policy has backfired on towns that are now held responsible for emergency response following severe weather events. Where docks and marinas have

replaced natural buffers, storms have become more impactful. Costly manmade assets have been accumulated in areas that have become increasingly vulnerable.

Approach

Initially, I set out to construct a quantitative model for valuing ecosystem services in Massachusetts and Rhode Island. The model I hoped to build would rely heavily on insurance databases, from which I planned to gather loss and liability statistics. There were two primary issues with this approach that both hindered progress and called into question the validity of such a methodology. First, the high-quality insurance loss statistics that I thought would yield results were not accessible. While the process of attempting and failing to garner data from the private insurance industry did not result in the desired outcome, the effort was not altogether unfruitful. The experience opened my eyes to the reality of disconnectedness among academia, insurance, and ecology. The foregone prospect of private insurers gaining outside perspective from environmental and actuarial science student researchers interested in loss modeling underscores the opportunity cost of failing to collaborate.

Second, as my vicarious learning from the field of literature evolved into actual exposure to research methods, I encountered what might be classified as an epistemological dilemma. The things I set out to do—approaches that I thought would be valuable—were not as useful as previously imagined. From studying existing ecosystem valuations and attempting to piece together a theoretical model of my own, I realized that quantitative information is not necessarily knowledge. I had hoped to produce a predictive model for prioritizing conservation projects based on insurance loss. My study would have been driven by belief that predictive power equates to knowledge. Had my method been "successful," I would have

ignored an entire world of information that is relevant to the field. Moreover, my findings likely would not have resulted in increased collaboration, but would have simply turned the professional into the scholarly.

What I have instead tried to do is to develop a theory that explains what is meaningful to all participants in coastal life by "trusting in emergence" (Corbin & Strauss, 1990). I had initially come to the task of research with one intention, but was serendipitously frustrated. Although propriety insurance data was excluded in this study, this paper represents an attempt to abstract general insights from the substantive but isolated areas of coastal management, coastal science, insurance, sociology, and economics. My hope is that what has emerged may offer future researchers a "set of concepts that provide a thorough theoretical explanation of [the] phenomena under study" (Corbin & Strauss, 1990).

Through interviews, literature review, and my aborted attempt to access the world of private insurance, I found that the language common to developers, policymakers, risk professionals, and municipal planners relies heavily on the concept of value. Furthermore, I found that these parties view the world through lenses that color the topic of coastal planning with a definite bias. My research explores the idea that an effective way to converge the differing perspectives of stakeholders is to unify divergent coastal land use paradigms in the pursuit of value. As social but self-preserving creatures, humans have the propensity to privatize gain and socialize risk. Social, personal, and environmental goals align when coastal resilience is enhanced if participants are provided with accurate measures of value creation.

In the descriptive phase of studying the material, I have provided a compendium of dominant approaches to coastal land management and valuation. Following the iterative process

prescribed by the grounded theory methodology, these materials under study are further broken down by other salient themes, such as assumptions about sea level rise and perception of time-horizon. In this paper, the emergent theme methodology is especially useful as a precursor to statistical analysis because we attempt to translate budget information into environmental attitudes. After general themes and budget categories are "cracked open," deeper steps of analysis are performed.

The study encompasses a review of coastal management theory and practices, as well as an analysis of valuation techniques used in ascribing meaning and worth to ecosystem services. I have explored natural benefits for shoreline protection with the intent of making a comparison with built structures, identified key models for ecosystem services valuation, researched the major threats to coastal ecosystems, and explored the coastal resilience concept. After discarding our attempt to access private insurance databases containing statistics on loss and liability, I was compelled to rely on published historic databases. Enlightened about the disconnect between academia and industry, I started anew with sensitivity toward an emerging-theme approach. Thus, I have incorporated grounded theory as an organizing theme, a method that I believe is appropriate for addressing the broad question of coastal resilience that encompasses many disciplines.

FACTORS IN COASTAL DECISION MAKING

When we see communities struggling to recover after storms or disruptive change, we ought to look at the processes that led to a vulnerable rather than resilient community. In the background were a number of industries and agencies working toward separate goals. These groups consist of the insurance industry, municipal governments, state and federal agencies, coastal scientists, real estate developers, and homeowners. This group could be referred to as the coastal interaction complex. In the future, these stakeholders in coastal lands will form partnerships in support of a larger and longer-term goal of enhancing the value of the environment.

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Legal Environment

The U.S. Congress passed the Coastal Zone Management Act (CZMA) in 1972 in order to balance the needs of economic development and environmental development (Coastal Zone Management Act of 1972). As stated in section 303, the act's first objective is "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations." The federal law requires all coastal states to have coastal zone management plans that address roads, houses, zoning, and other concerns.

The CZMA calls for the protection of "wetlands, floodplains, estuaries, beaches, dunes, barrier islands, coral reefs, and fish and wildlife and their habitat, within the coastal zone."

The CZMA should be appreciated for recognizing the importance of conservation. The flexibility it offers states in developing permissible land uses and water uses within the coastal zone allows states to address environmental needs in ways that uniquely apply to particular locales. A potential shortcoming of the act is that it leaves room for ambiguity in its definition of value, and this ambiguity actually impedes collaboration. The act defines the term "coastal resource of national significance" as an area "determined by a coastal state to be of substantial biological or natural storm protective value." Generally, while the type of value—biological or protective—is explicit, a methodology for evaluating the degree of value is not specified.

Degree of value is different from measurement of change, but specific goals are a step in the right direction. The CZMA sets measurable goals where categorical description, identification, and measurement of the impact of coastal management action are relatively easy and the value of the action is self-evident. For example, in a subsection entitled "Guidance for coastal nonpoint source pollution control," the act calls for quantitative estimates of the pollution reduction effects and costs of measures for reducing pollution in coastal waters. The value of clean water is apparent to most stakeholders, and the methods of testing for water quality are widely practiced and accepted. Calling for states to establish these specific and measurable goals is relatively easy when it comes to water pollution, but asking states to set goals regarding beaches, dunes, wetlands, and barrier islands is more difficult. Many people outside of the ecology field have great difficulty appreciating the extent to

which management of coastal development has the potential to reduce loss of life and property in flood-prone, storm surge, and erosion-prone areas.

Standardized methodology for determining progress in coastal management is not as simple as water quality tests. This means that both the value and the measurability of progress in enhancing coastal resilience need to be translated into a common language. Economic valuations of ecosystem services can serve to bridge this gap. Where there is no common language, there is a lack of communication. For example, insurers may set rates or drop coverage without so much as notifying town officials. If town officials had economic models of how areas would be affected by sea level rise, land subsidence, saltwater intrusion, and loss of natural protective features written in a common language, insurers could collaborate with town officials and compare models. Mutual gains would be made in the form of enhanced town management and more efficient, consumer friendly, sustainable, and perhaps even more profitable insurance products. This would reduce risk for insurers, increase coverage for homeowners, and give town managers insight into prioritizing coastal resilience action plans. A common language would also allow ecologists to make recommendations to insurers on risk management matters related to zoning, such as how far a house should be set back from a dune and then share this information with home owners and policymakers. It would also force developers to extend their time-horizons. If prospective buyers were informed in clear economic language the value of sustainable development practices, they would be willing to pay a premium for an ecologically friendly home. Homeowners would demand a steep discount for homes established in areas that might not be able to obtain federal flood insurance in the future.

Insurance Market

The question of who should pay for the burdens imposed by increased coastal development is unclear. In the same way that towns are both part of the problem and the solution, the role of insurance is complex. The National Flood Insurance Program (NFIP) has helped many families—including one belonging to this author—to rebuild their lives after experiencing loss of property in the wake of flooding. Unfortunately, the sense of security that insurance offers encourages development in vulnerable areas, many of which are home to natural resources that should be protected. The large debt incurred by the National Flood Insurance Program is revealing. Much of this debt burden was inflicted by Hurricane Katrina in 2005 and Hurricane Sandy in 2008. After Katrina, the program was $18 billion in debt (Lipton, 2012). Currently, the National Flood Insurance Program is close to $27 billion in debt to taxpayers (Lehmann, 2013). The economic unsustainability of this program suggests that many of our prior assumptions need to be reevaluated.

Property and casualty actuaries generally insist that an insurable risk is one associated only with a random loss. If a loss is not random, the insurer may be vulnerable to adverse selection, where a consumer possesses information that is not factored into the contract's premium. The National Flood Insurance Program, when it was created in 1968 to protect homeowners against flood loss, had the ability to prevent adverse selection in a way that private insurers cannot. That is, homeowners of property in regions that FEMA designates as Special Flood Hazard Areas are compelled to purchase flood insurance. Adverse selection might not be contaminating the risk pool considerably, but the risk pool is deteriorating nonetheless from a different cause. Losses are becoming more frequent and more severe due to climate change and decreasing coastal resilience, yet premiums have not increased to levels commensurate

with risk associated with the policy (Widmer, 2012). Meanwhile, the private commercial market has been experiencing significant rate increases.

Looking at a hypothetical privatization of flood insurance offers two obvious risk management insights. According to John Prible, Vice President of Federal Government Affairs for Independent Insurance Agents & Brokers of America, Inc., private insurers might not accept many National Flood Insurance Program customers because of difficulties of accurately and actuarially rating risk (Widmer, 2012). Second, private insurers would likely evaluate a risk on an individual basis more closely than what is currently done in the NFIP. Both insights suggest that the National Flood Insurance Program uses underwriting standards that are more favorable to coastal development than those of the private market, creating additional incentive to build in areas that ideally would remain protected. The NFIP serves as a reminder of the importance of looking ahead to factor into our assumptions a reasonable set of expectations about the increasing frequency of severe weather and flooding.

On a simplistic level, severe storms that were once considered occasional are now more common. The situation is complicated in part by interaction between the amount of coastal development and the impact of storms. This scenario is similar to systemic financial risk seen in the crisis of 2008 as a result of unwise credit practices and improperly priced risk involved with mortgage-related financial products. In the financial crisis, the direct link between financial markets and the macroeconomy became apparent. Likewise, it could be argued that in Hurricane Katrina and Hurricane Sandy the linkage between human activity and the global risk of severe weather became apparent. Long-term insurance risk models are improved by

realistic assumptions of sea level rise, for example, but they must be further improved to take into account the reality of interconnectedness.

One way to accomplish this might be to include ecosystem valuations—which measure the linkage between human activity and its potential to impose systemic costs—into insurance models. Risk management professionals, actuaries for example, know how to measure these risks once proper valuation techniques and data have been established. The problem is that these common practices for gathering data have not been established, in part because of a lack of communication between differing fields of study. Actuaries would be able to develop techniques for data analysis and business application, but they would not be cognizant of the environmental complexities without help from ecologists. Here is an opportunity for synergistic gains from collaboration among academia, business professionals, and ecologists.

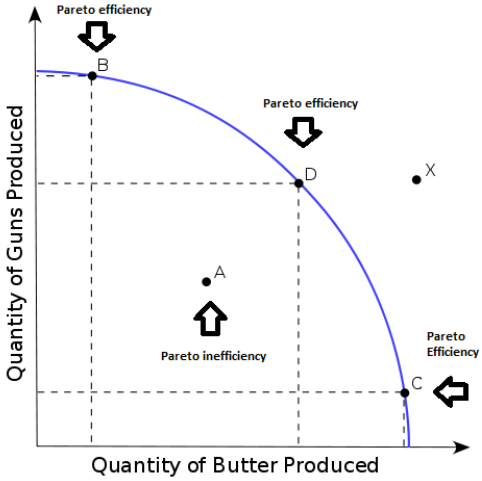
Optimization

Climate change awareness has come along side increasing awareness of the interrelated and constantly changing nature of the many aspects of coastal management. We are now recognizing the rate of change of these factors and the extent to which stakeholders are plagued by a lack of coordination. This paper proposes that economists, developers, coastal ecologists, and town managers collaborate on sustainability models to reduce property damage, enhance safety, protect economic value, and maintain and increase coastal resilience. The opportunity cost of not increasing collaboration is immense. Those who understand the value of built infrastructure must also understand the value of natural services. We need not suffer the loss of ecosystem services from ill-planned development and infrastructure construction.

Decision makers must interact, but in order for them to do so, they must have something in common. They need tools and models that can help them uncover the value associated with natural resources. When professionals and academicians of different fields do not share information, their efforts may result in maximization of a given resource rather than optimization of the mix of resources. Optimization involves prioritization of goals as well as an understanding of synergistic gains to achieve a resilient coastline for the long-term good of society.

The tendency to maximize rather than optimize can be seen in the intersection of agriculture, wetland restoration, and water quality restoration. Agricultural applications of fertilizers and pesticides have increased over the past five decades, and as a result, surface and ground water contamination has become a serious concern (Crumpton, 2010). Federal and state programs have been implemented to promote wetland restoration since the mid-1980s. The programs tend to focus on waterfowl habitat loss rather than agricultural watershed, and the conservation approach is not optimal (Crumpton, 2010). The sites selected and the amount of land used included in restoration plans do not meet the variety of needs that could be met in a different approach using the same amount of resources.

Choosing to invest in clean water or habitats is analogous to the classic example of guns versus butter in a simple production-possibility frontier. The classic illustration does not come close to adequately addressing the complexities of coastal decision making, but the example serves as a reminder of the basics of efficiency.



Source: http://www.economicswiki.com/economics-tutorials/pareto-efficient-pareto-optimal-tutorial/

A production-possibility frontier graph compares the production rates of two goods or services from the same set of resources. When the allocation of resources changes the status quo so that one party improves without making another worse off, a Pareto Improvement is made. Pareto efficiency is achieved when the all possible Pareto Improvements have been made and the quantity of goods produced lies on the production-possibility frontier curve (Krugman & Wells, 2006).

VALUING COASTAL LANDS

Nonmarket Valuation Techniques

Coastal managers and policymakers attempt to weigh costs and benefits of using land for a particular purpose in a way that involves tradeoffs between short-term and long-term benefits. Decision makers can benefit from quantitative methods for prioritizing management actions to promote coastal resilience. There are differing nonmarket economic valuation methodologies for constructing integrated economic studies for resource preservation and restoration. Researchers at the University of Rhode Island highlight four different approaches that meet the needs of New England states. The approaches they emphasize are based on property value, travel cost, wetlands productivity value, and resource value (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009).

Some Natural Functions of Floodplains

WATER RESOURCES

Natural Flood and Erosion Control
- Provide flood storage and conveyance
- Reduce flood velocities
- Reduce peak flows
- Reduce sedimentation

Water Quality Maintenance
- Filter nutrients and impurities from runoff
- Process organic wastes
- Moderate temperature fluctuations

Groundwater Recharge
- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows

BIOLOGICAL RESOURCES

Biological Productivity
- Rich alluvial soils promote vegetative growth
- Maintain biodiversity
- Maintain integrity of ecosystems

Fish and Wildlife Habitats
- Provide breeding and feeding grounds
- Create and enhance waterfowl habitat
- Protect habitats for rare and endangered species

– *A Unified National Program for Floodplain Management*
FEMA-248 (1994)

Approaches based on property value attempt to use an economic identification strategy for recovering preferences known as hedonic modeling. Hedonic models “characterize markets for heterogeneous goods that implicitly price out the attributes that characterize the goods”

(Ekeland, Heckman, & Nesheim, 2003). The attributes that Johnston et al. (2009) discuss are estimates of the impact of land use and the environment embedded in the observed value of local property. Results of a hedonic study reveal home buyers' willingness to pay to obtain increased levels of desired land use of environmental properties. The econometric models used in this type of analysis rely on advanced statistical methods to compare a variety of properties with different attributes.

In travel cost studies, resources are valued according to the preferences of residents and visitors who use natural resources recreationally for outdoor enjoyment. Studies based on travel cost examine the economic value of recreational swimming, boating, fishing, and bird and wildlife viewing (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). For example, the analysis can focus on water quality and its effect on the number of swimming trips taken. It might also examine the catch rates on recreational fishing. This approach generally uses data collected from surveys. The Travel Cost Model "uses the number of recreational trips an average person takes to a specific site, as a function of the cost of travelling to that site, the comparative costs of travelling to substitute sites, and the quality of the recreational experience at the sites" (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). The assumption behind the model is that demand for recreational trips is driven by high quality coastal resources. The implicit price of clean water and abundant fisheries is determined to be the cost of travelling to a particular site, opportunity cost of a person's time, parking fees, and other additional costs associated with access to the site.

A third valuation technique is a measure of productivity value rather than use value. It is based on wetlands productivity and market values associated with commercial fishing. A

wetlands productivity value study estimates the economic value of eelgrass, inter-tidal salt marshes, and sand or mud bottoms (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). Fish, shellfish, and bird species that these ecosystems provide are used as the basis for these estimates. This approach uses a simulation model rather than a statistical model, and relies upon the judgment of professionals. In a wetlands productivity analysis, ecologists are asked to estimate the increases in food produced for higher trophic levels and the increased production of higher trophic levels brought about by the increases in habitat availability. The commercial value of fish, viewing value of birds, hunting value of waterfowl, and other nursery and habitat services is calculated.

In resource value studies, the public's willingness to pay for ecosystem services is estimated using contingent choice methodology (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). Residents and second homeowners are surveyed to estimate their relative preferences for preserving and restoring natural resources. These could include open space, farmland, unpolluted shellfish grounds, eelgrass beds, and inter-tidal salt marsh. This type of valuation is different from the others in that it tries to capture a "sense of place" value for a local environment, with its particular set of characteristics (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). Based on the responses to contingent choice questions, the statistical model calculates values for an additional acre of a natural resource.

Some researchers caution that these models should be used separately so as not to obscure findings or double count values (Johnston, Grigalunas, Opaluch, Mazzotta, & Diamantedes, 2009). However, one study that might successfully make use of integration of techniques is a highly intricate model used to value ecosystem services in the Indonesian province of Aceh

(Beukering, Grogan, Hansfort, & Seager, 2009). The study attempts to find the Total Economic Value of the forest ecosystem in Aceh under several different scenarios and under several different discount rates. Beukering et al. place a high value on the watershed's flood alleviation capacity (2009). Another study in the province concurs that the flood and landslide damage alleviation of forests are crucial (Wibisono & Suryadiputra, 2006). It was found that the condition of mangrove vegetation was critical in preventing major loss in the event of a flood and that areas where vegetation formations were compromised through deforestation suffered considerably more damage in a recent tsunami (Wibisono & Suryadiputra, 2006).

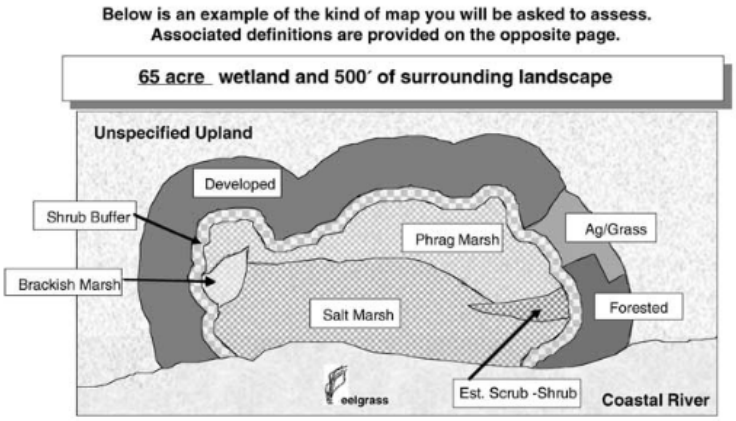
Noteworthy Studies in RI

Practical approaches to wetland conservation recognize that there are infinite points on the frontier curve. That is, whereas current conservation approaches are myopic in their resource allocation, only focusing on water quality or on some other aspect of conservation, a better approach would attempt to reach an ideal allocation of resources to meet multiple goals. In practice, this would mean developing integrated model simulations in selecting wetlands to target for restoration. There are a variety of factors besides watershed that should come into the equation when determining optimal resource allocation.

There are researchers in Massachusetts and Rhode Island who attempt to build such integrated models. These researchers should be given more attention. One study by Newall and Swallow attempted to determine the preferences of individuals for certain land attributes through questionnaires (Newell & Swallow, 2002). The attributes consisted of type of road, character of surrounding land, level of wildlife diversity, level of public access, sustainability of habitat quality, role as conservation area, size of parcel and cost (Newell & Swallow, 2002). The

questionnaires were followed up with real money payments to simulate the consequences that a real decision might have. It is interesting to note that Newell and Swallow conclude that socio-economic variables affect the decisions of individuals taking the survey, but this effect did not appear to be significant (2002). As explained in the Spending Analysis section, the results of my analysis of municipal spending do not indicate a significant correlation between environmental spending and socio-economic variables.

Another notable study was conducted by Johnston and Opaluch. This study used surveys that included diagrams like the one below.



The survey was administered to over 100 coastal scientists, who then ranked the areas of land that were most important to restore. I held an interview with Dr. James Opaluch at URI to get his perspective on policy decision making. Opaluch told me that indeed policymakers have an interest in valuation models, and that he believes this type of modeling will be a very useful tool for future decision making. Opaluch commented that the language of coastal planning ought to change from prioritization, which has a maximization connotation, to optimization.

Opaluch indicated the importance of uniting perception and knowledge. “Experts know a lot, and individuals care about things. The question is how we can link expert opinion and public value” (Opaluch, 2013). Opaluch described that his study used GIS maps and posed the question to participants, “Suppose wetlands look like this. How would you rank them? How good would a wetland like this be for different ecosystem services? We were concerned about how people really understand things,” Opaluch explained (2013).

ANALYSIS OF MUNICIPAL SPENDING

Overview

Our grounded theory approach led us to reevaluate our initial impulse to conduct a valuation model for ecosystem services similar to one already completed. We found that the questions we hoped to answer and realities regarding resources at our disposal were pointing us toward a different approach. Ecosystem services are undeniably valuable, but perceptions about the relationship of people to the environment vary widely. We wanted to find out to what extent Rhode Island cities and towns pattern their spending to reflect this value. Because so much of the policy that affects individuals is generated on a local level, we had confidence that a municipal spending analysis would reveal answers to some of the questions we sought to answer, including the following:

1. If residents feel a greater fear about flooding, would this empower a town to move faster to restore sand dunes on open beaches?

2. Can larger towns and cities afford to set aside more open space?

3. Does the proportion of wealthy residents influence decisions about environmental protection, positively or negatively?

4. Does a higher level of education result in citizens who see the bigger picture, or are more willing to deal with future impacts?

The analysis represents an attempt to understand a municipal perspective of value by looking at municipal dollars spent on the environment. Evaluating documents for language, themes, and motivation is a substantial component of a comprehensive analysis of perception. This

spending analysis takes into consideration a variety of documents, but it primarily attempts to understand a city or town's commitment to environmental quality in terms of budgetary information.

Speaking broadly but frankly, some municipal governments are strapped for cash. Municipal decision makers feel the considerable force of practical and immediate demands by constituents for spending on short-term concerns. Thus, cities and towns that implement good policy often do so by relying on forward-looking coastal leaders (Beatley, 2009). Since spending on the environment tends to counteract the human propensity to shorten the time horizon by prioritizing short-term goals over long-term ones, this study is a measure of the extent to which cities and towns possess forward-looking coastal leadership.

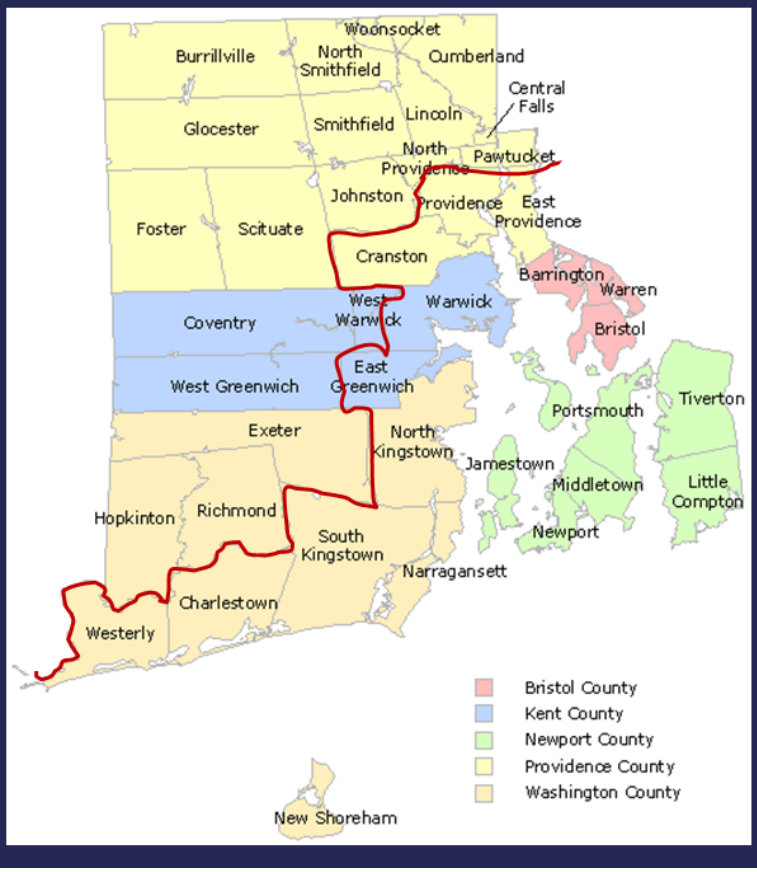
Grounded Theory

My analysis uses grounded theory as an organizing theme. The approach involves integrating data gathering and analysis in a way that illuminates specific patterns (Strauss & Corbin, 1990). The method begins with categorical analysis of descriptive data framed by a broad research question, in this case related to coastal resilience and municipal spending. After key issues and spending patterns emerged, the process was repeated to discover underlying patterns of motivation and beliefs of municipalities (Holtzman, 2011). The somewhat open-ended approach to data gathering is coupled with inductive analysis and statistical methods. The qualitative aspect of creating "eligible spending categories" allows for the phenomenon under study—municipal spending patterns—to reveal interactions and beliefs crucial to the "big picture" (Holtzman, 2011).

Methodology

In our analysis, we looked at 20 cities and town in RI that border a major body of water. These communities range from Westerly to Little Compton and from Narragansett to Providence. They border Block Island Sound, Rhode Island Sound, Narragansett Bay, and the Providence River. In the map below, these cities and towns lie southeast of the red line.

- Westerly
- Charlestown
- S. Kingstown
- Narragansett
- N. Kingstown
- E. Greenwich
- Warwick
- Cranston
- Providence
- E. Providence
- Barrington
- Warren
- Bristol
- Jamestown
- Portsmouth
- Middletown
- Newport
- Tiverton
- Little Compton
- New Shoreham



For each city, we looked at several source documents. We looked through the most recent revised line-by-line annual budget as published on the town's website. This was supplemented by information from the town's annual report. We compared each of these documents with the

municipal audit report submitted to the State of Rhode Island Department of Revenue. These reports are typically prepared according to Generally Accepted Accounting Principles (GAAP) and are generated with intent to disclose information affecting a municipality's ability to borrow. Further, accounting schemes across towns are at times inconsistent. As a result, determining which spending to classify as environmental was a challenge. We decided to consider eligible spending to include the following categories:

- Wastewater and sewer
- Open space acquisition
- Park (not recreation)
- Beaches
- Landfill and well monitoring
- Tree care and preservation
- River authorities and environmental commissions
- Miscellaneous categories such as GIS mapping and litter control

For each of the towns and cities included in our sample, we used eligible spending categories to compare statistics among communities. Our total governmental-wide spending category includes current expenses as listed on the Statement of Revenues and Expenses for Governmental Funds plus those for Proprietary Funds. Propriety Funds consist of activities that municipalities operate as a business, such as wastewater treatment facilities. These

numbers were checked for reasonability against the Grand Total of Operations in the Annual Budget when applicable. Note that our figures include capital outlays and debt servicing where these are considered current operating expenses. Capital expenses are included because some accounting standards consider environmental spending as a capital outlay. Fiduciary Funds, mainly comprised of pension expenses, are excluded from the calculation.

We also looked at factors that are sociological in nature, including population, median household income, percent of the eligible population to achieve a high school education, and crime per capital. Median household income was taken from the 2011 American Community Survey 5-year estimates. Education statistics were taken from the Census 2010, accessed through the Department of Labor and Training. Crime statistics from 2011 were collected by the FBI and accessed via the agency's website. National Flood Insurance Program statistics were accessed via the FEMA website.

In addition, we developed metrics incorporating data from the National Flood Insurance Program. There are two important metrics:

- $Flood\ Frequency\ Ratio = \frac{35\ Year\ History\ of\ Number\ of\ Losses}{Contracts\ in\ Force}$
- $Average\ Claim\ Ratio = \frac{35\ Year\ Payment\ History}{Contracts\ in\ Force}$

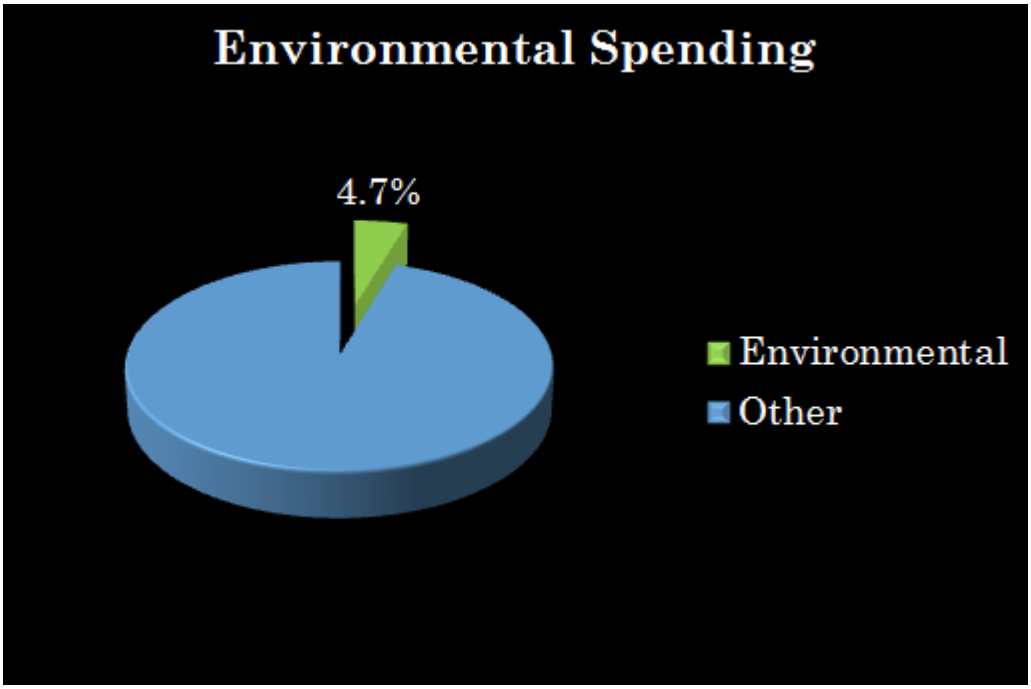
The purpose of these metrics is to look at frequency and loss from floods from a relative perspective, that is, to look for trends after taking into account the differing number of insurance contracts. There is also an additional metric that divides the normalized claim ratio

by population; however, we do not rely on this metric for meaningful conclusions. We include it for commentary purposes only.

After calculating average spending patterns, we completed an analysis of correlation among factors, trying to identify relationships that might influence spending decisions. In addition to the correlation, we also conducted regression analysis using town demographics as the independent variables and spending as the dependent variable. Also, regression was performed to relate spending to the insurance metrics as the dependent variables.

Results

After looking at the budgetary information, we found that total government-wide spending in RI coastal cities and towns, excluding fiduciary expenses, amount to about $2.4 billion. Our analysis indicates that about $111 million or roughly 5% of municpal spending is directed toward the environment.

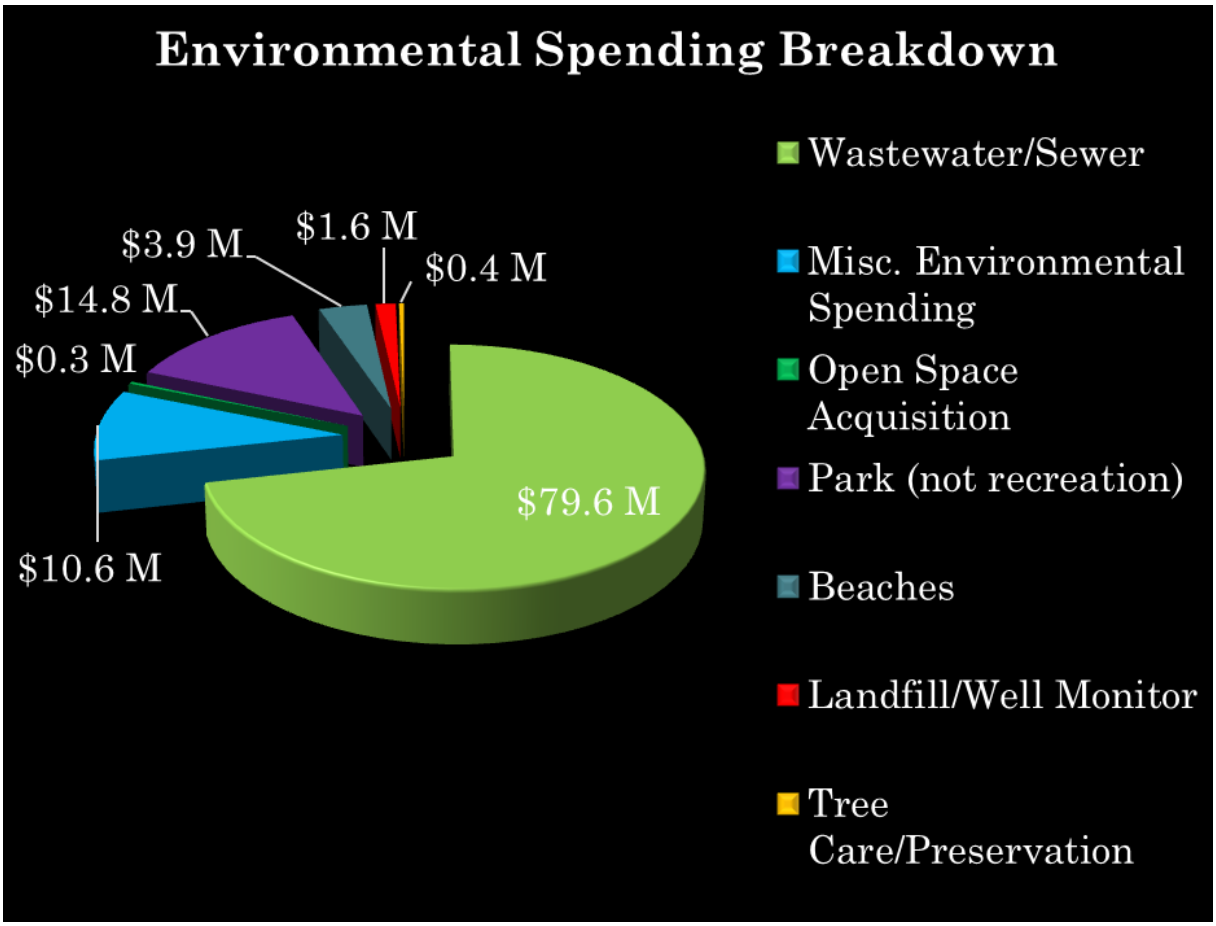


The breakdown of eligible spending revealed that wasterwater and sewer expenses generally accounted for the largest environmental spending within cities and large towns. Total wastewater and sewer spending was $79,591,000.

Items included in a category we deemed miscellaneous enviromental spending are as follows:

- Environmental engineers
- Turbine genenerators
- GIS mapping
- Litter control
- Special grants
- Environmental commissions
- River authorities

Miscellaneous environmental spending totaled $10,644,000. Money spent on acquiring open space totaled $324,000. Spending on beaches amounted to $3,853,000. Landfill and well monitoring expenses were $1,612,000. Dollars directed toward tree care and preservation amounted to $396,000.



The fact that much of the environmental spending is on wastewater and sewers is not surprising. If a sewer system fails, it can cause considerable damage to property and the environment. Middletown and Newport have faced lawsuits for system overflows and contamination, and Warwick has been accused of contaminating beaches across Narragansett Bay (NELC Interview: Rhode Island's "Sewer Rats", 2010).

If the category representing maintenance of parks is an indicator of a community's attitude toward managing the environment, then it is encouraging to find that it is the second largest environmental spending category after wastewater and sewer. However, two other measures

that might also represent such an attitude are tree care and open space acquisition, which are the smallest categories. Overall, if we combine all three of these categories, the total is $15.5 million, which is a little over half a percent of total spending.

We hoped to test whether communities with higher population levels and/or incomes and/or high levels of education and/or higher levels of crime spend more on the environment. The rationale for including income was that wealth might induce spending from those who consider environmental protection a luxury. We reasoned that education might bring about a greater awareness of the value of ecosystem services and that it would lead to more forward thinking. Finally, we included crime as a proxy for feeling of insecurity. We thought that feelings of insecurity might reflect a greater fear of future coastal damages. We were not afraid to reason out hypotheses to test or to venture out into the boundaries of sociology and accounting because we were operating under the grounded theory approach.

First, we looked for connections among municipal characteristics and the flood frequency ratio. We also looked for connections among municipal characteristics and the average claim ratio.

Regression analysis resulted in a mildly significant negative relationship when measuring median household income against both Flood Frequency (p-value = .068) and Flood Loss Claims (p-value = .08).

We observed that both flood metrics are correlated with the following:

- Median household income (negative correlation above 40% in absolute terms)
- Level of education (negative correlation above 50% in absolute terms)
- Population (positive correlation above 60%)

Additional regression gives limited useful information since multicollinearity is present when the income and education variables are used together. That is, the income and education variables compete as predictors of flood frequency and severity. It may be that lower frequency and dollar amounts of flood loss relative to the number of contracts are slightly negatively correlated with income and education because of the awareness and environmental luxury effects described above. However, since income and education are correlated highly with population and it appears that multicollinearity may be present, we are open to the possibility that population was the driver of the apparent income, education, and flood connection.

Regression analysis was also performed using environmental spending as the independent variable and the insurance metrics as the dependent variables. No significant results were obtained. We observed a weak negative correlation of 13% between environmental spending and income and a weak negative correlation of 10% between environmental spending and education. Therefore, the amount of dollars spent on the environment does not appear to be connected with the relative frequency and severity of flood loss.

It is difficult to determine precisely the cause of this misalignment in spending. One plausible interpretation is that environmental spending was not measured properly by municipalities in the first place. Perhaps the budget categories do not adequately reflect environmental spending. Budget categories are created by specific processes that do not necessarily take into consideration factors outside of the realm of general municipal budgeting and public accounting standard practices. It might also be that there is a time lag. We attempted to find a linkage between past patterns of damage and current levels of environmental spending. It might be that there is a gap between perceptions of recent storm events and perceptions of the need to take action by municipal or state governments.

Limitations and Further Study

It is important to recognize the limitations inherent in our research. The insurance statistics that were available on the FEMA website said nothing of the type of contracts issued. We were not able to group losses by category and we were not able to find out any more information about the properties where specific losses were experienced. Neither were we able to access risk categories on a meaningful level. This lack of access to data makes a holistic approach to research challenging. We decided to refrain from including the results of a drill down to lower levels of spending detail because of the reporting inconsistencies among municipalities.

Modeling tools provided by statistical packages more advanced than Excel might have revealed patterns that are not exposed by regression and correlation analysis. There might also have been trends that were not apparent because of our inability to compare environmental spending across communities. We were constrained by the kinds of information that is

collected and measured. For example, budgets do not record all of spending directed toward the environment and the accounting for those expenses are complicated. The reality is that budget information cannot be relied upon as a sole indicator of a municipality's dedication to environmental quality.

The number of variables in our study could be expanded. The regression analysis highlighted a linkage between population size and flood claims, the details of which could be better analyzed with additional layers of information. For example, spatial analysis and GIS mapping could be used to reconcile income levels with information about proximity of homes to water. In this way, a more precise analysis of the linkage could be undertaken.

The flood metrics could be improved. The flood frequency ratio and the average claim ratio use information publicly available from the National Flood Insurance Program. The ratios are an effort to take imperfect data and link that data to municipal decision making. The numerator is over a 35-year period, but the denominator is the number of contracts currently in force. In addition, to test the effects of population, we divided the average claims ratio by population. The value of the metric is questionable because it may exaggerate the effect of population. We do make inferences based off the metric, and tests with this metric were only conducted as additional step to further explore population differences. Therefore, the risk of the metric undermining the main findings of the study is negligible. Although the metric is not essential to our findings, we discuss its presence because we hope that this line of thought will spur innovation in future studies.

Future studies should attempt to further integrate information collected by different stakeholders in coastal lands. For example, the National Flood Insurance databases contain an

incredible amount of useful information, but not all of it is publically available. Using the NFIP databases to prioritize actions and programs will be valuable going forward.

A further consideration for future study is that limiting analysis to Rhode Island gives us a small data set. Thus, the effects of outliers should be carefully evaluated. Relative population size, as in the case of Providence, and total coastal area in relation to community land area, for example, in New Shoreham, should be given careful consideration.

CONCLUSION

This paper represents multi-disciplinary thinking. Our spending analysis attempts to bring together sociological, accounting, and insurance data for the purpose of bringing into focus a larger picture of coastal resources sustainability. We have developed a collage of ideas about the relative and complex roles of the insurance industry, municipal government, state and federal agencies, coastal scientists, and real estate developers in identifying and measuring the value of coastal lands and how they should be developed and/or protected going forward. Since we believe so strongly that understanding the multi-faceted and dynamic human and ecological interactions that affect our coastline is essential to addressing our most pressing coastal dilemmas, we have been open to an emergent theme approach. We believe that an approach focused on the interrelated role of participants within the coastal interaction complex and centered on the themes of coastal resilience and the value of ecosystem services ought to shape future policy decisions.

Recommendations

Our interview with Dr. James Opaluch, a researcher at URI who has conducted notable valuations of RI ecosystem services, confirmed our assessment that climate change is often a forgotten variable in coastal decision making. This variable could be better accounted for with enhanced communication among local, state, and federal agencies, industries, and individuals. If we could open the door to increased collaboration, for example integrating municipal budget information with NFIP databases and information about climate change from coastal scientists, we might find a path toward answering the following questions:

- How can this information be better used by community and state decision makers?

- How can past patterns be linked with climate change models to predict vulnerability in a given region?

In addition, this information could be used to assess development impact fees that more accurately reflect the value of ecosystem services. Several towns already have impact fees in place, primarily to account for increased demands on the government's proprietary use of wastewater facilities. Some towns have discussed fees for development disrupting the flow of water generally. Increased integration of coastal stakeholder information would lead to a better understanding of the economic and social value of ecosystem services. This information is essential to developing new and effective impact fees.

After completing the spending analysis, we make the recommendation that municipal budget reporting be broken down into categories that more accurately reflect a resilience focus. Implementing changes in reporting would open several questions:

- Would this have implications on GAAP accounting for revenues and expenses?
- Should these categories be constructed on the level of the community or state?
- What is the role of the Coastal Resources Management Council in changing these policies?

<u>Going Forward</u>

No matter how much we expect seas to rise or the increasing intensity of storms to exacerbate flooding, preparing for these changes should be a priority of every coastal city and town. Our evaluation of the literature indicates that natural methods of preparing for disaster lead to the greatest extent of resiliency at the lowest cost. However, our analysis indicates that

municipalities may not be patterning their spending to reflect the high value of natural capital. Unnatural infrastructure solutions and unchecked coastal development are still carried out for their short-term benefits, while their long-term costs are ignored. Furthermore, low municipal spending on the environment underscores that the opportunity cost of the services that ecosystems impaired by anthropogenic intervention could have provided is greatly misunderstood and undervalued.

Impending coastal changes have already begun to unfold. In the face of these changes, we need to consider coastal resilience. Forward coastal planning is imperative in expanding coastal resilience. Governmental investment will be necessary to enhance natural coastal barriers and to relocate public and private infrastructure. Valuation models could play a key role in prioritization. Public support of governmental spending and coastal regulations will be required. Certainly, developing coastal resilience will be difficult, and if it is actually to be achieved, it will require public and private collaborations.

Our analysis concludes that communities with more frequent or severe relative flood losses may not be more likely to spend more money on the environment. In this way, environmental spending does not appear to have an effect on the frequency or severity of relative flood loss. We also tested a restatement of that claim. In other words, we looked at whether environmental spending predicted a decrease in the frequency and severity of relative flood losses. Our analysis does not indicate that this is the case.

We can only speculate what this means. Perhaps the money spent was not spent optimally. There also may be a lag in results, where the positive impact of spending is not seen until the future. Moreover, the safety net of flood insurance likely obscures the relationship between

spending and flooding. Most importantly, perhaps there is a threshold that environmental spending must meet before it has a considerable impact. This could be an area for future research. Communities that spend heavily on the environment could be identified and tested.

Two of the salient themes that form the bedrock of our analyses are the value of ecosystem services and coastal resilience. Coastal resilience and the value of ecosystem services ought to be unifying themes among coastal stakeholders in the future. In fact, these themes have received attention in the most recent proceedings of the Coastal Resources Management Council. The Coastal Resources Management Council is responsible for the preservation, protection, development and where possible the restoration of the coastal areas of RI. They act by issuing permits for work done in coastal areas.

A CRMC report released this month emphasizes the importance of municipal and state roles in planning for upcoming coastal zone changes. It expresses urgency for taking action immediately and discusses the importance of looking at relative cost and benefit for environmental projects. It is an affirmation of the importance of this project and highlights the need for future study (Willis, 2013).

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