COASTAL EROSION CHAPTER

Introduction

Beaches and coastal bluffs are some of the most dynamic landforms, responding to a myriad of variables. Both landforms are constantly changing (at varying time scales) as they respond to changes in the ocean processes (waves, nearshore currents and tides) that affect the beach and toe of the bluff as well as those sub-aerial processes (rainfall, sun, wind) that directly affect coastal bluffs. There are many dangers inherent in living on the coast. While coastal bluffs gradually erode over the long-term, they can also respond very rapidly at times sliding away (in a matter of minutes to a few hours) so that homes and sections of highways are damaged or destroyed. Beaches are especially dynamic features, as sand is constantly shifted about. This is especially noticeable in major storms, with the shoreline retreating rapidly, periodically destroying homes built too close to the sea. At other times, large quantities of sand migrate back onto beaches, burying homes built atop coastal dunes.

The Capes, a multi-million dollar condominium complex constructed on an old Holocene dune field adjacent to Oceanside. Due to the erosion of sand at the toe of the bluff during the 1997-98 El Niño winter, the bluff face began to fail threatening a number of condominiums built near the bluff edge. (photo courtesy of DOGAMI)

A) Erosion at Salishan Spit
B) Sand accumulation around houses at Pacific City
(photos courtesy of Dr. Paul Komar, Oregon State University)

There is no location on the Oregon coast that is immune to coastal hazards. Without question, the most important natural variables that influence changes to the shape and width of the beach and ultimately its stability are the beach sand budget (balance of sand entering and leaving the system) and the processes (waves, currents, tides, and wind) that drive the changes.

Furthermore, human influences associated with jetty construction, dredging practices, coastal engineering, and the introduction of non-native dune grassed have all affected the shape and configuration of the beach, including the volume of sand on a number of Oregon's beaches, ultimately influencing the stability or instability of these beaches. A full list of acronyms used in this chapter is provided in Appendix 8-B.

Hazard Analysis/Characterization

Figure CE-1: Littoral cells of the Oregon coast (from DOGAMI)

The Oregon coast is a 360-mile long stretch of generally wide, gently sloping sandy beaches separated by headlands. The present coastline is the result of geologic processes that include a rise in sea level as Ice Age glaciers melted. Sandy beaches, which are generally a few miles to tens of miles long, and bounded by resistant headlands at their northern and southern extents are called “pocket beach” littoral cells (Figure CE-1 on the next page). Headland capes effectively prevent the exchange of sand between these littoral cells.

Some beaches form barrier spits, creating estuaries or bays behind them. Eroded sea cliffs back other beaches. About 72% of the coastline consists of sandy beaches backed by either dunes or bluffs, while the remaining 28% of the coast is comprised of a mixture of rocky cliffs (including headlands), rocky shores, mixed sand and gravel beaches, and gravel beaches.

Sand Budget

The beach sand budget is the rate at which sand is brought into the coastal system versus the rate at which sand leaves the system. A negative balance means that more sand is leaving than is arriving and results in erosion of that segment of shoreline. A positive balance means that more sand is arriving than is leaving, expanding that segment of shoreline. Along the Oregon coast, potential sources of sand include rivers, bluffs, dunes, and the inner shelf. Potential sand sinks include, bays (estuaries), dunes, dredging around the mouths of estuaries, and mining of sand (photo of sand erosion, page 1).

Attention is often focused on the effects of beach and dune erosion. Yet, there are segments of Oregon's coast where periodically the concern is excess sand build-up, as has occurred in places like Pacific City, Manzanita, Bayshore Spit, Nedonna and Cannon Beach (photo of sand accumulation, page 1).

CLASSIFYING COASTAL HAZARDS

Natural hazards that affect coastal regions can be divided into two general classes, chronic and catastrophic:

Chronic hazards are those we can see clear evidence of along the shore: beach, dune, and bluff erosion, landslides, slumps, and flooding of low-lying lands during major storms. The damage caused by chronic hazards is usually gradual and cumulative. However, storms that produce large winter waves, heavy rainfall and/or high winds may result in very rapid erosion or other damage that can affect properties and infrastructure over a matter of hours. The regional, oceanic, and climatic environments that result in intense winter storms determine the severity of chronic hazards along the Oregon coast. One should be aware that the Oregon coast is exposed to one of the most extreme ocean wave climates in the world. As a result, it is not uncommon during storms for the wave heights to exceed 33 ft over the course of a winter season.

Catastrophic hazards are regional in scale and scope. Cascadia Subduction Zone earthquakes, and the ground shaking, subsidence, landsliding, liquefaction, and tsunamis that accompany them are catastrophic hazards. Tsunamis generated from distant earthquakes can also cause substantial damage in some coastal areas. More information about the processes of earthquakes, tsunamis, floods, and landslides can be found in the specific chapters on each of those hazards.

Chronic hazards are local in nature, and the threats to human life and property that arise from them are generally less severe than those associated with catastrophic hazards. However, the wide distribution and frequent occurrence of chronic hazards makes them a more immediate concern.

CAUSES OF COASTAL HAZARDS

Chronic coastal hazards include periodic high rates of beach and dune erosion, sand inundation, “hotspot erosion” due to the occurrence of El Niños and from rip current embayments, intermittent coastal flooding as a result of El Niños, storm surges and high ocean waves, and the enduring recession of coastal bluffs due to long-term changes in mean sea level, variations in the magnitude and frequency of storm systems, and climate change. Other important hazards include mass wasting of sea cliffs such as slumping and landslides, which may be due to wave attack and geologic instability.

Most of these hazards are the product of the annual barrage of rain, wind, and waves that batter the Oregon coast, causing ever-increasing property damage and losses. A number of these hazards may be further exacerbated by climate cycles such as the El Niño Southern Oscillation, or longer-term climate cycles associated with the Pacific Decadal Oscillation. Other hazards, such as subduction zone earthquakes and resulting tsunamis, can have catastrophic impacts on coastal communities’ residents and infrastructure, and in many areas these impacts will persist for many decades following the event due to adjustments in the coastal morphodynamics following subsidence or uplift of the coast. All of these processes can interact in complex ways, increasing the risk from natural hazards in coastal areas.

Wave Attack and Ocean Water Levels

Along dune- and bluff-backed shorelines (72% of Oregon's coast), waves are the major factor that determine the shape and composition of beaches. Waves transport sand onshore (towards the beach), offshore (seaward to form nearshore bars etc.), and along the beach (longshore transport). Short-term shoreline stability (i.e. storm related changes) is directly dependent on the size of the waves that break along the coast, along with high ocean water levels, and cell circulation patterns associated with rip currents.

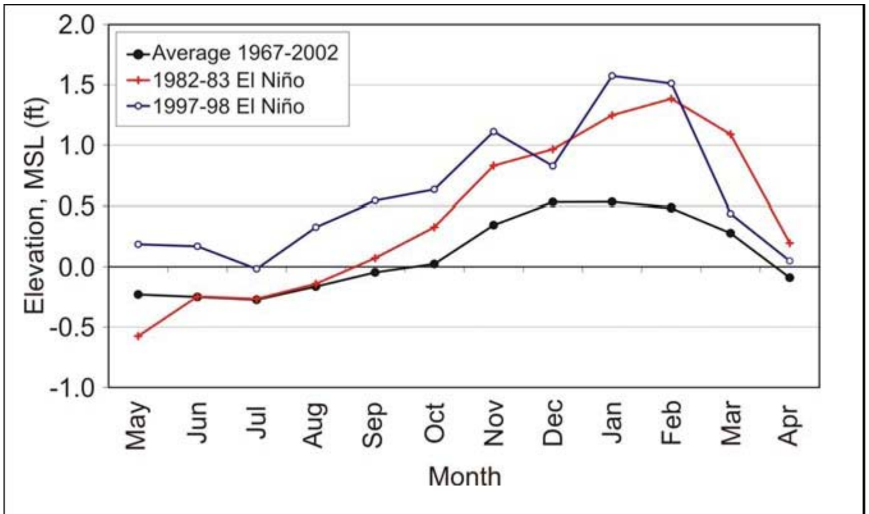

Figure CE-2: Monthly mean tidal averages for the Yaquina Bay Tide gage expressed as an average for the period 1967 – 2002, and as monthly average for the 1982-83 and 1997-98 El Niños

The elevation of the sea is controlled in part by the astronomical tide. High ocean water levels at the shoreline may be the product of combinations of high tides, storm surges, strong onshore-directed winds, El Niños and wave runup (Figure CE-2). When large waves are superimposed on high tides, they can reach much higher elevations, contributing to significantly higher rates of coastal erosion. It is the combined effect of these processes that leads to the erosion of coastal dunes and bluffs, causing them to retreat landward.

Dune-backed shorelines respond very quickly to storm wave erosion, sometimes receding tens of feet during a single storm, and hundreds of feet in a single winter season. Beach erosion has reached as much as 150 feet along the Neskowin and Netarts littoral cells, and as much as 195 feet adjacent to Port Orford.

Winds and waves tend to arrive from the southwest during the winter and from the northwest during the summer. Net sand transport tends to be offshore and to the north in winter and onshore and to the south during the summer (Figure CE-3). El Niño events can exaggerate the characteristic seasonal pattern of erosion and accretion, and may result in an additional 60–80 feet of "hotspot" dune erosion along the southern ends of Oregon's littoral cells, particularly those beaches that are backed by dunes, and on the north side of estuary inlets, rivers and creeks.

The processes of wave attack significantly affect shorelines characterized by indentations, known as inlets. Waves interact with ocean tides and river forces to control patterns of inlet migration. This is especially the case during El Niño's. During an El Niño, large storm waves tend to arrive out of the south, which causes the mouth of the estuary to migrate to the north, where it may abut against the shoreline, allowing large winter waves to break much closer to the shore. This can result in significant "hotspot" erosion" north of the estuary mouth. Recent examples of the importance of inlet dynamics during an El Niño are the Bayshore Spit at Waldport,Netarts Spit near Oceanside, and at Hunter Creek on the southern Oregon coast at Gold Beach.

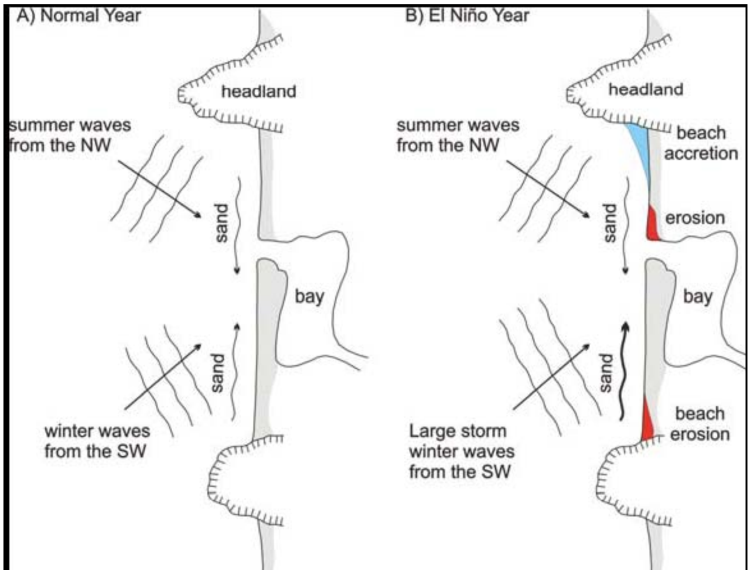

Figure CE-3: Patterns of sediment transport during "normal" and El Niño years (From Komar 1986)

The Oregon coast experiences some of the most extreme wave conditions in the world. Waves are characteristically highest in December and January (~9 to 13 feet on average) and smallest (less than 7 feet) between June and September. Previous analyses of extreme waves for the Oregon coast estimated the "100-year" storm wave to be around 33 feet. In response to the large wave events that occurred during the latter half of the 1990s, the wave climate was re-examined. The 100-year storm wave height is now estimated to reach approximately 52 feet (Table CE-1).

Recurrence Interval (*years*)	**Extreme Wave Heights** (*feet*)
10	39.7
25	44.3
50	47.6
75	49.2
100	52.5

Figure CE-4: Projection of extreme wave heights for various recurrence intervals: Each wave height is expected to occur on average once during the recurrence interval

Floods

Flood Insurance Rate Maps (FIRMs) and Flood Insurance Studies are also often used in characterizing and identifying flood-prone areas. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. Included were "VE" zones, areas subject to wave action and ocean flooding during a "100-year" event that encompass the area extending from the surfzone to the inland limit of wave runup, and/or wave overtopping and inundation, and or the location of the primary frontal dune or any other area subject to high velocity wave action from coastal storms. Areas identified as VE zones are subject to more development standards than other flood zones. Currently, DOGAMI is working with FEMA to update and remap FEMA coastal flood zones established for coastal communities along the Oregon coast.

Landslides

Simple surface sloughing is the dominant process along bluff-backed shorelines. Other shorelines are backed by steep slopes and landslides, where deep-seated landslides and slumping are the dominant processes (photo of The Capes on page 1 and below). The geologic composition of the bluff is a primary control on slope stability. Headlands, generally composed of basalt, are more resistant to erosion and do not readily give way. In contrast, soft bluff-forming sandstone and mudstone are highly susceptible to slope movement. Prolonged winter rains saturate these porous bluff materials, increasing the likelihood of landslides.

The geometry and structure of bluff materials also affect slope stability by defining lines of weakness and controlling surface and subsurface drainage. By removing sediment from the base of bluffs and by cutting into the bluffs themselves during storm wave attack, the bluffs become increasingly vulnerable to slope failure. The extent to which the beach fronting the bluff acts as a buffer is thus important in this regard. Thus a reduction in the sand beach volume in front of a bluff increases its susceptibility to wave erosion along its toe, which can eventually contribute to the failure of the bluff. A recent example of such a process occurred at Gleneden Beach in Lincoln County in November 2006 (photo below), when a large rip current embayment (an area of the beach that exhibits more erosion and beach narrowing due to removal of sand by rip currents) formed in front a portion of the bluff, allowing waves to directly attack the base of the bluff. In a matter of two days, the bluff eroded back by up to 30 ft, undermining the foundation of two homes, almost resulting in to their destruction. Similar processes occurred nearby during the 1972/73 winter, which led to one home having to be pulled off its foundation. Both examples provide a stark reminder of the danger of building too close to the beach and that these types of changes do occur relatively frequently.

Human Activities

Human activities affect the stability of all types of shoreline. Large-scale human activities such as jetty construction and maintenance dredging have a long-term effect on large geographic areas. This is particularly true along dune-backed and inlet-affected shorelines such as the Columbia River and Rockaway littoral cells (Figure CE-1). The planting of European beachgrass (Ammophila arenaria) since the early 1900s, and more recently American beachgrass (Ammophila breviligulata) has locked up sand in the form of high dunes. Such a

The Capes, adjacent to Oceanside, Oregon: note the scarp failure along the top edge of the developed dune. (photo courtesy of OEM) process can contribute to a net loss in the beach sand budget and may help drive coastal erosion.

Residential and commercial development can affect shoreline stability over shorter time periods and smaller geographic areas. Activities such as grading and excavation, surface and subsurface drainage alterations, vegetation removal, and vegetative as well as structural shoreline stabilization can all affect shoreline stability.

While site-specific coastal engineering efforts such as the construction of riprap revetments is less likely to cause direct adverse impacts to the beach, ***the cumulative effect of constructing many of these structures along a particular shore*** (e.g. as has occurred along the communities of Gleneden Beach, Siletz Spit, Lincoln City, Neskowin, Pacific City, and Rockaway) ***will almost certainly decrease the volume of sediment being supplied to the beach system***, potentially affecting the beach sediment budget and hence the stability of beaches within those littoral cells.

Heavy recreational use in the form of pedestrian and vehicular traffic can affect shoreline stability over shorter time frames and smaller spaces. Because these activities may result in the loss of fragile vegetative cover, they are a particular concern along dune-backed shorelines. Graffiti carving along bluff-backed shorelines is another byproduct of recreational use that can damage fragile shoreline stability.

Existing Strategies and Programs

Much is understood about how to reduce potential damages from coastal hazards. Some mitigation tools are part of the standard practices used by engineering and geologic professionals, while other tools are specific to Oregon. The Oregon *Technical Resource Guide* (TRG) describes existing programs and strategies for coastal hazards. It contains a summary of the authorities and responsibilities that local, state, and federal agencies have that affect coastal erosion.

Identify and characterize the hazard: Hazard identification and characterization (risk assessment) is a significant part of the foundation for developing a plan for mitigating natural hazards.

Implement mitigation measures: Hazard mitigation techniques are most effective when implemented on an area-wide basis (for example, minimizing potential losses by requiring low density development in hazard areas). In some cases, however, mitigation techniques can be implemented on a site-specific basis.

Avoid the hazard: For areas with high risk potential for severe property damage or loss of life, development restrictions are an option.

Evaluate site-specific development: Communities can require site-specific geotechnical reports to evaluate hazards. Developers can be required to have remediation steps approved by geotechnical and engineering design professionals.

Figure CE-5: Hazard Mitigation Approaches

General Mitigation Strategies

The most effective way to reduce risk is to avoid development in hazard areas.

There are, however, many areas in Oregon where some degree of hazard is unavoidable.

A wide range of techniques is available to reduce risks associated with chronic coastal hazards (Figure CE-4). When choosing a risk reduction technique, the type of hazard and physical location must be considered. For example, methods that address rapid erosion along dune-backed shorelines may not be applicable to some bluff-backed shorelines where slow moving landslides are the primary concern. A broad range of economic, social, and environmental factors should be considered in evaluating each alternative in order to choose the most appropriate mitigation technique[1].

Ocean Shores Regulation

The Oregon Parks and Recreation Department (OPRD) is responsible for protecting the scenic, recreational, and natural resource values of the Oregon coast. OPRD accomplishes this through an extensive permitting program for shoreline protection under the authority of The Ocean Shores Statutes (ORS 390.605 - 390.770), also known as the Beach Bill. OPRD is the permitting authority for actions affecting the ocean shorelands up to the statutory vegetation line or the current vegetation line, whichever is furthest landward.

The Ocean Shores Statutes require that a permit be obtained from the OPRD for all "beach improvements" seaward of the Statutory Vegetation Line or the actual vegetation line, whichever is farther inland. Permits for shoreline protective structures may be issued only for developments established on the property) that existed on January 1, 1977. This includes properties with buildings, or vacant subdivision lots that had improved streets and utilities provided to the lot on January 1, 1977.

OPRD approval is also required for foredune management plans and subsequent dune management, resloping or other alterations of bluff slopes below the vegetation line, alteration of stream channels on the ocean shore, and other ocean shore alterations associated with hazard mitigation.

The Department of State Lands (DSL) regulates removal and filling of the seabed (seaward of the extreme low tide line) and estuaries, including any dredged materials or seabed materials. DSL manages the state-owned seabed within three nautical miles of the low tide line.

In some instances, a permit may also be required from the U.S. Army Corps of Engineers. When a Corps permit is required, the Oregon Department of Environmental Quality may also need to issue a water quality certification and the Department of Land Conservation and Development (DLCD) a coastal zone concurrence before the Corps can issue a final permit.

The U.S. Army Corps of Engineers is responsible for the protection and development of the nation's water resources to ensure that they are used in the public interest (Figure CE-5). Any person, firm, or agency planning work in the waters of the United States must first obtain a permit from the Corps. Permits are required even when land next to or under the water is privately owned. Examples

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[1] For details see http://www.oregon.gov/LCD/ODMP/Publications.shtml -*Appraisal of Chronic Hazard Alleviation Techniques*

of activities in waters that may require a permit include: construction of a pier, placement of intake and outfall pipes, dredging, excavation and depositing of fill. Permits are generally issued only if the activity is found to be in the public interest. DLCD reviews and certifies that Corps permits and other federal activities are consistent with state and local requirements for protecting coastal resources.

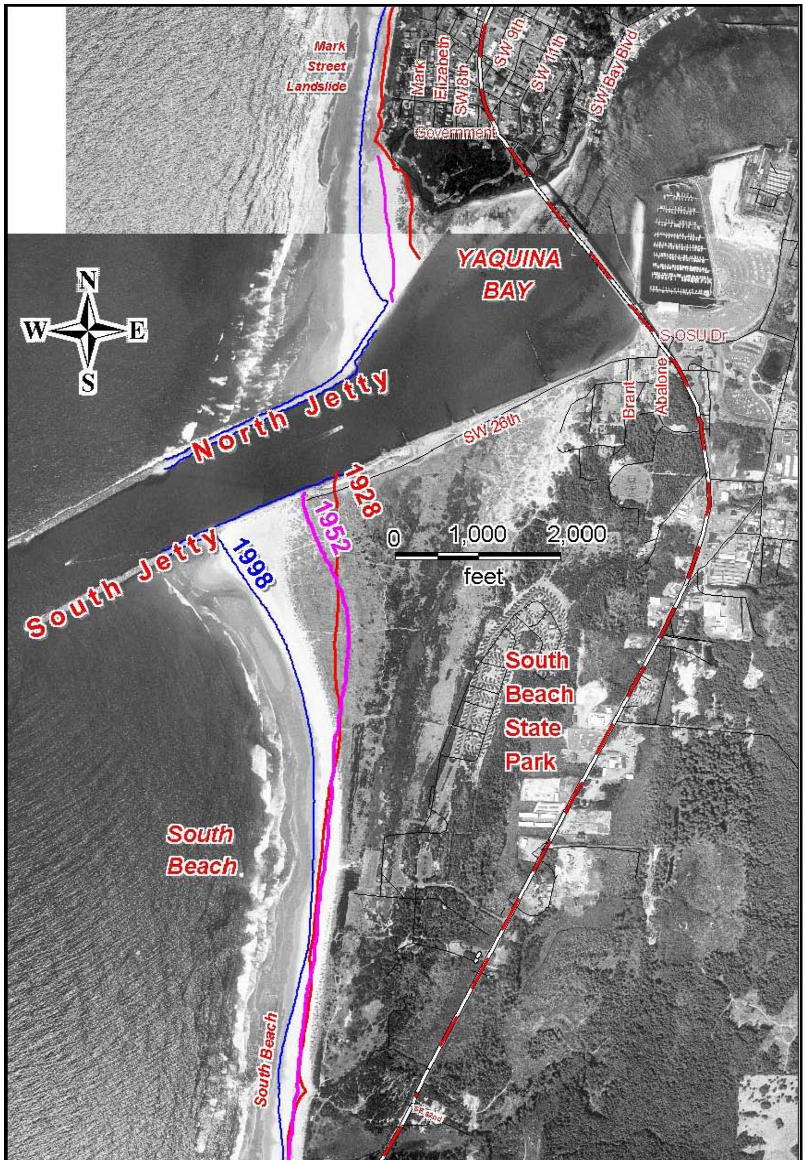


Figure CE-6: The U.S. Army Corps of Engineers maintains the jetties and channel at Yaquina Bay in Newport. Historical chorelines are taken from National ocean Service topographic maps and from a 1998 LIDAR survey done by U.S. Geological Survey. Note how jetty construction has caused the sand accretion, moving the shoreline progressively westward. Base map is a 1993 orthophotograph.

(from DOGAMI archives)

Education Programs

Education programs play a pivotal role in reducing risk from coastal hazards. The amount of preparation an individual is willing to do depends on how well they understand the problem. Realistic perceptions can minimize potential risk by influencing siting and design decisions.

Educational materials are available from a wide variety of sources, including the American Red Cross, Oregon Sea Grant, Oregon Partnership for Disaster Resilience, Military Department, Oregon Emergency Management, Department of Geology and Mineral Industries, and the Oregon Department of Land Conservation and Development.

A guide to further resources appears at the end of this chapter.

Engineering Solutions

A variety of engineering solutions are available for protecting property and infrastructure. All these solutions will require maintenance to fix damage caused by wave attack. Property owners must generally obtain permit approvals before installing beach protection structures of any type. See the TRG Coastal Chapter for a description of local, state, and federal roles in regulation of beach protection structures. Property owners should anticipate a need to explore alternatives to structural projects and to investigate various types of structural approaches (i.e., "soft" and "hard" approaches).

Construction of a rip rap revetment along the shores of Neskowin essentially halts the erosion of the dunes and fixes the shoreline in place. (photo courtesy of OSU)

A "dynamic revetment" cobble berm at Cape Lookout State Park (photo courtesy of DOGAMI)

<u>Soft stabilization</u> refers to techniques that reduce potential risk by enhancing the natural shoreline system. These techniques include foredune enhancement, beach nourishment, and boulder berms, a form of dynamic revetments. Soft stabilization techniques are potentially applicable along both dune-backed and bluff-backed shorelines with both high and low intensity use.

<u>Hard stabilization</u> refers to techniques that attempt to fix the position of the shoreline. Specific techniques include groins, breakwaters, rock revetments, and seawalls. Hard stabilization techniques are potentially applicable along both dune-backed and bluff-backed shorelines, and along shorelines with either high or low levels of development. Over a long period of time, however, hard stabilization measures can cause a loss of beach in front of the structures.

Reducing Landslides

A variety of techniques can be used to improve slope stability and slow the weathering of a slope surface. These strategies include vegetation management, drainage controls, slope regrading, reinforcing structures, and surface fixing. These techniques are typically applied in combination. They are principally applicable along bluff-backed shorelines with both high and low levels of use.

Land Use Planning

Permits

State permitting agencies are required by state statute and rule to ensure that their permit decisions affecting land use are compatible with local land use programs. A common approach used by state permitting agencies is to request local review of the permit application and completion of a local land use compatibility statement (LUCS) by the local government. The LUCS indicates whether the local government has reviewed the project, if local permits or other approvals are required, and if the project is consistent with the local land use requirements.

When federal permits are required, two state agencies – the Departments of Land Conservation and Development (DLCD) and Environmental Quality (DEQ) – need to issue approvals before a final federal permit can be granted. DLCD is responsible for addressing compliance with the state's coastal zone management program, including local land use programs incorporated into the state program. DEQ is responsible for addressing compliance with state water quality standards. Both DLCD and DEQ must, in consultation with affected local governments, address local land use compatibility in their reviews.

Statewide Planning Goals

The Oregon Land Use Planning Act (ORS 197) requires all of Oregon's cities and counties to have comprehensive land use programs. Those local land use programs must be in compliance with state standards known as the Statewide Planning Goals (OAR 660-015). Land use decisions are then made at the local level in conformance with the local comprehensive land use programs approved by the state as meeting the Goals.

Several of Oregon's Statewide Planning Goals are designed to mitigate the risk posed by natural hazards to ocean shore development and to protect ocean shore resources. Goal 17-Coastal Shorelands and Goal 18-Beaches and Dunes require local governments to adopt: (1) inventories of coastal hazards, (2) comprehensive plan policies for coastal hazards, and (3) local measures, such as zoning ordinances and development standards, that implement plan policies. In addition, Goal 8 prohibits development in dune areas subject to overtopping and undercutting. Goal 7, Areas Subject to Natural Hazards, also reinforces the requirement for coastal cities and counties to address coastal hazards in their land use programs. Goal 7 specifically identifies coastal erosion as one of the hazards that must be addressed. (See the TRG for additional discussion about Goals 7, 17, and 18.)

Natural resource protection laws are generally designed to protect significant resource areas, but they often result in some degree of hazard mitigation. When viewed as a risk reduction technique, natural resource protection planning is closely related to construction setbacks. Both attempt to reduce potential risk by influencing the location of development. Oregon's Statewide Planning Goal 17 requires protection of "major marshes, significant wildlife habitat, coastal headlands, and exceptional aesthetic resources." These requirements, as well as the requirement to maintain riparian vegetation, are all forms of natural resource protection law.

With respect to dune-backed shorelines, Statewide Planning Goal 18 requires that local governments and state and federal agencies "***prohibit residential developments and commercial and industrial buildings on beaches, active foredunes, on other foredunes which are conditionally stable and that are subject to ocean undercutting or wave overtopping, and on interdune areas that are subject to ocean flooding***." These requirements qualify as natural resource protection laws and actually address risk reduction directly.

Goal 18 also restricts the breaching or grading of foredunes to ensure shoreline stability and protect the source of sand in the dune beach system.

Statewide Planning Goal 7, Areas Subject to Natural Hazards, is designed to protect people and property from natural hazards. It requires local governments to consider new information related to a wide variety of natural hazards as it becomes available from state and federal agencies. They must then conduct a process to evaluate the risk from those hazards and adopt measures to mitigate that risk.

Statewide Planning Goal 5 may indirectly affect risk reduction, particularly flooding, through protection of wetland and riparian areas.

Rip embayments, as occurred at Gleneden Beach in November 2006, can locally result in tens of feet of erosion in a matter of a few hours, increasing the hazard risk to buildings and infrastructure built too close to the beach.

(photo courtesy of Tony Stein, OPRD)

Zoning and Other Techniques

Oregon's coastal cities and counties employ a variety of land use techniques to regulate development in hazardous locations. Land use regulation can reduce damage from coastal hazards by influencing the location, elevation, and design of existing and new development. Specific hazard mitigation techniques include zoning regulations and infrastructure planning; site, design and construction standards; construction setbacks; and relocation incentives and land acquisition programs.

Siting, design, and construction standards regulate aspects of development in an identified hazard area. Examples include standards governing the removal of existing vegetation, excavation and drainage controls, foundation standards, frame, and roof design, and required construction materials. Construction setbacks are appropriate for both dune-backed and bluff-backed shorelines.

Relocation incentives and land acquisition programs can be provided to move existing development away from an identified hazard. In some instances development is relocated on-site. In other instances it is necessary to move development off the site, or perhaps to demolish and reestablish it elsewhere at a new, safer location. Generally, some sort of subsidy is required to encourage relocation.

In some situations the most viable option may be to buy the entire parcel at market value. Land acquisition programs have broader applicability than relocation incentives because they may apply to undeveloped areas as well as to areas with existing development. Undeveloped areas can be acquired and preserved for recreation, open space, or other appropriate public purposes.

Hazard Mitigation Success

Safe

COASTAL EROSION

disaster avoided through hazard mitigation

Oregon Beach and Shoreline Mapping and Analysis Program (OBSMAP): Pacific Northwest Estuaries and Shores

http://www.oregongeology.org/sub/nanoos1/index.htm

In 2004, staff from DOGAMI initiated a pilot beach and shoreline observing effort along the Rockaway littoral cell in Tillamook County to begin documenting both short and long-term changes in beach dynamics. The beach observing program utilizes Real-Time Kinematic Differential Global Positioning System (RTK-DGPS) technology to regularly measure changes in the elevation and position of the dune and beach face as they respond to storms, El Niño climate events, and in the long-term, changes that may occur as a result of climate change. While the initial emphasis was focused on the Rockaway littoral cell (25 monitoring sites), the OBSMAP program has since been expanded to include other littoral cells, which include: the Clatsop Plains - Seaside north to the Columbia River (6 monitoring sites), Netarts – Cape Lookout to Cape Meares (24 sites), Neskowin - Cascade Head to Cape Kiwanda (15 monitoring sites), Beverly Beach - Yaquina Head to Otter Rock (15 monitoring sites), Newport littoral cell - Yachats to Yaquina Head (58 monitoring sites),Gold Beach – Cape Sebastian to Otter Pt. (21 monitoring sites), and Nesika Beach – Nesika to Sisters Rock (14 monitoring sites) . Beach surveys are carried out either on a quarterly basis, bi-annually or annually. Additional beach change information was derived from 1997, 1998, 2002 and 2008/2009 Light Detection and Ranging (LIDAR) data, extending the record of coastal change back to the late 1990s. All data are posted on the DOGAMI web page for easy viewing and access. This project is ongoing and is part of DOGAMI's effort to document climate change effects on the coast.

Locations: Coastal beach and bluff monitoring is presently occurring at various locations in Clatsop, Tillamook, Lincoln, and Curry counties.

Lead Agency: DOGAMI

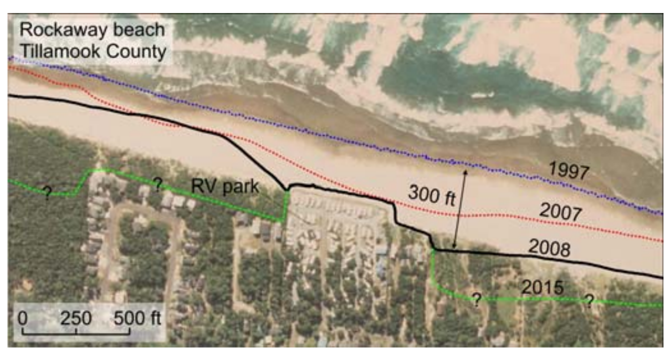
Support Agencies: NOAA, DLCD, OPRD

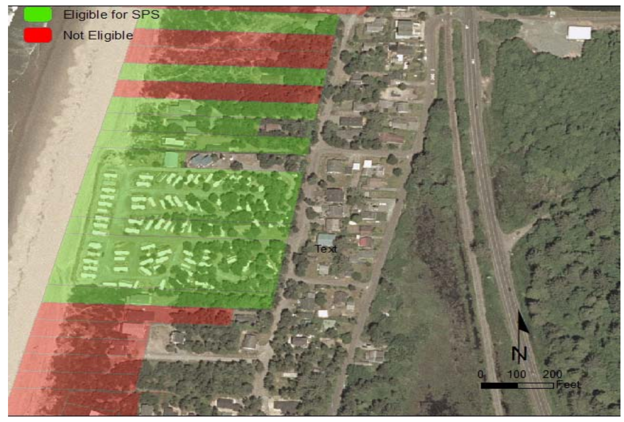
Project Type: risk assessment – quantitative data on coastal change (erosion and accretion) for 178 monitoring sites on the Oregon coast

Funding Sources: NOAA through the Integrated Coastal Observing System (ICOOS) initiative, the Coastal Management Program of the Department of Land Conservation and Development, and the Oregon Parks and Recreation Department.

Problem: The establishment of coastal setbacks (the distance to which property is "set back" away from an eroding beach) on the Oregon coast has in many cases occurred without good geologic information of the degree of erosion that occurs during major storms, or from long-term changes associated with climate variability and climate change. As a result, many homes on the Oregon coast have been built too close to the beach and are now being subjected to both coastal flood and erosion hazards.

Solution: The Oregon Department of Geology and Mineral Industries began measuring the response of beaches and bluffs to storm waves in October 2004 in order to provide up-to-date scientific information on the changes (erosion and accretion patterns) taking place on the Oregon coast. These data are now being used by the geotechnical community to assist with the design and placement of new property along the coast, as well as Oregon Parks and Recreation Department as part of their effort to better mange the beach.





Oregon Creates GIS Database for Shoreline Structure Eligibility

http://www.coastalatlas.net

The construction of riprap and other shoreline protective structures (SPS) continues to be a controversial issue facing the Oregon Coastal Management Program. A new tool being developed by Coastal Program staff at the Department of Land Conservation and Development will help identify properties where SPS permits applications can be submitted. This will assist local planners and state agencies with decision-making as well as long range planning on Oregon's beaches. Statewide Planning Goal 18 describes limitations on where oceanfront shoreline protective structures (SPS) can potentially be permitted. These limitations are based on whether development existed on individual properties on January 1, 1977. The term "development" can range from structures built on the property, to vacant, improved subdivision lots.

To build the project, a database table and form was developed that contain the necessary information to make a determination. This includes the parcel I.D, history of building, subdivision, and infrastructure improvements, comments regarding aerial photo interpretation, and information from city and county planners. Using this information, a final determination was made on whether the property owner is or is not eligible to apply for a permit. If eligible, the property owner may apply for a permit from the Oregon Parks and Recreation Department (OPRD), which eventually approves or denies the permit.

When converted to a GIS shapefile, the determinations can be graphically displayed, and the form information looked up in the attribute table. In addition to city and county use, the GIS mapping also helps OPRD visualize potential build-out of SPS, and consider revision of policies to keep certain beaches from being affected by shoreline armoring in the future. The maps also display potential conflicts for future permitting, where eligible properties adjoin ineligible properties. Transfer of the data to the Oregon Atlas creates easier access to the information without the need for GIS software.

Problem: Making a determination of whether a property is eligible to apply for a shoreline protection structures (SPS) permit on a case-by-case basis can be inefficient and time-consuming for local planners, and for the public at large, confusing. Some planning departments don't have inventories of eligible properties or they were vague and incomplete. Also, there are several examples where property owners found out too late that their property did not qualify for an SPS permit. There are also instances where eligible properties abut ineligible property which can cause conflicts for property owners and permitting agencies. To assist local planning departments, as well as other Coastal Management Program partners involved in long range planning for the ocean shore, the Department of Land Conservation and Development (DLCD) has created a GIS/database of permit eligibility for individual oceanfront tax lots, with the collaboration of cities and counties.

Solution: DLCD embarked on a database and mapping project to create a set of GIS shapefiles which indicate at the tax lot level, the status of Goal 18's provisions for SPS eligibility. Further, the maps have been added to the *Oregon Coastal Atlas*, so those without GIS software (including the public) can

Locations: The counties completed are Curry and Lincoln, with Clatsop and Tillamook in progress.

Lead Agency: DLCD

Support Agencies: local governments, Oregon State University, and Oregon Parks and Recreation Dept.

Project Type: planning – quantitative data at tax lot scale to produce informational maps for the entire ocean shoreline

Funding Source: NOAA through the §309 Special Area Planning Strategy

Appendix CE-1: Glossary

El Niño-Southern Oscillation: A cycle in the Pacific Basin involving water and air temperatures that has a profound effect on weather patterns around the world; events typically last 6-18 months

Foredune: A dune lying parallel to the ocean, occurring at the landward edge of the beach or at the landward limit of the highest tide, that has been stabilized by vegetation

Littoral cells: Beaches comprised of either sand and/or gravel that may be bounded by prominent headlands that limit sand exchange between adjacent littoral cells. Typically, the cells may range in length from a few miles to tens of miles.

Pacific Decadal Oscillation (PDO): A similar but longer-term cycle than the El Niño-Southern Oscillation with typical events lasting 20-30 years. During the warm (positive) phase of the PDO, El Niños tend to be prevalent, while the cold (negative) phase is dominated by mainly La Niñas.

Shoreline profile: A cross-section that shows the shape (elevation and slope) of a section of the beach

Subduction zone earthquake: Earthquake along the Cascadia Subduction Zone (CSZ), which lies offshore the

Oregon coast; previous earthquakes have been as large as moment magnitude (M_W) 9

Tsunami: A series of waves generated by undersea earthquakes or landslides; modeling and field research suggest waves of up to 40 feet, perhaps higher, are possible along the Oregon coast after a locally generated Cascadia Subduction Zone earthquake; distant (far field) earthquakes produce much smaller waves on the Oregon coast

Wave runup: The swash of a broken wave as it travels up the beach face

Appendix CE-2: Relevant Publications and Websites

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