IMPACT OF CLIMATE-INDUCED SEA

LEVEL RISE ON COASTAL AREAS

STATEMENT OF:

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Introduction

A significant portion of the world's population lives within the coastal zone, with many buildings and facilities built at elevations less than 10 feet above mean high tide level along the shoreline. Presently, many of these structures are not adequately above existing water levels or located far enough landward to adequately ensure their survival and safety of the people during major storm activity. This hazard has grown increasingly apparent and serious along much of the U.S. East and Gulf coasts, particularly the highly urbanized sandy barriers, as relative sea levels have risen during the twentieth century.

The general effect of sea level rise on coastal lowlands is to induce landward retreat -- beaches erode and marshes are lost. Most sandy shorelines worldwide have experienced recession during the past century. Such has also been the case along the U.S. coasts; historical data indicate that about 90 percent of our sandy beaches are eroding. Accelerated sea level rise due to greenhouse-induced global warming will only increase erosion rates and exacerbate the present shoreline dilemma. Also, coastal marshlands will be lost at ever-increasing rates, with the nation's marshes perhaps disappearing at the high rates of loss presently experienced in Louisiana.

Coastal Wetlands

Coastal wetlands account for much of the land less than 5 feet above sea level. These extensive marshes, swamps, and mangrove forests fringe most of the U.S. coastline, particularly along the Atlantic and Gulf coasts. These areas are vital to our fisheries industry, maintenance of water quality, and are important in coastal recreation.

Salt marshes exist in a delicate balance with water levels. With gradual sea level rise (due to local subsidence or worldwide changes), marshes can generally keep pace by trapping sediments in the water column and through accumulation of their own organic material (dead stems and leaves). However, an imbalance can develop if sea levels rise significantly faster than deposition on the marsh surface, eventually resulting in waterlogging and loss.

Land losses in most wetlands result from a combination of mechanisms, with shoreline erosion at the seaward edge of the marsh being the most obvious process. This factor can be expected to accelerate with increased water levels, but shoreline erosion probably accounts for only a few percent of all marsh losses annually. Most marshes will be long since submerged before extensive shoreline erosion occurs.

A more probable catastrophic mechanism of marsh loss with a significant increase in sea levels (e.g., several feet) will be formation of extensive interior marsh ponds. These shallow-water bodies enlarge and coalesce at the expense of marsh vegetation in response to rapid coastal submergence. The magnitude of such losses can be quite extensive as shown by studies at the Blackwater Wildlife Refuge in Maryland, where over one-third of the total marsh area (about 5,000 acres) was lost between 1938 and 1979 by this process. These marshes are being lost because sea levels outpace the ability of the marsh to maintain elevation, ultimately resulting in root death of the marsh plants.

Beaches and Coastal Barriers

Most sandy shorelines worldwide have retreated during the past century. Progradation has been restricted to coastal areas where excess sediment is supplied by river sources or where the land is being elevated due to uplift in some northern regions (e.g., Maine). Human interference cannot be considered a primary cause of erosion since retreat also occurs on sparsely populated and little-developed sandy coasts. Such recession could result from an increase in storminess, but this trend would have to be almost worldwide to account for erosion on geographically dispersed sandy shorelines. Therefore, in view of the demonstrated general relative rise of sea level along the U.S. shoreline, the link between shore retreat and sea level rise is based on more than circumstantial evidence; it can be stated that the relationship is causal in nature.

In some areas, it is clear that human actions have caused substantial erosional pressures. Undoubtedly the principal problem has been construction of jettied inlets and deepening of channel entrances for navigation. Along shorelines with high rates of longshore sediment transport, these constructed features trap sediment at the updrift jetty and, if material dredged from the navigation channel is not placed on the downdrift beaches, cause an amount of downdrift erosion equal to the reduction in transport. At some Florida entrances, tens of millions of cubic yards of dredged material have been dumped offshore and thus are permanently removed from the beach. This has resulted in very high erosion concentrated downdrift of tidal inlet entrances.

Historical data (maps and aerial photographs) can be used to determine rates of shoreline change. Over one hundred years of record are available for the U.S. coasts from the National Ocean Service of the National Oceanic and Atmospheric Administration (NOAA). This accurate informational base has been utilized for large stretches of the coastline (including much of the U.S. Atlantic and parts of the Gulf and Pacific coasts) to determine historical rates of beach erosion and barrier recession.

The national (unweighted) average rate of shoreline recession is slightly more than one foot per year. Along the Atlantic coast, beach erosion has historically amounted to about two to three feet per year, with the Virginia barrier islands exhibiting the highest rates of erosion (tens of feet per year). The Gulf coast states are distinguished by having the highest average erosion rate in the nation (over five feet per year). While parts of the Florida panhandle are fairly stable or only slightly eroding, the deltaic coast of Louisiana is by far the most dynamic (15 feet/year of erosion on average). The Pacific coast is essentially stable on average, considering the fact that more than half of the shore is hard rock. Locally there are severe erosion problems (e.g., Oceanside, CA), and winter storms have caused dramatic losses of very valuable property in recent years where the beaches are already quite narrow (e.g., Malibu during the 1981-82 storm season).

A number of techniques have been developed to project shoreline retreat due to sea level rise (see 1987 National Academy of Sciences report). Accelerated sea level rise due to the greenhouse effect will increase the erosion rate and cause stable beaches to begin eroding. Based upon the projected rates of sea level rise, it is estimated that sandy beaches will erode at two to five times their current rate. This portends major problem for low-lying areas, such as coastal Louisiana, and increased problems at such beach resorts as Ocean City, Maryland, where the historical rate of beach erosion has amounted to two feet per year. Many of the urbanized beaches along the East and Gulf coast barrier chain are already critically narrow and in need of beach nourishment to protect the existing buildings and infrastructure. Such is the case at Ocean City, Maryland, where a $30 million beach fill project is scheduled to begin next spring. Elsewhere, many other recreational beaches have been nourished (e.g., Atlantic City, NJ; Myrtle Beach, SC; Miami Beach, FL). The expected lifetime of nourished beaches will be greatly foreshortened by accelerated sea level rise, increasing the frequency and magnitude and hence the cost of such activitie

Responses

There are three general responses to accelerated shoreline erosion: retreat from the shore, (2) armor the coast, or (3) nourish the beach. Th choice of a response strategy will depend upon a number of factors, includ socioeconomic and environmental conditions. The decisions reached will likely be site-specific so that each area/community must be evaluated separately.

For highly urbanized areas, such as Miami Beach, FL or Ocean City, MI the abandonment option is not realistic. The value of such beachfront property with high density and high-rise structures often approaches $100 million per mile, making beach restoration the most attractive alternative Elsewhere, sea walls have been constructed to stabilize the shore and prot coastal communities from the ravages of major hurricanes (e.g., Galveston, TX). For eroding shorelines that are less developed, the decision becomes more difficult. Therefore, the costs and benefits of protection must be weighed against those of retreating from the shoreline.

Conclusions

1. Worldwide sea levels have risen about one-half foot in the past cent The rates have been variable along the U.S. coasts for a number of

reasons, but have amounted to one foot per hundred years along the mid-Atlantic coast. The rate of relative sea level rise in coastal Louisiana is about 10 times greater than the worldwide average due to subsidence.

2. The general response of low-lying lands to sea-level rise is retreat via beach erosion and wetlands loss. Already extensive coastal marshes are being lost in Louisiana, and it is expected that many of the barrier systems on this deltaic coast will break-up and disappear in the next half century. Extensive salt marsh loss has also been reported in the Maryland Chesapeake Bay (over 5,000 acres lost at Blackwater marsh, mostly occurring during the past 40 years).

3. The prospect for coastal wetlands is bleak in light of existing conditions and projected changes (e.g., greenhouse effect). Marshes in Louisiana, for example, are not able to keep pace with relative sea level rise, and are presently being drowned in place. A rapidly subsiding land surface or accelerated sea level rise can yield similar results. There will be substantial losses of coastal marshes in the future.

4. Approximately 90 percent of the nation's sandy beaches are experiencing erosion. Historical shoreline studies indicate a wide range in erosion rates (essentially stable to over 30 feet per year). The Atlantic coast average is between two and three feet of beach erosion per year, the Gulf coast exceeds five feet per year, and the Pacific coast is stable on average (much of the shore is hard rock).

5. Accelerated sea level rise due to the greenhouse effect will at least double and perhaps quadruple erosion rates, depending upon which rise rate is actually realized.

6. There are three general categories of human response to shoreline recession: (1) retreat from the shore, (2) armor the coast, (3) nourish the beach. The proper response will be site-specific on a community or coastal sector basis due to large differences in environmental and socioeconomic factors. The abandonment alternative is not realistic for highly urbanized beaches, like Miami Beach, FL and Atlantic City, NJ. For less developed areas along eroding shorelines, the decision becomes more difficult. Therefore, the costs and benefits of stabilization vs. retreat must be carefully considered as the cost in either case is likely to be quite high.

7. The apparent national desire to live in the coastal zone has long term and expensive consequences. The Federally-insured flood program is already burdened with billions of dollars of insured properties close to the water's edge. Accelerated sea level rise due to the greenhouse effect will further jeopardize these vulnerable properties, eventually resulting in massive destruction (without ameliorating action) during future major storms at great expense to the American taxpayer.