Sea Level Rise and Private Property Rights in Shoreline Management

by

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ABSTRACT

The objective of this study was to research the ability of shoreline management systems and policies to handle sea level rise and private property rights. Coastal hazards, including erosion, flooding, ocean dynamics and storms are a current management dilemma. Sea levels are rising and will rise an estimated 56 cm to 368 cm over the next century. Private property rights are presently a high profile issue. The combination of these factors has stretched the present day policies thin and exposed the problem that current policies are inadequate to address the shoreline management problems created by sea level rise.

The present policies are examined from their birth through to present day. They are considered from a national perspective and at a state level. Oregon and Rhode Island illustrate the differences in state’s varied needs as well as their approaches towards shoreline management. Future hazards, primarily sea level rise, are examined to better understand their potential impact. Policies and approaches are considered in order to determine their readiness to adjust to and handle sea level rise.

The current U.S. policies are found to be unprepared to handle sea level rise but they are in a position to change that. Linking sea level rise to more immediate and tangible issues such as coastal erosion, beach access, and hazard mitigation provide present day solutions. Future solutions require the federal government to regard sea level rise as a national problem. Once it is recognized as such, national standards and goals can be established, and the states can continue to manage their shorelines subject to national requirements.

Thesis Supervisor: Judith T. Kildow

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1. Introduction

1.1 Statement of problem

Sea levels are rising. During the past few millennia, sea levels have risen at the rate of roughly 12 cm per century. Global climate change and global warming are potentially capable of accelerating this up to predicted rates of 0.5 m to 3 m per century (for the next century). As the sea level rises, the existing shoreline (relative shoreline) recedes and the existing land mass is reduced. This exacerbates all existing coastal problems and hazards and, potentially, can increase the associated risks to humans and property. This is a serious concern as nearly 65% of the population in the United States (roughly 129 million people) live within 50 miles of the coastline (Edwards, 1989), including nine of our ten major metropolitan areas which consist of a population of 71.9 million (Platt, 1994).

Coastal hazards (regardless of any climate change or accelerated sea level rise) include long term erosion due to the dynamics of the oceans and wind as well as short term erosion, flooding, inundation and coastal destabilization due to hurricanes and storms. This is a current management dilemma. Add a rising sea level to this and erosion rates and the resulting land recedence increase. According to the Brunn Rule, sandy beaches on the outer coast exposed to ocean waves may cause beaches to erode 1 m or more for a 1 cm rise in sea level. That same 1 cm rise causes Louisiana to lose 100 km² of its wetlands while a 10 cm rise may advance salt water an extra 10 km further upstream in estuaries and tidal rivers (NRC, 1987). Granted, these are more vulnerable areas and, as such, will be more adversely affected than will other more sheltered (less wave action) areas or rockier (less easily erodeable material) shorelines. However, every state within the 53,677 miles of United States shoreline contains such high risk areas, some, more than others. Finally, it must be remembered that there are no “non vulnerable” areas, just a shoreline that has segments that are at relatively higher and lower risk due to sea level rise.
A rising sea level reduces the buffer zone between man and coastal hazards. As a shoreline recedes, the effects of storms increase dramatically. This is due to the severity of the waves, the increased storm surge (relative to populated areas), increased salt water inundation, reduced efficiency of shoreline protection structures and increased erosion. Hurricane Hugo in 1989 inflicted total insured losses of $7 billion while Hurricane Andrew (while missing major coastal metropolitan areas) caused over $20 billion in damages with, in excess of 100,000 demolished homes and commercial structures (Wang et al, 1994). Imagine the costs if a rising sea level were to place the ocean at the foot of the population.

There are two responses to sea level rise. Stabilize the shoreline or retreat from the shoreline and maintain a more-or-less equal elevation above sea level. The technology (costs and feasibility's aside) exists to accomplish the first, but does the policy exist to even consider the latter? Due to the diversity of the coastline, both must be capable of being considered and implemented. The primary issue at stake with a feasible retreat (as well as, to a lesser degree, protecting the shoreline) is private property rights and takings. There is no stated national land use policy in the United States and the individual state’s policies regarding land use has varied greatly without any well defined pattern (Caldwell et al, 1993). There are stated national shoreline management policies based on the Federal Emergency Management Agency and the Coastal Zone Management Act. These are not consistent with each other, nor are they clearly defined policies which leaves an enormous gray area regarding private property rights and public accountability. This puts an even greater strain on shoreline management policies to do their job and protect coastal resources as the sea level rises. All of which leads to the foundation of this thesis: Current U.S. policies are inadequate to address the shoreline management problems created by sea level rise.

1.2 Statement of Purpose

In the United States we tend to strive toward concrete solutions and absolutes. Americans tend to consider their landholdings as absolute land ownership rather than a land
tenureship or a temporary holding of specified and conditional rights over the land (Paul, 1988). These landholdings are defined by specific boundaries that are considered to be non-moveable by governments or nature. When they do move, we assume that we have the right to protect those boundaries. But do we?

The seventeenth century philosopher, John Locke, insisted that governments are constructed by men for one reason only, and that is to protect their property rights. He believed that the right to acquire, possess and enjoy property is the fundamental liberty upon which all other inherent rights of life and liberty depend. This reasoning was deeply rooted in America’s founding fathers. Today, the governments in the United States have three primary powers over property: taxing power, police power and the power of eminent domain (Caldwell et al, 1993). It is from these last two powers that the struggle over where private rights leave off and public accountability picks up has arisen.

Private property rights became an issue the day the early colonists set foot in this country and staked out land claims. This was not a problem during America’s early history as land was plentiful and nature had yet to shift these newly defined boundaries of coastal property. Since then, over 65% of our population has crowded along the shoreline. This same strip of land has also claimed the highest growth over the last 30 years with an average population increase of 40% and localized population increases of over 85% (Edwards, 1989).

The shoreline of the United States is the most populated, sought after, and developed strip of property and is worth more (economically speaking), on average, than any other comparable parcel in the country. The shoreline is also the most dynamic (physically speaking), unstable and risk or hazard ridden strip of property in the country (Dean, 1990). This has set the stage for a very interesting battlefield. Several important cases involving land use regulations have come before the U.S. Supreme Court in the past few years (see Appendix C). In these cases the sides have argued over many issues. The primary two being the position that land use regulations are necessary to protect
environmental quality and public accessibility versus the position that land use regulations are tantamount to seizures (in the form of uncompensated “takings”) of private property (Tibbetts, 1995). Land use regulations have also resulted in bitter disputes over shoreline protection. In many states, seawalls and other forms of “hard” protection are illegal since these methods of protection have been proven, while they may reduce erosion (equivalent to protecting a property’s boundary) locally, to cause increased erosion further down the coastline (Dean, 1990). Therefore regulations have been put in place to regulate people’s harmful effect on others again causing a dispute over private rights versus public interests.

These issues are a primary basis of the shoreline management dilemma in the U.S. today. The fragmentation and conflict among existing policies both at the state and federal levels have led to inconsistent responses to coastal disasters and problems. Historically, responses have been in answer to an immediate threat or recent disaster, and policies have shifted according to the present political arena (Platt, 1994). With a rising sea level, these issues will no longer be a few individual cases, but a widespread concern that policies must be prepared to address and respond to.

1.3 Statement of Scope

Sea level rise is occurring fairly consistently around the coast of the United States. Individual states can therefore be singled out and studied so long as the specific physical characteristics of that coastline and the specific human activities are understood and considered. This analysis will consider the basis of the national shoreline management “system” by looking at the history of the Federal Coastal Management Act (CZMA) and how it has evolved into existing policy. Other federal laws give powers to federal agencies to address coastal zone management (CZM). These include the Clean Water Act under the Environmental Protection Agency, the National Flood Insurance Program and the Federal Emergency Management Agency (FEMA), the Coastal Barriers Resources Act of 1982 under the Department of the Interior, and the Rivers and Harbors Appropriations Act of 1899 under the U. S. Army Corps of Engineers (see Appendix B). These form the
basic national shoreline management programs and coastal policies. This system will be studied from a legal and policy based perspective in order to understand the federal guidelines that states use in forming their own individual shoreline management (SM) programs.

National coastal policy was designed to provide national policy objectives from which each individual state would voluntarily establish an individual CZM program that responded to the national objectives while also fulfilling their own physical, societal and political needs (Godschalk, 1992). This led to 29 (out of a possible 35) CZM programs that are extremely diverse in their methods and ambitions. The shoreline management programs of the individual states and relevant legal proceedings concerning private property will be discussed and compared and contrasted. Then two states that differ most in their SM approach will be looked at in greater detail. These states are Rhode Island and Oregon.

Both Oregon and Rhode Island had shoreline management policies in place prior to the passage of the federal Coastal Zone Management Act of 1972. Oregon’s CZM program was the second federally approved program (1977) while Rhode Island’s CZM program was approved the following year. As initial, active shoreline management “participants”, these states contain a relatively lengthy and relevant SM history of growth and change. The CZMA, in attempting to allow states to create the best possible CZM programs for their own needs and diversities, specified three alternative state/local techniques for managing the coastal zone. In a nutshell (see Appendix B.1 for specifics) these are:

1. Local shoreline management implementation based on state criteria that is subject to state review and enforcement.
2. Direct state shoreline management planning and regulation.
3. State administrative review for consistency of all shoreline management projects proposed by state, local or private with the power to approve or disapprove.
Oregon and Rhode Island have each chosen different roles that, between the two, encompass all of the three federally specified techniques without any major overlap (Scott, 1981). By considering two differing and active management programs, a better policy evaluation can be made as to the effects of private property rights on shoreline management programs. Finally, since these states effectively consider all of the federal policy directives, a more complete assessment can be made of the policies with regard to sea level rise.

Rhode Island’s coastal powers and policies are lodged primarily with the state government. Here they are centralized in a multimember Coastal Resources Management Council that does not share its regulatory authority with any other state agencies or with local sub-state governments. This calls for two separate management jurisdictions. The local governments exercise traditional land use and zoning controls except for certain specified land uses and coastal features. The state government regulates the entire seaward side of the coastal zone as well as certain land areas and shoreline protection.

Oregon, meanwhile, chose to involve local governments in the shoreline management process. This is based upon an iterative process through which state level objectives, policies and guidelines are established. Local programs are then designed. These are evaluated and approved (or not) by the state, carried out locally and monitored and reviewed by the state. This has resulted in a state-local collaborative planning of the coastal zone.

States such as California and Florida, while very active with their shorelines, were not considered due to their internal physical, societal and political diversities. These diversities coupled with the physical length of the state’s coastlines and the size of their populations result in policy demands that are not consistent with the majority of U.S. states (Christie, 1989). As, “special cases”, states such as these require a study in themselves to fully understand the evolution of their shoreline management. This is beyond the scope of this study.
The histories leading up to the formation of the present shoreline management systems of Oregon and Rhode Island must be understood in order to understand the basis of the policies. This is where the case studies start. Once the reasons and stakeholders have been identified the policies can be examined. As the policies differ between case studies, their strengths and weaknesses within their own arena are considered. Effective policies will be judged to allow private rights and public interest to coexist without huge legal battles and societal outcry at every coastal hazard. This examination will consider coastal hazards with private property implications for each case study and follow the existing policies through governmental action, private reaction (legal and media), and final outcome. That final outcome will be compared against the policy standpoint prior to the hazard. Finally, assuming an accelerated sea level rise, both states programs will be studied for specific policies relating to sea level rise and the resulting loss of land.

1.4 Assumptions

Certain assumptions need to be made about natural processes:

- Global warming and increased global surface temperatures leads to increased sea level rise.
- Sea level rise leads to increased coastal erosion and reduced land mass.
- Future storm trends are at least as severe as present and past storm trends.
- It is not possible to control nature.

Certain assumptions need to be made about human activity:

- Population levels will continue to grow along the coasts.
- The value of coastal land will remain relatively high.
- The desire to own property will remain unchanged.
- The “taking” of land is negative in the eye of the owner.
• The “need” to develop the coastline will remain unchanged.
• The litigiousness of our society will remain unchanged.
• Political and societal attitudes toward the coastline will remain unchanged.
2. Framework

2.1 The problem: *Man v. Nature*

But look! Here come more crowds, pacing straight for the water, and seemingly bound for a dive. Strange! Nothing will content them but the extremist limit of the land,...They must get just as high the water as they possibly can without falling in.

Herman Melville, *Moby Dick*, 1851

Man has a fascination, a love affair of sorts, with the water. The emotional draw that the ocean possesses has lured many people into living on or near the coastline, and many more into traveling great lengths to spend vacations and “escape”. This has resulted in the highest population density and growth of any geographic land division in the history of mankind (Edwards, 1989).

The shoreline is, simply put, the land-sea interface. Rivers, estuaries, inlets and harbors all fall under the same heading. This is nature’s boundary. It is a highly dynamic boundary which fluctuates in both the geographic and temporal sense. This boundary stretches for thousands of kilometers along the coasts, however its form and dynamics vary from meter to meter (Kaufman et al, 1983). Add to this a range of natural processes that contain destructive forces and this boundary starts to look less and less like our classical definition of a boundary.

Man’s boundaries are static lines, fixed in space, that define a specific area. These divisions are based on legal definitions and agreements, having no necessary “natural” division. These borders are not dynamic and usually stretch for meters, sometimes kilometers. Their form and dynamics however, are roughly similar throughout the millions of square kilometers of this country. The problem arises when the latter imposes its values and definitions on the former.
Most of the land use planning in the United States is not planning but zoning (Cullingworth, 1993). The problem that exists is man’s drive to section and define the shorelines while nature is driving to retain its fluctuating boundaries. This is further fueled by the lack of compromise or understanding of either side towards the other. Understandably, this is a lot to ask of nature. Society’s valuation system has increased the difficulty that exists with regard to compromise. We have set such a high premium on shoreline property (both private ownership and development) that a certain level of affluence is required to reside on the shoreline (Kaufman, 1983). The closer you are, the higher the premium. This premium also breeds a certain stubbornness. The more land costs, the more residents struggle to possess the right to protect it. This has placed an even greater strain on the political controls regarding the shoreline, as politicians attempt to win and maintain the approval of their wealthier and more powerful constituents. In most cases, this has led to a “do nothing until disaster occurs” policy.

2.1.1 Cause and effects

The fluctuation and migration of the shoreline is due to erosion and deposition resulting from nature’s constructive and destructive forces (see Appendix A). The strength and consistent pounding of the waves, wind, currents and tides against the coast is beyond our control. This is painfully obvious after every major coastal storm or disaster. Each successive “major” hurricane inflicts greater (or at least, no less) damage than the one before (Godschalk, 1989). This is due, primarily, to the growth, both economic and population, along the shoreline. However, new designs and materials usage still is resulting in no less damage. Even with technological advances in coastal construction and better forecasting techniques we are unable to construct buildings or protection structures that are capable of preventing the impact of nature’s forces (Wang, 1994).

The history of human civilization is a history deeply involved with land relationships. Early culture was entirely dependent upon the land and its resources for survival. This has slowly evolved to the present day in which land has become a basis for economic, social
and political power (Paul, 1988). What were relationships, have now been codified through statutes to become law. From this, the rights that we know to be private property rights (see Appendix C) have emerged. The stubbornness of shoreline residents is therefore more than just ego and righteousness. It is land policy undergirdled by political commitments (e.g. a reluctance to interfere with the “rights” of land holders) (Caldwell et al, 1993). The disadvantage to historically evolved policy is the reluctance to change it. Slow evolution tends to dull the senses and with it the recognition of trends and their direction. United States land policy has been based upon a set of historically derived assumptions; legal, economic, and political. These provide no means for taking the fundamental ecological or environmental properties of land into account. Ecological considerations have influenced land policies but not been the basis for them (Caldwell et al, 1993).

Existing land use controls in the U.S. are primarily a local concern (Cullingworth, 1993). Local governments have the authority to determine land use subject to state authority and approval. For example, New Jersey, along with many other states, has a State Development and Redevelopment Act which establishes statewide goals and objectives for, among other things, land use. This act sets standards that local governments must conform to but does not actually regulate land use. This is still a function of the local governments. The existence of controls, however, is not a requirement. Therefore, many local governments have no land use system (most have a zoning system of sorts) and many states do not require that any comprehensive planning system be present. The only nationwide presence of this lies within the courts and the judicial system (Cullingworth, 1993). The courts exist to ensure that local governments act in a legal and constitutional manner, not to set local policy. It must also be noted that until a matter is settled by the U.S. Supreme Court, the law can differ amongst the states. Therefore it is theoretically possible for a legal issue to exist with fifty differing interpretations (Caldwell et al, 1993). This is particularly true in land use and shoreline management, as the majority of these issues are dealt with at the state level. This falls under the heading of “localism”, whereby land and shoreline management policy is considered a local government prerogative under
the supervision of the state in which the federal government is not supposed to interfere (Platt, 1994).

The effect of all of this is somewhat confusing. Response to coastal disasters is a relative jumble of public and private efforts and is usually in answer to a crisis or immediate threat (Platt, 1994). As major disasters (usually hurricanes or winter storms) have damaged the coastline, policies have shifted and new legislation has come into play. For example, the two billion dollars worth of damage inflicted by Hurricane Betsy in 1965 greatly influenced the adoption of the National Flood Insurance Act of 1968, the Coastal Barriers Resources Act of 1982 was passed, in a large part, in response to the damages resulting from Hurricanes David and Frederick (1979-1980), and the winter storms of 1985-1986 resulted in the South Carolina Beachfront Management Act of 1988.

Shoreline management views have also shifted. Twenty years ago, shoreline management was dominated by shoreline protection methods (Platt, 1994). These methods consisted of localized remedial projects to reduce the impact of specific erosion hazards. Management through structural protection (groins, jetties, seawalls, bulkheads, etc.) was considered a feasible method of preventing shoreline damage and degradation from natural processes (see Appendix A.1). This was due to four primary factors:

1. The high value of coastal property.
2. Our ability to ignore the risks of floods, hurricanes, and erosion while embracing our preference to build and live as close to the water as possible.
3. Our insistent faith in the belief that technology can tame nature so that we need not address it and adapt to it.

On top of all that, was the federal government’s open wallet approach to funding shoreline protection projects (Titus, 1991). The importance of these factors has been lessened as society has shifted (again, primarily in response to disasters). Federal funding for shoreline protection has decreased due to government cutbacks and higher levels of nonfederal participation (Platt, 1994). There has also been a widespread emergence of
public interest in coastal and marine environments as well as a better public understanding and awareness of environmental processes.

There remains much conflict regarding shoreline management. There has been an increase in judicial support for regulatory programs despite resulting reductions in property values over the last few decades (Paul, 1988). However, this is contradicted by the Lucas and Nollan cases where the property owner won over the existing regulations (see Appendix C.3) (Harness et al, 1991). Lucas indirectly contributed to the defeat of proposed amendments to the National Flood Insurance Program (see Appendix B.4) that would have required coastal communities to adopt erosion management, including minimum setbacks for new or rebuilt structures (Platt, 1994). These cases show the present strength of private property rights in the eyes of the courts. There are new federal programs designed to mitigate coastal hazards. Included in these are the Coastal Barriers Resources Act and many of the existing and emerging state setback laws. However, there are many programs that stimulate new coastal construction, such as the Federal Emergency Management Act’s federal disaster relief and the availability of flood insurance for new construction through the National Flood Insurance Act (see Appendix B).

2.1.2 Future Threats

This study is based upon the assumption (one of them) that society and the political process of enacting policy are stable in the short and medium term. Therefore this section is considering only the external threats to human civilization along the shoreline. This excludes pollution, overuse of marine resources, unsafe overdevelopment of hazardous areas and many other human based dilemmas. The largest external threat looming on the horizon is sea level rise (Mehta et al, 1987). The earth, as an entire ecosystem viewed at an instant in time exists in a natural balance. It has an overall median temperature that is regulated, in part, by the composition of the atmosphere. The atmosphere allows the exchange of heat and moisture to occur between the earth and space. At this temperature, a fairly consistent balance of ice, water and vapor is maintained. Change the composition
of the atmosphere, and the levels of heat and moisture trapped at the earth will change. Looking forward in time, this change will result in a different overall median temperature of the earth. Assuming global warming, the temperature will rise and a resulting rise in sea level rates occurs (see Appendix A.2). The earth has been evolving for millions of years and so will slowly shift to its new temperature and its new ice, water, vapor balance without considerable trauma. However, the impact on human life is devastating. These impacts include changed sea-level boundaries, food chains and living conditions. These are all impacts that are not readily (if at all) returned to their previous states. The enormity of the threat of a rising sea level is not only from the damage to property and life but also from the necessity of forward thinking and looking policy.

This issue is much the same as a crashing fishery due to overfishing. The current policies don’t account for lag time. A significant temperature rise in the earth’s median temperature has been shown to increase sea level rise due to the melting of ice at the poles and the thermal expansion of the existing water volume in the oceans (see Appendix A.2). However, there is a period of years that occur during a composition change in the atmosphere and the corresponding change in sea level rise. At this point it is not technically possible to return the earth to previous “stages” or to recool the earth and rebuild the ice volumes once the sea level has risen.

Historically, shoreline management policies have been shaped based upon disasters. All of these crises have been event based (Klarin, 1990). Sea level rise is not an event but a long term trend (NRC, 1987). As has been shown by our management (or mis-management) of fisheries, the response to a known negative trend that exhibits no initial negative impact is usually one of “do nothing new”. Once the negative impacts become apparent and there is a lifestyle, health or economic downturn, action is taken. This method has failed with many fisheries and has resulted in fishing moratoria in many cases. The overfishing of the cod and flounder in New England have resulted in the closing of the Georges Banks. The failure is due to the inability to account for a lag time. By the time action is taken, fish populations are so low that they either continue to decline and eventually crash regardless
of a moratorium, or they take years to slowly rebuild to their previous levels (Wenzel et al., 1993). This is due to the reduced population density and therefore the reduced reproductive cycles. As the species reduces in number, their feeding and spawning grounds are also now unprotected against other species. The costs associated with attempting to return the fisheries to their prior state, if possible at all, are enormous. Ignoring the actual costs of spawning and raising the fish still leaves the untold costs that arise with introducing a "new" species into nature. When the fish decline in number, their feeding and breeding grounds do not become vacant. Rather, new species move in to claim them, and the fisheries need a new balance. This must now be disturbed if no action has taken place until the fishery has crashed.

A moratorium on all emissions of all greenhouse gases in order to prevent global warming is highly unlikely to be considered as a feasible option, and thus may be dismissed from consideration. This is considered unfeasible since it would require a major departure from the standard of living of the world. Developed nations are not yet ready to discard all combustion engine transportation. Underdeveloped nations do not have the financial or technical resources to halt all coal fired energy sources nor are the nations with those resources likely to accept huge debts in order to solve the rest of the world’s problems. Therefore, it is reasonable to assume that greenhouse gasses will not diminish, at the very least, over the next years. As with fisheries, once a significant sea level rise has occurred and property is severely threatened or damaged, it is too late to take actions in order to attempt to "solve" the problem. At this point, any actions taken will continue to result in further disaster as the short term future is driven by (due to the response lag time) the lack of action during the years prior.

2.1.3 The stakeholders

This is a rough overview of those parties who harbor concerns over the management of the shoreline.
2.1.3a Nature

In essence, nature (with regard to the shoreline) is easy to figure out. Long term, the shoreline lives in a dynamic equilibrium (Dean, 1990). When any force, structure, or obstacle alters that equilibrium, nature slowly sets about destroying or removing the effects of said disturbance until the equilibrium is restored (see Appendix A). Short term, nature is very unpredictable. Storms and other events self-inflict changes that alter the equilibrium and the shoreline drastically. Then nature’s long term stability returns and the strive to return to equilibrium regains control.

There are two primary things to remember about nature and her forces. First is that everything is interconnected. As one system or section is changed, there occurs a change(s) in many other subsystems, sometimes beneficial (as far as man is concerned), sometimes not. The second is that nature is stubborn. There is no reasoning with or altering nature as anyone who has been outdoors can attest to. The best that can be hoped for is to adjust to work with nature.

2.1.3b Private citizens and landowners

The residents of the shoreline have a variety of differing desires. The most straightforward of which are high property values, aesthetics and shoreline access. These desires do not result in a coherent plan of attack however. As erosion occurs and the shoreline retreats, property values diminish due to the potential for loss of property and useable (including aesthetic) beaches (Mehta, 1987). The waterfront residents prefer restrictions to coastline access (which raises their property values but diminishes others) while the remaining near-shore residents prefer free shoreline access (which raises their property values but diminishes others) as shown in Table1. Most residents would rather not have a shoreline that consists of protection structures or the associated construction problems. However, most residents would also rather not incur the costs of beach renourishment when there is no guarantee of long term results.
This leaves most shoreline residents in a state of continual debate over alternatives (Tibbetts, 1995). The result is action that is remedial and judicial rather than preventative. Most communities reach agreements based on the shoreline only after an event or disaster has occurred (Platt, 1994). As a result, most of the effort is spent after it is too late to reduce or prevent damage and loss. This is driven, in part, by the economics of the situation. Shoreline protection of any type is very expensive (Tittus, 1991). Immediate residents tend to push for the expenditure of public (federal, state and local) money to remedy the situation. Inland residents (primarily those far enough inland to have little or no contact with the coast) understandably have other concerns that they consider to be more pressing concerning the spending of public money. The prioritizing, and justification, of public expenses thus arises as a highly volatile issue with landowners (Paul, 1988). As for spending private money, aside from the often hundreds of thousands of dollars costs of shoreline protection, shoreline accessibility becomes an issue. Residents spending thousands of dollars each toward private and public shoreline projects (eg. the renourishment of a beach) are usually not overwhelmed by the prospect of free and open public access to the beach that they have just paid for. Residents living in the same community, and paying the same local tax percentages, desire open access to the shoreline as a percentage of their tax dollars also pays for those same public shoreline protection structures. Additionally, most local governments and businesses push for public, state and federal money to fund these projects as well as maintaining federal flood protection (see

<table>
<thead>
<tr>
<th>Desired Coastline Accessibility</th>
<th>Shorefront Residents</th>
<th>Near-shore Residents</th>
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<tbody>
<tr>
<td>Restricted or closed to non property owners</td>
<td>Free and open access to non property owners</td>
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</tr>
<tr>
<td>Resulting Property Values due to Open Accessibility</td>
<td>Property values reduced</td>
<td>Property values increased</td>
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<tr>
<td>Resulting Property Values due to Restricted Accessibility</td>
<td>Property values increased</td>
<td>Property values reduced</td>
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Appendix B). In short, shoreline occupants want all of the benefits that living on the shoreline has to offer but they are not willing to accept all of the responsibility of living in a hazard zone.

### 2.1.3c Developers and industry

The other side of the landowner’s desires are based on straightforward economic needs. The residents of the shoreline want income and employment which imply an economic desire for nearby industry. One of the primary industries of the shoreline is tourism. In order to satisfy the attraction of tourists, development and a functional coastline are required (Christie, 1989). Development in this sense relates to hotels, motels, restaurants, shops and entertainment facilities. To a large degree, the closer these places of business are to the shoreline, the greater the potential economic inflow. A functional coastline is also needed for tourism potential to be recognized. Functional refers to a shoreline that is useable, attractive (in a natural sense) and accessible. In most cases this requires beaches that are not just a few feet wide and a shoreline that is not coated with concrete structures.

Developers and tourist-based industries are very concerned about policies regarding shoreline retreat as these imply moving or destroying structures. The value of remaining on the coastline far outweighs the risks of loosing structures due to storms or other natural forces. The need for an aesthetically pleasing shoreline outweighs the desire for an overabundance of concrete protection structures also. In general, these stakeholders are willing to spend money (usually government, both local and federal) for shoreline protection methods rather than considering alternatives. This is due to the short term economic gains that are necessary for their year to year survival which far outweigh the potential long term environmental losses. In these cases, long term is, at most, four to eight years (Christie, 1989).

Other industries exist along the shoreline in nearby metropolitan areas. Most industries that historically existed near the coast for transportation reasons have shifted to other
inland locations. This is due to the lower property values inland as well as the reduced risk associated with less hazardous sites. The changes in transportation have also reduced the needs for such locations. Air and overland transportation systems have become more efficient, allowing industries to relocate to less expensive inland locations. Increasingly, coastal transportation is based out of hub ports that are served by feeder ports and other transportation feeds, which has further reduced the need for industries to be located on the shoreline. Industries located within ports are not as concerned by shoreline policies, since most ports operate outside of the realm of shoreline setbacks. Waterfront access within ports is primarily located on piers and other manmade structures that are more easily rebuilt and protected (remember that ports are partially sheltered areas). Therefore, the requirements of such industries usually falls outside of the jurisdiction of most shoreline management.

2.1.3d Government: State and Local

State and local governments carry out their land use policy and management within the framework conferred on them by the state, either by constitutional home rule or a specific enabling Act. This results in fifty different systems of local government. In 1987, the fifty states contained over 19,200 municipal governments which ranged in size from less than 1,000 inhabitants to well over 100,000 (Paul, 1988). The number of these units per state also varies widely with Texas and Pennsylvania having over 1,000 municipalities each to Massachusetts and Connecticut which each contain under 50. This doesn’t lead to an overabundance of uniformity.

From the smaller municipal governments all the way up to the state government level, a wide range of concerns is found. Elected officials want to be re-elected. To achieve this, they must juggle the needs and desires of many organizations, individuals, and lobbies as well as many issues. These issues include the day to day economic concerns of the voting public as well as the greater long term health, environmental and ecological concerns. Most shoreline based issues and decisions become a trade-off between positive short term
economic impacts and private property rights against long term environmental health. This is rarely a win-win situation. Elections occur every four years. Government officials are not usually concerned with decisions that will make them popular sixty years from now, but rather decisions that will be remembered at the next decision time. This is simply a part of the system. Therefore, the more pressing issues (from a purely political point of view) are those which immediately benefit the voter’s homes, property, economic well-being. Potential long-term sea level rise is not the highest priority issue for local officials.

In the more recent past, this balancing act has begun to swing to a more even balance. Private property infringement is still a big no-no in the eyes of the majority of waterfront owners. However, the general population is more concerned with the impact that decisions have on future generations than in the past. This is shown by the closing of fisheries, the attempts to save natural resources (eg. the Rio Declaration on Environment and Development) as well as increasing federal and state legislation regarding management plans (eg Coastal Zone Management Act). These are all forward thinking moves that are based upon the premise that there is no guarantee that the future will provide what the present does. This is a large boost for the health of the environment. Economic health of shoreline communities is now being studied and understood in longer range (temporal) terms. Development and industry (commerce and tourism) desire a healthy shoreline and beaches to attract potential revenues, and this involves planning. Finally, states are taking some initiative in setting policy and policy precedents regarding shoreline construction and development (see Appendix B). This is due in a large part to the lack of federal initiatives, the damages incurred by coastal hazards and storms, and the higher coastal population. The few federal initiatives that do exist are ineffective. For example, the Upton-Jones Amendment was intended to be cost saving and pro-active (see Appendix B.4). However, due to its inability to overcome market and regulatory incentives for oceanfront owners to remain on the coastline, the Amendment has actually increased expenditures of the NFIP while providing no pro-active mitigation measures (Davison, 1993).
The lack of strict federal guidelines is now forcing states to look out for themselves more than in the past. This has resulted in bans of hard protection methods (such as seawalls) and the passing of stricter regulations and setbacks (Titus, 1991). Driving this is hindsight and storm damage. Storms and coastal hazards serve as superb catalysts. Increased shoreline population and property values have resulted in significantly increased storm damages over the last few decades (Godschalk et al, 1989). This is a wonderful reminder to the population of the risks they face. The networked media and television industries have successfully spread this reminder through their ability to almost instantaneously present visual images of nationwide and worldwide events. The media’s tendency to dramatize events has further spread the impact that coastal storms and hazards possess. You no longer need to have suffered through the eye of a hurricane to be emotionally touched.

Hindsight is the other catalyst. State and local governments are now facing the disasters left behind by past government shoreline decisions. Older state approved projects involving shoreline protection (hard methods), inlet and harbor construction and coastal construction are now showing their negative impact (Mehta, 1987). Many of these projects (due, in a large part, to a less complete understanding of coastal processes at the time of design and construction) have increased erosion and storm effects problems and are costing millions of dollars to correct. In addition, the location of previous building construction has left houses in proximities that place them at great risk to coastal erosion. The North Carolina Coastal Commission, for example, has identified nearly 5,000 buildings in that state at risk of erosion within the next sixty years, of which 777 will be threatened within ten years (Platt, 1994). It is buildings such as these that the Upton-Jones Amendment was intended to pro-actively remove from harm prior to damage. However, due to the failings of the Amendment, these buildings still exist as future reminders of past decision disasters.
2.1.4 Government: Federal

A variety of federal agencies and programs have authority with regard to shoreline management. The federal Coastal Zone Management Program (CZMP) (see Appendix B.1) approves and sets basic national interest guidelines for the individual state's coastal zone management (CZM) programs. The federal system has a much broader outlook than the individual programs based upon the assumption that the states are in the best position to determine how to best meet the federal objectives. This has led to a federal system that is largely "hands-off" during the day to day management of the shoreline (Godschalk, 1992). The federal CZMP provides differing choices of program approach, interests and areas of concern while retaining only the power of approval of the individual states' CZMPs. The prioritization of concerns and the choice of organization and implementation are left to the state (Owen, 1992).

Other federal agencies, empowered by other federal acts and laws, have authority over the shoreline that conflicts and compliments the policies of the CZMP (see Appendix B). The Environmental Protection Agency is charged with the protection of all aspects of the nation's water resources. One area of their concern is the protection of wetlands and their vulnerability to sea level rise and development. They are also authorized under the National Environmental Policy Act of 1969 to require that all projects that have any potential for any impact on the environment provide a detailed environmental impact statement. The National Flood Insurance Program, administered by the Federal Emergency Management Program, provides federally subsidized insurance for damage to structures that meet minimum national standards. Implementation and enforcement of the federal standards are left to local governments, while federal authorities retain the final judgment of approval. The U.S. Army Corps of Engineers (USACOE) has the longest and most direct involvement in shoreline management dating back to 1899. The USACOE is authorized to conduct and regulate development affecting the nation's navigable waterways. They also have the power of approval, under federal guidelines, over all state and private construction within navigable waterways. This is often in direct
conflict with state coastal policies regarding construction since these shorelines and waterways also fall under state jurisdiction.

2.1.5 Environmental Lobbyists

These stakeholders generally accept the basis of the CZMA but differ widely on their interpretation of it, as well as the means by which to carry it out and the relative values embodied in the national objectives. All of the environmental lobbyists believe that the preservation and management of the coastline is necessary, it is the prioritization of the management that raises disagreements. The coastal environmentalists include NGO’s such as the National Resources Defense Council and the Sierra Club, as well as government agencies like the Fish and Wildlife Service. These organizations all tend to promote the tightening of environmental conservation requirements. These stakeholders prefer management techniques that preserve the natural habitats first while allowing human development to exist around nature. The coastal developmentalists are focused on the promotion and expansion of coastal development. They prefer management techniques that promote and allow development first while preserving the natural habitats within human constraints. These include the USACOE, the National Association of Homebuilders and energy organizations such as the American Petroleum Institute.

2.2 The options

There are a variety of options for reducing the potential damage that natural hazards are capable of inflicting on shoreline property. All of these options have one main intent. That focus is on keeping nature’s forces away from “man’s” property. These options all fall under one of two main choices. The shoreline can be allowed to migrate naturally and everyone and everything can migrate (usually a retreat) with it or the sea can be fended off while preventing the shoreline from moving.
2.2.1 Shoreline protection

Shoreline protection takes the approach to protecting the shoreline through the strengthening, reinforcing, or replenishing of the natural environment in order to be less susceptible to the physical forces of the ocean and storms. Protection generally takes one of two forms. These are defined as either hard or soft. Hard protection is achieved through the use of structural stabilization of the shoreline. Soft protection utilizes the renourishment or artificial accretion of the beaches by placing sediment on the shoreline. Both of these have their pros and cons as to effectiveness and feasibility.

2.2.1a Hard protection

Hard methods are structurally-based and attempt to either trap sand, protect the shoreline or control flooding. The construction of groins, jetties, seawalls, bulkheads, armoring systems or revetments, when designed and constructed properly, all reduce or stop local erosion and absorb wave energy. Groins are structures built perpendicular to the shoreline with the intent to trap sediment and thereby stabilize eroding shorelines. Seawalls and revetments are designed to prevent erosion from occurring behind them, thereby stabilizing and “anchoring” the shoreline locally. Armoring and riprap distribution are other methods of “anchoring” the shoreline. However, they tend to do so by creating a non-erodeable surface on the shoreline that is closer to the natural profile than an upright seawall. These all reduce local erosion and shoreline migration which are definite advantages. However, it is very expensive to design and erect structures that are strong enough to withstand such a dynamic environment.

Newton’s third law of motion states that for every action there must be an equal and opposite reaction. This holds true in nature and shoreline management. If erosion is prevented in one location, it must occur elsewhere. This becomes a serious issue when this additional erosion impacts on an already eroding shoreline. This is the result of all
hard protection methods regardless of how well designed or built they are. They enable the protection of a local area which further exacerbates the far field erosion (Dean, 1990).

The other downside to hard protection is costs and accuracy concerns. As the structures reduce erosion and storm effects they are absorbing an enormous amount of energy. This energy eventually reduces their effectiveness by destroying their structural integrity. The only way to prolong this is to build bigger, stronger structures which rapidly drives the costs beyond feasible levels. Construction costs in any hazardous, dynamic, and corrosive environment are close to prohibitive. The accuracy concern refers to the necessity for design precision. If the orientation, size and method chosen are not conducive to the specific environment, the solution can prove to be more harmful than the initial problem (Dean, 1990). All hard structures have been shown to increase downstream erosion. Studies of historical (and theoretical) projects have proven that the local erosion can also be worsened, instead of halted, by incorrect design. Unfortunately, the more modeling and field testing that is done to reduce this, the more the costs soar.

A considerable side effect of hard protection is the never ending cycle that gets entered. Once a shoreline is protected and a sea level begins to rise, protection methods cannot be discontinued (Klarin et al, 1990). The raised sea level will require taller and stronger structures to keep the sea where it is. It is also not possible, at least not without great costs, to shift to soft methods. The lack of beach between the ocean and the structures at this point would require vast amounts of material to be placed along the shoreline in order to replace the buffer zone.

Hard methods such as seawalls have been outlawed or severely restricted in many states, such as South Carolina, Maine and Rhode Island. It is considered unconstitutional to destroy or to permit the loss or deprivation of use or the enjoyment of a person's property. The increased erosion further down the coast due to seawalls and other hard methods has resulted in many states finding these methods to be unconstitutional and therefore unacceptable.
2.2.1b Soft protection

Soft methods involve the establishment of a buffer zone between nature's forces and man's development. This can be accomplished in two ways. The buffer can be enlarged or maintained by the addition of sediment to the shoreline or by the implementation of new construction (and reconstruction) setbacks which prevent intrusion into the buffer zone. Beach nourishment is the primary product of soft protection. It involves the placement of fairly large volumes of sediment on the beach through the use of pumping or dredging of offshore sediment (from areas on the seafloor that are suitable or from within inlets and harbors). The inshore mining of sand and its subsequent transportation to the coast is another option. Sediment build-up on the shoreline can also be accomplished through the construction of sand trapping structures as well as the bypassing of sediment around other man made coastal structures such as jetties. In many cases, manmade structures disrupt the alongshore sediment flow and cause erosion. By bypassing the trapped sediment around the structure (or inlet), erosion can be reduced. Bypassing consists of moving sand trapped by the upshore side of the structure down to the downshore side of the structure through the use of dredges, trucks or permanently installed pumping stations.

The use of shoreline plantings such as sea grasses and the placement of wind fences all help retain sediment. These methods reduce the amount of sediment that the wind is able to erode away. While this doesn’t prevent wave based erosion, it does reduce the effects of storms by providing that much more of a buffer (primarily height not width) zone. These methods also tend to be environmentally sound and low cost as well as not impinging on anyone’s constitutional or property rights.

Renourishment has become the method of choice whenever it is feasibly possible. The downside to these methods is that none of the coastal processes are changed. Erosion and sediment transport are unchanged. The upside is the lack of induced negative side effects further down the shore. This is also the only method that increases the buffer zone between man and nature. In this case, nature’s forces are left untouched and unabsorbed.
while they are simply moved further away from areas in which they can cause harm. There are also major economic benefits that hard structures do not easily offer. Increasing beach widths with clean sand and no concrete boosts tourism, property values and desirability. Erecting concrete structures tends to reduce all of the above.

Soft methods, like hard methods, also require continual use and reuse once started. As sea levels rise, the relative beach height will sink. This combined with the short "useful" lifespan of these projects (on the order of tens of years) results in the occasional renourishment of shorelines. One of the advantages of soft methods over hard is the ability to choose other decisions at this point. You are not locked into repeating the same situation over and over.

2.2.1 Shoreline retreat

Retreat is the most sensible and least feasible approach. When a non-vindictive, destructive, unchangeable force approaches you, the obvious move is to get out of its way. Shoreline retreat is just that. All property and possessions that enter the buffer zone between the coast and the setback or baseline are abandoned. Shoreline protection can, at best, temporarily stabilize the shoreline through the cost of enormous sums of money. From an economic standpoint, in general, it is more expensive to hold the sea back than to move the people back. This is based on a compilation of factors including sand costs and structure costs required to prevent the sea from inundating the land mass as well as increased storm damages due to a reduced buffer zone width. This statement will also vary in validity based upon the population density and land value of a specific location. Titus (Titus et al, 1991) estimates that the sand costs alone (to replace what erosion removes) for the next hundred years along the east coast to be over $20 billion with the structure costs topping $185 billion. These figures are hard to justify outside of major metropolitan areas. Regardless of what we erect, the shoreline will continue to erode. As that shoreline moves, if a constant buffer zone is maintained, potential damage will be minimized. That is the reasoning behind utilizing an engineered retreat. Private property,
communities and personal rights are why even a sensible theory may not be feasible in a real world situation.

2.3 The ideal solution

The concept of an ideal solution is a loaded topic. Depending upon biases and background, any one solution will possess benefactors and detractors. What may be ideal for one person, may be entirely unacceptable to another person, even a neighbor. This is all aside from whether or not a solution is even partially feasible politically or economically.

2.3.1 Description

The starting point for this must be the assumption, and acceptance, that the processes in play along the shoreline are very real and are unlikely to change. More specifically, human civilization, at this point, is unable to change nature’s processes and forces. In addition, sea level rise must be accepted to be rising at a steady level that will be at least as high as present levels and in all probability, much higher. Given this, the question is not how do we change or fix this, but how best do we fit in while maintaining as much of our demands as possible. Valuable time, effort and money will only be wasted if we attempt to “solve” nature’s fluctuations.

Possible solutions will be considered in chapter 4. The ideal solution would manage the shoreline with enough strength to provide consistent protection throughout the states while maintaining flexibility to adapt to future hazards. This consistency should consider land use methods and shoreline protection methods so that no one state’s management can infringe on the constitutional rights of another. The strength refers to the necessary implementation and enforcement power needed to provide consistency. There should be a clear coastal hazard mitigation policy based on:

1. Hazard avoidance
2. The minimizing of adverse effects of development and redevelopment in hazardous areas

3. The compensation for adverse effects of natural and human intervention.

Legislation and regulation must be considered and written with the goal of reducing private property infringement. It must also be understood that infringement may be the most feasible solution in certain circumstances. Therefore, guidelines must be designed to specify those circumstances which necessitate a taking and the resulting compensation for the property owners. Finally, preemptive policies must be incorporated. Sea level rise and other future issues must be addressed and the appropriate legislative groundwork laid in order to handle such future issues.
3. Case Study

3.1 Rhode Island

Rhode Island is a small coastal state that has a well developed shoreline. Rhode Island has a conservative, New England population that has strong historical ties (residential and commercial) to the coast. As a result, this state is a good example of the pressures that an already developed state faces with regard to coastal hazards, redevelopment and future risks. This case shows some of the advantages that an historically active population can present with regard to policy. Rhode Island’s shoreline management system provides consistency throughout the coastline by centralizing the decision making process as well as making sure that these decisions are in the overall best interests of the state as a whole. The conservative nature of the population provides a permitting system that is very rigid and cumbersome. The up side of this is that permits are not easily issued which results in the lessening of negative human induced effects along the shoreline. This case examines the positive and negative effects of such a centralized policy system.

3.1.1 Rhode Island’s shoreline

The Rhode Island coastline stretches for 64 kilometers along the Atlantic Ocean. The eastern end of the state is deeply embayed by Narragansett Bay which provides Rhode Island with an actual coastline closer to 540 kilometers long (Stephen et al, 1991). The majority of the shoreline within the Bay consists of rocky headlands of bedrock left over from the glacial periods with small pocket beaches between them. The western shore of the state is an unbroken line of sandy, barrier beaches providing the majority of the 290 kilometers of beach length that Rhode Island contains (Ringold, 1980).

Wave energy is greater during winter months and tends to drive the littoral drift to the southeast with help from the winter storms (these storms are northeasters, generally, and produce dominant northeasterly winds). Hurricanes are common along the southern coast
during the earliest fall months and the State has been struck with 71 hurricanes in the last 350 years. Almost the entirety of Rhode Island’s shoreline, 98 percent (530 kilometers), is considered to be significantly eroding (Ringold, 1980). All this combines to give Rhode Island a natural background erosion rate of 0.75 meters/year over the last fifty years (Dean, 1990). This rate is primarily due to natural causes, not man induced erosion or man accelerated erosion. It is also a misleading number as the erosion is primarily storm and event driven while the erosion during the intervening periods is relatively minor. Therefore, depending upon the severity of the storm season and the storms themselves (storms have pushed storm surge levels up to almost 5 meters over mean high water), Rhode Island’s erosion rates fluctuate significantly. This has caused problems in the past as some of the initial setbacks were based upon average rates. This case highlights some of the positive and negative outcomes that arise from Rhode Island’s shoreline management system.

3.1.2 Coastal stakeholders

Rhode Island’s shoreline is over 80 percent (430 kilometers) privately owned. This is roughly average for the New England region. The remaining 18 percent of shoreline length, is almost all, 15 percent (80 kilometers), non-federal, publicly owned land. There is no stretch of the shoreline that is considered to be undeveloped, therefore these 80 kilometers contain the only length of public recreational shoreline within the state (Stephen et al, 1991). This does not provide the most publicly accessible coastline in the country. The state of Rhode Island is comprised of five counties, all five of which have a coastline. These five counties are still undergoing population growth even though their population density is already considerably high by national standards.

The shoreline population is primarily residential. The remainder of the shoreline population is tourism based. There are many small hotels and motels, stores, and entertainment properties scattered along the coast. Just over 70 percent of the shoreline consists of coastal stakeholders such as these (Olsen, 1991). Their primary concerns
revolve around erosion, coastal hazards, beach access and the quality and preservation of the coastline and beaches. The remainder of the shoreline occupants are from the commercial and maritime industry sectors. Rhode Island has a long history of fishing, ship building, commercial shipping, recreational boating, and all of the support services these all require. These are all located near and in port and harbor facilities. Their interests lie in hazard protection, navigational access, commercial support and clean waters.

The government is both pro-tourism and pro-industry. The marine industry, commercial fishing, and marine recreation provide over $1 billion in economic benefits to the state (Farrell et al, 1981). Therefore it is in the state’s best interests, to which they have responded, to support the shoreline and it’s resources.

3.1.3 Political pressures

A shoreline that has no “undeveloped” land left faces considerable pressure from property rights activists. By the early 1980’s, all of the readily developable shoreline land had been subdivided (Stephen et al, 1991). The principal concern of the shoreline residents is erosion, flooding, and how to minimize coastal hazards and harm to existing property. Other pressures arise from the tourism industry which fuels a large part of the seasonal industry of Rhode Island. These pressures include public access to the beaches as well as shoreline protection for hotels, restaurants, stores, and other tourism related activities. They all push for the use of shoreline protection measures as well as beach access. This last issue is not-supported by those residing directly on the coastline while it is supported by all others.

There is additional pressure for the state to increase industry and to be more pro-development. This is due to the large Naval pullouts in 1973 and 1980. The state is still highly underutilized in many of the port facilities, which have been further hurt by the declines in commercial shipping into Rhode Island. The other pressures from this sector
include the use of hard protection structures and looser restrictions on dredging and shoreline modifications.

The push for shoreline management that truly protects and enhances the coast and its resources comes from the residents. The fact that Rhode Island is such a small state yet has such a long coastline gives each resident a personal stake in shoreline management.

### 3.1.4 Shoreline management system

In 1954, Hurricane Carol hit Rhode Island killing 60 people, destroying 3,800 homes, and causing $461 million in damages. This prompted a study of the resulting shoreline damage and led to the inclusion of coastal resources into the State General Laws in 1956 (NOAA, 1976). This did not, however, include any plan for the regulation of such resources. In 1971, the State, with pressure from a citizen’s group, created the Coastal Resources Management Council (CRMC). This Council holds the regulatory authority with regard to Rhode Island’s coastline. In 1973, the State became one of the first to receive federal planning money under the Federal CZM Act. A year later, detailed policies regulating the management of barrier beaches was passed. Finally, in 1977, Rhode Island’s CZMP was authorized by the federal government.

Rhode Island is fairly unique in that all of the coastal authority rests in the 17 member CRMC. The Council does not share its regulatory authority with any other state agencies or local governments. The composition of the members is almost the most complex part of the process (Stephen et al, 1991). Of the seventeen:

- Two must be members of the house of representatives, one of which must be appointed by the speaker of the house and must represent a coastal municipality;
- Two must be members of the senate, each represent a coastal municipality and be appointed by the lieutenant governor;
- Four must be from the general public and appointed by the speaker of the house. Two of which must represent coastal municipalities;
- Four must be officials of local governments and appointed by the governor;
- Three members must be from the general public and appointed by the governor with the approval and consent of the senate;
- The Director of Environmental Management;
- The Director of Health;

The CRMC has broad powers over all of the water areas and specific landward areas as well as any activities that in any way affect the health and well being of the tidal waters. The regulatory power over landward areas are limited to those that are required for effective coastal zone management. The remainder of the shoreline management comes under the jurisdiction of the standard land use and construction setback policies of each of the local governments. These are regulated by the Comprehensive Planning and Land Use Regulation Act of 1988 which requires consistency between every local government’s comprehensive plan and the state’s comprehensive plan (Cullingworth, 1993). The shoreline is regulated by the council which has specific setback rules based upon annual erosion rates for all waterfront construction (Good, 1995). These are stricter than inland setbacks and have precedence in such designated areas. These rules do not apply to reconstruction.

Shoreline protection features are covered by the CRMC. The council, by policy, favors non-structural methods (soft methods) for controlling erosion. In areas where this is not feasible, riprap revetments are favored over vertical structures and seawalls. In order to build such a structure, the CRMC requires permitting which satisfies the conditions:

- The existence of a problem
- That the proposed structure/method will control erosion
- That the proposed structure/method will not increase erosion in adjacent areas
- That the proposed structure/method is the appropriate method considering long term erosion, storms and the stability of the shoreline
• That there is a long term maintenance program and fiscal commitment
• That the proposed structure/method shall be designed and certified by a registered, professional engineer

A large portion of Rhode Island’s beaches are classified as barrier beaches. The CRMC policy is to be consistent with and to allow the protection of these beaches under the Coastal Barrier Resources Act of 1982. The CRMC covers the protection of all beaches under it’s policies designed to preserve the beaches and public access to them as well as preventing activities which in any way disrupt any coastal zone processes that could create an erosion or flooding hazard.

3.1.4a Strengths and weaknesses

Rhode Island chose to centralize all of the shoreline management power at the state level. There are two major concerns regarding the avenue that this follows. First that the CRMC, wherein most of the power lies, is composed of state and local legislators and private citizens all of whom serve in a part time capacity (on the council, that is) and represent diverse interests (Scott, 1981). This has, since its inception, worked considerably well as the resulting commission has been balanced between pro-development and pro-conservation interests, usually taking the middle ground. There is still the fear that this precious balance is not always going to remain so stable. The second concern is that the council is not comprised of the people best suited for the task (Scott, 1981). The council’s complicated appointment process was derived entirely out of compromise. These seventeen “slots” fulfilled the task of keeping the balance of power between the state government and its multi-layers, the local governments, and the private citizens at a point that all sides could accept. Unfortunately, this tracking system does not base itself on shoreline or management knowledge but rather on political position. The major concern with this arises when forward thinking policies become a necessity. It is crucial that the council either be restructured or guided. If the balance of power (in the filling of the council “slots”) remains, as it probably will, then the state’s best interests will
be better met by ensuring that the council be continually kept in check (and further educated) through public scrutiny. This would include the call for comments on all reports as well as public forums to address coastal concerns and issues.

The argument as to the effectiveness of placing all of the decision making in the state is still a large untested gray area. On one side the feeling is that one body is more effective at maintaining consistency as well as holding the power vital to assuring that programs are implemented and utilized. This is especially true with regard to all shoreline permitting processes. It is also of greater concern to higher state officials to be aware of the issues as they are more involved with and in the council. The other side argues that this same consistency destroys the shoreline as local governments are not directly involved in defending and prioritizing their own resources. This is partially due to the fact that the council has only five members that represent coastal municipalities when they are making shoreline decisions. This is not as great a concern in Rhode Island as it might be elsewhere since every county in the state has a shoreline and therefore resources at stake and with a small state, it is that much harder to be disconnected from the rest of the state.

The one other weakness in the system comes from the discrepancies between the CRMC’s jurisdiction and the local government’s on land use issues (Stephen et al, 1991). There is no mapped landside boundary; rather, the council has authority over specific land features and uses; while the local government has the right to exercise their land use decisions everywhere CRMC’s jurisdiction does not apply. As the shoreline changes due to erosion and sea level rise, the physical features will disappear and change. It is possible, under very realistic circumstances, for environmentally significant areas and activities to go unregulated under the state’s management program. Many states solve this by blanketing the entire coastal zone with land use regulations. That is not easily feasible in this instance as that would give the CRMC powerful land use regulatory power that would limit the local government’s powers, which the latter find unacceptable.
The primary strength in Rhode Island's system lies within their permitting process regarding shoreline protection. The extensive requirements and the difficulty in obtaining an approval have prevented man-induced shoreline damage.

3.1.4b Private property rights and takings

Rhode Island is not currently facing property rights problems. The shoreline has been developed for long enough that new construction is not infringing on public access to the beaches (Bird, 1985). The amount of public shorefront has not changed significantly over the last 25 years which helps reduce problems as there has been no significant reduction in public accessibility. Rhode Island's efforts to minimize shoreline protection impacts and to require forward thinking in the permitting process have reduced the potential for infringement upon neighboring properties. This has occurred partially by default. Having a population that is used to restricted and regulated shoreline land while simultaneously possessing some historical knowledge of the coastline and the ocean, increases the odds that a restrictive regulatory system can exist. These efforts will help prevent future impacts as the sea level rises and SPSs cause further erosion. The problem that Rhode Island faces in the future is the inconsistent land use regulation and policies along the shoreline. As the shoreline continues to retreat, these inconsistencies have the potential to become enormous private property infringements.

3.2 Oregon

Oregon is one of the larger coastal states and has a currently developing shoreline. Oregon is experiencing rapid development throughout the state. Oregon's early coastal residents developed small portions of the shoreline and lived fairly free of policy restrictions. As a result, this state is a good example of the pressures that a fairly underdeveloped state faces with regard to coastal hazards, redevelopment and future risks as it experiences population growth and rapid development. This case shows some of the problems that a changing population can present with regard to policy. Oregon's
shoreline management system provides local governments with the ability to manage their local shoreline as their needs require. The open nature of this regulation combined with a population that largely has enjoyed free and open access to the coastline provides a permitting system that is very inconsistent and unguided. This case examines the positive and negative effects of such a localized policy system.

3.2.1 Oregon's shoreline

The Oregon coastline stretches for 504 kilometers along the Pacific Ocean. Roughly 28 percent (140 kilometers) of this shoreline is comprised of rocky sea cliffs and headlands with little or no beachwidth. The remaining 72 percent (364 kilometers) of the shoreline is all beachfront (Bird, 1985). The southernmost 150 kilometers consists primarily of sandstone, volcanic rocks and bluffs. The northern portion of the coasts is a mix of long beaches separated into pockets by rocky headlands. In many areas these beaches are backed by sea cliffs. These natural pockets help to provide some erosional protection from nature's forces.

The Oregon coast is characterized by high wave energies driven by average wave breaker heights of 2 meters during summer months and 3-4 meters during the winter. Individual storms generate significant wave heights of up to 7-10 meters. The direction of these waves varies seasonally. Half of the year these waves dominantly arrive from the southwest while the other half of the year they are from the northwest. This results in shoreline erosion without significant net littoral drift. The significant erosion is fueled by events, with severe winter storms and tsunamis generating the more severe destructive forces. This has led to 33 percent (166 kilometers) of Oregon's shoreline being classified as significantly eroding (Ringold, 1980). This is primarily beach erosion. The remaining 67 percent of the coastline is not considered to be under significant erosion. This is misleading as the bluffs and headlands are not counted as eroding but are undergoing bluff erosion.
The erosion of the uplifted land, upon which most of the coastal development occurs, has rendered many of the bluffs unstable. This instability leads to the danger of landslides, slumping and increased headland erosion. In many cases, the high-water point is not disturbed (thereby registering no shoreline erosion) but the developable bluff terrace may be drastically altered, usually recession.

3.2.2 Coastal stakeholders

Oregon's shoreline is only 44 percent (222 kilometers) privately owned. Only two other states (North Carolina and South Carolina) have less privately owned shoreline property. Of the remaining 56 percent, 32 percent is non-federal, publicly owned land. Only South Carolina has a higher percentage. This provides one of the most publicly accessible coastlines in the country (Ringold, 1980). The state of Oregon is comprised of 36 counties, only eight of which have a coastline. These eight counties are undergoing rapid population growth as large numbers of retirees, second-home buyers and visitors are creating a shoreline development boom.

This results in two major players. Residential homeowners are the primary stakeholder while developers are rapidly taking all of the remaining land. The developers are split among creating more residential homes, creating more stores and retail areas, and those working on tourism. The more accessible and developed the shoreline becomes, the more the tourist industry becomes prevalent.

The government is playing catch up with the shoreline. The state of Oregon has always supported the coastline and its resources while trying to protect them. They are now experiencing enormous population growths which are changing the groundrules of the shoreline. Historically, the groundrules have called for open use of the shoreline and its accessibility with virtually no restrictions. This works as long the population is sparse enough to prevent any infringement. This is no longer true. The increased population and
development have brought increased shoreline use with restricted access as property lines and buildings spring up.

### 3.2.3 Political pressures

The push for development has resulted in no-developable land left untouched. Hazardous sites avoided earlier are now being developed or considered for the near future. Older structures that are unstable due to cliff recession and bluff erosion are now becoming too valuable for people to heed nature's warnings. The typical response to shoreline degradation has been to construct seawalls, bulkheads and riprap revetments in order to stabilize the shoreline (Allen, 1993). All of these methods, subject to permitting, are legal in Oregon and there has been great pressure to continue to allow their usage.

The pressures on setbacks have been to allow for pro-development conditions that provide access to previously unfavorable (and undesirable) building sites. Along with this is the push for continued beach accessibility. The other side of all this is the pressures coming from environmental concerns to disallow hard protection structures and to restrict setback variances. The basis behind this is that Oregon needs to use more long term thinking.

### 3.2.4 Shoreline management system

Oregon's shoreline management system was initiated in 1967 with the passage of the Beach Bill which led to the preservation of public beach rights. In 1971, the Coastal Conservation and Development Commission (CCDC) was created for the development of a natural resource management plan which would:

1. Inventory and evaluate coastal resources, hazards and needs
2. Develop coastal land and water resource policies
3. Develop methods of implementing a comprehensive coastal management program.
This led to the passage of the 1973 Oregon Land Use Act and finally on to the creation and federal approval of the state Coastal Zone Management Program in 1977 (LCDC, 1977).

The Land Use Act is a statewide land use planning program that is managed by the Land Conservation and Development Commission (LCDC). The Act is considered statewide in the context that all of the Act’s guidelines apply statewide. The actual preparation and implementation of the land use program is undertaken at the local level. Each of the 241 cities and 36 counties within Oregon is responsible for proposing and, after state review and approval, undertaking a Local Comprehensive Plan (LCP) which addresses all locally relevant aspects of the Land Use Act. Currently there are 277 LCPs that have been reviewed and approved (Good, 1994). This includes those cities and counties that are situated along a shoreline. The LCDC and the Act include coastline specific standards which comprise the basis of the federally approved Oregon Coastal Zone Management Program. These standards must be addressed by every local government that has any jurisdiction or bearing upon the coastline.

Oregon’s shoreline management is a compilation of statutes and laws. These include the:

1. Oregon Beach Law which regulates shore protection structures.
2. Oregon Beach Improvement Standards
3. Oregon Removal/Fill Law which regulates revetments and fill.
4. Oregon Administrative Rules
5. Oregon Land Use Planning Law
6. Lincoln County and City Comprehensive Plans and Zoning Ordinance along with the State Building Code Agency which regulates all building standards.
7. LCDC Statewide Planning Standards.

   Goal 7 - Areas Subject to Natural Hazards and Disasters: To protect life and property from natural disasters and hazards.
Goal 17 - Coastal Shorelands: To conserve, protect, where appropriate develop, and where appropriate restore the resources and benefits of all coastal shorelands.

Goal 18 - Beaches and Dunes: To conserve, protect, where appropriate develop, and where appropriate restore the resources and benefits of coastal beach and dune areas.

These three LCDC standards define the Oregon Coastal Zone Management Program (Good, 1994). All of the above listed laws and policies are designed around three fundamental state designed goals (Godschalk, 1992):

1. To protect the beach for public recreational use and enjoyment
2. To conserve, protect, and, where appropriate, develop or restore oceanfront land
3. To protect human life and property from natural or human-caused hazards.

3.2.4b Strengths and weaknesses

Oregon chose to allow (or require) each local government to regulate and manage its own shoreline subject to state review. This is essentially the same approach taken by the Federal CZM Act. It is also very much in keeping with the political tradition of Oregon which involves a wide provision for citizen involvement (actually stated as the first of the state standards under LCDC) (Scott, 1981). It also opens the door to a wide range of interpretation of standards and their relevancy.

The involvement of local governments has provided a management plan for each part of the state. Each of Oregon’s 241 cities has an individual, approved land use program that is specific to that area. Each of these includes an established and supported citizen advisory committee or committees that are open to the general public. Oregon manages to take this local involvement one step further by providing incentive for compliance (Good, 1994). State law establishes the initial requirements which are backed up by maintenance grants which are distributed to jurisdictions that possess state approved
plans. Finally, the LCDC may enforce programs that progress too slowly and the state may withhold cigarette, liquor, and gas taxes from these jurisdictions. This allows shoreline jurisdictions to ensure that shoreline based decisions are made by those residents who must face the consequences rather than by politicians removed from the coastal arena. It also reduces the need for state planning in local jurisdictions, as once state standards have been incorporated within the LCPs, the state can step back, facilitating local decision making.

This same advantage can also be a disadvantage. The three previously mentioned LCDC standards (7, 17 and 18) all directly or indirectly relate to coastal construction setbacks and provide guidance or standards to local governments. However, the state has no specific technical guidelines for determining setbacks (facilitating local decision making), therefore each local jurisdiction uses its own criteria and procedures. This has caused problems as many of these criteria are not very successful. Local governments, in general, do not have the technical resources to accurately determine the optimal setbacks and have attempted to stay away from takings issues. The local governments also have no need to be consistent among themselves. Therefore these setback procedures vary widely among jurisdictions (Good, 1995). There is also a great deal of pressure on local officials to encourage and facilitate growth which includes development-friendly decisions. Therefore, most coastal setbacks are too small and have created a demand for seawalls and riprap revetments (both legal in Oregon) (Good, 1994). In other cases, the practice of granting setback variances is very common which is leading to the development of marginally buildable properties which in turn usually leads to the need for shoreline protection structures (SPS). These SPSs have affected neighboring properties, jurisdictions and beaches in some cases (Allen, 1993). This borders on private property infringement as well as adversely affecting the public beaches that are protected by the Oregon Beach Law of 1967.

It is the prevalence of hard shoreline protection structures that is potentially the greatest weakness of Oregon’s system. The LCDC goal 7 states that hazardous sites shall not be
developed without "appropriate safeguards", which state land use policy interprets to mean "adequate safeguards". Legally, hard structures are deemed to be "more adequate" than nonstructural mitigation, which leads to more SPSs (Good, 1994) and a conflict with the beach protection goal. There are no state specific criteria with regard to the need and justification of SPSs. In a study of a 16 mile stretch of Oregon's shoreline (which includes over 900 oceanfront property parcels) it was found that 49 percent of the properties had some form of hard SPS installed by 1991 (Allen, 1993). In 35 percent of these cases, it was found that there was absolutely no hazard or threat that even warranted the consideration of hard SPSs. To make matters worse, 30 percent of all SPSs built have not required a state permit due to gaps and overlaps between the local jurisdictions (Good, 1994). This inconsistency within the coastal management system has also prevented accurate evaluation of present and future permits and SPSs.

3.2.4c Private property rights and takings

Oregon is on the verge of facing a private property infringement nightmare. Presently, there are no problems as population densities have been low enough to prevent development on hazardous sites. The recent past has seen population densities soar and officials are being pressured to free up all possible land to development. This is currently resulting in unreasonable setback waivers as existing setbacks are rendering many shallow lots virtually unbuildable (Good, 1995). The widespread use of hard SPSs, which have been shown to adversely affect the erosion rates of neighboring properties, is another result as some setbacks are not placing structures far enough out of hazard's way. The fear among many in Oregon is that as the adverse effects of these SPSs (especially those having to conform to no permits of any kind) is realized in the future, a litigious backlash will become entangled in takings issues and local shoreline management inconsistencies.
4. Discussion

4.1 Shoreline management procedures

There doesn’t appear to be a shoreline management procedure, from among those that the CZMA allows, that is inherently any “better” than the others. There are definite differences among them and clearly some are more effective in certain situations than others, as was the intent for the flexibility in the differing approaches. A large part of this “effectiveness” is due to the geographic size of the state as well as the population density. A centralized state run program works better in smaller states such as Rhode Island due to proximity. Blanketing policies have more consistency as all residents and industries are more closely connected to the shoreline. The dependence, as a state, on maritime industries for jobs and income also force the entire state to be more aware of the shoreline and its resources. In these cases, the state-local collaboration system would also work. However, the centralized system has a greater potential for consistency which should benefit future decisions.

The state/local collaboration benefits larger states more so than smaller states. A state the size of Oregon has greater geographic diversity, due primarily to the span of its shoreline. The shoreline’s resources and features vary along that span and this system provides the ability to carry out the same goals in the most locally effective manner. The larger states, in general, have a population that is spread further away from the shoreline and a population that is less dependent upon the coastline for economic well-being. In such a scenario, it would be difficult to provide for feasible blanketing policies, such as land use, that best serve all locations within the state. However, as Oregon shows, this collaboration can be ineffective if the state does not require adequate guidance. The local governments are not capable, on average, of providing the necessary technical knowledge base required for effective decision making. Therefore, in order for the collaboration to work, the state must provide specific criteria and guidelines (as well as enforcement) under which the local governments can provide the appropriate localized management.
4.2 Sea level rise

None of the coastal states have policies which specifically address sea level rise and include mitigation plans to prevent problems. Rhode Island and Oregon are among the sixteen states which officially recognize that sea level rise is an event with implications for their shorelines as shown in Table 2. For nine of these states, this simply includes a setback line that is periodically recalculated (such as a tideline) or a law prohibiting redevelopment within a hazard prone area (Klarin et al, 1990). The other seven states have existing regulations that are partially adaptable to handle sea level rise. This recognition occurs through regulations that address the impacts of sea level rise under certain conditions such as the reconstruction of flood damaged structures or for dune protection. North Carolina is the sole state with existing regulations that are fully adaptable to sea level rise, even though sea level rise is never specifically mentioned. North Carolina’s setbacks are based upon annual erosion rates, which, in part, are indicators of sea level rise.

<table>
<thead>
<tr>
<th>State</th>
<th>Official Recognition and Assessment of Problems and Issues by CZMP</th>
<th>Existing Adaptable Regulation</th>
<th>New Policies Responding to Sea Level Rise</th>
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</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>No</td>
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<td>No</td>
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<tr>
<td>Alaska</td>
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<tr>
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<td>Partial</td>
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<tr>
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<td>Partial</td>
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<td>Hawaii</td>
<td>Yes</td>
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<td>Partial</td>
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<tr>
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<tr>
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<td>Massachusetts</td>
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<td>North Carolina</td>
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<td>Oregon</td>
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<tr>
<td>Pennsylvania</td>
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<td>Partial</td>
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<tr>
<td></td>
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*Note: Partial existing adaptable policies provide partial restrictions on coastal development.*

Maine and South Carolina are the only two states which have any new, direct policies which respond to sea level rise (Klarin et al, 1990). Oregon’s Department of Energy studied the impacts of global warming and issued a report which examined the impacts of sea level on the Oregon shoreline. This report made no reference to policy strategies or responses except to say that the price of protection may be too high (Oregon TFGW, 1989). The states that have adaptable regulations are those with setback regulations which are based upon erosion rates. Rhode Island CRMC lists historic sea level rise as one of the contributing factors for erosion but does not mention it with regard to setbacks. It is however, one of the states which uses erosion rates for setback determination. Methods like these indirectly address sea level rise, but not in a preemptive manner. Accurately determining erosion rates requires extensive shoreline surveying throughout the year. As this is prohibitively expensive, averaged historical erosion rates are used. Unfortunately, this results in future setback determinations that are based on historical erosion and sea level rise.

Except for the two states that have sea level policies, many other states have taken the official position that sea level rise is a national problem and as the federal government has no direct declaration or directive concerning it, they also have no reason to act (Klarin et al, 1990). South Carolina Beach Management Act of 1988 goes against this by establishing setback requirements of 40 times the annual erosion rate for the next 40 years. The baseline would be reset every 5-10 years based upon scientific monitoring and analysis. Within the next 30 years, all vertical seawalls would have to be replaced with an approved erosion control device and those that had sustained more than 50 percent damage must be replaced. This is all based upon the state’s realization that an accelerated sea level rise will exacerbate current problems and that the state’s current policies are not capable of dealing with them (Harness et al, 1991). The other state, Maine, reacted to a
similar realization by changing the Sand Dune Law in 1987. All new construction was limited to 11 meters in height and 232 square meters in area while staying landward of the buffer zone. Every structure must be moved or abandoned if the wetland encroaches on it for a period of 6 months or longer, or if it is more than 50 percent destroyed. In conjunction with the existing prohibition on hard structures, this constitutes a policy of a forced retreat (Klarin et al, 1990). These two policies are the first policies that actually recognize sea level rise and attempt to prepare for it. Maine is not a state with a high percentage of coastal sand dunes, nor is it a high risk shoreline from storm damage or overpopulation. These are greater concerns of southeastern states, yet only South Carolina is involved at this time.

In fairness to the states which lack any sea level rise policies, a few of the inherent problems with this hazard (sea level rise) must be mentioned. There is a large lack of information (or rather, very little existing accurate information) and data regarding the effects sea level rise may have on a particular shoreline. There is no background, or historical, information on the effects of an accelerating sea level rise, just unverified models (NRC, 1987). On top of all that, there are many uncertainties regarding the direct connection, linkages and sequence of the climate changes that lead to global warming and sea level rise. It is universally agreed that sea level rise is happening (Emery et al, 1991), but to what degree it is and will occur, is still unsure. The points that danger and action levels exist at are also not universally agreed upon including what the accurate warning signs and intensity indicators are. This does justify, to some degree, the uncertainty and incremental nature that policy changes must follow. It does not justify being unprepared.

4.3 Private property rights and takings

All state and local shoreline management share a set of constraints that inhibit the development of sea level rise policy. The most prominent is the issue of property rights. Any policy that allows for development or beach access to be unprotected as the shoreline shifts is going to be challenged on the basis that it infringes on private property rights (see
Appendix C). The previously mentioned South Carolina Beach Management Act was challenged by a property owner (Lucas) who was awarded $1.2 million (see Appendix C.3.1). It is still not clear as to the extent that reconstruction will be allowed due to Hurricane Hugo as many of these cases are currently tied up in court. Current cases are all against present regulations which address moving boundaries. States such as Rhode Island, which are well developed, face issues regarding reconstruction and redevelopment due to storm and erosion damage. Oregon and other states, which are still developing, face issues regarding the permissibility of new construction in known hazardous zones. States need to pass legislation regulating these issues. However, present regulations have not held up in court with the property owners winning over the regulations. It is unsure, at best, what will happen within the legal system when natural boundaries start moving at accelerated rates due to sea level rise, and these occurrences become more widespread rather than the spotted, isolated instances they are currently.

The public has no right to cross private land to reach navigable waters (Christie, 1994). This is the second private property dilemma facing the shoreline. If the oceans are considered a “common good”, then the public must have access to it. As development increases along with coastal tourism and shoreline usage, coastal access becomes increasingly more difficult. Governments are obligated, in the public interest, to regulate and provide this access (Caldwell et al, 1993). However, Nollan (see Appendix C.3.2) has shown that the public interest is not more powerful than the private property right. In this case, the public’s access to the beach and ocean was deemed to be secondary to the rights of the property owner. Accelerated sea level rise will change the existing coastal access routes. If the public’s right to access is to remain, then new routes must be provided as the previous routes no longer suffice. In highly developed areas, this will be a serious conflict. Nollan has provided property owners with ammunition against the taking of property in order to retain the public’s access. There are no existing policies which are exempt from the takings rulings. This issue will only become more volatile as governments attempt to find new access routes to the coastline without infringing on private property rights.
4.4 National land use policy

“It is not feasible for the highest level of government to design policies that can operate successfully in all parts of the nation” (Cullingworth, 1993). This is where the idea of a national land use policy currently resides. There are three arguments as to why states alone are not capable of supplying policies that meet land use needs. The first is that states are often unable to regulate and enforce protective legislation. State governments cannot easily resolve instate controversies in which opinion is divided between rural, pro-development interests and protectionist groups that are largely urban (Caldwell, 1993). The timber industry is one such example. In Oregon and Washington, a long bitter battle is still being waged between the small timbering communities that want to cut the forests in order to save jobs while the residents of Portland and Seattle are attempting to save the forests. This lack of state dispute resolution is one of the compelling reasons for the existence of the National Environmental Policy Act, the Clean Water Act, and the Oil Pollution Act to name but a few. The second is the preemptive presence of the federal government, and the third is the need for governmental action capable of responding to large scale environmental issues (Caldwell et al, 1993). States are usually reluctant to initiate international and national precedences on their own accord. For example, upstream communities and states are less likely to exhibit the same concern over watershed pollution than those downstream communities (and nations) that are directly confronted by water pollution, marine degradation and flooding. This is especially true in the case of sea level rise. Sea level rise, and global warming, are not going to be simply U.S. problems. As a country, we expect international cooperation and acceptance of the problem of global warming and have designed federal policies to respond to the issue. Therefore, it is not unreasonable to deal with a direct result in the same manner.

Opponents to federal land control argue the point of property rights (see Appendix C) and the inability of a “blanket” policy to capably handle vastly different land areas. States and local governments are in a better position to know and react to their residents than the federal government is. North Dakota and Florida do not have the same land use concerns,
priorities, or features. Similarly, there is no blanket national water use policy in the U. S., just policies that indirectly drive certain uses (eg. EPA and watershed uses) and policies that strive for clean water uses. It is simply left for the states to handle internally based upon their needs and supplies.

Oregon and Rhode Island both have different land use systems and legislation. They both have different policies regarding the ability of residents to protect themselves from the ocean and a rising sea level (based upon the ease and permissibility of shoreline protection methods). The question that needs to be answered for the issue of a national policy to be decided is whether the ocean, and therefore to some degree, the coast, is a common property or a state or individual property. Each state is itself common property, as is the ocean and the immediate coastline (below mean high water at least). If the ocean and the coast are the “property” of the United State’s, then they must be protected as such (consistent). Presently, the federal courts have the power to decide on the validity of the land use controls that each state has, and to overrule the state courts as they did in Nollan and Lucas (Appendix C). Emergency relief, flood insurance, and erosion insurance are all initiated from the federal level. The federal government is therefore not that far from having a national “policy” of sorts regarding land use, albeit with upside down incentives. The next step is providing states with the incentive necessary to consistently handle sea level rise and the complimentary land use conflicts.

4.5 Alternative methods

Assuming that a national land use or sea level rise policy is not feasible in the near future, it is necessary to consider other methods. The use of setbacks based on erosion rates, Maine’s Sand Dune Law and South Carolina’s Beach Management Act are all good examples. The restrictions of hard protection structures, such as in Rhode Island, land acquisition and conservancy programs, such as in California and Florida, and beach renourishment programs all prepare the shoreline for an engineered retreat. This is crucial. A study by the Environmental Protection Agency (Titus et al, 1991) concluded that a one
meter rise in sea level would require $43-$146 billion just to keep the beaches in the U. S. at their present state. This is simply the low and high estimates of the beach renourishment costs for a sea level rise that is a fairly conservative estimate for the next 100 years. It doesn't consider elevating roadways, harbors, protecting non beach shorelines, or what happens when easily obtainable sand sources are exhausted.

Other alternative programs are being proposed. Long Island is attempting to end long term leases and to mandate the state acquisition of flooded properties. The EPA is considering the establishment of a state program to buy coastal property and lease it conditionally (Klarin et al, 1990). San Francisco Bay requires that proposed developments must consider sea level rise in their project engineering plans. Delaware proposes favorable tax assessments to property owners who develop property for uses compatible with the preservation of beaches. These are all forward thinking programs.

Protecting the shoreline in the most appropriate manner is feasible up to a certain point. Determining the options and evaluating them requires a better educated public and public officials. Learning more about the natural system and the potential effects of sea level rise is the single most important program that needs to start. At some point in time buyer beware property sales (property owners allowed to build on the condition that when shoreline encroaches too close, they must move the structure) and engineered retreats will be the only choice. For governments and property owners to accept this and to devise alternatives, is for them to be educated. Other policy methods are discussed below and in Table 3.

<table>
<thead>
<tr>
<th>Policy</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| New Incentives       | • Easy initial implementation as existing regulations are maintained  
|                      | • State control of local shorelines  
|                      | • Forward acting                     | • National land use policy or equivalent required  
|                      |                                    | • Strong national incentives and guidelines required  
|                      |                                    | • Difficult to implement proactive policies  |

Table 3: Policy pros and cons
<table>
<thead>
<tr>
<th>Protect the Shoreline</th>
<th>Do Nothing</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Easy to be consistent</td>
<td>* Easy to implement</td>
</tr>
<tr>
<td>* Reduced human induced erosion</td>
<td>* Inexpensive (as a program)</td>
</tr>
<tr>
<td>* Takings issue still exists</td>
<td>* Allows natural shoreline movement</td>
</tr>
<tr>
<td>* Reduced outcry concerning takings</td>
<td>* Expensive</td>
</tr>
<tr>
<td>* Preserves developed areas</td>
<td>* No turning back</td>
</tr>
<tr>
<td>* Protection from coastal hazards</td>
<td>* Expensive for government funded disaster relief</td>
</tr>
<tr>
<td>* Degrades natural habitats</td>
<td>* Coastal hazard problems</td>
</tr>
<tr>
<td>* Difficult to be consistent between rural and urban areas</td>
<td>* Takings issues</td>
</tr>
<tr>
<td>* Prevention from coastal hazards</td>
<td>* Inconsistent</td>
</tr>
<tr>
<td>* Difficult to be consistent</td>
<td>* Reactive policies</td>
</tr>
</tbody>
</table>

### 4.5.1 Do nothing policy

A policy of do nothing would allow existing shoreline management techniques and legislation to provide guidance. Assuming that conservative estimates are accurate (a sea level rise of 1 m), the existing shoreline would be roughly 170 m further landward by the year 2100 (see Appendix A.2). Assume that all shoreline property lots are one acre lots (as an overexaggeration), or roughly 40 m square. This potentially results in the loss of up to three or four parcels of property deep in some locations. As this shoreline moves landward, so too will all existing setbacks and development buffers. The *Lucas* case (see Appendix C.3.1) shows what happened when a setback prevented any development on a parcel. Even if it can be shown that the prevention of development through setbacks can be characterized as preventing a harmful or “noxious” use, *Lucas* states that the prevention of construction (through a diminution in property value) constitutes a taking. So, in the case of hundreds of properties being designated as unbuildable (or unrebuildable) as in the above mentioned instance, this scenario would provide each of these lost properties with an opportunity to challenge regulations and to seek compensation. Each of these properties would also be eligible for NFIP and FEMA emergency funding.
Another potential problem would arise from the inconsistency between states regarding shoreline protection structures. States, such as Oregon, would allow for armoring the shoreline. That would exacerbate erosion rates in the states directly downstream (see Appendix A.1) and leave them even more vulnerable to coastal hazards. It would also raise the issue of unconstitutional takings of one state by another.

The positive side to this policy is ecological health. This method forces a retreat as the shoreline moves landward. This retreat allows wetlands and marshes an opportunity to migrate naturally which preserves a large percentage of the existing biodiversity. The existing inshore structures would prevent this from happening truly naturally, but none-the-less, coastal resources would migrate.

4.5.2 New incentives policy

A policy that established new incentives without dramatically changing existing regulations would essentially smooth out the do nothing policy described above. The incentives would have to start from the federal government through a national land use policy or a revamped CZM Act. The primary drive would be consistency along the coastlines with regard to shoreline protection and land use. This should be accomplished through national goals in shoreline management that recognize existing coastal hazards. The inconsistencies that exist due to the lack of federal initiative are easily visible when looking at the shoreline protection measures that Oregon and Rhode Island possess. There is no need for the federal government to manage the shoreline, but the federal government must provide certain guidelines:

- The means and incentive must be provided to ensure state by state consistency.
- Education of policy makers and property owners must be increased.
- Local governments should inform the public of risks from sea level rise and coastal hazards.
- State and local governments should initiate research that directly affects their shorelines.
- Finally, FEMA (Appendix B.4) should develop policies that encourage communities to address shoreline retreat and erosion.

These incentives will not prevent sea level rise or protect the shoreline any better than the do nothing policy but it will allow society to live better with the problems. There is little cost associated with this scenario and potential reductions in judicial costs and time as a better educated public may be more involved with pressing for positive regulations than fighting them. The greatest challenge facing this policy is the Federal enforcement of FEMA regulations and the maintaining of consistency of regulations.

4.5.3 Protect the shoreline policy

This policy would protect the shoreline from a rising sea level. This is an expensive proposition, therefore, it would have to be a combination of shoreline protection and shoreline retreat. This would mean building revetments, groins, seawalls and bulkheads along certain shores and enhancing these structures with sand in order to maintain the buffer zone between developed areas and the sea. Titus (1991) undertook a study to determine some economic estimates of shoreline protection. Assuming a 1 m rise in sea level, Titus estimate that 36,000 square km of land would be lost resulting in a rough value of $270 - $475 billion. This policy proposes the protection of the heaviest developed areas (roughly 15 percent of the U.S. coastline) and an engineered retreat of the remaining land. According to Titus, it would cost roughly $180 billion to elevate the roads and structures and $75 billion to nourish these shorelines. From a cost/benefit ratio, this is clearly promising (eg. greater savings in land value than the associated costs to save it).

A major flaw in this is the assumption that development won’t continue. If development grows at present or greater rates, this would require far more than just 15 percent of the
shoreline being protected. This policy also suggests that the unprotected areas would be retreated from. This includes the abandonment of homes and businesses. As the possibility of restricting all coastal development is unlikely, this abandonment would have to occur. These issues raise feasibility concerns for this policy. The legal implications of designating specific developed areas over other areas is unknown. There could be severe takings issues raised by such legislation however. Also, the costs of protecting more than 15 percent of the shoreline could easily change the positive tilt of the cost/benefit ratio.
5. Conclusion and Recommendations

Sea levels are rising, as has been proven by study after study (Emery et al, 1991, Klarin, 1990, Platt, 1994, and Tibbetts, 1995). Conservative estimates of potential land loss due to this hazard include a receded shoreline of 190 m, a loss of 36,000 square km of land, and up to $475 billion in land loss (Titus et al, 1991). This is a serious concern considering that roughly 129 million people live on the coastline. Additional concerns include increased damage and erosion from storms and coastal hazards as the shoreline looses its buffer zone between human development and the ocean.

Regulations and legislation exist to mitigate coastal erosion and hazards. These regulations are not consistent with each other however. The Coastal Barriers Resources Act and many state’s setback laws restrict construction in hazardous areas. Programs such as the Federal Emergency Management Act’s federal disaster relief and the availability of flood insurance for new construction through the National Flood Insurance Act stimulate new coastal construction however. Recently, even existing regulations are being tested and overruled by the judicial system. The Lucas and Nollan cases both challenged existing land use regulations and in each case the property owner prevailed over the regulation. The Lucas case is an extreme case where the regulation resulted in a total loss of use. It is unsure how the courts will act when partial losses are claimed by regulations. When a setback constrains the location and physical size of a building on a property lot how much, if any, value has been taken? This is the initial scenario that will confront the judicial system as sea levels continue to rise. The primary, glaring response to this dilemma is that the courts will become bogged down with unclear takings issues unless policies are capable of providing guidelines. This is further frustrated as governments and government agencies are in the midst of downsizing and budget cuts. Increased court cases (both in number and time) combined with a reduction in the ability of government agencies to defend themselves will almost assuredly result in regulations that are not well enforced. It also forces regulations and agencies to deal with past
problems and defend yesterday’s regulations instead of worrying about providing guidance for tomorrow’s issues.

These issues are all in conflict without the immediate threat of a rising sea level. There exist only two states with any specific sea level rise legislation. This all leads to one conclusion. Current U.S. policies are inadequate to address the shoreline management problems created by sea level rise. Comparing Rhode Island and Oregon makes this evident.

Both states have followed differing shoreline management procedures, both of which are federally approved. There are no inherent advantages to one of these methods over the other. In fact, each state seems to be better off with their chosen route. Oregon’s state local collaboration provides public participation at the local level and a management scheme that allows each jurisdiction the ability to address their local concerns. This works well as the physical shoreline and population densities change along the coast. Rhode Island’s centralized approach provides more consistency along the shoreline. This is appropriate as the shoreline is fairly consistent in population and makeup. Neither state, however, is consistent with each other or prepared to address sea level rise. Both states do, however, account for their public’s preference in their management systems which is the consistency that the CZM Act sought to provide.

Each state has a different policy regarding shoreline protection and setbacks with regard to mitigating coastal hazards. These types of inconsistencies are not by themselves an issue, but they point to a problem. Sea level rise will affect the nation’s shoreline as a long term trend not as an event. In other words, the sea level will continue to rise into the future, it will not suddenly rise up over a few days. There is no federal incentive for states to address present events such as storm damage consistently let alone future trends such as sea level rise.
Sea level rise will increase erosion rates, shoreline recession, and coastal hazard damage. The federal government, through FEMA and NFIP provide financial aid to damaged property. Sea level rise will increase the instances of damage to coastal property. Yet the federal government which will provide aid has no official policy on the prevention or reduction of the potential damage. FEMA does provide setback regulations and building codes which must be met in order to qualify for aid. However, this has not been shown to reduce potential damage or increase the incentives to push property owners from simply expecting the federal government to pay for their hazardous building decisions. While this financial support is offered, there is no need for the states to step forward and supply the incentive. Some states have taken the initiative through erosion based setback requirements but not enough states have yet followed suit. Finally, the federal government has a national policy of setting standards and monitoring guidelines regarding clean air and clean water, both of which are considered “common heritage” or common property, but the ocean and the land along the shore, which are also considered to be “common heritage”, have no such policy.

There are some steps that can be taken to better prepare for sea level rise. The first is the altering of federal policies (such as the CZMA and FEMA) to include sea level rise and coastal hazard protection. The existing method of allowing the states to manage the shoreline is fine as long as incentives are provided for the states to incorporate consistent, forward thinking policies. There must be a reason for the states to respond to a future danger. The federal government can supply this, each state has no incentive to address it until it becomes a present danger. The federal government also needs to be consistent within. Conflicting policies regarding coastal construction must be revised to provide incentive not to develop hazardous areas that will be supported by taxpayer’s money. This has been started with the designation of areas where development is restricted by FEMA (eg. A-zone and V-zone areas).

Future policies must also be considered and researched. It has been shown (Titus et al, 1991) that it is cost effective to protect highly developed areas on the shoreline. Less
developed areas are not feasible to protect and must be retreated from. For this to be a possible solution, society and legislation must be considered now. It is too late to pass legislation providing this solution once the sea level has reached a critical level. Finally, education and research must be increased. There is a lack of baseline data to fully understand the effects of a rising sea level or global warming on a shoreline. Private property rights are held sacred in this country and that is unlikely to change or to be changed by politicians. It is therefore crucial that shoreline residents and policy makers be aware of everything before the courts become tied up with private property and takings cases that challenge regulations.

The U.S. policies are not prepared to handle sea level rise but the policy makers are in a position to change that. Linking sea level rise to more immediate and tangible issues such as coastal erosion, beach access, and hazard mitigation provide present day solutions. Future solutions require the federal government to regard sea level rise as a national problem. Once it is recognized as such, national standards and goals can be established, and the states can continue to manage their shorelines subject to further national requirements.
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Appendix A. The Natural Processes

The natural processes are, quite simply, the physical dynamics of the world ignoring the presence of humans. The forces of nature; wind, waves, atmospheric pressure and ocean currents just to name a few, all combine to create a dynamic equilibrium between the atmosphere, the land and the water. These processes are not risks and hazards in themselves until viewed by society. Humans have created a static existence that does not coexist peacefully within a dynamic arena. This leads to the defining of certain natural processes as risks and hazards.

Coastal hazards are those natural hazards (as viewed by society) that directly affect the shoreline. Erosion occurs naturally but no erosion problem existed until people laid out property lines and built within them. These “hazards” include coastal erosion, ocean born storms, flooding and inundation, as well as dune and beach migration. Sea level rise is a double edged sword. A rising sea level is a hazard in itself as well as an “accelerator” as a rising sea level also exacerbates all other coastal hazards (Mehta et al, 1987).

A.1 Coastal Hazards

Erosion is the landward displacement of the shoreline or mean high water line in response to various factors. This section considers only those natural processes that affect the shoreline. The human influence, as a rough approximation, can be considered to accelerate (or decelerate in some cases) the natural forces. The primary forces that drive the dynamics of the shoreline include the tides, waves, currents and wind (Bearman, 1989). These interact with one another on a continual basis as well as on an event basis such as during storms when many of these forces increase in strength.

Shoreline sediments are continuously responding to direct wave action, wave induced littoral currents, wind and tidal currents. The movement of a shoreline can be considered to be the net result of a combination of constructive and destructive forces (Dean, 1990).
Of the destructive forces, gravity is the most obvious. Acting with gravity is the breaking wave energy. As waves break, their previously organized wave energy (i.e. all the force is primarily directed in one orientation) is transformed into highly turbulent fluctuations. These fluctuations act to dislodge sediment from the sea floor and shoreline and with the aid of gravity, these particles are transported offshore.

Countering the destructive forces are constructive forces that include net onshore shear stresses, seabed streaming velocities and sediment transport under cresting waves. For the sake of simplicity only the latter will be considered here. A wave has higher velocities under the crest than under the wave trough (Bearman, 1989). Under the crest, the wave velocities are shoreward, therefore, a sediment particle that is suspended under the crest of a wave will be acted upon by onshore forces. These forces, when balanced, result in an oscillating equilibrium. When either force strengthens, such as during a storm with more powerful breaking waves, an imbalance occurs and sediment is transported. In the case of a storm, that transport is offshore.

Both direct and indirect effects of wind play an erosional role. The wind is in continual contact with the shoreline above mean high water, causing sediment to shift in the direction of the prevailing wind. Indirectly, wind plays a larger part by generating waves, which causes sediment motion as well as generating currents. These nearshore currents are driven by the waves. Waves tend to hit the shoreline at an oblique angle. This non normal direction generates a longshore current that moves down the shoreline in the direction of the waves. While sediment is suspended, as mentioned earlier, these longshore currents move the sediment. So even if the forces are in equilibrium, sediment is being transported along the coast. Any physical disruption or obstacle on the shoreline can therefore cause erosion (or accretion with a resulting erosion downstream of the obstacle) even though the natural forces are in balance.

The stability of a section of sedimentary shoreline depends on a balance between the volume of sediment available to that section and the net onshore-offshore and alongshore
sediment capacity of waves, wind, and currents in that section. The volume of sediment available is supplied from two primary sources. This volume consists of the sediment transported out of the upstream section and that sediment that is provided from rivers and estuaries (as they carry sediment from inland sources out to the ocean) minus the sediment that is transported out into the next section. The shoreline may thus be eroding, accreting, or remaining in equilibrium. If an equilibrium does exist, it is at best a "dynamic equilibrium", where the shoreline is responding to continuously variable winds, waves, and currents. Also, the supply of sediment is usually irregular temporally and geographically, providing sections of the same shoreline with varying relative positions and trends at any one point in time. Dynamic equilibrium usually means that the average shoreline position is relatively stable over a period of months or years while the instantaneous position undergoes short term oscillation. This all results in the natural "background" movement of sediment up and down the coast.

Nature plays with fluctuating boundaries. Man plays with an existence based on fixed locations. As erosion reduces the buffer zone of shoreline between the ocean and man, coastal storms become more of an issue. Coastal storms, part of the environment’s natural occurrences, provide short term and long term hazards. The long term hazards are due to the increased wave energy associated with a storm. This increased energy accelerates the erosion process and, due to the increased wave size and storm surge, exposes a much wider (deeper) portion of the shoreline to these destructive forces. During this time period of heightened energy, the sediment suspension potential is dramatically increased as is the velocity of the "carrying" currents. Naturally, storms heighten erosional problems for a short period of time and then slowly, over time, return the sediment back to the shoreline (Dean, 1990).

The short term effects are hazards to humans as property damage can occur before the natural cycle can restore the shoreline. Increased storm surge and wave height (and wave energy) inflict a powerful battering of forces against all obstacles. In any developed area these obstacles tend to be man made structures. The strength of these forces are
greater than the feasible design strengths of the majority of buildings (excluding some expensive shoreline protection structures) which results in enormous economic (and property) damage. The increased storm surge (which can be further heightened by the unfortunate occurrence of storms at high tides) also results in water inundation ending up in flooding and salt water intrusion. The maximum storm surge for hurricanes Andrew and Hugo were 16.9 feet and 20.2 feet respectively while the significant (the average of the highest one-third wave heights) wave heights were 14 feet and 24 feet respectively (Wang et al, 1994).

A.2 Sea Level Rise

Historically, there have been fairly large fluctuations in sea level. Some 20,000 years ago, near the time of the last ice age, the sea level was roughly 120-150 m below its present level (Shepard, 1963). These fluctuations in sea level are due to long-term climactic changes. During the ice ages, substantial quantities of water accumulated within the polar ice caps and glaciers. These vast bodies of ice extended down to the lower latitudes during many of the more severe ice ages. From that last ice age till about 6,000 years ago, the sea level rose rapidly (roughly 1 m/century). This rapid rise is associated with the retreat of the glaciers and the warming of the atmosphere. Over the last 6,000 years, sea level has risen at a reduced rate of roughly 13-14 cm/century which is more consistent with present trends (Hicks et al, 1983).

For nearly a century, the relative mean sea level has maintained a steady rise at tide recording stations worldwide. Hicks (Hicks et al, 1983) has published sea level data from the present back to the mid 1800’s for tide stations around the U.S. shoreline. This data accurately portrays the steady 10-15 cm sea level rise over the last century. There is a fair amount of noise in the historical data due to land uplift. As the ice pulls further back towards the poles, the land (over many years) rebounds from the weight and “lifts” relative to the sea level. This leads to fluctuations in sea level rise values throughout formerly glaciated areas of the world.
The past century has shown a steady rise in atmospheric greenhouse gases. Long term carbon dioxide monitoring stations have measured increases of 30 ppm (an increase of 10%) during the past 30 years and estimates of increases of 50 ppm since pre-industrial (mid 1800's) times (NRC, 1983). To many, this increase in gasses implies a warming of the world’s climate. It was concluded by the National Research Council (NRC, 1979) that a doubling of CO2 would raise the earth’s average temperature 1.5-4.5° C, with the warming at the poles two to three times as great as the average warming. It was concluded that there was a 75% chance of this occurring within the next 100 years.

Four primary hazards affect sea level rise as a result of global warming. The buildup of gasses in the atmosphere traps radiant energy that would normally pass outward into space. This in turn heats up the atmosphere and the earth, resulting in accelerated glacial and ice sheet melting. Thermal expansion of ocean water (or the increasing of the volume of a given water mass), the melting of mountain glaciers, the melting of Greenland and Antarctic ice fields, and the possibility that Antarctic glaciers may slide into the ocean. The Arctic ice pack is floating, therefore, whether it is in a frozen or liquid form it doesn’t displace any additional water. The combination of these factors combined with estimates of global warming have lead experts to estimate a sea level rise of 56 cm (minimum) to 368 cm (high) by the year 2100 (Emery et al, 1991). These numbers are further backed up by remote sensing of the sea ice in the Arctic and Antarctic. The sea ice in both locations is decreasing (melting) with the rate of reduction having accelerated from 2.5 percent to 4.3 percent per decade in the Arctic over the last 16 years. The Antarctic has accelerated by roughly 1.4 percent per decade over the same time period (Sea Technology, November 1995).

Compaction is a secondary hazard affecting sea level rise (Emery, 1991). Compaction is the subsidence of ground level due to the reduction in the void ratio (the natural response of a soil resulting from increased loading) of the underlying soil. In coastal areas, this “sinking” of the shoreline results in an additional “relative” sea level rise. Compaction
(and the opposing sediment deposition) are naturally occurring. However, compaction is also induced by man through such activities as:

- loading by the weight of structures and buildings
- the extraction of oil and natural gas
- the depletion of the level of the groundwater table or the prevention of aquifer recharge.

The dominant engineering approach to predicting shoreline response due to a rise in sea level is the so-called Bruun Rule (Mehta et al, 1987). The Bruun Rule yields a simple relationship resulting in a horizontal shoreline retreat of approximately 50-100 times the rise of the sea level. This is based on a conservation of sediment approach. Coastal engineering assumes that each shoreline has an active equilibrium profile that nature always strives to retain, regardless of shoreline movement or opposing forces and structures. This profile shape is based upon the sediment size and roughness and the magnitude and direction of all energy based forces at that location. The profile always maintains its relative position to sea level and the active portion of the profile is limited by the “depth of effective motion”, $h_4$. This depth, $h_4$, is defined as the depth beyond which the waves are no longer capable of sediment suspension.

As the sea level rises a vertical distance, $S$, the entire active profile also rises by $S$. This requires a volume, $V_{\text{required}}$, of sediment (all volumes can be assumed to be per unit shoreline length) to maintain the equilibrium profile form.

$$V_{\text{required}} = SL$$

where $L$ is the width (cross shore and seaward direction) of the active profile. This volume of sediment needs to come from somewhere, and nature provides it by retreating the profile shoreward a vertical distance $h_4 + B$. This provided volume, $V_{\text{provided}}$, is equal to:

$$V_{\text{provided}} = (h_4 + B)$$

where $R$ is the shoreline (profile) retreat and $B$ is the shoreline height above sea level. If
these two volumes are equated, the shoreline retreat due to sea level rise can be shown as:

\[ V_{\text{required}} = V_{\text{provided}} \]

\[ R = S \frac{L}{h_s + B} \]

The primary hazard resulting from all of this is the exacerbation of all existing coastal hazards. The U.S. Atlantic coastline has been eroding, on average, 60 - 90 cm per year for the last century (U.S. Army Corps). Assuming a fairly conservative estimate of a 1 m sea level rise over the next century, this equates to a minimum additional erosion of 1 m per year, more than doubling present erosion rates. That results in an Atlantic shoreline that is roughly 160-190 m further shoreward by the year 2100.

According to EPA estimates, the same 1 m rise in sea level would destroy some 46% of all U.S. wetlands due to inundation, flooding, and salt water intrusion. This would include the destruction of the Chesapeake Bay and the Mississippi delta. In many lower lying areas such as Texas, Florida and the Carolinas, the 1 m rise would transform the 100 year floodplain into the 10 year floodplain. A moderate storm would now become equivalent to a disaster with respect to property and environment (Titus, 1991).
Appendix B The Political Process

The first national land use policy bill was introduced by Senator Henry Jackson in 1970. This ill fated drive towards a national land use policy established no policy and conferred no new power upon government but its evolution prior to 1970 did lead up to notable environmental legislation (Cullingworth, 1993). Included in this were the National Environmental Policy Act of 1969, the Federal Water Pollution Control Act of 1972 (or the Clean Water Act), and the Coastal Zone Management Act of 1972 which itself led to further shoreline relevant legislation.

B.1 Coastal Zone Management Act

The federal Coastal Zone Management Act of 1972 (CZMA), 16 U.S.C.A., emerged from a national reevaluation of the effectiveness of U.S. environmental policy and land use policy that came to highlight the importance of the coast. The Stratton Commission report noted that the coast is, in many respects, “the nations most valuable geographic feature and, as such, has unique characteristics and requires special management”. The general consensus was that the problems had outrun the abilities of local governments and a state based management system was necessary (Godschalk, 1992).

The three years prior to the signing of the CZMA in 1972 by President Nixon saw Congress struggling over the direction of the Act. The debate focused on whether the CZMA would be focused on ocean development with NOAA as the lead agency or on land use and conservation with the Department of Interior as lead agency. In the end, the national land use failed while the CZMA gained enough support to win congressional passage.

The resulting act was relatively broad, stating that it is the national policy (Christie, 1994):
• to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation’s coastal zone for this and succeeding generations,
• to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve the use of land and water resources of the coastal zone giving full consideration to ecological, cultural, historic, and esthetic values as well as to needs for economic development,
• for all Federal agencies engaged in programs affecting the coastal zone to cooperate and participate with state and local governments and regional agencies in effectuating the purposes of this title, and
• to encourage the participation of the public, of Federal, state, and local governments and of regional agencies in the development of coastal zone management programs.

The 96th Congress passed the reauthorization of the Coastal Zone Management Act of 1980 which was intended to aid states in the implementation of their programs. In order to provide more guidance and specific criteria for setting national objectives, the Act declared a new national policy defining nine areas of national interest that states were required to address. These were:

(1) Natural resource protection
(2) Hazards management
(3) Major facility siting
(4) Public access for recreation
(5) Redevelopment of urban waterfront and ports
(6) Simplification of decision procedures
(7) Coordination of affected federal agencies
(8) Public participation
(9) Living marine resource conservation
The Coastal Zone Act Reauthorization Amendments of 1990 added a little more to the CZMP including:

- The Coastal Zone Enhancement Grants Program (section 309) was set up to encourage each coastal state to continually improve its CZM program in one or more of eight areas:
  
  (I) coastal wetlands management and protection  
  (ii) natural hazards management  
  (iii) public access improvements  
  (iv) reduction of marine debris  
  (v) assessment of cumulative and secondary impacts of coastal growth and development  
  (vi) special area management planning  
  (vii) ocean resource planning  
  (viii) the siting of coastal energy and governmental facilities

- The establishment of a Coastal Nonpoint Pollution Control Program to require each state to develop a program to protect coastal waters from nonpoint pollution from adjacent coastal land uses

Finally, the CZMA provides for federal consistency reviews. These ensure that any federal activities which directly affect the state coastal zone are, “to the maximum extent possible”, consistent with the state’s coastal zone management program. This is a mixed blessing. This provides a vehicle for compliance while also slowing down the entire process as states review hundreds of determinations each year, many of which are based upon interpretations of legislation and policies (Owens, 1992).

State participation under CZMA was designed to be voluntary, with each participating state given funds to prepare a program plan, and when approved, follow up grants to implement the program. In order to be approved, each state had to define the boundaries of the coastal zone, define acceptable land and water uses with these boundaries as well as proposing means for exerting state control over land and water uses. Each program also
had to propose an organizational structure to implement the management program, including responsibilities and interrelationships of local, state, regional, and interstate agencies.

The CZMA, 16 U.S.C.A. § 1455(d)(11) recognizes three general approaches that a state may adopt in its organizational structure:

(a) State establishment of criteria and standards for local implementation, subject to administrative review and enforcement.

(b) Direct State land and water use planning and regulation.

(c) State administrative review for consistency with the management program of all development plans, projects, or land and water use regulations, including exceptions and variances thereto, proposed by any State or local authority or private developer, with power to approve or disapprove after public notice and an opportunity for hearings.

Once a federally approved state program is in place, the states, theoretically have the power to manage their shorelines. The vision of the CZMA was that each state’s individual coastal management program would be uniquely tailored to address those national interests that are relevant in that state in the way that is most effective in that particular state. Twenty nine states have approved programs that address a wide range of national interest areas while six states still choose not to participate (Owens, 1992).

B.2 River and Harbors Act

The River and Harbors Act of 1899 is one of the primary sources of jurisdictional authority for the U.S. Army Corps of Engineers. This Act gives the Corps (a federal agency) the power of approval over the construction of any bridge, dam, dike or causeway within state coastal waters. It also prohibits the obstruction of any navigable waterway (within state or federal jurisdiction) unless approved by Congress.
B.3 National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) established the Council on Environmental Quality as well as the requirements for Environmental Impact Statements (EIS). These impact statements are required for every significant federal project and every federal action that significantly affects the environment. Through this, NEPA has established a legislated requirement that environmental impact be considered. Each statement must contain a detailed analysis of the environmental impact, any adverse environmental effects that cannot be avoided, and alternatives to the proposed action.

B.4 National Flood Insurance Program

The National Flood Insurance Program (NFIP) was established by Congress in 1968 under the National Flood Insurance Act of 1968. The NFIP is administered by the National Insurance Administration which is within the Federal Emergency Management Agency (FEMA). The program provides a nationwide system of federal insurance for property (land and structures) that is located in designated flood hazard areas. This was intended to reduce federal flood disaster relief by providing flood insurance coverage to communities that adopted building standards and land use controls that minimize property losses and damages.

Local implementation and enforcement of minimum NFIP standards has been a controversy. FEMA has the authority to suspend noncompliant communities but this is rarely done. The other problem/issue with NFIP has been the extent to which communities and neighborhoods subject to chronic flooding have been subsidized. This has led to disagreement as to the actual incentives provided by NFIP. On the one hand, it is argued that the increased construction costs incurred from having to meet stricter building standards, serve as a disincentive (Davison, 1993). On the other hand, the availability of subsidized flood insurance is likely to serve as incentive for such building.
In 1987, Congressmen Fred Upton and Walter Jones co-sponsored an amendment to the NFIP which was enacted into law in 1988. The Upton-Jones Amendment revised the NFIP to allow for payment of flood insurance claims to relocate or demolish buildings imminently threatened by erosion, prior to actual damage. The basic purpose of this amendment was to reduce the amount and number of future flood losses by providing incentive for pre-flood mitigation actions.

B.5 Coastal Barriers Resources Act

The Coastal Barriers Resources Act (CBRA) was legislated in 1982 as an attempt to withdraw Federal incentives that encourage development within specific locations while establishing a policy of not subsidizing future development in hazardous undeveloped coastal barrier areas. Public Law 97-348 finds that “barrier islands serve as natural storm protective buffers and are generally unsuitable for development because they are vulnerable to hurricanes and other storm damage and because natural shoreline recession and the movement of unstable sediments undermine manmade structures” (U.S. Statutes at Large, 1982). Under CBRA, federal expenditures (including flood insurance under NFIP) to assist private development within designated areas is prohibited. This includes roads, bridges, community development, and disaster relief.

CBRA does not prohibit owners from building on their property but it does shift the infrastructure cost and risk of loss away from the Federal government (Godschalk, 1984). This places the risk on the state and local government. It is up to the state and local governments to decide whether or not to replace the funds withdrawn by the Federal government or to parallel the Federal government’s decision to not subsidize development (in these specific areas). The constitutionality of CBRA has already been challenged and upheld through Bostic et al v. United States et al.
B.6 Setbacks and Control Lines

A number of coastal states have established horizontal setbacks for new construction. These are state established and justified under the coastal construction standards of the NFIP. There are three basic approaches that have been utilized:

- fixed setback lines
- natural resource protection
- average annual recession rate setbacks

Early setbacks utilized the first of these approaches but as the shoreline and coastal processes have become better understood, delineation of setback lines have been based upon a mixture of all three approaches. South Carolina, for example, passed setback legislation in 1990 that is based upon a baseline established at the “crest of an ideal primary oceanfront sand dune.” From that baseline, a setback was established at a distance forty times the average annual erosion rate, but at a minimum distance of twenty feet landward of the baseline. This becomes more accurate from an engineering perspective, but less definable from a policy perspective (London, 1991). In addition, new coastal construction setbacks may disproportionately affect unimproved lots in developed coastal areas further enflaming the issue.

The other major issue facing setbacks has to do with the inclusion of existing development into the system. This becomes a concern when large scale improvements or rebuilding is concerned. Many states have adopted legislation defining rebuilding permissibility after damage has occurred. Limitations are placed on the rebuilding of structures that are “destroyed beyond repair”. “Destroyed beyond repair” is defined as “more than XX percent of the replacement value of the habitable structure has been destroyed”, where the percentage value is state set, usually ranging from 50 to 70 percent destroyed. The valuation of these structures, and their placement relative to the new construction setbacks arises as a very controversial problem (Caldwell et al, 1993).
As an example, in *Esposito v. South Carolina Coastal Council* the baseline was established landward of a group of existing structures. The owners alleged that a taking had occurred since, in the event of a destroyed house, the owners would not be able to rebuild. They contended that this had caused a loss in value since they were now uninsurable and unable to finance or refinance. The federal district court determined that no takings had occurred. In *Chauvous v. South Carolina Coastal Council* the baseline was established landward of vacant lots on which the owners were now unable to build. In this case, the lower court found that a taking had occurred (Harness et al, 1991). This is very controversial and is having mixed outcomes. The only thing that seems certain is that more and more court cases will occur.
Appendix C. Private Property Rights

Legally, everyone has the right to own property (Paul, 1988). The fourteenth amendment of the U.S. Constitution states, "No State shall make or enforce any law which shall abridge the privileges or immunities of the United States, nor shall any State deprive any person of life, liberty, or property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the law." The fifth amendment states that "...no person shall be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation." These are broad statements that are, and have been, open to many differing interpretations as to the exact rights people have to and over private property.

Included in the set of rights known as "property rights" are eleven subrights typically known as "incidents of ownership" (Caldwell et al, 1993). These are

- the right to possess
- the right to use
- the right to manage
- the right to income
- the right to the capital
- the rights to security
- the incidence of transmissibility (the right to pass on property to one’s successors)
- the incidence of absence of term (the right to hold onto one’s property forever, if one lived forever)
- the prohibition of harmful use
- the liability of execution (property may be taken to cover debts)
- residual rights (full rights to property after other limited interests in it cease)
There is also the assumption that the right to ownership is not absolute (Tibbetts, 1995). There are two conditions that qualify this. First, that one not use one's property in such a way to impair one's neighbor's equal right to enjoy property and that the state, through eminent domain, has an ultimate right of possession that, in appropriate circumstances, can override private ownership. The struggle has always been, where do you draw that boundary and who decides what is “appropriate”.

C.1 Takings (Fifth Amendment)

The takings issue arrives from the assumption that certain measures or actions are so severe that they “take” the value of the property leaving it disadvantaged. The fifth amendment, as quoted above, states that “…nor shall private property be taken for public use without just compensation”. When the government “takes” land for public development (roads, Post Offices, government buildings, etc..) there is no doubt that a taking has occurred and that compensation is required. However it is not so clear as to when a regulation, which has affected the value or utility of a property, constitutes a taking and when compensation is required (Cullingworth, 1993). Pennsylvania Coal Co. v Mahon (1922) is generally regarded as the earliest of modern day takings cases. In the ruling, Justice Holmes wrote, “The general rule at least is, that while property may be regulated to a certain extent, if regulation goes too far, it will be recognized as a taking.” This statement did nothing for clearly defining where regulation ends and takings begin.

The Supreme Court, and with it lower federal and state courts, have followed various theories in determining whether a taking has occurred (Christie, 1994). These include:

(a) The Noxious Test: This is based upon the understanding that private property cannot be used in ways that injure the similar rights of other property owners use and enjoyment of their property.

(b) The Diminution of Value Test: This focuses on the devaluation (usually economic based in present cases) of the property due to regulation or other
reasons. This has produced a variety of results based upon the methodology used to determine the existence and extent of the impact.

(c) The Balance Test: This examines the balance of private loss against public benefit.

(d) The Harm-Benefit Test: This test is viewed as a derivation of the previous test. It dictates that when a regulatory act aims to prevent a public harm, no compensation need be given to affected property owners to guarantee the act’s constitutionality. However, when a regulatory act aims to further a public benefit, it would have to be accompanied by compensation in order to avoid a taking.

C.2 Differing Interpretations

There are no disputes as to the legality of owning property. There are major disputes as to the form and extent of that ownership. On one side are those who agree with regulating land use. They find that under the present interpretation of the constitution by the U.S. Supreme Court no constitutional right to develop land exists. Opposing that view are those who believe in privatism, whereby owners are presumed to be entitled to use their land as they wish, subject only to reasonable constraints to protect the public interests (Good, 1994).

The primary distinction between these sides comes down to the distinction of takings. Those favoring regulation view shoreline regulation as necessary to protect our shoreline from short sighted development that might detract from its present and future uses and value. Here, the public or common rights are seen as being in danger and therefore shoreline regulation is not a takings issue. Those against regulation feel that the many of the regulations (by imposing unrealistic standards) detract more from the value and use of the shoreline than the public loss. Therefore, takings have occurred and compensation and deregulation are required.
C.3 Legal Responses

There have been two major landmark cases regarding the takings issue along the shoreline. In both cases, the issue of private rights versus public interests was put to test. Both cases are still debated as in both instances, the regulations were not upheld (findings were for the property holders) but yet neither regulation was found to be unconstitutional.

C.3.1 The Lucas Case

In *Lucas v. Carolina Coastal Commission* (112 S. Ct. 2886, 1992) Lucas challenged the South Carolina Beachfront Management Act of 1988 on the issue that existing regulation amounted to a taking. Lucas was the owner of two oceanfront lots that he purchased in 1986. In 1988, the Act established a baseline that left both lots entirely seaward of the baseline. Under the Act, no new construction was permissible seaward of baselines resulting in the denial of construction permits for Lucas. Lucas claimed that the denial of permits was a taking of the entire value of the property for "public use" without compensation in violation of the 5th amendment. The trial court agreed with Lucas but on appeal, the State Supreme Court overturned the ruling basing the permit denial to be a reasonable exercise of the public power in the regulation of hazardous land.

Appeal by Lucas to the U.S. Supreme Court resulted in a overturning of the state's decision. The Supreme Court found that a taking, requiring compensation, had occurred unless the state's erosion restriction could be justified under common law. As the state could find no such justification, the final ruling was for Lucas. The Supreme Court did not find the Act to be unconstitutional and therefore it remained in effect.

C.3.2 The Nollan Case

In *Nollan v. California Coastal Commission* Nollan challenged the California Coastal Commission on the issue that their permit requirement amounted to a taking. In 1982,
Nollan applied to the commission for a permit to demolish a beachfront bungalow and replace it with a larger house. The commission, which has a policy of increasing access to and along the beach, gave a conditional permit requiring that Nolan file a deed allowing public access to the beach between the average high tide line and the owner’s seawall. The case was taken to court on the basis that the commission’s condition amounted to the state taking a piece of their property without compensation.

The case finally ended up at the U.S. Supreme Court in 1987, where the majority (in a 5-4 decision) held that the commission’s condition amounted to a taking of property. The ruling was based on the point that the commission’s condition cannot be treated as an exercise of land use power since the condition does not serve public purposes related to the permit requirement. It was further found that although the state is free to advance its comprehensive program (beach access and use) by exercising its eminent domain power and paying for access agreements, it cannot compel coastal residents alone to contribute to the realization of that goal.