The Sensitivity of the Coastal Management Framework within Oregon to Climate Change and Variability

by

Elizabeth P. Arden

Research Report

Submitted to

Marine Resource Management Program
College of Oceanic & Atmospheric Sciences
Oregon State University
Corvallis, Oregon 97331

1998

in partial fulfillment of
the requirement for the
degree of

Master of Science

through the support of
Joint Institute for the Study of Atmospheres and Oceans (JISAO)
Climate Variability, Impacts, and Response Strategies Group
School of Marine Affairs
University of Washington

The Sensitivity of the Coastal Management Framework within Oregon to Climate Change and Variability

Abstract

A heightened awareness to climate phenomena such as the El Niño Southern Oscillation, Pacific Decadal Oscillation, and global warming has initiated much research concerning the impacts of climate change and variability on coastal resources. These events are perceived to exacerbate existing chronic natural hazards, including beach and dune erosion, sea cliff recession, bluff slumping and landslides, and coastal flooding. This paper presents an analysis of the third phase of an integrated study that aims to link the impacts of climate change and variability on coastal resources with an evaluation of the institutional arrangements for policy development and response. Through interviews with representatives at eleven federal, state, and local agencies within Oregon, the sensitivity of the coastal management framework to climate change and variability was evaluated in consideration of the existing range of policy responses and the extent of climate forecast utilization. Findings show that policies that provide for hazard assessment and response are inadequate and that managers are constrained by the numerous institutional and informational barriers, as well as by the conflicting pressures of multiple constituencies. The recognition of climate change and variability helps to build governmental processes that encompass a greater consensus and acknowledgement of climate issues. However, development of policies to respond directly to climate change and variability is generally absent, due to the inherent uncertainty of climate change and the lack of convincing evidence about the impacts. The vulnerability of coastal resources corresponds to the degree of sensitivity within the management system governing those resources. When climate events exceed the management response capabilities, implying that adaptation is not possible, resources are at risk. The findings suggest that a management system designed with greater flexibility would more adequately allow for use of climate projections. This would facilitate consideration of mitigation and adaptation options that may promote sound development practices and reduce the risk to resources along the coast.

Table of Contents

List of Figures:

List of Tables:

List of Acronyms:

ACOE: Army Corps of Engineers

DLCD: Department of Land Conservation and Development

DOA: Department of Agriculture

DOGAMI: Department of Geology and Mineral Industries

DSL: Division of State Lands

EDD: Oregon Economic Development Department

EPA: Environmental Protection Agency

FEMA: Federal Emergency Management Agency

FPMS: Flood Plain Management Services

JISAO: Joint Institute for the Study of Atmospheres and Oceans

LCDPD: Lincoln County Department of Planning and Development

LCP: Local Comprehensive Plan

NFIP: National Flood Insurance Program

NOAA: National Oceanic and Atmospheric Administration

OCMP: Oregon Coastal Management Program

ODFW: Oregon Department of Fish and Wildlife

ODOT: Oregon Department of Transportation

OEM: Oregon Emergency Management

OPRD: Oregon Parks and Recreation Department

ORS: Oregon Revised Statutes

OWRD: Oregon Water Resources Department

PWG: Coastal Natural Hazards Policy Working Group

TCEM: Tillamook County Emergency Management Program

TBNEP: Tillamook Bay National Estuary Project

USGS: United States Geological Survey

Acknowledgements

I would like to thank my committee, Dr. Jan Auyong, Dr. Jim Good, and Paul Klarin for their helpful guidance in finalizing this report and their suggestions for perfecting my masters defense presentation. I also appreciate the invaluable information that Paul Klarin provided as a participant in the study. I would like to thank the entire JISAO Climate Impacts Group for providing me with the opportunity to conduct this assessment. I would especially like to acknowledge and thank my research counterpart in Washington, Zoe Johnson, with whom I worked and collaborated. I am indubitably grateful for having been a part of the PNW regional team and I wish them continued success. More importantly, support from my peers and professors within the Marine Resource Management Program made my whole graduate experience a pleasure. Jim Good helped me gain a priceless and extensive education and Laurie Jodice provided unwavering advice, assistance, and patience in the face of many moments of great challenges. My friends filled my two years in Oregon with unending distractions and detours that made the pathway towards obtaining a masters degree a great deal more fun.

I. Introduction

The consequences of recent climatic events within the Pacific Northwest (PNW) and beyond have initiated a great deal of research on the driving forces and impacts of climate change and variability. Records of climate from seasonal to millennial timescales indicate that the normal state of the physical environment is one of dynamic change (Johnson et al, 1998). Many of the most significant consequences of global climate change will be witnessed at regional and local scales (Gibbons, 1997). Though climate change will be manifested directly through changes to the hydrologic cycle, which is intertwined among various sectors of the PNW, the coastal zone will experience additional impacts from disruptions in the physical ocean environment. Among various climate phenomenon, the El Niño Southern Oscillation, the Pacific Decadal Oscillation, and global warming are three that exhibit a discernible influence on the coastal zone.

On seasonal to interannual time scales, the dominant climate driver in the PNW is the El Niño Southern Oscillation, an event that has potential to exert a direct influence on the coast by changing the tracks and intensities of storms and shifting the wave climate and energy (Battisti and Sarachik, 1995; Field, 1997). The ENSO signal and related impacts in the coastal zone are of particular interest not only as the dominant mode of interannual variability, but also as a potential proxy of how global climate change may impact coastal resources and processes on various regional and temporal scales (Field, 1997). It is still uncertain as to whether ENSO events are increasing in their intensity or

frequency as associated with global climate change and destabilization of the climate system, but it is now being considered a real possibility.

Extreme phases of the Pacific Decadal Oscillation will affect the Pacific Northwest with widespread changes in climate, resulting in a tendency for relatively warm and dry winter and springtime weather during the positive phases and relatively cool and wet conditions prevailing during the negative phases of the PDO (Mantua, 1998). These interdecadal modes of variability are observable in the primary effects of long-term variations in storm and wave intensity and in the secondary impacts of increased vulnerability of coastlines to flooding and erosion. These impacts may be exacerbated by ENSO events that can further induce bluff failures, cliff retreat, and dune recession on unstable and sensitive regions of the coast.

Implications of long term global climate change, with an ensuing rise in sea level, are also of concern regionally. The global sea level is currently estimated to be rising an average of approximately 5 mm/year, within a range of certainty of 2 - 9 mm/year (IPCC, 1995). Sea level is one of the principal determinants of shoreline position. Rising sea level tends to cause shoreline recession, except where this trend is offset by an influx of sediment (Leatherman, 1989). Although it is clear that in certain areas human modification has caused erosion, human interference cannot be considered a primary cause, since erosion also occurs on undeveloped and unmodified coasts. Therefore, the linkage between shore retreat and sea level rise may be considered causal in nature (Leatherman, 1989). Sea level changes will not have as immediate an effect on the Pacific Northwest due to the tectonic rise, but should still be an important consideration within coastal management.

II. National and Regional Assessments of Climate Change and Variability

National Assessment

To examine the implications of climate change for the United States, a national assessment is being conducted under the auspices of the United States Global Change Research Program (USGCRP), the federal interagency program established through the Global Change Research Act of 1990 (P.L. 101-606). In cooperation with the Office of Science and Technology Policy (OSTP), the program aims to undertake scientific assessments to identify and analyze the consequences of climate change on the people, the environment, and the economy. By engaging in a comprehensive planning effort, including regional workshops, National Forums, and extensive discussions among federal agencies and science and stakeholder communities, the program will provide the information link that is needed to increase resilience to climate change and variability (USGCRP, 1998). The overall assessment effort will result in three classes of products: a National Synthesis Report, 5 Sectoral Studies, and a set of Regional Studies and Analyses. The National Synthesis Report will draw together the results of regional and sectoral analyses, studies, and workshops combined with additional quantitative analysis. In order to facilitate synthesis and ensure a sufficient commonness of purpose, a standard set of scenarios for climate change is being used (NAST, 1998). The report is targeted at those who make policy decisions within both the public and private sectors and the primary audience is the Administration and Congress (NAST, 1998).

The other two classes of products that will result must be able to stand on their own merits, but contribute to the overall report. Each sectoral team will be composed of both public and private participants. The papers that are prepared will communicate more in-depth study on critical issues affecting the country as a whole and shall be part of scientific, peer-reviewed literature (NAST, 1998). In addition, regional analyses will be prepared using stakeholder interactions, region specific projections, and the common set of scenarios projected through the National Assessment.

Joint Institute for the Study of Atmospheres and Oceans (JISAO) Regional Assessment

One of the leaders in the regional analyses has been the Joint Institute for the Study of Atmospheres and Oceans (JISAO) and the School of Marine Affairs (SMA) Climate Variability, Impacts, and Response Strategies Group. JISAO recognized that while there has been a great deal of research focusing on the impacts of climate change and variability, there has been little attempt to couple this research with an evaluation of the institutional arrangements for policy development and response (Johnson et al, 1998). To address the issue of using climate change and variability information within the management framework, JISAO has undertaken a three part integrated assessment that aims to "work through the causal chain from climate dynamics to climate impacts to policy response strategies" (Miles, 1995). Through a three step process, the group more specifically aims to provide 1) an analysis of climate variability and change signals in the Pacific Northwest 2) an identification of the potential impacts of the dominant climate signals on natural and man-made resources (Field, 1997; Lettenmaier, 1997; Francis, 1997; Franklin, 1997) and 3) the comprehensive evaluation of the institutional arrangements for policy development and response among the different sectors within the PNW (Callahan, B., E. Miles, and D. Fluharty, 1998).

JISAO's research design examines the physical, biogeochemical, and social dimensions of the region and considers the three as components within a reciprocal cause-and-effect relationship (See Figure 1). Various spatial realms are considered depending on the particular sectors within the Pacific Northwest that were chosen for the study. Thus far, the integrated assessment has incorporated five sectoral components, including hydrology, aquatic ecosystems, forests and rangelands, fishery resources, and coastal activities, and will soon include the components of agriculture and grazing lands, human health and welfare, energy production and use, and urban centers. Time factors are based on the identified climate phenomena and their seasonal, inter-annual, decadal and inter-decadal timescales.

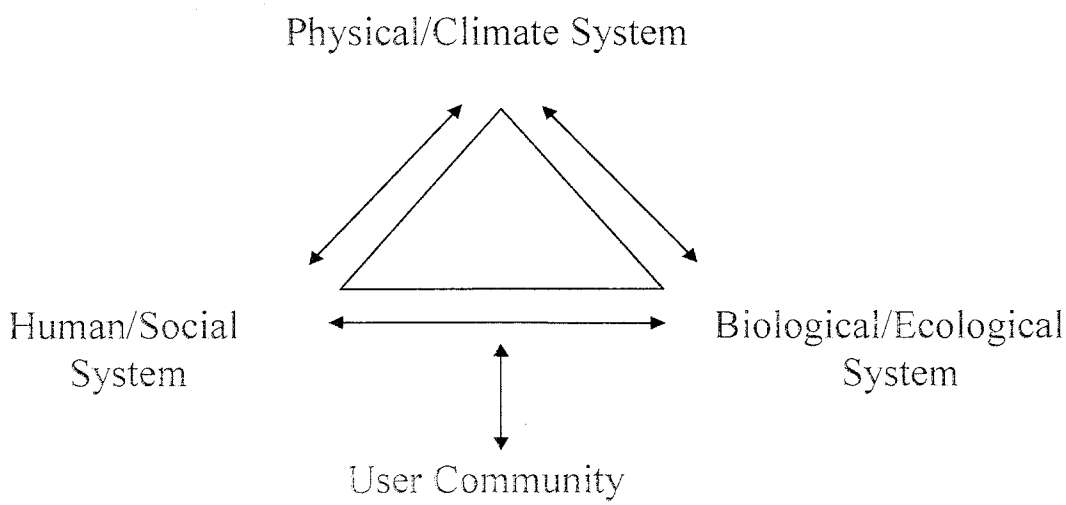

Figure 1. JISAO's Research Design

Because vulnerability to climate change and variability is a function of both natural factors and anthropogenic stressors, the user community is also considered as a variable in the feedback loop. Figure 2 illustrates how climate information and forecasting can be used as an application within existing management frameworks to affect decision-making among various sectors in the Pacific Northwest.

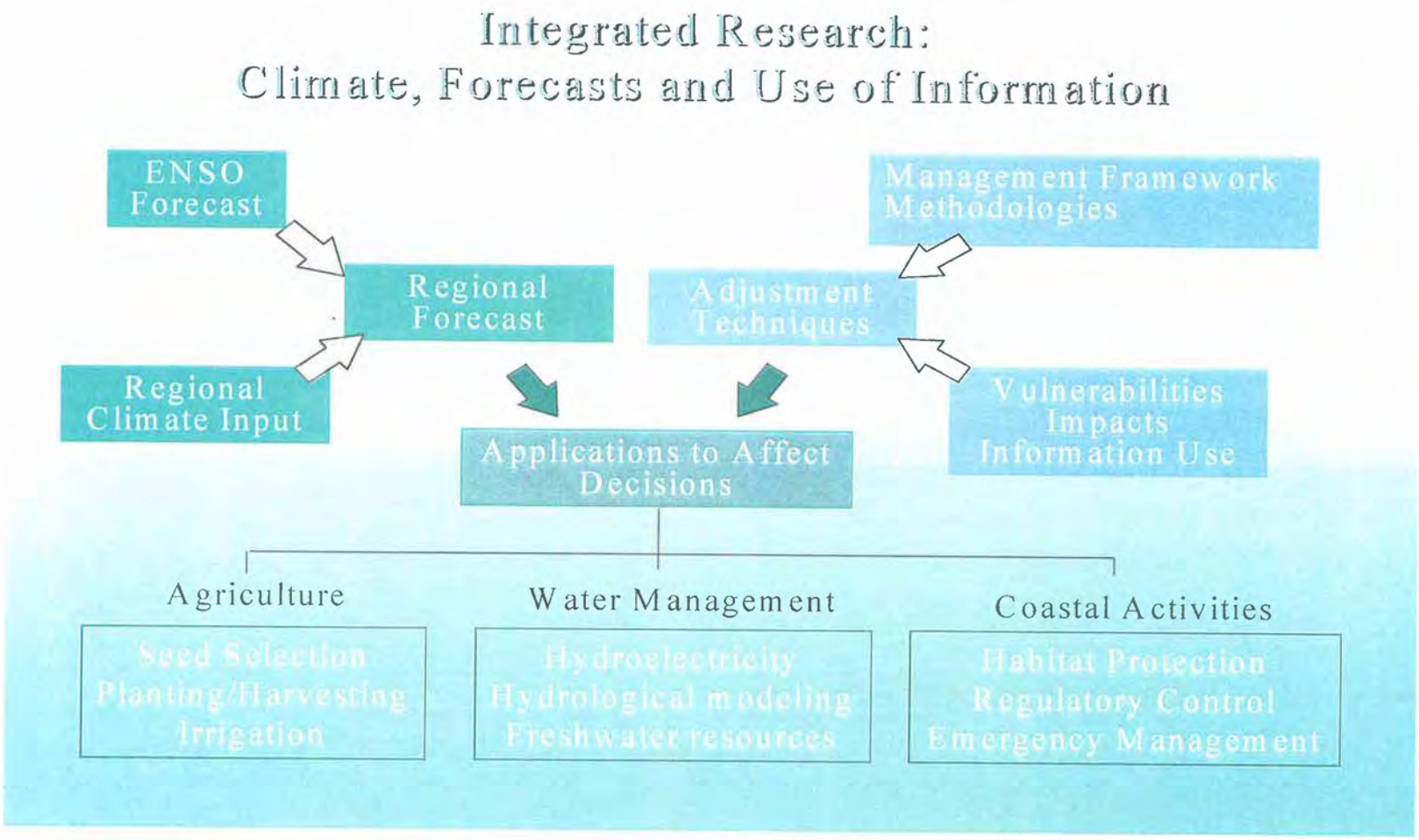

Figure 2. The use of climate information as an application in management decisions.

The Coastal Sector Analysis

Phase one of JISAO's Integrated Assessment, the analysis of climte variability and change signals, was completed in 1997. Mantua (1997) examined the trends in air temperature, precipitation and water year flow deviations and demonstrated their correlation with the El Niño and Pacific Decadal Oscillation indices. In fulfillment of phase two of the coastal sector analysis, a comprehensive literature review was conducted to identify the major climate related impacts on coastal resources in the Pacific Northwest (Waldeck and Hershman, 1996). As a result of the study, the South Puget Sound, the Southwest Washington and Oregon Coasts, and Willapa Bay were chosen as case study areas for further evaluation. Field and Hershman (1997) provided a detailed identification of the impacts to these areas from current modes of climate variability and long term impacts associated with climate change.

The paper presented here builds directly from the research conducted by Waldeck, Field and Hershman. This report offers an analysis of the third phase of the JISAO Integrated Assessment, the comprehensive evaluation of the institutional arrangements for policy development and response, and focuses on the Oregon coastal sector. More specifically, the paper presents the current incorporation of policy options that address climate change and variability and the potential use of climate forecasting within the organizational structure. The Washington coastal activities sectoral analysis can be found in a separate document (Johnson et al., 1998).

The research described here was based on a series of interviews with representatives from eleven federal, state, and local agencies with coastal management responsibilities and authority over the issues that stem from climate change and variability. A modification of JISAO's standardized interview questions was used for the coastal sector analysis and can be found in Appendix A. Because the realm of climate impacts to coastal resources is so large, we narrowed the focus to two issue areas: coastal erosion and flooding. These subjects were chosen because they have such widespread effects along the coastlines of both Oregon and Washington and are representative of the major climate change and variability impacts.

This paper continues with an overview of the basic coastal setting within Oregon, with emphasis on the impacts derived from chronic and episodic coastal hazards. Chapter three and four focus on the framework for managing these coastal resources and include the organizational structure and the major roles, responsibilities, and legislative authorities of the key institutions participating in the analysis. The primary issues related to hazards management and the patterns of communication and coordination among agencies is examined in Chapter five. The final section of the paper is devoted to an analysis of the present findings on climate change and variability with particular focus on the knowledge of climate dynamics and its influence on management decisions. The current and potential use of climate forecasts and the extent to which changes are required to create a pathway for continuous feedback between climate diagnosticians and the user community are also evaluated. Through this analysis, it is then possible to evaluate the capacity of the institutions to adapt to climate variability and change and to assess the vulnerability of coastal resources given the management response. I conclude with some final recommendations on how policy-makers and implementers can increase the level of sensitivity to climate change and variability factors.

III. Oregon's Coastal Setting

Coastal Environment

Many types of chronic natural hazards including beach and dune erosion, sea cliff recession, bluff slumping and landslides, and coastal flooding have continually threatened development along Oregon's shore. There are a number of factors which contribute to the stability of the shoreline, including precipitation, wind, waves, nearshore currents, and runoff. The tectonic setting is an important factor in limiting the influence of these parameters on erosion. The coast of Oregon is part of a convergent continental margin where plate tectonics has caused the collision of two major plates, the oceanic Juan de Fuca Plate which is moving eastward and sliding beneath the continental North American Plate (Sayre and Komar, 1988). The result is long term uplift of the Oregon coast. Figure 3 illustrates that tectonic uplift has exceeded the global rise in sea level over much of the coast, including the far northern and southern portions. However, along the north central portion of the coast, the rise in sea level has exceeded the land level rise and in areas such as Lincoln County, there is a corresponding intensity of seacliff erosion (Komar, 1992).

Coastal erosion in Oregon is seasonal and highly episodic with cyclical periods of accretion and erosion. Dune-backed shorelines have relatively stable long term positions although a combination of high waves, strong tides, rain, winds, and previous sliding and recession episodes can result in severe erosion events (DLCD, 1997). Although erosion on the coastal sandspits has been dramatic and the focus of much of past research, the long-term and progressive erosion of sea cliffs may account for greater property losses, because most communities along the coast have been built on marine terraces or on alluvial slopes emanating from the nearby Coast Range (Komar and Shih, 1991). Therefore, bluff retreat, although occurring on an episodic or infrequent basis, affects more citizens and property.

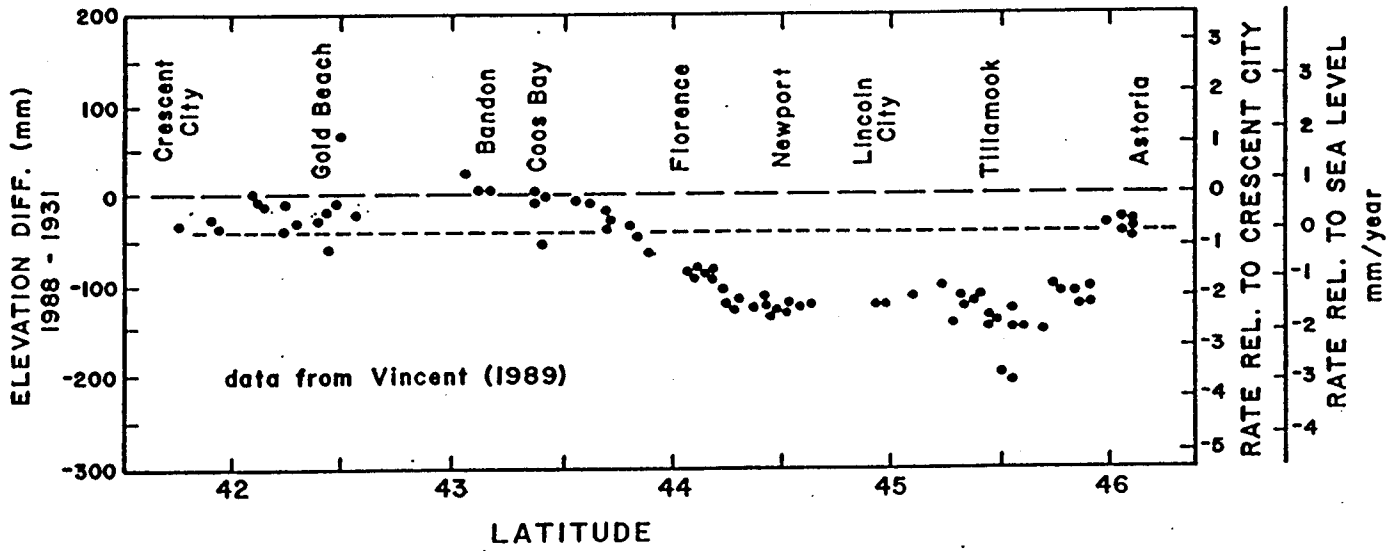

Figure 3. Elevation changes and their relationship to sea level rise along the length of the Oregon coast from Crescent City, California north to Astoria, Oregon based on geodetic surveys along the coast [From Komar and Shih, 1993 (after Vincent, 1989)].

There is considerable spatial and temporal variability in cliff retreat along the coast as a result of its tectonic setting, as well as local beach processes (Komar and Shih, 1993). The extent of sea cliff erosion and associated landsliding is accounted for by a multitude of factors. The most common factors are diagrammed in Figure 4. The material composition and structure, including horizontal or seaward dipping stratification, joints and faults are important in determining whether large scale landsliding or more continuous failure of small portions of the cliff face will occur (Komar, 1997).

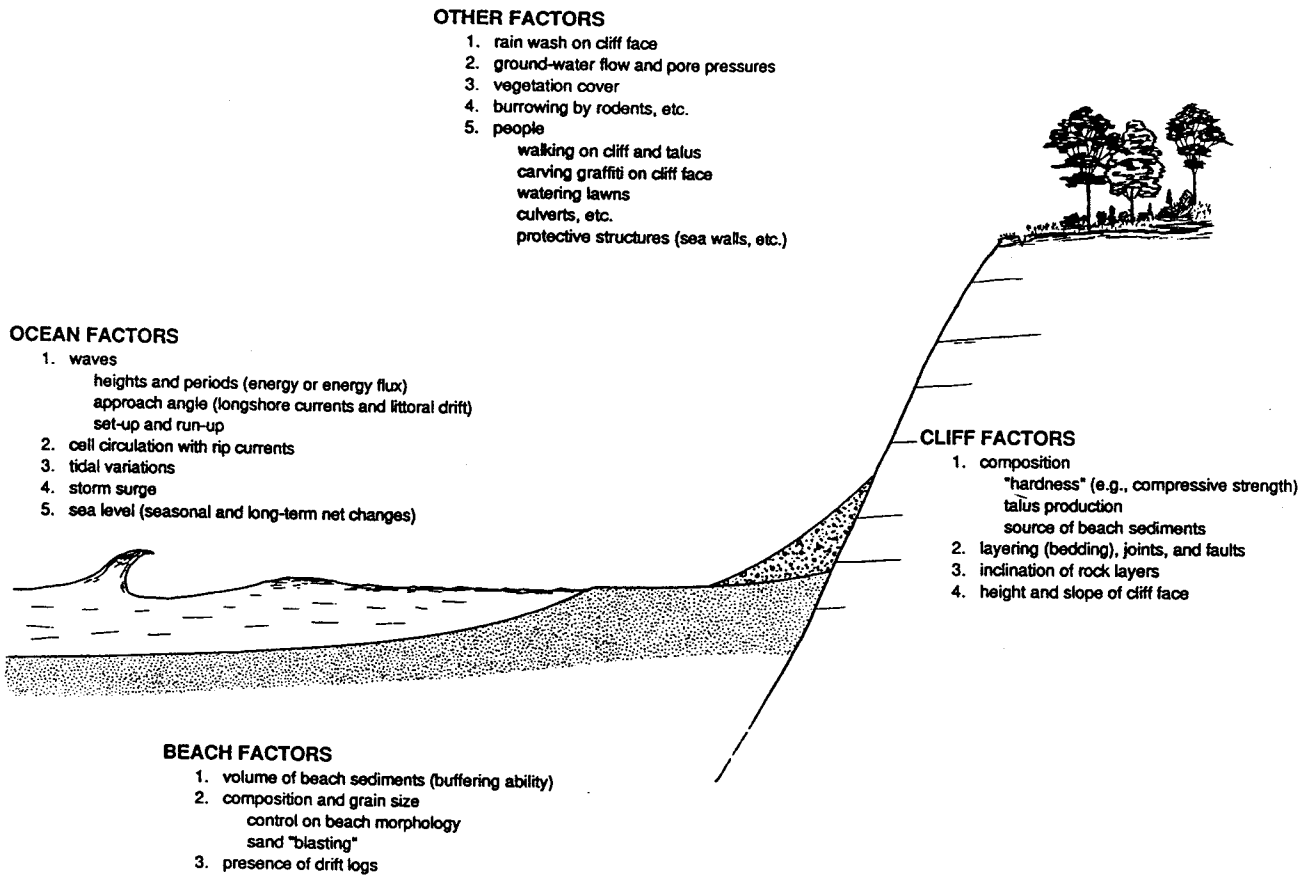

Figure 4. The many factors and processes involved in sea-cliff erosion.

Second order factors that control cliff retreat are related to the buffering capacity of the beach and the annual cycles in beach morphology. Sand volume and sediment coarseness, which vary from one littoral cell to another, determine the ability of the beach to act as a buffer between seacliffs and the physical processes of waves and near shore currents (Komar, 1992). The coarseness of the sediment also reflects bottom topography and the local intensity of turbulence and wave-energy dissipation, with the largest particles generally located in the zone of most intense wave breaking (Komar, 1997). Coarse-grained "reflective" beaches undergo a larger degree of cross-shore sediment transport than finer-grained "dissipative" beaches, denoting them as weaker buffers from wave attack. In addition, rip-current embayments, which ultimately determine where wave swash can reach the cliff, cut deeper into reflective beaches.

Tides, storm events, the type of wave propagation, and human alterations all control the elevation of wave swash run-up and may contribute to localized erosion and inundation. When the atmosphere is dominated by low pressure systems, severe storms causing heavy rains, high velocity winds, and high waves may hit the coast and cause localized areas of flooding and erosion. Winter storms generate significant wave breakers with heights measuring over 7 meters producing frequent episodes of erosion (Sayre and Komar, 1988).

Climate change and variability factors increase the risks to coastal hazards. The natural processes involved in beach erosion were displayed at much greater intensities during the 1982-83 El Niño. The generation of sea-level variations, which took the form of a large wave, propagated along the coast and raised sea levels about 35 centimeters above the average winter level (Komar, 1992). Large storm waves struck the Oregon coast at the same time as maximum sea levels and resulted in a significant cutback along the beaches. Due to the southwesterly direction of the waves, sand erosion was experienced at the south end of each pocket beach and deposited at the north. Many of the erosion problems continued even after the direct processes of the 82-83 El Niño had ceased and resulted in loss of parklands and property, particularly on the Alsea and Netarts spits on the central-Oregon coast (Komar, et al, 1988; Komar, 1986).

Long term global warming trends are expected to put the low-lying cities of Oregon, where land uplift is minimal, at great risk to rising sea levels. Combining the effects of

sea level rise with changes in precipitation patterns or the effects of El Niños, will likely increase the vulnerability of these areas to flooding and inundation.

The state experienced the worst flood disaster in over 25 years during the winter of 1996. Six of the seven coastal counties were declared major disaster areas as a result of a combination of unseasonably cold weather and heavy snowfall followed by unusually warm temperatures and record rainfalls, which thawed mountain snowpacks and flooded streams. Extensive earth movement in the form of landslides, mudslides, streambank erosion, washouts, and massive sediment transport resulted in damages exceeding several hundred million dollars (DLCD, 1997).

The extent of damage highlights the need to better assess and mitigate these hazards. Existing policies include provisions for hazard assessment, land use planning and regulation, and shore protection, however governments are faced with managing a number of conflicting resource uses and balancing the needs of various constituencies. Increased growth pressures, redevelopment of the shoreline to higher intensity uses, private property rights litigation and governmental liability, and structural solutions to mitigate chronic hazards all contribute to a shoreline managed with various degrees of success. In combination with consideration of these factors lies the additional necessity to recognize the complexities of climate variability and change and how to incorporate the information into management responses. Despite the uncertainties of the magnitude of change, there is sufficient evidence that climate variability and climate change have very real and significant impacts on coastal systems of the Pacific Northwest (Field, 1997) and is deemed worthy of consideration.

In the next section I will explain the framework for managing the resources within the coastal zone, with particular emphasis on the hazards policies that are both contributing to and hindering effective coastal management.

Coastal Management Framework

In response to public concern over rapid growth and development that was threatening to intrude on the quality of life and resources within Oregon, the Legislature adopted a series of laws to help shape development on the coast and throughout the state. Oregon's Coastal Management Program (OCMP), approved in 1977 by the U.S. Department of Commerce under the authority of the Federal Coastal Zone Management Act of 1972, combines the key components of these laws into a coordinated program for managing coastal resources and waters. The Oregon coastal zone consists of 362 miles of coastline and encompasses 7800 square miles of land area, including the coastal watersheds (See Figure 5).

The program for managing the coastal zone consists of three major components: the planning authorities administered under ORS 197, which sets planning requirements for all levels of government through a series of Statewide Planning Goals; the planning authorities of cities and counties in adopting and implementing comprehensive plans and zoning ordinances under ORS 215, 221, 227, and 197; and several special-purpose statewide statutes for management, such as the Beach Bill (ORS 390.605 - 390.770)), the Removal-Fill Law (ORS 196.800 - 196.990), and Senate Bill 100 (mandating statewide land use planning). Administrative Rules were adopted to interpret most of the Goals and parts of the land use planning laws (OAR 660.01 – 660.35).

By setting standards for management of land and water uses, establishing priorities for the use of various resources, and defining informational needs and inventory requirements for sound planning, the Statewide Planning Goals form the foundation of compliance with the requirements of the Coastal Zone Management Act (DLCD, 1996a). State agencies participate in local comprehensive plan development, review, and amendments, and are therefore able to assure that the necessary technical information and state needs and interests are incorporated. The local plans have three parts: a factual base, plan policies and designations, and implementing measures. The factual base is the information from which plan decisions are made, including inventories of lands and resources and developments in the planning area, an analysis of the local economy, projections of future population growth and demands for residential, industrial and

industrial and commercial land. Ultimate local authority for planning and zoning decisions rests with local elected officials, however, most daily administration is done by local planning commissions and their staffs.

To insure that state actions comply with the planning goals and are compatible with local plans, state agencies are required to adopt coordination programs (OAR 660-30), which outline agency plans, programs and actions affecting land use, and adopt the State Permit Compliance and Compatibility Rule (OAR 660-31), which addresses permit decisions. These programs also set forth opportunities for local governments to participate in agency decisions and describe how the agency will provide technical assistance to local governments for comprehensive planning.

Figure 5. Oregon's coastal zone - prescribed by law to encompass the area west of the crest of the Coast Range out to the three mile limit of the territorial sea (picture taken from the Department of Land Conservation and Development homepage).

Hazards Policy

Section 303(2)(B) of the Coastal Zone Management Act identifies hazards as a national concern needing to be addressed by state coastal management programs. More specifically it addresses the need for, "the management of coastal development to minimize loss of life and property caused by improper development in flood prone, storm surge, geologic hazard, and erosion prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and salt water intrusion and by the destruction of natural protective features, such as beaches, dunes, wetlands, and barrier islands."

Oregon addresses hazards through Goals 7 (Natural Hazards), 16 (Estuarine Resources), 17 (Coastal Shorelands), and 18 (Beaches and Dunes) which includes several requirements for protection of life and property from natural hazards and disasters, both independently and as they are implemented through local plans and ordinances. The goals mandate specifications that either prohibit development in areas subject to erosion or regulate development to minimize erosion. More specifically Goal 7 mandates:

- Development in areas of known natural disasters or hazards to be prohibited unless adequate safeguards are provided to protect development.
- Comprehensive plans to be based on an identification of areas of known natural disasters and hazards, including areas of flooding, groundwater, erosion and deposition, landslides, earthquakes, weak foundations, soils, and other hazards unique to local or regional areas.
- Local ordinances to typically require developers to provide detailed engineering studies that show how property in potentially hazardous areas can be safely developed. The Land Conservation and Development Commission has interpreted appropriate safeguards to mean measures adequate to protect proposed development from identified hazards for the life of the structure (DLCD, 1996b).

Goal 16, 17, and 18 recognizes and requires protection of the natural protective features of wetlands, shorelands, and beaches and dunes. More specifically:

- Goal 16 requires the protection of virtually all estuarine wetlands from filling that are not demonstrated to be needed for a water-dependent use.
- Goal 17 requires that riparian vegetation, which plays an important part in erosion control, be maintained and enhanced.
- Goal 18 prohibits development of foredunes that are subject to ocean flooding or wave overtoping and requires protection of groundwater from drawdown that would lead to loss of stabilizing vegetation.

A majority of the Oregon dunes are also afforded protection by being held in public ownership, either as state parks or part of the Oregon Dunes National Recreation Area. In addition, undeveloped dunes that remain in private ownership are partially protected by requirements that limit development outside of Urban Growth Boundaries.

The installation of shore protection structures (SPSs) along the oceanfront is regulated through a joint permit program administered through the Oregon Parks and Recreation Department (OPRD) and the Division of State Lands (DSL) which have regulatory authority under the Beach Law and the Removal-Fill Law, respectively. The statewide planning goals also emphasize a preference for nonstructural solutions and require adverse effects of erosion control structures to be minimized. Goal 18 specifies that permits for beachfront protective structures be issued only where developments existed on January 1, 1977. The objective of the goal is to minimize the developments that would otherwise occur on unstable regions of the coast, by prohibiting landowners from relying on structural solutions. However, in effect, the policy does little to achieve its goals because of the lack of measures that facilitate implementation. There is currently little to no mapping of the developed versus undeveloped areas and therefore no awareness of where SPS's will not be allowed. Thus, building in "undeveloped" areas continues to occur.

Other hazards management problems stem from developments that are pre-existing in flood and hazard prone areas and from the loopholes and gaps in policy that allow for exemptions to be made and consequent building to occur on unstable areas. Infill

development areas are committed and zoned for development because of the supporting infrastructure. Geotechnical site reports are based on variable standards and are not subject to quality assurance measures. Setback standards based on either county, city or consultant guidelines have proven ineffective (Good, 1994). Local officials often must make decisions with competing objectives, for example, facilitating growth while at the same time protecting life, property, and natural resources. With weak geotechnical reports and sufficient political and economic support, developments are built on marginally stable bluffs and dunes. The results can be devastating and costly.

Sayre and Komar (1988) documented the damages that were incurred to the developments that were constructed on the Jump-Off Joe bluff in Lincoln City. In 1975, an inventory of geological hazards along the Lincoln County coastline concluded that such active landslides should remain undeveloped. However registered geologists and engineers determined that the site was stable even though it was adjacent to an active landslide and in an area where the rate of erosion was greatest along the Oregon coast (Sayre and Komar, 1988). In 1982, construction of a condominium began on the bluff. Within 3 years a slump developed causing the foundation to fail and the city ordered the demolition of the unfinished structures. Numerous parties to the development went bankrupt and the geologist lost his certification. When damages are incurred, however, it does much to ultimately reinforce public support for tighter controls on development, as will be noted in the section addressing principal issues later in the paper.

As a result of the 309 Assessment and Strategies Program as part of the amended Federal Coastal Zone Management Act, DLCD determined that coastal hazards was one of two "high priority enhancement" areas of the OCMP, because significant management problems exist (DLCD, 1996c). The five year improvement strategy focused on hazard policy, assessment, mitigation, and education and formulated ways to initiate changes in the local comprehensive plans addressing coastal hazards, through plan amendments or periodic review.

The Coastal Natural Hazards Policy Working Group (PWG), which was initiated by participants at a coastal hazards conference and organized through Oregon Sea Grant and the Department of Land Conservation and Development, was the primary group responsible for leading the Coastal Hazards Policy Improvement Strategy. The 20

member group evaluated natural hazards policy effectiveness on the Oregon coast and provided recommendations to facilitate management (Good, 1994). The Group consisted of scientists, local officials, state and federal agencies, property owners, environmental organizations, realtors, and the public.

Although they had no formal mandate, they defined their mission as "identifying important coastal natural hazard issues, evaluating existing management strategies, examining alternatives, and recommending and supporting needed policy improvements to decision-makers at all levels." (CNHPWG, 1994). In their report, the PWG identified 23 issues and developed 79 specific recommendations relating to hazard assessment and information access, beach and shore protection procedures, land use planning, governmental coordination, and fiscal responsibilities, and earthquake and tsunami disaster preparedness and response. Since that time, several recommendations have been implemented by state or local agencies, particularly in the area of beach and shore protection (Good, 1996). Moreover, based on the recommendations, two bills out of the twelve that were introduced into the 1995 state legislative session passed. One mandated tsunami disaster preparedness and the other required siting limitations in tsunami inundation areas.

Federal, State, and Local Coastal Management Authorities within Oregon

By the nature of the mandates, several federal, state, and local agencies have strong ties to programs associated with hazards. Figure 6 presents the basic management framework highlighting those authorities that are required to consider natural hazards in their resource planning and decision making process. Table 1 lists the functions of those agencies and the primary legislative authorities that mandate their actions.

The federal government gets involved in land use management indirectly through provisions of the National Flood Insurance Program (NFIP), administered by local governments through the Federal Emergency Management Agency (FEMA). NFIP provides federally subsidized insurance for damage to structures by storms in certain qualifying areas. Coverage is available both for the structure itself and for the contents. Participating communities are required to adopt certain minimum floodplain management

standards based on FEMA's delineations of flood hazards and base flood elevations. Additional standards are imposed for high hazard coastal zones (velocity zones), including the requirement that buildings must be elevated on pilings, all new development must be landward of mean high water, that the base flood elevation include potential wave heights, and that new development must not damage dunes or dune vegetation (Beatley, 1994). Program participation is not mandatory, but strong incentives exist. Under the 1973 Flood Disaster Protection Act, federally backed or federally insured and regulated financial institution mortgages mandate flood insurance. Local governments not participating in the program will be unable to obtain disaster assistance grants. However, individual property owners are still able to obtain grants. Due to participation in the program, the NFIP is the second largest financial obligation at the federal level. It is estimated that more than 70% of the NFIP policyholders are located in coastal communities, with many located in the most hazardous locations and 68% of the claims and funds paid out have been for damages occurring there (Beatley, 1994).

Improvements to the program include Section 1362 Flooded Properties Purchase Program, in which FEMA offers to buy out owners of damaged property, plus the value of the land. To be eligible, the property must have federal flood insurance and meet a certain damage criteria. In addition, there must be community participation, an ability to accept the land, and a plan for its use ensuring no development in the future. As a result of the National Flood Insurance Reform Act of 1994 (NFIRA), FEMA must list all communities that are likely to be identified as having erosion hazard areas, estimate the amount of flood insurance claims that are attributable to erosion, and assess the full economic impact of erosion on the National Flood Insurance Fund (FEMA, 1998). Nonetheless, flood provisions are less likely to be applied in Oregon due to most erosion-related property loss being in bluff-top areas where residents do not have flood insurance.

The Federal Disaster assistance framework was modified in 1988 when the Stafford Disaster Relief and Emergency Assistance Act was passed, which provided greater

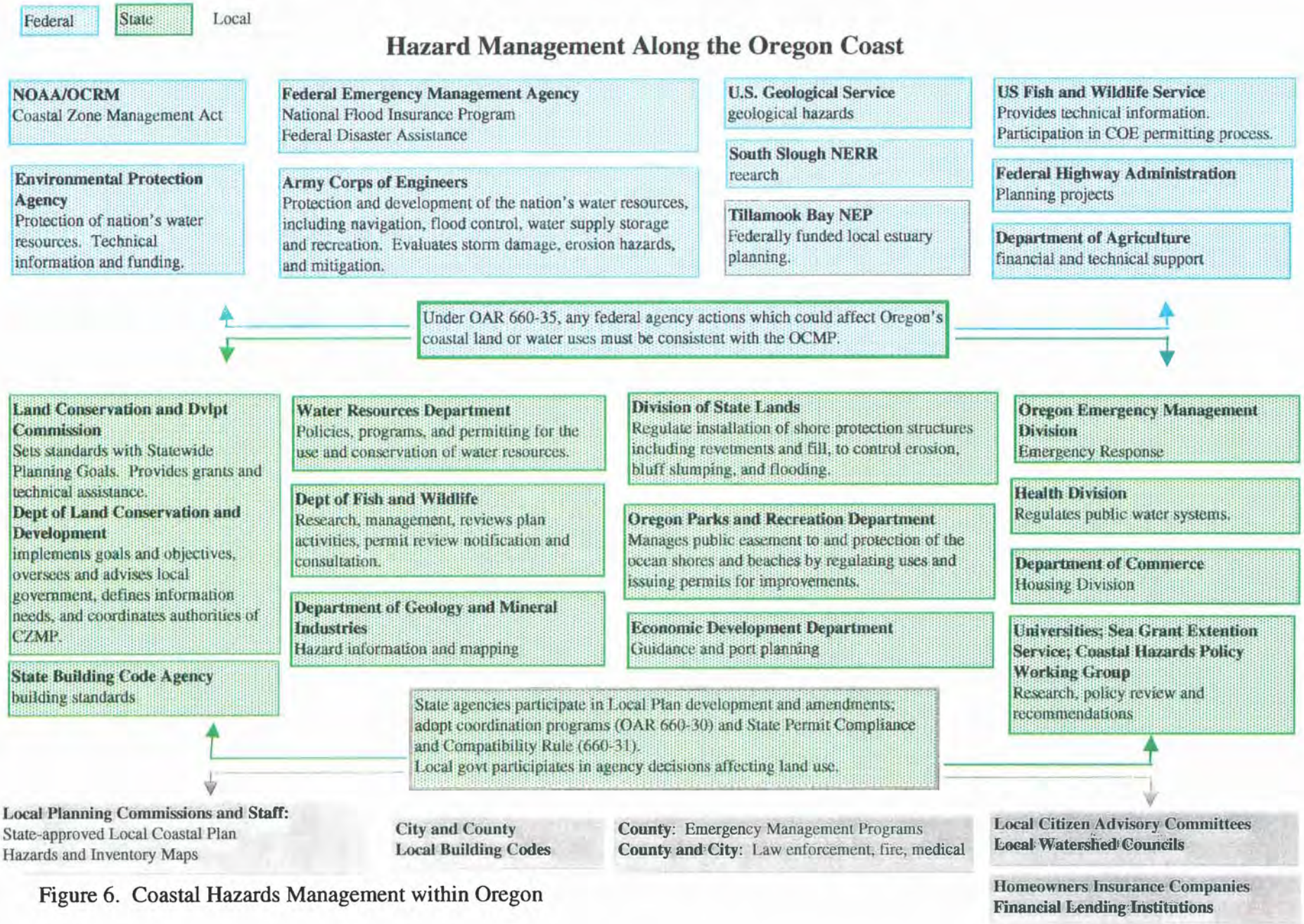

Figure 6. Coastal Hazards Management within Oregon

Table 1. Summary of functions and legislative authorities dealing with hazards (modified from Good, 1994)

Planning and Site Development	
Local	City/County planning offices: State-approved LCP planning requirements and local subdivision, zoning, and flood damage prevention ordinances
State	DLCD: statewide planning standards (Goal 7, 17, 18); Other State Agencies: legislation appurtenant to the resources they are charged with managing
Federal	FEMA: NFIP, Stafford Disaster Relief and Emergency Assistance Act
Design and building codes and standards	
Local	City and County: local building code administration
State	State Building Code Agency: building standards
Federal	FEMA: coastal and flood construction standards
Shore protection	
Local	LCP and development ordinances
State	OPRD: Beach Law (ORS) DSL: Removal/Fill Law (ORS)
Federal	ACOE: Clean Water Act (Section 404), Rivers and Harbors Act (Section 9,10), Nationwide Permit #13
Emergency planning and response	
Local	County: Emergency management County and City: law enforcement, fire, medical
State	OEM: disaster response and planning
Federal	FEMA: Flood Disaster Protection Act; Flood Disaster Relief Act
Research, technical information, and mapping	
Local	LCP: hazards inventory and maps
State	DOGAMI: hazards information and mapping DLCD: inventory standards
Federal	USGS: geological hazards FEMA: flood and erosion hazards ACOE: erosion hazards Universities/Sea Grant: research

emphasis and financial support for mitigation activities under either individual and family assistance or public assistance. Under the program, grants of aid can be made to individuals to cover disaster-related expenses and repairs not covered through insurance.

State and communities, who are participating in the NFIP, can receive grants at a cost share basis to cover damages to public facilities. However, because the state or local community is not required to cover the majority of the damages, there is little incentive for them to plan with mitigation in mind. In order to compensate, the Stafford Act also created the Section 404 and 406 Hazard Mitigation Grant Program, which provides federal matching funds for state and local mitigation projects tied to disaster declarations.

Recently a strategy has been developed to eliminate or reduce the impacts of natural hazards through a National Mitigation Strategy, which includes the participation of government agencies, private institutions and associations, and the natural and technological hazards community. Through hazards identification and risk assessment, applied research and transferal of information, incentives and resources, and leadership and coordination, the strategy supports moving toward an approach that converts future losses into present mitigation investments (FEMA, 1996).

Other federal programs and policies which influence and subsidize developments in coastal areas are included within the Department of Housing and Urban Development which provides home loans, and the Department of Transportation which provides extensive funding for the construction of highways, roads and bridges, and other infrastructure serving coastal areas. Coastal development subsidies also come in the form of tax expenditures and deductions, such as interest and property tax deductions for second homes. Subsidies are also provided in the form of funding and technical assistance from other federal and state agencies for flood control and oceanfront property protection.

A description of other federal, state, and local agencies with authority over the issues of erosion and flooding will be provided in the following section describing those agencies that participated in the study.

IV. Participating Agencies within the Oregon Coastal Sector Analysis

The influence of climate change and variability factors, as well as the extent and potential of climate forecast utility, were examined through interviews with key authorities that were identified as having significant influence over issues that stem from climate change and variability impacts. The eleven agencies that were interviewed represent a broad range of authorities that have various roles and responsibilities associated with erosion and flooding. The extent to which the major tasks of each agency are categorized as regulatory, advisory, policy setting, operational, resource management, or emergency response, is listed in Table 2. The listing demonstrates the complexity of obligations and the extent of overlapping authorities of each agency in managing the resources of the coastal zone.

Table 2. Roles of participating agencies.

Agency	Issue*	Regulatory	Advisory	Policy Setting	Operational	Resource Management	Emergency Response
ACOE	F	x	x		x		x
TBNEP	F					x	
DLCD	E, F		x	x		x	
DSL	E, F	x	x	x	x	x	x
OPRD	E	x	x	x	x	x	x
OWRD	F	x	x	x	x	x	x
DOGAMI	E	x	x	x	x		x
OEM	E, F					x	x
EDD	E, F		x	x			
TCEM	E, F						x
LCDPD	E, F	x		x			

* E - erosion F - flooding

ACOE: Army Corp of Engineers

TBNEP: Tillamook Bay National Estuary Project

DSL: Division of State Lands

OPRD: Oregon Parks and Recreation Department

OWRD: Oregon Water Resources Department

DLCD: Department of Land Conservation and Development

DOGAMI: Oregon Dept of Geology and Mineral Industries

OEM: Oregon Emergency Management

EDD: Economic Development Department

TCEM: Tillamook County Emergency Management

LCDPD: Lincoln County Department of Planning & Devlpt

Federal Government

U.S. Army Corps of Engineers

The US Army Corps of Engineers (ACOE) has had a long and direct involvement in coastal development through section 10 of the Rivers and Harbors Act of 1899 and section 404 of the Clean Water Act. The ACOE has been assigned the responsibility for protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation (ACOE, 1989). The waters of the US that are subject to Corps authority include the territorial seas, the navigable coastal and inland waters, interstate waters, wetlands, and isolated wetland and lakes. The Corps is charged with protecting our nation's harbors and navigation channels from destruction and encroachments, and with restoring and maintaining environmental quality. This is accomplished by regulating activities that include the discharge of dredge and fill material in coastal and inland waters and wetlands, the construction and dredging in navigable waters of the US, and transport of dredged material for dumping into ocean waters under Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972.

Activities requiring a permit may include the construction of structures such as shore protective structures, groins, breakwaters, levees, dams, dikes, piers, wharves, and ramps; placement of fill such as riprap and building site fills; the placement of wires and cables over or under the water; dredging, excavation and the depositing of fill and dredged material; and the transport of dredged material for dumping in the ocean. The permit program seeks to insure that our nation's water resources and wetlands are used in the best interest of the public, including environmental, cultural and other public interest concerns (ACOE, 1989). Other statutes which affect Corps regulatory policy are the National Environmental Policy Act of 1969, the Coastal Zone Management Act of 1972, the Endangered Species Act of 1973, the Fish and Wildlife Act of 1956, and the National Historic Preservation Act of 1966.

The Portland District encompasses nearly 97,000 square miles of land and water in Oregon and southwest Washington. Conflicts among competing uses of water are likely to grow more prevalent and the Corps must find ways of balancing the needs of all. To

protect the environment, the District regulates work in water and fragile wetland areas along waterways and control water released from the dams to protect natural habitats during periods of fluctuating flows. The Corp's Emergency Operations and Water Management Division is also held responsible for evaluating flood control, storm damage, and mitigation projects. The flood storage projects have prevented an estimate of $15.8 billion in flood damages.

The objective of the Flood Plain Management Services (FPMS) Program within the Reservoir Regulation and Water Quality Section is to support comprehensive flood plain management planning with technical services and planning guidance at all appropriate government levels, to encourage and guide them toward prudent use of the Nation's flood plains for the benefit of the national economy and welfare (ACOE, 1997). Recently the Corps has made attempts at combining the purposes of flood damage reduction with environmental restoration in order to minimize damages within and to the floodplains.

The Portland District issued a new nationwide permit for "bank stabilization" (NWP 13), with regional conditions for Oregon, which replaced a similar 1986 regional permit. NWP 13 removes the Corps from the majority of day-to-day shore protection decision making. Coordination among other agencies and organizations is not restricted as much by level as it is by purpose. Because many Corps projects are performed on a cost-share basis and are restricted to non-federal entities, it is necessary to have state, county, local city, or diking district participation in the implementation process (Mason, pers com). From a planning standpoint, individual entities must first work through their Congressional delegation in order to receive Corps funding and services. Emergency response happens more instantaneously, with the planning stages expedited or dropped out completely in times of perceived need. Individuals become involved with the Corps only through statutory regulations, including the permit process.

Climate change and variability may factor into the Corps role when higher intensity storms warrant greater need for mitigation projects and flood response. However, because of the uncertainty of sea level rise, the Corps relies primarily on historic sea levels within their overall strategy, particularly in evaluations of proposed projects.

Tillamook Bay National Estuary Project

The National Estuary Project (NEP) is a local estuary planning effort funded by the Environmental Protection Agency. Two exist in Oregon: the Lower Columbia River NEP and the Tillamook Bay NEP (TBNEP). The TBNEP has been set up in Oregon to provide a community-based identification of priority problems for the bay and watershed, a four year scientific and technical characterization of the bay, and the development of a long range monitoring plan and comprehensive conservation management program (Hinzman, pers com). The three priority problems within the TBNEP include loss of critical salmonid habitat, sedimentation, and bacterial contamination, with floods posing an additional concern. Management, fiscal, technical, policy, and science advisory committees are set up to guide the planning, management, and research of the estuary. Climate change and variability factors may induce changes in water quality and quantity, potentially exacerbating the existing priority problems, but occurring over a period of time in which resource management practices may adapt.

State Government

LCDC and the Department of Land Conservation and Development

The Land Conservation and Development Commission (LCDC) administers ORS 197, 215, 221, and 227 through the adoption of Statewide Planning Goals and the review of state and Local Comprehensive Plans (LCPs) and actions for conformance with state-mandated goals. The Department of Land Conservation and Development (DLCD), the administrative branch of LCDC is charged with reviewing actions to assure consistency and compliance with the Statewide Planning Goals, local comprehensive plans, and land use regulations. DLCD provides grants and technical assistance to local governments for preparation of comprehensive plans and then reviews the plans for compliance with the statewide goals and programs of other units of government. DLCD is also charged with coordinating among state agencies the implementation of various components of the management program, including the regulatory aspect.

The issues surrounding climate change and variability have the effect of influencing DLCD over a longer term, due to the nature of the long planning horizon. Coastal

hazards are already a central concern to the agency and become heightened when coastal issues, such as protecting habitat, preserving public access, and ensuring appropriate coastal developments, are further threatened by changes in climate.

The State Land Board and the Division of State Lands

The State Land Board, composed of the Governor, the Secretary of State, and the State Treasurer, is responsible for managing the land and other resources for the greatest benefit of the public consistent with sound conservation practices. State lands are often leased to public and private interests and waterways areas are leased for such uses as sand and gravel removal, moorages, and marinas.

The Division of State Lands provides administrative support to, and implements the policies of the State Land Board. DSL manages about 800,000 acres of submerged and submersible land under navigable rivers, lakes, estuaries, ocean bays, and offshore land within the territorial sea (DSL, 1995). The primary purpose of resource management is to maintain the public interests of fisheries, recreation, and navigation. The Removal-Fill Law of 1967 (ORS 196.800 - 196.990) requires that a permit be obtained from the Division to remove, fill, or alter more than 50 cubic yards of material within the bed or banks of the state's waterways. The requirement applies up to the line of nonaquatic vegetation of wetlands and up to the highest measured tide or upland vegetation line of tidelands. The statute establishes an overall policy to assure that fill and removal do not interfere with the state's interest to preserve public use.

DSL becomes involved with emergency response when flooding causes losses to streambank property, and emergency permits for protection such as riprap or bank sloping are issued to increase stabilization (Johnson, pers com). The permit review process involves coordination with the applicant, adjacent land owners, natural resource agencies, the State Geologist and affected local governments. The Division's policy is to work with applicants to assist in designing projects which will have a minimum effect on water resources and adjacent properties.

Because the Army Corps removal-fill law parallels that of DSL, the two agencies have a joint application form. DSL circulates the ACOE public notice to local government and state agencies in order to receive comments. The Division evaluates

comments in order to assess the proposed project against the requirements in law and administrative rules and to prepare operating conditions under which a project can be approved. The permit is either denied or issued with conditions, depending on local government approval. There are both criminal and civil proceedings available to enforce the Removal-Fill Law.

A change to the regulatory program came about in 1993 when the Legislature required DSL to provide a special review and approval for any alteration within Essential Indigenous Anadromous Salmonid Habitat streams (ORS 196.810) and within Oregon's 20 designated State Scenic Waterways (ORS 390.805 - 390.925). DSL also administers the state statute requiring mitigation of intertidal dredging and filling by creation, restoration or enhancement of an estuarine area, in support of the comprehensive wetland regulatory and management program.

Climate change and variability factors, such as higher sea levels and increased wave energy and sediment transport, may affect DSL by enhancing the need for the administration of shore protection permits, subject to the Removal-Fill Law.

The Oregon Parks and Recreation Department

If projects are located on the beach along the Oregon coast, permits are regulated through a joint permit with the Oregon Parks and Recreation Department. The Oregon Parks and Recreation Department, through the Beach Bill 0f 1967 (ORS 390.605 – 390.770), manages the perpetual public easement to the ocean shores and beaches by regulating uses and issuing permits for improvements on the shore. The Beach Bill mandates that OPRD regulate any alteration or structure placed on or made to the ocean shore up to the surveyed beach zone line established in 1967. This statute also requires review notifications for development along the Willamette River Greenway and the State Scenic Waterways and lists the kind of development and management practices that are acceptable in order to meet the visual impact standards.

OPRD also manages the network of state parks, waysides, and access points that provide areas for recreation, research, and preservation. Although the primary extent of the agency tasks is regulatory, a combination of responsibilities is performed. State parks staff play an advisory role to the Commission on different aspects of ocean shores and

scenic waterways programs. OPRD also drafts administrative rules which helps set policy, authorizes land resource management for park activities, and performs emergency services by issuing emergency permits designed to expedite the process of preventing imminent loss of structures or loss of property.

OPRD works in close cooperation with DSL, having completed a Memorandum of Agreement (MOA) making the permit system more efficient. OPRD also works with DLCD in complying with state goals, and with ODFW, DOGAMI and a host of other natural resource agencies and local governments through the permit review and notification process. OPRD's constituency consist of a wide spectrum of environmental organizations, from beach preservation groups such as Oregon Shores Conservation Coalition to activist organizations, and the general public who use the beaches as state park resources.

Climate change and variability factors, such as migration of the shoreline resulting from sea level rise, could possibly increase the need for OPRD issuance of emergency permits, as well as contribute to the overall loss of beach area that is held in the public trust.

Oregon Water Resources Department

Through ORS 536, 537, and 540 the Water Resources Department develops policies and programs for the use and conservation of surface and groundwater resources, issues permits for the appropriation of water and for dams, and coordinates water basin programs with plans. The Department advises policy setters on practical use and the state engineer is required by law to be the principal advisor to the Director in advising the ways in which policies and administrative rules can best be implemented in regulating the community (Norris, pers com). The Department must set policy on how to regulate use of such a limited resource. They try to encourage voluntary action and cooperation over procedures of due process where civil penalties or administrative hearings may be required. The operational wing of the Department consists of the engineers and the scientists who investigate and develop models for processing water right applications and use of water, determine water availability, and meet with watershed councils. The state engineer also works with the emergency management divisions through participation in

and advising committees, through chairing technical committee for the drought council, and participation in the committee for developing flood response and dam safety in Oregon, which require emergency action plans and response processes.

Although OWRD is concerned with freshwater, their jurisdiction extends into the coastal zone, where the rivers and streams interface with the ocean. The Division continues to get involved where a public interest for withdrawal and protection of stream values has been determined. This may incorporate unique ecosystems and unusual overlaps of resource uses, such as in the New River at Coos Bay. The river meanders along parallel to the coast and creates a watershed between the dunes and the ocean, subject to OWRD authority. Here, the conflict arises among those who want protection of the watershed and instream flows and those who want to prevent upstream flooding, by bulldozing the dune banking and creating a wider and direct mouth from the river to the ocean.

Climate variability and change influences OWRD's responsibilities by affecting the supply of water that is available, thereby increasing the regulation and protection of existing appropriations for private and public use.

Department of Geology and Minerals Industries

The Department of Geology and Mineral Industries (DOGAMI) regulates oil, gas and geothermal activities along the coastal zone and is responsible for mapping tsunami, earthquake, and coastal erosion hazards, including landslides along the Oregon coast. DOGAMI also provides research and technical information on mineral resources and geologic hazards to users. The issues that they are charged with providing information on range from the building of critical facilities in potential tsunami inundation zones to the proliferation of building on landslides or unstable shorelines and the resulting installation of shoreline protection structures which lock up sand supplies and threaten beaches. Coordination is most often with county and local governments of affected areas and other state and federal agency cooperators. Recently, DOGAMI has constructed a chronic hazards maps and stability database, catastrophic hazard maps, and a debris avalanche warning system, which uses precipitation versus time as a trigger for sliding (Priest, pers com). Climate change and variability could possibly exacerbate chronic hazards and

compel DOGAMI to address the causal components and resulting changes along the coast.

Oregon Emergency Management

Oregon Emergency Management housed in the Department of the State Police is charged with disaster response and planning, as well as resource management and coordination. They are closely linked with the Federal Emergency Management Agency and the twenty two state agencies that comprise the Oregon Emergency Response System Council (OERS). Their main constituencies include local elected officials, sheriffs, local emergency program managers, search and rescue coordinators, and public safety answering point (PSAP) directors (Kershaw, pers com). Coastal hazards are a primary recognition in their planning efforts. Recently the agency has been very active in the Tsunami Warning Program and the Earthquake Program by taking the initiative to provide public educational outreach efforts to educate and warn the public regarding these hazards. Climate change and variability and the resulting impacts may enhance the need for emergency response.

Oregon Economic Development Department

The Economic Development Department (EDD) provides state guidance on economic planning and port planning and are involved primarily in managing programs that provide funding and technical assistance for economic development activities and for selected federal activities that are not directly tied to job creation, such as public infrastructure, and financing of projects, like sewer and water systems. EDD also involves themselves in emergency response by managing federal disaster grants related to flooding in Oregon during the past few years. Many of the programs can be considered reactive in that they respond to applications for funding. Activities include business loans and some grants or tax abatements, and technical assistance and funding for community development, infrastructure, and ports. In addition, ACOE maintains navigable waterways through projects that require local or state paid matching funds which are provided through EDD.

Climate change and variability may increase the expenditures of funds needed for emergency response and alter the distribution of grants and public financing for projects that may be affected by sea level rise or vulnerable to storm threats.

City and County Government

Lincoln County Department of Planning and Development

Tillamook County Emergency Management

The two government entities, Lincoln County Department of Planning and Development (LCDPD) and Tillamook County Emergency Management (TCEM), were chosen for the study based on the extent and magnitude of the hazards found in these areas. The first agency is located within an area known for high coastal erosion rates and the second is found in an area of extreme flooding. Each are charged with effectively managing the resources and the community, in an area with a great deal of property loss. The degree of difficulty is heightened with the need to balance competing uses, the need to determine acceptable levels of risk, and identifying who will be responsible for assuming that risk.

Under the authority granted through state statute, local governments are able to enact and administer comprehensive plan regulations. The Lincoln County planning office has some policy setting discretion within the framework of the Local Comprehensive Plan, but is primarily responsible for the implementation of programs and policies found within the plan, which includes regulatory activities (Spangler, pers com). The Department is charged with various tasks including review of development proposals, review of subdivisions, commercial siting and design, and developing construction regulations. Their jurisdiction is overlapped by state and federal entities with permitting authority. Cities and local jurisdictions found within Lincoln County may have separate land use planning entities, but areas outside the existing incorporated city, such as the city's urban growth boundary, will be recognized under a formal management agreement as having joint authorities between cities and counties. The implications of climate change and variability are similar to those of the state planning department, in that existing policies that deal with hazards are ultimately linked to the effects of climate change.

The principal coastal zone and resource related tasks that Tillamook County Emergency Management executes is emergency planning and response. Though not directly involved with management of coastal hazards, they are held responsible for responding to issues such as flooding, hazardous materials on the beach, and landslides (Spencer, pers com). Working closely with the County Sheriff's Office, the Commissioners, and Oregon Emergency Management, TCEM exchanges information with planners, notifies the public of flood events, and coordinates a response to disastrous situations. Similar to the state emergency management agency, the reactive nature of TCEM's responsibilities will be magnified by the effects of climate change and variability.

V. Findings on Principal Issues and Degree of Centralization and Fragmentation

Bluff Failures, Erosion, and Shore Protective Structures

The issues that have been principal to the eleven agencies interviewed are various and usually applicable to the particular resources the agency is charged with protecting and regulating. The increase in shoreline development, the proliferation of buildings on landslide or unstable shorelines, and the resulting increase in public sensitivity to the effects of development on the shoreline are indicated as three primary issues among those who regulate or protect resources along the ocean shoreline. Particular occurrences of damage and loss of property along the coast help to raise public awareness.

Conflicts arise over various uses of resources in the coastal zone by multiple constituencies, as well as the inability of certain agencies to exert their influence over particular resources. Many state agencies do not have policies that allow them to participate in development decisions. For instance, if placed high on the bluff, a development is beyond the boundaries of both OPRD and DSL jurisdiction. If developments are allowed to proceed and damages are later incurred, it then becomes OPRD's problem when the landowners apply for a shore protection permit. In addition, OWRD is limited in its influence over development projects to making recommendations on ground water pumping, which is intended to lessen foundation instability.

Obviously, it is the planning process that needs to emphasize stricter criteria concerning resource evaluations for development. Consultants, DOGAMI, and academic institutions such as, Oregon State University are able to provide evaluations and technical reports, but discretion should be used when relying upon sources that have ulterior motives or incentives, such as a consultant hired by the developer seeking to win the proposal

In areas that were built prior to the planning goals, agencies must now deal with the impacts. What could greatly reduce the state's efforts is full disclosure of existing or potential hazards during real estate transactions. If people are willing to buy into a community, they need to be made aware of the hazards to the property. In many areas, property looks like paradise in the summer when the weather is good. For instance, the

Bayshore subdivision, just north of Waldport but out of city jurisdiction, was built before the statewide planning goals were established. The area has lost over 400 feet of sand in the last few months on what was usually a quarter to a half mile wide beach. When this beach is not being eroded during an El Niño year, it is being inundated by sand (Klarin, pers com). However, those who unwittingly purchased the low cost property when the beach was wide may be unaware of the coastal dynamics and chronic hazardous events that may threaten their property.

Even those who are familiar with Oregon's coastline and floodplain environments, have a tendency to forget the acuteness of the impacts over time. If they have survived a flood or lost property to erosion, the rationale that it wouldn't happen again or that the risks are not large enough to prevent rebuilding, leads to the reoccurrence of property loss. ACOE finds that the rash of requests that occurs during or proceeding a flood event, usually diminishes by the time the response process is even followed up (Miller, pers com).

Water Management and Flood Control

For those agencies managing water resources, such as ACOE, OWRD, DSL and TBNEP, the principal issues have been those associated with the recent implementation of the Oregon Salmon Restoration Plan. Aside from protecting in-stream water rights and water quality and mitigating habitat in which flood protection eliminated valuable habitat, these agencies are also dealing with the quantity and distributions of surface waters in regard to designating flood elevations and controlling flood design.

The Tillamook Bay National Estuary Project recognizes the two broad perceptions of flood control as seen by the general public. One is the idea that it is necessary to restore floodplain connectivity and minimize downstream effects by allowing flooding functions upstream. The second perception is that dredging will alleviate the problem. Because the floods of 1996 were so devastating, the TBNEP is currently addressing strategies to deal with future flooding.

Flooding issues arise when compliance with the Flood Disaster Protection Act goes unexamined or properties are not required under law to have insurance if they have no

mortgage or their mortgages are not federally funded. In addition, individuals are permitted to rebuild and continue to receive insurance, allowing for unlimited damage-rebuild scenarios. In fact, unless damage exceeds 50% of the cost to replace the building then it need not adhere to newer, more stringent elevation and construction standards. In addition, although the NFIP regulations were amended to allow creation of special erosion zones and to mandate local land management programs to take these hazards into account, few erosion zones have been delineated and FEMA has not sought to require local land management programs, including setbacks, to address erosion hazards or for floodplain mapping to take into account long term erosion trends. The rate at which the maps are updated is also not commensurate with the rate of changes that occur within the floodplains. If flood area is increased, significant flood hazard modifications within the affected communities should occur. However, without updated maps, many erroneous classifications of properties continue to go unnoticed.

The ACOE has removed itself from flood control operations in certain areas due to liability issues (Miller, pers com). Because the construction or removal of structures in one area will affect water levels elsewhere, the ACOE is vulnerable to claims that downstream flood damages arise from flood control projects. In addition, the inaccuracies of outdated flood maps allow building in areas that are ultimately flooded on a regular basis. In Tillamook, for example, the floods that were designated as 10 year events are now affecting the land like a 50 or 100 year event, due to the increased earth slippages that are settling out and filling in river channels at estuary interfaces. Because active navigation projects that involve dredging are no longer taking place, the river channels fill in and are unable to carry water that was envisioned in the flood insurance rate maps last updated. The October 1997 rains in Tillamook that resulted in only a couple inches, acted as if 10 inches had come down.

While hazard mitigation has gained in importance in recent years, it can be argued that the provision of disaster relief and federally subsidized flood insurance serves to encourage hazardous development, working at cross-purposes to EPA, the OCMP, and other agencies (Beatley, 1994). Construction standards that support development in hazardous areas and go as far as encouraging "breakaway" walls that wash away on wave impact and prevent reflection of energy, contradict the intentions of Oregon's goals and

undermine the importance of proper planning along the coast. The Army Corp's focus on funding and construction of shoreline protection projects such as seawall, jetties, and beach nourishment programs could also be perceived to work against the objectives of coastal resource protection.

Similar to those agencies who deal with erosion hazards, certain water resource agencies are also unable to exert their influence over particular resources. For instance, the Corps has a limited ability to perform coastal activities to aid in flood control. The law precludes them from responding to emergencies within the coastal environment, except for those dealing with maintenance of pre-existing structures or specific coastal zone protection projects that meet the purposes of navigation. There lies a fine distinction between projects for the purposes of navigation and those for emergency management and it has implications on the extent of Corps management within the coastal zone.

At the state level, the Water Resources Department also lacks the authority to address coastal flooding. The closest the agency comes is through participation in the interagency hazard mitigation team, which is a committee, chaired by Oregon Emergency Management with participants from many natural resource agencies. The issues addressed consist of any kind of emergency problem, such as landslides, tsunamis, and erosion on the beaches. With participation of all agencies, the committee will ultimately serve as the basis for strengthening the process of hazard review and stimulate the appropriate responses.

Due to the lack of regulatory authority, TBNEP is unable to direct people to use land in a certain way that would prevent damages from flooding. Because most land is in private hands, TBNEP can only look for ways to help in addressing the flooding issue or find other agencies that have authority over the land. However, the science based program can allow for sound recommendations to be made, such as for breaching dikes on marginal habitats.

Resolution of Issues

In general, the agencies interviewed have found that particular approaches to management are leading to a greater resolution of traditional conflicting issues. These

actions that are aimed at resolving the principal issues are listed in Table 3. The evidence over whether this has resulted in a more favorable setting for further consideration of climate change and variability and its impacts on coastal hazards, however, has not yet been rigorously proven and will be addressed later in the paper.

Table 3. Management approach in the resolution of principal issues.

Agency	Outcome
ACOE, DLD, OPRD, LCDPD	Adopted new priorities and approaches to traditional issues, such as variations in types of shore protection structures.
DSL, OPRD, OWRD, ACOE	Increased organizational linkages and coordination.
DLCD, TBNEP	Maintained coordination - which has always been a priority.
ACOE	Maintained planning process and comprehensive reviews.
LCDPD, DOGAMI	Heightened awareness - aids in moving in the direction for resolution.
TCEM, OEM	Not necessarily involved in resolving issues.

New Approaches to Traditional Issues

Erosion control has undergone a major paradigm shift as of late by agencies taking on a new approach which integrates and protects natural resources. DSL and ACOE are looking at safer approaches, which include establishing riparian communities to arrest erosion, bank sloping, and planting vegetation as a buffer. The agencies recognize that there is not full public support yet, but the message is getting out to the agricultural community and to the developers. Not only does this type of method provide flood protection, but it serves the purposes of sediment control, shading, and provides habitat.

In addition, federal agencies have the benefit of learning from their mistakes on a national scale. The magnitude of flooding in Mississippi affected policies throughout federal governments nationwide and provided the impetus for flood policies that could be adapted and applied along the Oregon coast.

Protection structures on beaches have also become more highly scrutinized in terms of the public interest. In the past, when OPRD was a division of Oregon Department of Transportation (ODOT), ocean shore structures were approved quite readily. Now OPRD has significantly improved the review process by determining the impacts to the natural

and public resources and determining if there is a critical need rather than an ongoing chronic problem with piecemeal remedies (Williams, pers com). Although developments that were constructed after December 1977 are prohibited from having shore protection structures built, much of the development along the Oregon coast was built or platted for subdivisions and infrastructure prior to that date and are therefore eligible for shore protection. Fortunately, these devices still must be subject to rule standards, project need, alternatives, and examination of adverse impacts to property or recreational resources. Often times it is the public recreational concerns that limit or prevent projects from occurring (Williams, pers com). For instance, OPRD previously allowed permits for removal of sand for gravel and cement factories, but that type of extraction from the public resource is no longer permitted.

Changes also arose from the multi-year Section 309 grant program strategy to improve coastal hazards management in Oregon, ultimately bringing about a broader understanding and awareness of hazards coastwide. All local coastal jurisdictions were asked to evaluate their plan's current policies and relevant circumstances related to coastal hazards as a result of the strategy. A number of jurisdictions have amended their plans to improve permit, siting standards, or geotechnical report standards for hazardous shoreline areas (Good, 1996). In addition, the concept of special area management planning is being applied to Oregon littoral cells for management of oceanfront development and shore protection. The results may allow for management that encompasses a scale larger than individual properties and the processes that occur on an area-wide basis.

Construction setbacks are in the process of being refined so that local governments can adopt them into the local plans. Back in the 1980's, the setback standard, based on an overly simplistic formula using sea level rise, bank height, and steepness, was leading to the development of structures too close to the bluff edge. Good (1994) documented a strong linkage between oceanfront setback for new buildings and the demand for hard shore protection structures (SPSs). In the Siletz cell, where setbacks met the minimum requirements in county or city hazard inventories, 40% of the sites later required SPSs to mitigate erosion hazards (Good, 1994). Apparently, the setback standards were under-compensating for annual erosion rates.

Recently, research funded by a CZM 309 project of special merit has been conducted to improve the setback methodology. Using a Geographic Information System (GIS), the formula based approach calculates standards for relative risk. Variables based on built in assumptions, such as building life expectancies and projections of sea level rise, are calculated with parameters, such as bluff heights and recession rates (Spangler, pers com). The model will be used to formulate standards that can then be used as the basis for new setback requirements

Increased Coordination Among Organizational Linkages

A majority of the agencies indicated that the history of the major issues has significantly influenced the organizational linkages among agencies. Now that there is more interest in protection and preservation, there is more sharing of resources, support among agencies, and greater day to day communication. Ultimately, developing management systems that are more streamlined and consistent eases the difficulty of resolving issues. Improvements to centralizing the management system have been made, particularly with the Memorandum of Agreement reached between DSL and OPRD, and the joint permit program between ACOE and DSL. Further improvements are being attempted in a few counties, with the issuance of the State Programmatic General Permit, in which the state is responsible for issuing the 404 CWA federal requirements (Johnson, pers com), relieving the Corps from becoming involved in every permit application.

In addition, Geographic Information Systems (GIS) can be uploaded to the Internet by those agencies that act as repositories for mapping information and data and downloaded by those agencies seeking the technical and geographic information. This ease of exchange facilitates communication sharing and maximizes the resources, while avoiding overlapping efforts.

Overall, agencies found that better coordination efforts and a heightened awareness of the issues have helped lead to resolution of conflicts. For those organizations such as the Tillamook Bay National Estuary Project, facilitating interactions among communities and natural resource agencies has been an ongoing priority of the program. This action led to a relatively consistent resolution of issues since the establishment of the project.

Comprehensive Planning Process

The Corps finds that the level of conflict and ease of resolving issues is addressed during the planning process, where comprehensive reviews of NEPA documents, the environmental impact statements and environmental assessments, lead to efforts to work out problems before they reach the implementation stage. ACOE looks for alternatives that can serve environmental restoration purposes without jeopardizing flood protection.

In addition, state agencies in general have the capacity to work effectively with local governments in the development, implementation and evaluation of local and state actions and plans that affect land use. This connection plays an important role in meeting both local and state needs and management program objectives

Heightened Awareness

Both DOGAMI and the Lincoln County Department of Planning and Development indicated that the issues they deal with all contain a moderate degree of conflict, but can be managed through fairly tractable resolutions. Given that DOGAMI concerns itself with the technical data side of the issues as much as possible, and maintains an ongoing rapport with federal, state, and local government, private organizations, and universities, the breadth of conflicts remain generally consistent over time. LCDPD must balance a broad spectrum of social values, economic and political issues, and resource management concerns and is therefore prone to the conflicts that arise over multiple users contending for limited resources. Conflicts can therefore never be completely resolved, but the heightened awareness over coastal sensitivity that has evolved over time has enabled the county to either look for appropriate solutions or rule out those that have not proven effective (Spangler, pers com).

VI. Findings on Climate Change and Variability

Knowledge of Climate Dynamics

The three major driving climate forces that are contemplated in this study are the El Niño Southern Oscillation, the Pacific Decadal Oscillation, and long term global climate change. Each, with varying causal factors, exerts an influence on the coast with numerous implications on the management responsibilities of the agencies we interviewed.

A majority of agencies recognized and were familiar with the three climate change and variability phenomena and their impacts to the coastal resources. All involved are very familiar with the ENSO phenomena and the related impacts on their responsibilities, particularly in regard to the 1982-83 event and the current event in 1998. Long term global climate change is also well known, especially in regard to the recognition of accelerated eustatic sea level rise as an event with implications for the coastal area. The issue of sea level rise has been previously addressed by the Oregon Task Force on Global Warming and the report, Possible Impacts on Oregon from Global Warming", issued by the Department of Energy in 1989, called for DLCD to have the capability to integrate global warming policies into local planning through the periodic review process, and for increased coordination between state regulatory agencies and the OCMP.

Eustatic (global) sea level rise has not been the only focus related to long term climate change. Relative sea level rise has also been demonstrated through tide guage records up to 80 years in length. Tide gauge records are useful in examining the year by year changes in the level of the sea compared with the level of the land and is important in determining erosion (Komar, 1997). Examples of records are illustrated in Figure 7. The curves are typical of those along the particular coastline. The east coast experiences more relative rise in sea level because of the subsidence along much of the coast and is particularly prevalent in the Gulf Coast from the extraction of oil and groundwater. Because of the tectonically active Pacific margin, rates of sea level are nearly constant or in some cases are actually experiencing a net lowering, as in Juneau, Alaska.

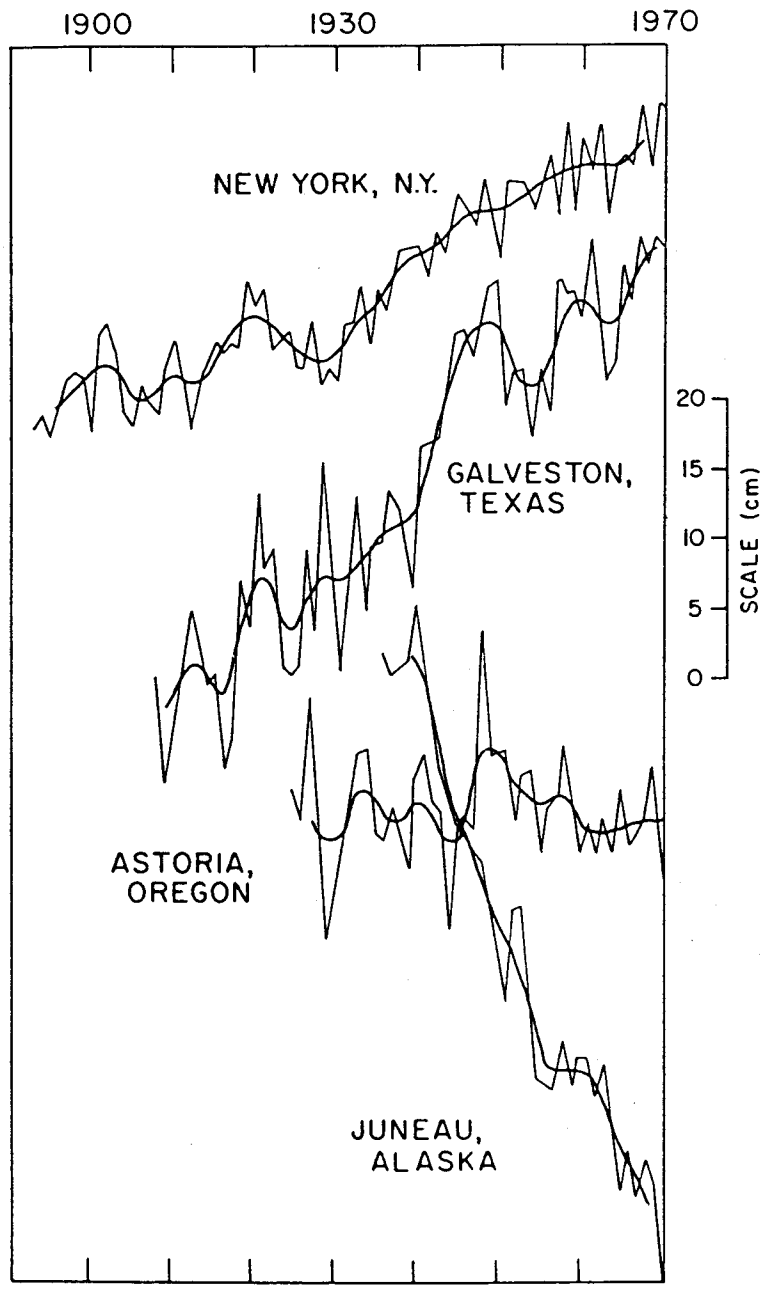

Figure 7. Yearly changes in sea level determined from tide guages at various coastal stations. [After Hicks, 1972].

In addition, relative sea level rise scenarios for the Oregon coast from 1990-2110 have been projected by the Oregon Coastal Natural Hazards Policy Working Group (Good, 1992b). Using global sea level rise assumptions of 1M by 2100 and assuming intersesmic uplift continues at present rates, they projected that by 2110, relative sea level will be 1.4 feet higher on the north and south coasts and will be 2.2 feet higher on the central coast. Direct physical impacts include shoreline retreat with permanent flooding of low-lying areas and erosion and landward migration of beaches, dunes and bluffs. Temporary flooding with landward movement of the 100 year flood boundary, salt water intrusion into ground water aquifers, and inundation of estuaries could also occur.

Despite the evidence on eustatic and relative sea level rise found within these reports, many managers that were interviewed were not familiar with the results because the data was not well publicized. In fact, they indicated that there was a lack of accessible information and data on how sea level rise may effect particular coastal regions and the lack of baseline data to actually monitor the resulting changes.

A few managers were aware of the nature of the PDO in regard to the interdecadal scale of wet and dry events, but were not familiar with that specific terminology. The managers within DLCD and OPRD had the opportunity to attend a JISAO conference on climate variability, but were still unsure on how to interpret such subtle effects of PDO for their management purposes. A listing of the climate phenomena and the recognition by the number of respondents is found in Table 4.

Table 4. Recognition by respondents of climate change and variability forces identified by the JISAO group.

Familiarity	ENSO	PDO	Long term climate change
Quite familiar	All agencies		7 agencies
Familiar but unsure of related impacts on responsibilities		6 agencies	4 agencies
Not familiar		5 agencies	

Relationship between Primary Issues and Linkages to Climate Variability

Nearly all the agencies stated that the primary issues of concern within their management purview, could be or were exacerbated by climate variability. Table 5 highlights the extent to which these linkages are evident to the particular agencies involved.

Table 5. The extent to which the principal issues are linked or exacerbated by climate variability.

Agency	Extent Of Linkage Between Climate And Issues Of Management
TCEM	Flooding, erosion, and even hazardous waste response is increased.
LCDPD	Sea level rise threatens development, thus trying to incorporate into setback standards.
DOGAMI	Greater focus on shoreline protection and coastal erosion due to El Niño.
DSL	Greater focus on erosion and protective structures. Shrinking wetlands and more encroachment into floodplains in dry cycle, higher peaks in wet cycle.
DLCD	Increase in all coastal hazards due to El Niño of 82-83 and current year.
OPRD	Sea level rise leading to hardening shoreline, loss of habitat, infrastructure impacted, money spent for protection
OWRD	Flooding and droughts creates bigger strain on agency in dry cycle.
TBNEP	All issues affected in a resource management perspective.
ACOE	Flooding and droughts affect flood control operations, but see no visible trends

Erosion

Whether it be the massive erosion, slumping, beach and dune loss, sand movement or sea level rise, it all translates into more water closer to areas of development. The increased magnitude of waves and the sediment transport disruption also furthers the erosive nature of the storm events. Because developments are not moving back, the losses to habitat both for recreational and wildlife values are also being aggravated by the landward movement of the coastline.

Disruption of sediment transport caused by the predominantly southwesterly angle of wave energy from the past El Niño event has impacted beaches along the Oregon coast. The flow and high water caused sinkholes to form in some areas and depletion of beaches

down to bedrock in others, and in some places left ancient tree stumps visible. Although significant challenges have arisen, OEM acknowledged that Oregon has not had to confront the magnitude of physical damages that has occurred in California during the past El Niño (Kershaw, pers com).

There is a recognition of a marked increase in the number of protective shore structures and the acknowledgement of the need for improved information regarding coastal geology on a littoral cell and site basis. Good (1994) documented the clear relationship between the construction activity of shore protection structures (SPSs) and the periodic El Niños (Figure 8). The sudden increase in SPS length directly after particular storm events has contributed to the cumulative armoring of 49% of the Siletz littoral cell.

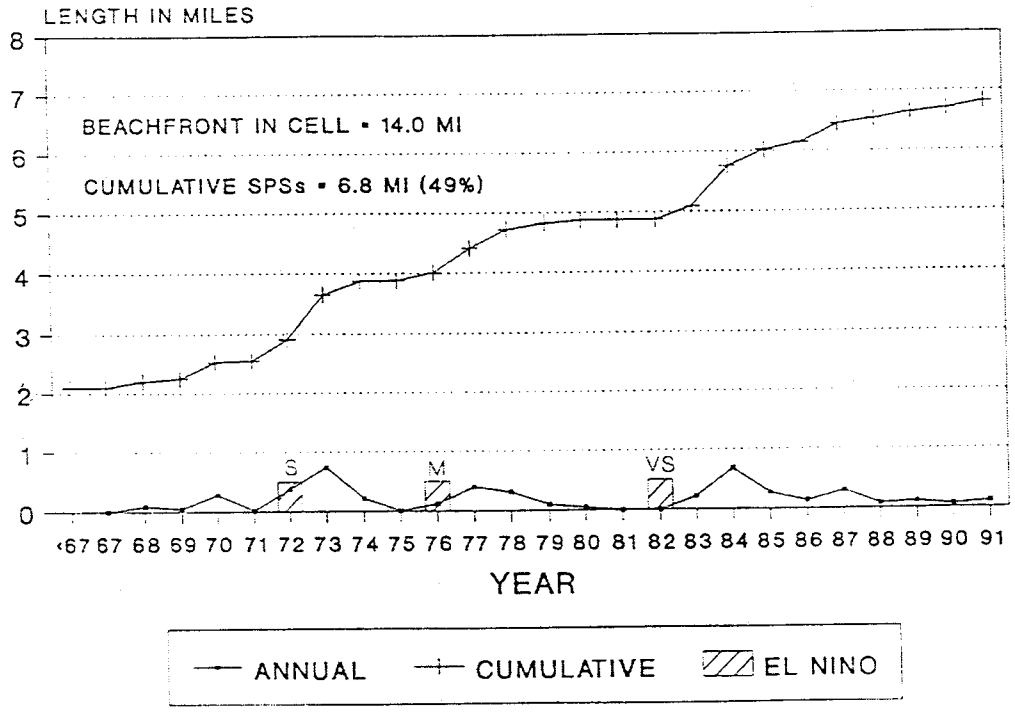

Figure 8. Cumulative and year-to-year length of shore protection structures constructed in the Siletz littoral cell (1967-1991) and the relationship to the moderate (M), strong (S), and very strong (VS) El Niño events [From Good, 1992].

A majority of the respondents witnessed a great deal more attention being paid to coastal issues by the media, which was ultimately heightening public awareness and concern and solidifying public support for tighter control on coastal development. An incident at a subdivision south of Oceanside, Oregon known as "The Capes" exemplifies this scenario. In 1991-92, The Capes was approved and built, notwithstanding the great amount of controversy that occurred over the instability of the bluff. The geologists concluded that if properly engineered, the developments would be secure even as close as ten feet from the edge of the bluff. However, the entire landform was unstable and provisions for avoiding erosion at the toe of the bluff were not adequate to prevent bluff fractionation and sliding. Four years later, in the midst of the 1997-98 El Niño, the structures were precipitously on the edge of the bluff and were being threatened with imminent collapse into the seas 150 feet below.

Goal 18 precluded any structural solution and the Governor turned down any request for an exception based on a state of emergency. The decision was based on the consideration of the extent to which shore protection devices would exacerbate losses to adjacent properties and the public beach area, as well as the recognition that the effects of an El Niño may actually increase over the next two to three years and further the problem. If cliff erosion continued, the only alternative in preventing complete loss of the structures was to retreat, which in itself posed certain dangers and is an extremely costly undertaking. The developer of the project was willing to provide some financial assistance and the remaining funds would come from private homeowners associations.

Questions remain over whether the subdivision was developed with the appropriate safeguards indicated in the construction plans or whether or not the construction plans should have ever been approved. This scenario may have been completely avoided with better local or state planning that takes into account the vulnerabilities of the coastline to El Niño-induced erosion. The citizens who relied on insufficient information and resource evaluations and who are now dealing with costly remedies, are now initiating a lawsuit against the developer. However, they claim the loss has nothing to do with the weather. Ultimately, the dramatic effects of the situation and the attention it consequently received may reinforce public support enough to provide the impetus for more effective resource planning.

Flooding

A concern of agencies dealing with water resources was the effect of climate variability on the magnification of the relationship between the wet and dry cycles. During a long dry cycle, developments tend to encroach upon apparently dry, albeit seasonal, wetlands or floodplain areas. Come the wet cycle, developments may now be located directly in the floodplain, being subjected to flood events. In addition, the shrunken ecosystem, is no longer able to absorb, filtrate, or buffer the water flows, and higher peaks lead to flooding and erosion downstream.

These linkages between climate and coastal and floodplain vulnerabilities are well recognized and acknowledged by all the agencies interviewed. The acknowledgment and the recognition of the connection is a precursor to actions that can be taken to incorporate climate forecasting information into the management regime.

Influence on Decision Making

In order to determine if agencies have taken steps to incorporate in their process of agenda setting and policy formulation, a broad range of efforts that deal with climate change impacts, respondents were asked to indicate if climate phenomena influence or change their decision-making process. From their responses, the degree of action and policy initiatives can be categorized into three basic levels, official recognition and assessment of problems and issues, new public and intergovernmental processes to build consensus on climate change issues, and existing adaptable regulations or new policies responding to climate change (modified from Klarin and Hershman, 1990). The extent of agency participation within this range of management strategies is depicted in Figure 9.

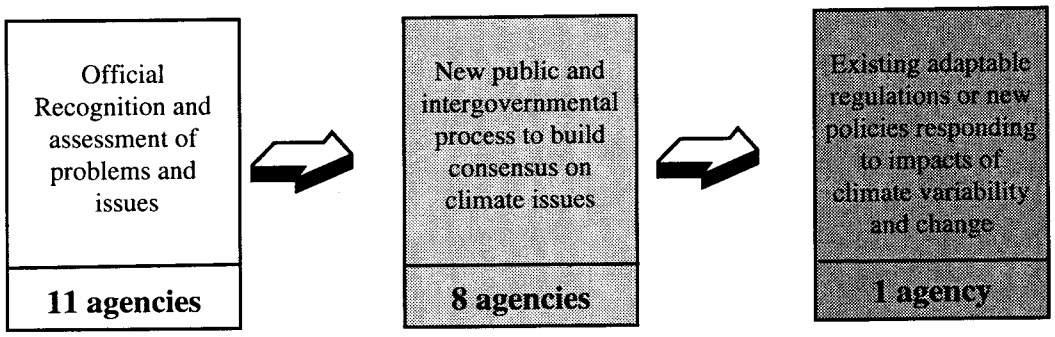

Figure 9. Degree of action employed by agencies to address climate change and variability issues (Modified from: P. Klarin and M. Hershman, 1990).

Out of the eleven agencies interviewed, all recognized the issues associated with climate change and have officially assessed the problem through some form of documentation. However, three agencies, Tillamook County Emergency Management, Oregon Emergency Management, and the Economic Development Department indicated that they can not include new policy formulation processes, because of the management framework that precludes them from involving themselves in regulatory management actions. EDD's efforts are largely to help local economies recover quickly, regardless of what is causing the problem, notwithstanding environmental change. In spite of this, the EDD economist did indicate that if they were absolutely certain of rising sea levels, they may be able to modify the programs so as to incorporate the vulnerabilities of coastal business development projects or infrastructure that is funded by the grant program (Ayre, pers com).

The other eight respondents were in fairly good agreement that the climate factors would and currently are influencing the decision making process, at least in terms of building a greater consensus on issues through public and intergovernmental processes. The DLCD manager affirmed that coastal hazard policies are being improved to address the high degree of geologic variability in the shoreland environment resulting from among other factors, climatic impacts. The respondent believed that all sorts of events lead to the same types of impacts whether they be chronic or episodic, and therefore adaptive policies to deal with these coastal hazards should be emphasized. DOGAMI

feels that changes to management have arisen when shoreline developments are being threatened by El Niño related erosion events and these issues are forced into the forefront. DSL claims that feasible changes that are made in dealing with climate change include adjustments in staffing that facilitate a close working relationship with other natural resource agencies and improve the communication of the emergency management department within the division. The Army Corps considers that in general professionals already take into account the climate change phenomena, and the real consideration needs to be taken by the user base who are demanding the developments.

Actions that are being undertaken and that can prove useful for State Parks are the creation of the Littoral Cell Management Plans (LCMPs). LCMPs develop hazard risk zones in a GIS to reduce the risk to development from chronic coastal hazards based on the prevailing geo-physical and social conditions of a particular site. OPRD is the recipient of the work being conducted through Lincoln County and a technical consultant through a DLCD Section 309 grant. Through these plans, the agency will be better equipped to define areas of critical need and more effectively evaluate whether projects should or should not be approved.

Although it is apparent that the agencies are aware of and are considering climate related impacts through particular governmental processes, such as agenda setting and planning strategies, almost none could say definitively that they are identifying climate change as a causal component and specifically responding by changing regulations or policies. In addition, none of the agencies consider all three types of climate phenomena due to the inherent uncertainties of climate change and lack of convincing evidence about the impacts. The respondent from OWRD indicated that from an operational standpoint, the lack of defined climate change or clear basis for change eliminates the possibility to incorporate new policies or regulations into the management regime. Despite his views, there is a contingent within the department who would like to see the incorporation of global climate change information in water rights processing, including one Commission member.

Information from long term climate forecasts, in particular, is difficult to incorporate into the planning process, because planning may take place on time scales of 20 years, while these events may occur at periods of 50-100 years. However, the coastal zone

management program does not lend itself to being able to deal with events that are about to happen either, because of the nature of the comprehensive long term planning process. One way that a planning department can take action is by improving the manner in which geo-technical information is used in approving developments and create better standards and stricter criteria for reports through local plans.

In regard to further changing policies relating to the hardening of the shoreline, the respondent at State Parks finds that the OPRD management regime will be hard pressed to change because of the limitations on their authority. In fact, it may be beyond their capacity to manage the resources, regardless of the how far back erosion may occur, because of the landward extent of their regulatory jurisdiction. No standards look at long term climate change probabilities and the effects of hardening of the shoreline resulting from sea level rise, but the manager's personal interest in the issues has the effect of driving smaller scale management responses that consider sea level rise (Williams, pers com).

For the climate change factors to significantly influence or change the management process, however, administrative rules and regulations within statutes would need to be strengthened or changed and the responding manager believed this would be a monumental feat. Private owners and cities will claim the right to protect and preserve their property rights, unless a major legislative or state mandate prohibits this action.

The one agency that gave a positive response in terms of climate change factors being the impetus for change within their management strategies was the Lincoln County Department of Planning and Development. The action they have taken is the initiation of a new setback standard based on the formula that factors in sea level rise discussed previously. Because the pilot project occurred in Lincoln County, the planning department is fortunate to be the first local government to have the opportunity to test the model and derive standards and polices that can then be incorporated into their local plans. El Niño events are indirectly factored in as well, because the model and scenarios they are using project large scale erosion analogous to what happens in an El Niño year (Spangler, pers com.). In this regard, the local planning community is specifically identifying climate change as a causal component for the problem and is creating new polices to respond.

VII. Findings on Climate Forecasts and Projections in the Coastal Decision-Making Process

Types of Seasonal to Interannual Climate Forecasts and Current Applications

The National Weather Service (NWS), a division of NOAA, provides weather and flood warnings, public forecasts and advisories for all of the United States and its territories. NWS has five major national operating centers, one of which, the National Center for Environmental Prediction (NCEP), is the largest organization in the country with capabilities of producing climate forecasts (Callahan, 1997). The Climate Prediction Center (CPC), one of the NCEP divisions, is responsible for maintaining a continuous watch over short-term climate fluctuations in order to facilitate diagnosis and prediction. CPC climate forecasts focus on seasonal outlooks of precipitation and temperature and are available in weekly, 30 day, or 90 day timeframes. The CPC is also a primary source for seasonal to interannual forecasts of ENSO. Another useful source for ENSO related information is the web page for the JISAO/SMA Climate Impacts, Strategies, and Response Group, which is http://tao.atmos.washington.edu/PNWimpacts.

The Oregon Climate Service (OCS), affiliated with the College of Oceanic and Atmospheric Sciences at Oregon State University, is the official archive agency for Oregon weather and climate data serving the PNW (OCS, 1997). OCS offers many reports, publications, and data in computer-accessible formats. Ongoing research includes precipitation mapping, agricultural meteorology, the effects of the ENSO on Oregon weather, and analysis of long term trends in temperature and precipitation. Almost all agencies rely upon information from the State Climatologist, George Taylor, to get a years view of predictions, a summary of past events, or on-call assistance as needed. George Taylor's information comes out on a quarterly basis or within a monthly newsletter and is utilized by a majority of agencies in some form.

The Service Water Supply Index put out by Natural Resources Conservation Service (NRCS) is sent on a monthly basis to those agencies concerned with water. Similar to the Palmer Index, but tailored to Oregon, the 5 month moving average supplies OWRD with a prediction of whether Oregon is heading for a drought or flood and general trends in water supply. In addition, snowpack or soil saturation forecasts, although not directly

used by OWRD, are apt to be used by the drought council on which the State Engineer sits (Norris, pers com).

Other sources of information can be obtained through direct links or via the web to the National Weather Service for coastal weather and marine conditions, NOAA's forecasting page, the Weather Forecast Center, and other internet sources that provide infrared radar, and stream hydrology reports. The manager at OPRD uses projected wave height data found on the Swell Animation Forecast, put out by Scripps Institute of Oceanography, to show the intensity and magnitude of swells and what angle they are expected to hit the coast. He relies on this forecasting in order to determine the urgency of emergency permits, as well as when would be the inappropriate time to initiate projects on the beach (Williams, pers com).

Out of all the seasonal and interannual forecast types available most agencies found precipitation data most useful (See Table 6). Because precipitation is indirectly linked to oversaturation of soil and to streamflows and runoff, many found reliance on that one source of data sufficient. Precipitation forecasts are used for various reasons, but all have the common purpose of indicating instances of flooding or erosion. A new warning system created by DOGAMI has been implemented during this past year to take into account those areas that have a high hazard probability for steep slope and debris avalanche. When rainfall amounts reach a certain level, the National Weather Service issues a warning, through Oregon Emergency Management via the Emergency Alert System (EAS), to those jurisdictions that may be at risk to debris avalanche.

ACOE uses precipitation as well as temperature in day to day operations, especially determining freezing and snowmelt, capacities of rivers, and frequency recurrence intervals. They use these forecasts to determine not only instantaneous flooding, but also for determining what locals should plan for over longer terms. Less of a priority, but still helpful to many agencies are projected wave heights, tidal surges, and wind speeds to aid in analysis of erosion episodes, as well as to predict the overtopping of levees.

TCEM relies on the NAWAS warning system, LEDS, e-mail, NOAA radio, river gages, and television and radio monitoring. Reliance on county emergency management office information such as high wind warnings and flood warnings in turn provides other local and state agencies with critical information.

Both DLCD and the local planning department do not make direct use of forecasts, but ultimately use the information as a point of interest in anticipating major erosion events and long-term trends in floodplains. The dispersion of information obtained through e-mail, Internet, and governmental and professional field related disseminations and publications aid in informal projections of climatic events. In addition, the reports on El Niño which were distributed to agencies, were indicated as a significant source of personal interest to most managers, but were not necessarily incorporated into management decisions.

Table 6. Forecast types utilized by agencies

	ACOE	DSL	OPRD	OWR	DOGAM	DLCD	OEM	TCEM	LCDP	EDD	TBNEP	Total
T	x			x			x	x		x		4
P	x	x	x	x	x		x	x		x		7
St		x*		x			x	x			x	4
RO		x					x	x			x	3
SST							x	x				1
WS	x	x	x				x	x		x		5
WD							x	x			x	2
PWH	x		x		x		x	x		x		5
SS	x		x*				x	x				3
RH										x		1

* Based on precipitation data

T: Temperature
P: Precipitation
St: Streamflow
RO: Runoff
SST: Sea Surface Temperature
WS: Wind speed
WD: Wind Direction
PWH: Projected Wave Height
SS: Soil Saturation
RH: Relative Humidity

Potential for Climate Forecasting

Given the responses to the questions in the previous section, it seems apparent that the potential for use of climate forecasting is strong. The interviewed agencies fall into three basic categories in terms of their utilization of climate forecasts: climate forecasting has served agencies in the past, more accuracy and information is necessary prior to agency reliance on forecasts, and forecasts could not significantly serve the agency, due to constraints or limitations within the management framework (See Table 7). Even for agencies that use forecasts currently in some aspect of management, the overall consensus is that accurate and timely accounts of future events obtained in advance and connected to impacts on the ground with greater certainty would greatly enhance the potential for their use. This would also increase the chance of initiating strategies that take into account climate change and variability factors. Without the assurance, managers and policy makers will be hesitant to support controversial initiatives without substantial evidence that those policies are necessary and in the public interest.

The TCEM and OEM which work very closely with the National Weather Service already relies on forecasts daily. OEM indicated that for emergency managers, forecasts are extremely important for planning and warning purposes. The El Niño forecasts are used like other types of climate information, but may not necessarily be used in the same manner as by other natural resource agencies. OPRD has been preparing emergency permit policies to accommodate this year's El Niño winter, but by the time they were making progress, the event was already happening. Although too late to be of use this year, these concerted efforts may better serve the agency in the future. DSL primarily uses forecasts in preparedness and through understanding how to act in a responsive and expeditious manner, and by still preserving the resources. In regard to forecast functionality however, the respondent at DSL claimed that even with accuracy of forecasts such as those projected this year, the reality is they are never really prepared (Johnson, pers com).

When questioned specifically about how the use of forecasts could better serve managers, most responded with the need for a close and strong connection between El Niño and the particular resources each agency was set up to manage. For instance, EDD

believes that accurate forecasts could help coastal communities prepare for a down turn or upturn in coastal economies. TBNEP could use forecasts to aid in conducting studies in the Bay, such as in the determination of oyster closures, which is currently being reevaluated based on storm events, precipitation amounts, river gage heights, and bacteria counts.

ACOE does a great deal of long-term planning based on forecasts that emphasize the peaks and lows in order to make determinations of where in that regime to design projects. Better lead time will give management a chance to respond by building temporary structures to provide extra levels over and above what was permanently put in place. OWRD believes that if forecasts are accurate enough they can assist with predictions for water availability which are currently done by NRCS. Although unable to use them directly, DLCD would like to see more information on patterns and intensities of storms and major ocean swell events so as to correlate these events to abrupt seasonal changes in the redistribution of sand and sediment within the littoral cells. DOGAMI also sees the value in predictions of potential wave climate and degree of sea level rise, especially during El Niño years, that would allow for judging the severity of erosion.

At the local planning level, the respondent felt that short-term forecasts will not significantly serve the government any better. The planning process must factor in the worst case scenario, regardless of recurrence intervals or frequencies. Decisions need to be based on the these chronic hazards, because the impacts will be felt, regardless of the underlying cause. On the other hand, the local planner did see the value and need for long term global forecasting in order to incorporate sea level rise predictions into setback models, due to the insufficiency of the past standards.

Table 7. The potential for climate forecasting in management decisions.

Has Served Agency in Past	Would Like to See More Accuracy and Information	Could Not Significantly Serve Agency
ACOE, TCEM, OEM, OPRD, EDD, OWRD, TBNEP, DSL, DOGAMI	EDD, TBNEP, ACOE, OWRD, DLCD, DSL, LCDPD	LCDPD, DLCD

Barriers Preventing the Utilization of Climate Forecasts

Legal Framework

When determining the potential for climate forecasting, it is important to take into account the constraints that prevent or hinder incorporation of climate information into the management framework. All agencies interviewed, with the exception of ACOE, indicated that there was neither legal requirements which mandated nor prevented the consideration of climate change information. Closer inspection of the ACOE policy indicates that the Advanced Measures Program which provides emergency services in advance of predicted disasters, has not been used on the coast because of the inability to forecast.

Most respondents also saw no need for a change in the law, specifying that the requirements to address coastal erosion are sufficient, given continued uncertainty of long term impacts, scope, and scale. ACOE sees the need for a pre-authorization program along the coast for actions that would be similar to advanced measures, but would not require consent from headquarters.

The constraints that limit decision making flexibility afforded to individual agencies often stem from the need to balance conflicting needs and multiple uses. Public skepticism and issues of property rights conflicting with environmental concerns hinders political feasibility to change laws. In this regard, environmental policies are often influenced by public pressures more than by scientific considerations. Climate change is considered an abstract phenomena and not willing to be taken seriously. In contrast, events like tsunamis generally gain public support because people can comprehend the degree of catastrophic impacts and consequently plan ahead. In fact, legislation was passed last session to prohibit public facilities from being built within tsunami inundation zones. In order for climate change considerations to be comprehended and policies to be appropriately influenced, interactions between the public, policymakers and scientists need to be improved. Science can predict what technique will lead to an outcome, but it is the policymaking process that must proceed to identify the technique or outcome that is acceptable based on human values (NRC, 1995).

Inadequate Informational Specificity in Forecasts

Prominent among major barriers mentioned was the lack of convincing evidence about regional impacts and a lack of awareness of the degree to which climate forecasts can relate to decisions on the ground. Tools for forecasts and trends analysis appear not to be precise or accurate enough for use and unreliable models and inconsistencies between sources of forecasts decrease confidence. Climate forecast utility is also limited by the lack of user readability and interpretation for understanding the relevance of the impacts. These factors consequently create an institutional barrier limiting the ability of managers to incorporate uncertain information into decision making. Most consequently rely on data and probabilities that have been historically used. A longer term climate outlook, on year to decade scales rather than short term forecasts, was indicated as having more potential for use because it allows agencies to gear up for changes in frequency and/or intensity of events.

Capacity of the Management System

Limitations of the management system to take into account climate forecasting often relates to the capacity of the organization to collect, use, and understand climate information. Although the size of staffing may be sufficient, the portion that are considered to have technical or scientific capabilities to utilize climate information may be lacking. Managers may have the critical knowledge of both the resources and of the relevance of forecasts for their management responsibilities, but are unable to interpret forecasts due to the lack of expertise or tools that allow for application of the information. In fact, none of the agencies had a solid understanding of how to include forecasts given the level of technical skill in deriving or interpreting data.

A majority of the agencies with the exception of EDD and to some degree LCDPD, TCEM, and OEM believed their agencies have the scientific and or technical capacity to use climate related information. The respondent at EDD acknowledges that the department has a limited capacity due to the time and work constraints on the two research analysts who may be able to digest and pass on information to those in need of the information. Those who need to know about upcoming climate and sea-level changes are more often not technical or scientific types and would need the information to be

accessible. The respondent at LCDPD recognizes that no particular staff members have the specialized technical expertise for writing hazardous reports and must ultimately rely on engineers and private practitioners. TCEM feels they are very limited in the scientific and technical capacity, especially since the staff is composed of two, who have primarily administrative duties. OEM, although having a mix of program personnel who provide technical assistance to local jurisdictions, relies on other state agencies for technical expertise in interpreting weather or climate data. In fact, Oregon Department of Forestry provides their meteorologist to the Emergency Coordination Center of OEM during weather related events to interpret weather data.

VIII. Sensitivity and Vulnerability

Sensitivity of the Management System to Climate Change and Variability

According to JISAO, management systems are considered sensitive to climate variability and change if they are able to adapt their activities in correspondence with changes in climate. Based on this definition, the managers were asked to determine their agency's level of sensitivity. Responses ranged from extremely sensitive to not sensitive at all and were usually directly related to the perception of how climate change and variability influences decision-making. Given the findings, I have categorized the level of sensitivity as a function of four variables: the time horizon on which planning is based, the type of change to be enacted, the prevailing statutory authority, and the technical and monetary resources available. The consequences of these four variables will be discussed in the next section as a function of vulnerability to the resources.

Time Horizon

It appears as if the level of sensitivity is closely linked with the time horizon within which agency planning is based. Sensitivity is highest for those agencies that have the ability and political feasibility to adapt within short to medium timeframes. Such examples of agencies with shorter planning horizons are the emergency management networks and some of the natural resource management agencies (Table 8). Emergency management reactions are inherently adaptable as numerous hazardous conditions warrant various warnings to affected people, businesses, and communities. Resource management decisions such as those made for water resources, are constantly being adjusted, due to the necessity to incorporate climate change information and deal with the impacts of a bad year, while planning for storage and supplies during a good year. Decisions made by TBNEP, start from the ground up, and change as the lists of priorities and citizens inputs change. For agencies that plan on long term horizons however, there is limited potential to be adaptable and little use of short term climate forecasts. While there is sufficient time to consider long term climate projections, the accuracy and

probability of the projected impacts is not such to convince upper level policy makers of the need (Johnson et al., 1998).

Table 8. Level of sensitivity given the planning horizon.

Planning Horizon	Agency	Example	Level of Sensitivity
case by case	ACOE, OWRD DOGAMI, TBNEP,	engineering design, water storage projects, research projects (coastal erosion study, flood reduction study, water quality study)	HIGH
<30 days	OEM, TCEM,	emergency response	MEDIUM/HIGH
5-20 years	LCDPD, DLCD, OPRD, FEMA	Statewide Planning Goals, Local Comprehensive Plans, Littoral Cell Management Plans, Floodplain mapping	LOW

Modified from Johnson et al., 1998

Type of Institutional Change

The amount of time to initiate and implement change also depends on the type of change that is being pursued. The decision making process is quite flexible and adaptable on small timescales if the changes relate to administrative rules or coordination responsibilities. Substantial changes in regulations or laws, however, take much more time and are dependent on legislature which meets every other year. Not only may this effect the timeliness of the formation of climate related policies, but also the legislature may be swayed by the current political environment and persuaded to act in the interest of strong real estate, property rights, or government constituencies.

The sensitivity of the federal government is also limited by the nature of change being considered. Federal regional offices are considered less adaptable in that they are bound by headquarters. If the headquarters can change, there will undoubtedly be a willingness at the local level to implement change and to be as responsive as possible. However, the federal government must evaluate changes to programs and procedures, weigh the costs and benefits, and then try to visualize how that will manifest itself throughout the country. To avoid this, the ACOE generally tries to delegate down when it comes to emergency management so as to allow more local responsiveness to climate change as a whole and only rely on FEMA in times of need.

Federal control nevertheless has some important benefits, such as uniform standards that avoid multijurisdictional conflicts and availability of funds for research. By developing federal standards and allowing states to manage their own programs, self-governance is encouraged and a more adaptable approach can be developed.

Statutory Authority

The level of sensitivity or adaptability is directly linked to the prescribed statutes and rules conferred to each agency. Statutory authority may act to limit the flexibility in decision-making. For instance, statutes and rules may require EDD to make an award if the applicant is eligible regardless that the award may not be desirable from a climate perspective, such as for coastal infrastructure that is vulnerable to floods by rising seas. In addition, although discretionary actions by OPRD are able to take sea level rise into account to some degree, the agency is not particularly adaptable or flexible due to the static nature of the jurisdictional boundaries that are determined through statutes.

Fortunately, Oregon's planning department has been relatively sensitive to the dynamic coastal environment which anticipates large scale events and changes over time. The existing hazards policies are moderately adaptable over the long term due to their broad planning mandate. Linking climate change factors to existing responsibilities has the effect of augmenting their inclusion into regulatory mechanisms. However, the state government has a more difficult time at mandating the incorporation of climate change information at the local level. As long as the local governments continue to comply with the Statewide Planning Goals or new laws passed by the legislature, the state government will neither have the legal authority nor the political leverage to challenge local land use decisions.

Hypothetically, the local planning department can incorporate climate change considerations, but due to constraints of operating under prescribed rules and regulations, the process is slow to change. Moreover, if states are unable to provide local governments with clear policy guidance on adaptable measures that incorporate climate change, the local governments are limited in their capacity to develop or implement them. Amendments to local plans occur at a greater frequency if there is a need, but due to the

lack of resources it is not common for the local government to initiate. They, too, must use their existing hazards policies to capture climatic concerns.

Technical and Monetary Resources

The availability of technical and monetary resources is a factor in determining the degree of sensitivity within agencies. Rarely do local governments have the resources to obtain such information that is necessary to predict climatic regional effects, nor do they have the funds to implement major change. Although the state distributes an average of about $1.8 million a year in assistance to local governments for planning, it must serve the needs of 36 counties and 240 cities (Church, 1998). In addition, because of budget cut initiatives, many counties have abridged their planning staff to the minimum needed to process permits, leading to a shortage of long-range planning efforts.

In terms of permit processing, local planners are ill equipped to handle increasingly complicated development proposals, regardless of climate change considerations. They are often unable to hire experienced, knowledgeable staff to critique the highly technical geologic, engineering, and transportation studies that developers present to support their proposals (Church, 1998). For instance, in Lincoln County, even with the county's new setback model, geologists may still conclude that construction can be safely located seaward of the setback boundary if adequately stabilized. In fact, in 1989, it was estimated that half of the newly constructed oceanfront buildings were located seaward of the 30 year erosion setback (Komar and Good, 1989). This breakdown in management and the abandonment of standards exists because of the lack of resources to counter the strong political and economic pressures. The degree of sensitivity must therefore be considered in light of actual implementation of policies and regulations.

Vulnerability of Coastal Resources

The vulnerability of coastal resources corresponds to the degree of sensitivity within the management system governing those resources. When climate events exceed the management response capabilities, implying that adaptation is not possible, resources are ultimately at risk. Vulnerability to hazards are often the result of limited access to power and resources (Blaikie et al, 1994). Overall, managers' responses differed depending upon the degree of vulnerability of the resources and types of resources at risk. Answers ranged from slightly vulnerable due to the relatively effective hazards management program to very vulnerable in cases where beaches are being lost.

A few respondents determined the resources at greatest risk to be the shoreline development and developments on unstable slopes, ranging from single homes to entire neighborhoods. From OPRD's perspective, seeing the disappearance of beaches especially in developed areas is the result of resources that are very vulnerable to change. Moreover, the major damage is more apt to be caused by structures put in place to prevent development loss, which essentially moves the problem elsewhere. Fortunately, Oregon is lucky to have a great deal of public lands on the coast to insulate the public from huge losses. However, this in no way justifies an acknowledged insensitivity to the changes that are occurring to the coast and most agencies realize the implications of their actions.

In general, the perception is that communities would suffer a great deal more from flooding which is far more damaging to both natural and human resources, as experienced in the 1996 Tillamook floods which accounted for 53 million dollars worth of damages. Many areas and resources are vulnerable to flooding because the prevailing management and response systems are not capable of dealing with events of this magnitude. In addition, due to the economic support for infrastructure, ports, and business development projects in coastal areas, communities are at greater risk to flooding from rising seas. The greater the number of threatened structures, the greater the need for disaster response and funds to help relocate, rebuild, or install dikes or protective structures.

Although most coastal managers identified these vulnerabilities to climate change and variability, none were sure of the magnitude of causation. This is mostly due to the

level of uncertainty associated with impact scenarios. Most managers, therefore, perceived climate change and variability as an exacerbation of already existing vulnerabilities to coastal hazards.

IX. Recommendations

A number of problems dealing with climate-related coastal hazards management have been identified through this evaluation process. The issues and corresponding recommendations are categorized into 3 sections: Hazard Risk Assessment and Information Exchange, Land Use Regulations and Building Controls, and Non-Regulatory Activities.

Hazard Risk Assessment and Information Exchange

Realizing the potential risks that climate change and variability pose to the resources and activities along the coast is the first step in natural hazard mitigation. The use of risk assessment as a means to determine the level of regional vulnerability should be encouraged so as to provide a factual basis for developing appropriate policy responses. Risk assessment is not designed to make quantitative predictions of the outcome of a particular management option, but is useful in weighing the relative effectiveness of alternatives (NRC, 1995).

- Provide risk assessment that considers sea level rise scenarios as projected by the CHNPWG and inventories of existing hazard data and maps; improve access to this information.

In order to properly evaluate impacts to the resources, managers should also increase their skills and abilities to utilize climate forecasts. By properly reading forecasts and relating climate projections to impacts on the ground, they will be better able to respond appropriately and efficiently. However, before this can happen, the dialog and link between climate forecasters and the management community must be improved (Johnson et al., 1998). In this regard, scientists have an important role in working with managers to ensure that the decision-making process and coastal policies are based on scientific understanding.

- Improve the interaction between scientists and coastal policymakers and implementers at all levels by ensuring that policy-relevant scientific research is intelligible and widely disseminated to decision-makers and the public.

In order to increase a general awareness of hazardous areas for development, climatological information should be properly disseminated to not only those who grant the support for development, but also to the public who is buying into it. Although a real estate hazard disclosure bill was introduced in the 1995 state legislative session, it did not pass. Initiatives to re-submit the bill should be pursued.

- Mandate full disclosure of natural hazards and potential threats from sea level rise or El Niño-induced erosion events.

Land Use Regulations and Building Controls

Land use regulations and building controls can be effective methods of reducing property and resource damage if soundly applied. Oregon's 19 Statewide Planning Goals, which are the foundation of the state's land use planning program, address the issue of coastal hazards, but do not specifically address the potential for impacts from sea level rise or climate phenomena, such as the El Niño Southern Oscillation. Due to the need for consideration of climate change and variability in land use planning, I recommend the initiation of Goal amendment proceedings to revise certain requirements. Pursuant to the Federal Coastal Zone Management Act of 1972, the state should "minimize loss of life and property caused by improper development in flood prone, storm surge, geologic hazard, and erosion prone areas and in areas likely to be affected by or vulnerable to sea level rise, land subsidence, and salt water intrusion and by the destruction of natural protective features, such as beaches, dunes, wetlands, and barrier islands".

- Oregon's inventory and implementing requirements found within Goal 7 and 18, should be supplemented with considerations of climate variability and change factors, with emphasis on vulnerabilities to rising sea levels and El Niño- induced erosion and accretion.
- Local, state, and federal agencies should base decisions for plans, ordinances, and land use actions on specific finding that shall include hazards to life, public and private property and the natural environment which may be caused by climate change and variability factors.
- Goals should also prohibit residential development, commercial or industrial buildings, or shore protection structures on beaches, active foredunes, or bluffs that are subject to ocean undercutting, wave overtopping, flooding, or El Niño-induced erosion.

Preparing for and mitigating climatic impacts along the coast can be accomplished through a variety of regulatory and non-regulatory tools, activities, and programs. Depending on the phase of the development process, the regulatory actions can either take the form of regulations to effectively remove activities from hazardous locations, building codes to strengthen structures that are better able to withstand storm forces, or engineered works to reduce the impacts of storm forces. When strategies are included in the planning phase, the potential to reduce or prevent damages is much greater. This section is further divided into the three sub-sections that correspond to the type of regulatory action: Planning and Siting of Development, Design and Building Criteria, and Beach and Shore Protection Procedures.

Planning and Siting of Development

In order to effectively regulate or remove activities from hazardous locations, state and local governments must provide sound planning and siting of developments within their region. Because the mapping of "developed" areas, defined by Goal 18, has not been adequately completed or distributed, building in "undeveloped" areas continues to occur.

- developed areas need to be mapped and made accessible to planners and the public in order to succeed in meeting the objectives of Goal 18.

Erosion based setbacks using variables such as sea level rise are now being initiated and a model implementing ordinance is being prepared. However, the new standards will only be voluntarily adopted into local comprehensive plans (LCPs). DLCD should develop a systematic approach for the incorporation of these new standards into all LCPs.

- Erosion based setback standards using the new formula-based approach should be incorporated into all local comprehensive plans.
- The Department of Land Conservation and Development should amend Goals to mandate incorporation of this standard into LCPs.

Because of the nature of the comprehensive planning process, an important strategy that a planning department can undertake is to improve the manner in which geo-technical information is used in approving developments and create better standards and stricter criteria for reports through local plans. With stricter standards, the assumptions that go into development of various sites would be drastically improved and local

governments wouldn't have to contend with challenging as many proposals in hazardous areas.

- Geotechnical reports should incorporate reliable climatological forecasts, as well as a site's geomorphic and environmental condition, in determining the appropriate setback and design features needed to mitigate the risk.

Land use plans can also provide detailed descriptions and restrictions on the size and density of developments through transfer of development rights, planned unit developments, and cluster developments. These land use planning tools provide land owners with economically viable property while also continuing to provide protection from climatically induced hazards. In addition, through capital improvement plans that acknowledge climatic concerns, a community can determine the sighting of infrastructure and influence the density of developments. Planning for low density development in hazardous areas will undoubtedly reduce the degree of damages.

- Restrict building in hazardous areas, which are subject to risks from climate change and variability, through such land use tools that maintain the hazardous portion of the property as open space.

Design and Building Criteria

Design and Building Criteria can be used to strengthen structures to better able to withstand storm forces. State and local land use plans may also be developed to include mandatory design and construction controls, such as elevation requirements above an appropriate base flood elevation and construction of development as to be moveable in anticipation of rising sea levels. In addition, code triggers that require a higher level of hazards resistance for renovations to buildings sustaining a certain level of damage, or post storm plans that restrict development could be adopted as cost-effective mitigation strategies. The development and application of new codes and standards is a complex process that relies on the consensus of engineers, land use planners, and building professionals, but if properly used, can assist in creating a community that is more resistant to natural hazard damages (FEMA, 1998).

- Project engineering plans should require sea level rise and El Niño impacts for proposed developments under the review process: structure size limitations or base flood elevation requirements.

- Flood control and drainage systems should account for sea level rise and subsidence through county and city planning and zoning and housing codes.
- Restrict reconstruction of structures that receive substantial flood damage through abandonment policies or buy-back policies.

Beach and Shore Protection Procedures

The third type of regulatory activity takes the form of permitting engineered works to reduce the impacts of storm forces. Fortunately, Oregon is insulated from minor changes along the beach by current policies that prohibit the development of beach structures. This was reinforced just recently in the US Supreme Court when the judge granted the state ultimate authority. However, through the CNHPWG process, problems with OPRD's authority to adequately manage the public resource mandated by the Beach Bill were identified. The local government notification process for proposed ocean developments is not extended to OPRD because of limitations of their jurisdiction west of the Beach Zone Line (BZL). However, as it relates to the need for future shore protection, developments should be reviewed by the agency charged with regulating SPSs. Therefore, I re-emphasize the PWG recommendation:

- Extend Oregon Parks and Recreation Department's jurisdiction over SPSs to all beachfront structures that are likely to impact the resources protected by the Beach Law, not just those west of the BZL.

Non-Regulatory Activities

If tighter land use controls in hazardous areas is absent and developments are allowed to proceed, there are a number of methods that may be used to reduce losses from climate impacts. Currently, the need for emergency services and the benefits to be derived from them are not equally distributed across the population and are inequitable to the taxpayers of a jurisdiction. Subsidies and support for development should be weighed according to the potential vulnerabilities of particular regions and sites.

- Redistribute the costs of emergency management expenses so that revenues are generated in proportion to a measure of risk associated with different locations and structures (Smith, 1997).

Tax incentives to property owners who adopt uses compatible with preserving beaches and shorelines, or a system of disincentives which limits growth in hazardous areas will help to avoid the scenario where governments have to react after-the-fact.

- Ensure favorable tax assessments to property owners who develop property for uses compatible with preservation of beaches.

As stated before, Oregon is lucky to have a great deal of public lands on the coast to insulate the public from huge losses. However, this does not mean substantial impacts will not be felt along the Oregon coast from climate change and variability factors if our society continues to expand into regions with significant coastal hazards. Land acquisition and conservatory programs are effective non-regulatory strategies that prevent development on hazardous coastal properties or protect resources that act to reduce storm forces.

- Acquire lands that are hazardous to build and protect as open space.
- Preserve critical habitats and wetlands or establish buffers around estuaries and wetlands to help reduce the density of adjacent development or developments vulnerable to sea level rise.

X. Conclusions

Consistent with Callahan, Miles, and Fluharty (1997), I found that recognition of climate change and variability was present, but few managers used forecasts in their operational responsibilities or within their decision making process. The principal reason for the lack of use, is the uncertainty of forecast accuracy and the inability to connect the effects to actual impacts that can be reasonably managed on the coastline.

However, as society continues to expand into hazardous regions along the coastline of Oregon, the need for sustained action taken to reduce or eliminate risks to people and their property should be a priority. Identification of climate change as a causal component and consideration of climate factors within the policy-making arena is a necessity. Although substantial changes in regulations or laws take more time to develop and implement, incorporating an adaptable and flexible approach into policies may facilitate the use of climate projections and create a planning process that foresees rather than reacts. Forecasting may provide for an effective method of cost-effective hazard mitigation, particularly if applied in the long-term planning process. With an ability to anticipate climatic effects, decision-makers will be better able to prevent loss of life and reduce damages, while also avoiding the associated costs for response and recovery operations.

The planning phase of any level of government can ultimately be more adaptive and flexible to new information once the knowledge of climatic events, impacts, and consequences has been instilled within the constituencies. Adaptive management systems in which science is a substantial part of planning, evaluating, and modifying management strategies are gaining favor as a means to improve interactions between scientists and managers (NRC, 1995). Promoting further research, evaluations, and assessment about the effects of climate change and finding appropriate methods of distributing the information can help raise an awareness that is crucial to increasing the level of sensitivity within the management framework. Overall, a management system designed with greater flexibility, one that has the ability to detect, learn from, and adapt to changing circumstances, may better enable the coastal community to deal with the dynamic nature of the climate system.

Literature Cited

Beatley, T., D.J. Brower, and A.K. Schwab. 1994. *An Introduction to Coastal Zone Management*. Washington, DC: Island Press.

Callahan, B., E. Miles, and D. Fluharty. 1998. Policy implications of climate forecasts for water resources management in the Pacific Northwest (PNW). Paper presented for The American Meteorological Society 10th Conference on Applied Climatology, October 20-23, 1997. JISAO Contribution #486.

Canning, D.J. 1991. Global climate change, sea level rise, and the Pacific Northwest. In: *Global Climate Change Resource Book for Educators*, 15 pp.

Church, F. 1998. Rural Planners Often Left High, Dry. *The Oregonian*, February 15. http://www.oregonlive.com/todaysnews/9802/st02153.html.

Coastal Natural Hazards Policy Working Group (CNHPWG). 1994. *Improving coastal hazards management on the Oregon coast: Final recommendations of the Coastal Natural Hazards Policy Working Group*. SG-94-002. Corvallis: Oregon Sea Grant.

Division of State Lands (DSL). 1995. *Oregon Division of State Lands-Unique Among Resource Agencies*. Salem: DSL.

Federal Emergency Management Agency (FEMA). 1998. *Reducing Risk Through Mitigation: The Riverine Erosion Hazard Area Study*. http://www.fema.gov/mit/reha_stdy.htm

Federal Emergency Management Agency (FEMA). 1996. *National Mitigation Strategy: Partnerships for Building Safer Communities*. http://www.fema.gov/mit/ntmstrat.htm

Field, J.C. 1997. *Assessing coastal zone sensitivity and vulnerability to regional climate variability and change in the Pacific Northwest*. Masters thesis: University of Washington, 82 pp.

Francis, R. 1997. "Impacts of Climate Variability on Aquatic Ecosystems: Freshwater and Marine Fisheries". Prepared for: OSTP/USGCRP Regional Workshop on the Impacts of Global Climate Change on the Pacific Northwest: Final Report. NOAA Climate and Global Change Program Special Report No. 11.

Franklin, J. 1997. "Impacts of Climate Variability on Forest Resources and Management". Prepared for: OSTP/USGCRP Regional Workshop on the Impacts of Global Climate Change on the Pacific Northwest: Final Report. NOAA Climate and Global Change Program Special Report No. 11.

Good, J.W. 1996. Improving natural hazards management on the Oregon coast: A progress report. Unpublished manuscript.

Good, J.W. 1994. Shore protection policy and practices in Oregon: an evaluation of implementation success. *Coastal Management* 22:325-352.

Good, J.W. 1992a. Ocean shore Protection Policy and Practices in Oregon. In J.W. Good and S.S. Ridlington (eds), *Coastal Natural Hazards: Science, Engineering, and Public Policy*. Corvallis: Oregon Sea Grant.

Good, J.W. 1992b. Relative Sea Level Rise Scenario for the Oregon Coast (1990-2110). Oregon Coastal Natural Hazards Policy Working Group.

Hicks, S.D. 1972. On the classification and trends of long period sea level series. *Shore and Beach* 40:20-23.

Intergovernmental Panel on Climate Change (IPCC). 1995. *Climate Change 1995: Impacts, Adaptations and Mitigation of Climate change: Scientific-Technical Analyses.* Press Syndicate of the University of Cambridge.

JISAO Climate Impacts Group. 1997. OSTP/USGCRP Regional Workshop on the Impacts of Global Climate Change on the Pacific Northwest. NOAA Climate and Global Change Program Special Report No. 11: July 14-15, Seattle, Washington.

Johnson, Z., E. Arden, D. Canning, and M. Hershman. 1998. *Sensitivity of the Coastal Management System in the Pacific Northwest to the Incorporation of Climate Forecasts and Long Range Climate Projections*. Unpublished manuscript. JISAO: University of Washington.

Klarin, P. and M.J. Hershman. 1990. Response of coastal zone management programs to sea level rise in the United States. *Coastal Management* 18(3).

Klarin, P.N., K.M. Branch, M.J. Hershman, and T.F. Grant. 1990. *Sea Level Rise Policy Alternatives Study: An Analytical Review of State and Federal Coastal Management Systems and Policy Response to Sea Level Rise* (2 volumes). Shorelands and Coastal Zone Management Program: Washington Department of Ecology.

Komar, P.D. 1997, Beach Processes and Sedimentation, Prentice Hall.

Komar, P.D. 1992. Ocean processes and hazards along the Oregon coast. In J.W.Good and S.S. Ridlington (eds) *Coastal Natural Hazards: Science, Engineering, and Public Policy*. ORES6-B-92-001. Corvallis: Oregon Sea Grant, Oregon State University.

Komar, P.D. 1986. The 1982-83 El Niño and erosion on the coast of Oregon. *Shore and Beach*. April: 3-12.

Komar, P.D. and J.W. Good. 1989. The Oregon coast in the twenty-first century: A need for wise management. In C.L. Smith (ed), *Ocean agenda 21: Passages to the Pacific century*, p. 73-79. ORESU-B-89-001. Corvallis: Oregon Sea Grant, Oregon State University.

Komar, P.D. and S.M. Shih. 1993. Cliff erosion along the Oregon coast: A tectonic-sea level imprint plus local controls by beach processes. *Journal of Coastal Research* 9:747-765.

Komar, P.D. and S.M. Shih. 1991. Sea-cliff erosion along the Oregon coast. *Coastal Sediments '91*, pp 1558-1570. Washington, D.C.: American Society of Civil Engineers..

Komar, P.D., J.W. Good, and S.M. Shih. 1988. Erosion of Netarts Spit, Oregon: Continued impacts of the 1982-83 El Niño. *Shore and Beach* 57:11-19.

Leatherman, S.P. 1989. Impact of Accelerated Sea Level Rise on Beaches and Coastal Wetlands. In J.C. White (ed), *Global Climate Change Linkages*, p. 43-57. Elsevier Science Publishing Co. Inc., MD.

Legislative Counsel Committee of the Oregon Legislative Assembly, 1995 edition. Oregon Revised Statutes (ORS). Chapters 197, 195, 215, 227, 92. http:// www.lcd.state.or.us/backinfo/statutes.htm

Lettenmaier, D. 1997. "Impacts of Climate Variability on Regional Hydrology and Reservoir Operations". Prepared for: OSTP/USGCRP Regional Workshop on the Impacts of Global Climate Change on the Pacific Northwest: Final Report. NOAA Climate and Global Change Program Special Report No. 11.

Mantua, N.J. 1998. Pacific Decadal Oscillation Report for the Joint Institute for the Study of the Atmospheres and Oceans, University of Washington.

Mantua, N.J. 1997. "Trends in the Present Climate and Climate Variability In the Pacific Northwest (PNW)". Prepared for: OSTP/USGCRP Regional Workshop on the Impacts of Global Climate Change on the Pacific Northwest: Final Report. NOAA Climate and Global Change Program Special Report No. 11.

Miles, E.L. 1995. Integrated Assessment of the Dynamics of Climate Variability, Impacts, and Policy Response Strategies for the Pacific Northwest: A Research Design.

National Assessment Synthesis Team (NAST). 1998. *US National Assessment: The Potential Consequences of Climate Variability and Change.* A plan for review by the Committee on Environment and Natural Resources and the National Science and Technology Council (Draft). Submitted by NAST in consultation with SGCR/NAWG.

National Research Council. 1995. Science, Policy, and the Coast: Improving Decisionmaking. Committee on Science and Policy for the Coastal Ocean, Commission

on Geosciences, Environment, and Resources. Washington, D.C.: National Academy Press.

Oregon Department of Energy. 1990. Oregon Task Force on Global Warming Report to the Governor and Legislature. Part one: possible impacts on Oregon from global warming. 49 p. Part two: state agency recommendations and proposed actions. 47 p. Salem: Oregon Department of Energy:

Oregon Climate Service (OCS). 1997. *Oregon Climate Service: Mission and Services.* http://www.ocs.orst.edu/ocs_description.html.

Oregon Department of Land Conservation and Development (DLCD). 1997. *A Citizen's Guide to the Oregon Coastal Management Program.* Salem: Department of Land Conservation and Development.

Oregon Department of Land Conservation and Development (DLCD). 1996a. Oregon's Statewide Planning Goals & Guidelines. DLCD: Salem, OR. http://darkwing.uoregon.edu/~pppm/landuse/INTRO.html

Oregon Department of Land Conservation and Development (DLCD). 1996b. The Oregon Coastal Management Program: Official Program Description. DLCD: Salem, OR.
http://www.lcd.state.or.us/coast/ocmpdoc/prog2c.htm

Oregon Department of Land Conservation and Development (DLCD). 1996c. *Coastal Program Assessment & Strategies for Improvement.* Portland: Department of Land Conservation and Development. 68 p.

Oregon Revised Statutes (ORS) 196.800-196.990, Removal-Fill Law.

Oregon Revised Statutes (ORS) Chapter 197, Oregon Land Use Planning Act.

Oregon Revised Statutes (ORS) 390.605 - 390.770, The Beach Bill of 1967.

Oregon Revised Statutes (ORS) 390.805-390.925, Removal and Filling in Scenic Waterways.

Sayre, W.O. and P.D. Komar. 1988. The Jump-Off Joe landslide at Newport, Oregon: History of erosion development and destruction. *Shore and Beach* 52:15-22.

Smith, R.A. and R.E. Deyle. 1997. A risk-based tax for funding local emergency management costs. Proceedings from the Coastal Zone Conference: Charting the Future of Coastal Zone Management, July 1997. Volume 2: 829-831.

United States Code 1972, P.L. 1451-1464 (1982 and Supp. III 1985), Coastal Zone Management Act.

US Army Corps of Engineers, Portland District. 1997. Flood Plain Management Services (FPMS) Homepage. Reservoir Regulation & Water Quality Section. http://npp71.npp.usace.army.mil/fpm/fpm_home.html

US Army Corps of Engineers, Portland District. 1989. *Regulatory Permit Program.* Portland: USACOE, Regulatory and Resource Branch.

Vincent, P. 1989. *Geodetic deformation of the Oregon Cascadia margin.* M.S. dissertation: University of Oregon, Eugene. 86 pp.

APPENDIX A:

COASTAL IMPACTS QUESTIONNAIRE

AND

INTERVIEW PARTICIPANTS

COASTAL IMPACTS QUESTIONNAIRE

INTERVIEWERS:
DATE:
NAME:
POSITION TITLE:
ORGANIZATION:
PHONE/FAX:
ADDRESS:
COMMENTS:

I. INTRODUCTION

Describe the JISAO projects goals and projected output.
Explain trends of climate change and climate variability:
El Niño/Southern Oscillation
Pacific Decadal Oscillation
Long Term Global Climate Change
Explain that this questionnaire is based on a design for all dimensions of the project, including water resources, forestry resources, fishery resources, aquatic ecosystems, urban centers, and agricultural lands. Therefore, some of the questions may have little relevance to the interviewee's role in coastal management.

II. USER PROFILE

A. TASKS AND RESPONSIBILITIES

1. To what extent can your major tasks be categorized as regulatory, advisory, policy setting, operational, resource management, emergency response?

2. Indicate level of primary legislative authority, a)Federal; b) State; c) regional; d) municipal; or e) Tribal.

3. With what other organizations are you most closely linked?

4. Does your organization have a constituency? If yes, who are its members?

B. APPROACH TO MANAGEMENT

1. How do <u>you</u> define the coastal zone for your management purposes? How far inland and how far offshore do you consider the coastal zone to extend?

2. What are the most important operational jobs actually done by your organization, with respect to managing the coastal zone and its resources?

3. How does your organization think about the coastal zone and its resources and how would you define your approach to management?

C. ISSUES AND PATTERNS OF CONFLICT/COOPERATION

1. What have been the principal coastal zone and resource related management issues in your area in recent years (decade)?

2. Which of these issues would you regard as consensual, moderately contentious, or highly contentious?

3. How has the history of the major issues affected:

   a) your approach to management?
   b) the number and type of organizational linkages?
   c) the level of conflict and ease or difficulty of resolution?

4. Can any of these issues be linked to or exacerbated by climate variability?

III. UTILITY OF CLIMATE FORECASTS

A. KNOWLEDGE OF CLIMATE DYNAMICS

1. Are you familiar with any of the following climate variability and climate change phenomena included in our study? *(Note level of familiarity if applicable)*

   El Niño/Southern Oscillation (warm-wet/warm-dry)
   Pacific Decadal Oscillation
   Long Term Global Climate Change (long term sea-level rise)

2. Would any of these factors influence or change your decision-making process? In what way?

3. Have you noticed a connection between El Niño events and changes in your areas of interest/responsibility?

4. How could the use of forecasts which take into account the El Niño phenomenon serve you better?

5. Do you use climate information in your management responsibilities? If yes, what type? If not, have you ever considered what type of climate related information may be of use to you?

FORECAST TYPE RELEVANT USES

Temperature
Precipitation
Streamflow
Runoff
Sea Surface Temp.
Wind Speed
Wind Direction
Projected Wave Height
Soil Saturation

B. BARRIERS

1. Are there requirements in your enabling legislation which mandate consideration of climate related issues? Are there legal requirements which prevent you from factoring in climate change information?

2. Do you see a need for a change in the law?

3. What is the major barrier preventing you from factoring in climate related information in your decision-making process?

C. SENSITIVITY AND VULNERABILITY

1. In your perception, how sensitive is your management system or decision making process to climate variability and change? *(Sensitivity is defined as how activities change as the climate changes, indicating that adaptation is possible.)*

2. Is your decision-making process flexible and/or adaptable to climate change and climate variability? On what timescales?

3. Given your response capability, how vulnerable are the coastal resources you manage to the impacts of climate variability and change? *(Vulnerability is defined as when the climate event exceeds the response capabilities, and therefore, adaptation is not possible.)*

4. What are the risks to the resources you manage given your response capability? On what time and space scales?

D. CAPACITY

1. What is the size of your organization's total staff? What portion of them do you consider to be scientific, technical and administrative?

2. Does your organization have scientific and or technical capacity to use climate related information?

3. Has your organization ever performed a formal needs assessment with respect to climate information? If yes, please provide a copy. If no, have you done or plan to do, an informal assessment of your needs in this area? If so, would you care to share the results?

E. CLIMATE INFORMATION

1. Do you currently receive climate information, including forecasts, and if so in what form does it come? (Specify type, source, and actual format, i.e. email, web, or hard copy.) If yes, continue.

2. Is there a different format that might increase the utility of the information?

3. When you receive the forecasts, what exactly do you do with them?

4. What additional climate information would you like to receive that you do not currently receive and in what form?

5. If you receive forecasts, are they received in a timely fashion?

   a. Do they arrive at the scheduled time?
   b. Do they arrive before you have to make irreversible management decisions?
   c. If not, how do you compensate for this?

Interview Participants

#	Name of Participant	Organization	Address
1	Matt Spangler, Director	Lincoln County Department of Planning and Development (LCDPD)	Public Service Building 210 SW Second St Newport 97365 (541) 265-4192
2	Joanne Spencer	Tillamook County Emergency Management (TCEM)	5995 Long Prairie Road Tillamook 97141 (503) 842-3412
3	Arthur Ayre, Economist	Oregon Economic Development Department (EDD)	775 Summer St. NE Salem 97310 (503) 986-0101
4	Earl Johnson, Western Regional Manager/Field Operations	Division of State Lands (DSL)	775 Summer St. NE Salem 97310 (503) 378-3805
5	Abby Kershaw, Section Director/Financial & Recovery Services	Department of State Police Oregon Emergency Management (OEM)	595 Cottage St. NE Salem 97310 (503) 378-2911
6	Paul Klarin, Coastal Program Specialist	Department of Land Conservation and Development (DLCD)	1175 Court St. NE Salem 97310 (503) 373-0050
7	Barry Norris, State Engineer	Oregon Water Resources Department (OWRD)	158 12th St. NE Salem 97310 (503) 378-3739
8	Dr. George R. Priest, Coastal Geologic Hazards Specialist	Oregon Department of Geology & Mineral Industries (DOGAMI)	800 NE Oregon St. # 28, Suite 965 Portland 97232 (503) 731-4100
9	Steve Williams, Coastal Land Use Coordinator	Oregon Parks and Recreation Department (OPRD)	South Beach State Park 5580 S. Coast Hwy South Beach 97366 (541) 867-3340
10	Roxanna Hinzman, Sci-Technical Coordinator	Tillamook Bay National Estuary Project (TBNEP)	P.O. Box 493 Garibaldi 97118 (503) 322-2222
11	D. Leslie Miller, Chief, Emergency Mgmt Operations, Construction & Readiness Division	US Army Corps of Engineers (ACOE) (Portland District)	333 S.W. First Ave Portland 97204 (503) 808-4400
11	Chuck Mason, Project Manager Programs and Project Mgt.	US Army Corps of Engineers (ACOE) (Portland District)	333 S.W. First Ave Portland 97204 (503) 808-4735

Appendix B

Other Coastal Management Agencies

Relevant Federal Entities

The Clean Water Act requires the **Environmental Protection Agency (EPA)** to protect virtually all aspects of the nation's water resources. One concern is the protection of wetlands. Under NEPA, the EPA set the standards for Section 404 of the Clean Water Act and thus has authority, with the Corps, in regulating removal and fill in wetlands. The EPA Office of Policy, Planning and Evaluation has been instrumental in developing a technical information base and a network of scientific and policy experts addressing sea level rise. The EPA also contributes funding for watershed plan development in order to better recognize major environmental threats.

The **National Estuarine Research Reserve** is a program that provides funding for designated reserves for the study and evaluation of the cause and effects of natural and anthropogenically induced changes in the ecology of estuaries and estuarine-like ecosystem. The **South Slough** NERR designated in Oregon is operated by the Division of State Lands under a cooperative agreement with the U.S. Department of Commerce (NOAA). The Reserve is oriented toward research, education, and stewardship, but also offers recreational facilities. A commission appointed by the Governor provides policy guidance for management of the Reserve.

The **U.S. Fish and Wildlife Service** has the responsibility for guiding conservation, development, and management of resources. They also participate in the Army Corps permitting process. Other federal agencies, such as the **United States Geological Survey (USGS)** and the **Department of Agriculture (DOA)** offer technical support when relevant issues arise on the coast.

Relevant State Agencies

The **Oregon Department of Fish and Wildlife (ODFW)** regulates harvests in the coastal zone and conducts research, manages refuges, propagates fish, and reviews land use plans and water use activities to assure protection of fish and wildlife habitat. As part of the permit review and consultation process, ODFW acts in an advisory capacity to OPRD and DSL. **The Health Division** establishes sanitary boundaries for harvest, reviews and approves construction of modified public water systems, and sets standards for new and existing water systems. The **State Building Code Agency** is responsible for setting building standards for developments and the **Department of Commerce**, through the **Housing Division**, provides state guidance on housing policies expressed through plan review. They are also responsible for subsidizes construction of new housing, administering state building codes, and issuing building permits in those jurisdictions that do not employ local building officials.

Sea Grant and universities provide other sources of information and research, such as providing numerical models of beach and foredune erosion, designed to evaluate the ocean processes and sediment transport in order to determine oceanfront construction setbacks in dune environments.