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TECHNICAL COMMUNICATION

New Shoreline Erosion Data for the Mid-Atlantic Coast

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ABSTRACT

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A geographically referenced data base of shoreline erosion and accretion rates is being compiled at the University of Virginia. The Coastal Erosion Information System (CEIS) now includes rate of change data for the shorelines of the Atlantic, Pacific, Gulf of Mexico, major bays, and Great Lakes of the United States. The CEIS data for the mid-Atlantic coast, from Southern New Jersey through North Carolina, indicates that approximately 72 percent of the coast has experienced a long-term erosional trend while 28 percent has experienced an accretional trend.

ADDITIONAL INDEX WORDS: *Coastal erosion, Atlantic Coast, barrier islands, geographic information system.*

INTRODUCTION

Historic trends show that about half of the continental United States' shorelines are eroding (USACE, 1971; DOLAN, *et al.*, 1989). Every year houses are lost to the sea while construction of new structures continues along our nation's shorelines (Figure 1). Rising sea level, losses of sediment, and local subsidence are among the factors that will continue to contribute to shoreline recession. Although many studies have been carried out on shoreline erosion, there has been no standard methodology used to calculate erosion and accretion rates. The Coastal Erosion Information System (CEIS) has been compiled at the University of Virginia in order to present the results of these studies in a common format.

FEDERAL FLOOD INSURANCE AND SHORELINE EROSION

The Housing and Community Development Act of 1987 authorized the National Flood Insurance Program (NFIP), administered by the Federal Insurance Administration (FIA) of the Federal Emergency Management Agency (FEMA), to provide advance insurance payments for the relocation or demolition of coastal structures which are subject to imminent collapse as a result of shoreline erosion (FEMA, 1988). This legislation, commonly known as the Upton/Jones amendment, allows home and business owners, whose structures are covered under the National Flood Insurance Program, to file claims for losses anticipated within five years. Once a claim is granted, the insured has

Figure 1. Beach home at Sandbridge Beach, Virginia, in "imminent danger of collapse." This photo was taken soon after the storm of March 7–11, 1989.

the option to relocate the structure with a sufficient setback distance, or to demolish it within a reasonable amount of time. Up to 40 percent of the value of the structure may be collected for relocating, and up to 110 percent of the value for demolition. No new structures can be placed in areas where claims have been filed.

Implementation of the Upton/Jones Amendment depends upon reliable shoreline rate of change data for qualification of "imminent collapse." An information storage and retrieval computer program, called the Coastal Erosion Information System (CEIS), is being used at the University of Virginia and at FEMA to assemble the best shoreline change data available, and to identify historic erosional trends for coastal sites around the nation. The data are being obtained from published and unpublished literature, federal and state agencies, coastal scientists, Sea Grant offices, and universities throughout the country.

THE COASTAL EROSION INFORMATION SYSTEM (CEIS)

CEIS is a computer program designed to provide a structure to collect, manage, and analyze large volumes of geographically referenced data on shoreline rates of change and associated information. Data in CEIS is stored in records identified by their longitude and latitude coordinates. Each record contains rate of shoreline change data as well as supplemental information on the location, such as the county, the township or other major local place name, and the name of the U.S.G.S. 7.5 minute topographic quadrangle covering the area.

The CEIS framework includes an hierarchical data file structure with ten levels of spatial resolution determined by the along-the-coast spacing of the data (Figure 2). Level 0 contains data for continuous grid cells along most of the U.S. shorelines. In areas rich with data, such as the mid-Atlantic coast, these cells are three minutes in longitude by three minutes in latitude. Shoreline rates of change recorded within the cells represent average conditions as determined from the available data (MAY, *et al.*, 1982). Levels 1 through 9 consist of data which range from large reaches of coast down to individual sites.

A criteria for inclusion into CEIS is that the data spans a minimum temporal period of

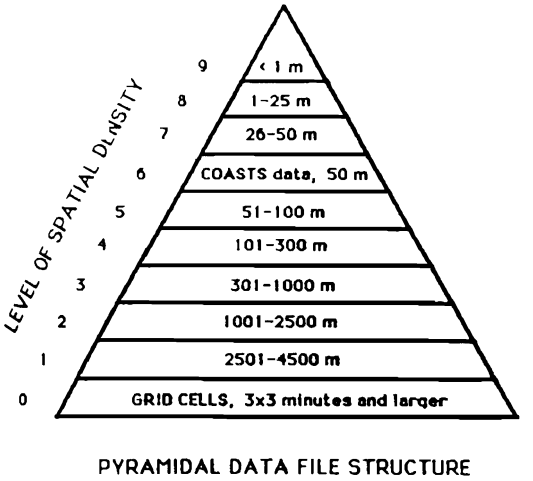

Figure 2. The CEIS pyramidal data file structure.

twenty years, but longer-term records are preferred. The majority of these longer-term data are calculated from analysis of the shorelines on 19th and 20th century charts and maps produced by the U.S. Coast and Geodetic Survey or the National Ocean Survey. The shorter-term records are usually based on analysis of historical aerial photography or ground surveys. If rates for more than one time period are given, they are included as supplemental notes.

There has been no standardized methodology adopted by coastal engineers and scientists for analyzing changes in the United States shorelines; therefore, the data in CEIS has been generated in many different ways. One of the attributes included in CEIS for each data set is an indirect reference to "accuracy;" we describe the methods used to delineate historic shoreline changes and the methods used to calculate rates of change. We do not attempt to judge data quality.

THE DATA IN CEIS

The data in CEIS were obtained from a wide range of sources spanning periods from as short as 20 years to as long as 165 years. Over 500 individuals and organizations have contributed data to CEIS. Most of this information was in the form of tabulated data published in reports; however, 25 percent of the source information came in the form of raw data, including traces of shorelines from maps and aerial photos, and distance measurements from baselines and benchmarks.

CEIS includes several high spatial resolution regional data sets. The "COASTS" data base, generated from aerial photography analysis at the University of Virginia (DOLAN, *et al.*, 1980), has been incorporated into CEIS and includes shoreline rates of change at 50 m intervals for approximately 1000 km of the mid-Atlantic region. In addition, we have incorporated a data set supplied by the University of Maryland (LEATHERMAN, 1983; LEATHERMAN and CROWELL, 1989) that covers shoreline rates of change at 50 m intervals along the Atlantic Coast from Maryland through Massachusetts. Additional high-spatial resolution data sets that we will soon include in CEIS cover Florida, Louisiana, Southern California and portions of the Great Lakes.

Recognizing that the data in CEIS are not consistent in terms of the methods that were used in their collection, or in the time that they span, we believe general statistical summaries are informative. Figure 3 shows the Level 0 data in CEIS for the contiguous U.S. shorelines. These grid cells contain data for 65 percent of the nation's shorelines; 35 percent of the cells do not contain data at this time. However, most of the "no data" areas are rocky coasts without sandy shorelines, or remote, undeveloped areas where data simply do not exist. For the data in the areas covered in CEIS, 54 percent of the shorelines have been eroding and 11 percent have been accreting. These percentages will change as we add data for the blank areas.

For the east coast, Florida to Maine, 76 percent of the shorelines covered contain average recession or accretion information. Along this reach most of the "no data" areas are located along the rocky coast of Maine (Figure 4). Fifty-six percent of the East coast shorelines in CEIS have a history of erosion and 19 percent have a history of accretion.

The most detailed data included in CEIS are for the mid-Atlantic coast (Figure 5). From North Carolina to New Jersey the average erosion rate for the shorelines that are eroding (which comprise 72 percent of the total) is −2.2 m/yr.

The CEIS data can be further stratified by states. North Carolina, for example, has 72 percent historically eroding shorelines; Virginia,

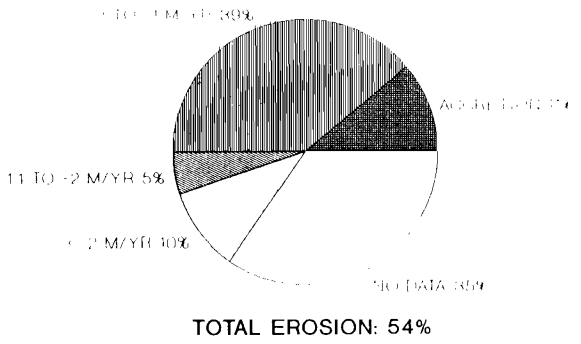

Figure 3. Rates of change for the shorelines included in the CEIS data base.

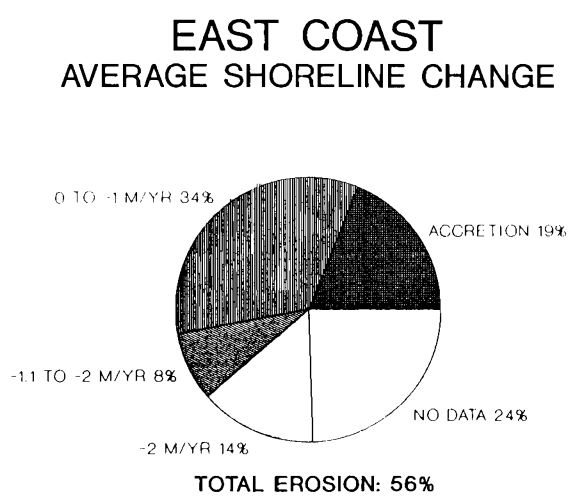

Figure 4. Shoreline change data for the east coast of the United States.

72 percent; Maryland, 94 percent; Delaware, 78 percent; and Southern New Jersey, 60 percent. The state with the highest overall erosion rate is Virginia, at −5.2 m/yr, although this is the average from the historically *eroding* shoreline data only, and does not incorporate measurements from areas that are accreting.

We plotted the shoreline data for Virginia, which span the period 1942 to 1988, in a histogram (Figure 6). The overall average rate of change for Virginia (accretion *vs.* erosion) is −3.1 m/yr; however, the distribution of erosion *vs.* accretion for the entire state is not normally distributed. When Virginia's ocean-facing shorelines are separated into two distinct reaches, the continuous beach from Cape Henry south to the North Carolina border, and the short, highly dynamic barrier island chain north of Chesapeake Bay, there is a striking difference. South of the Bay (Figure 7), the overall average rate of change (erosion and accretion) is −.12 m/yr, whereas for the seg-

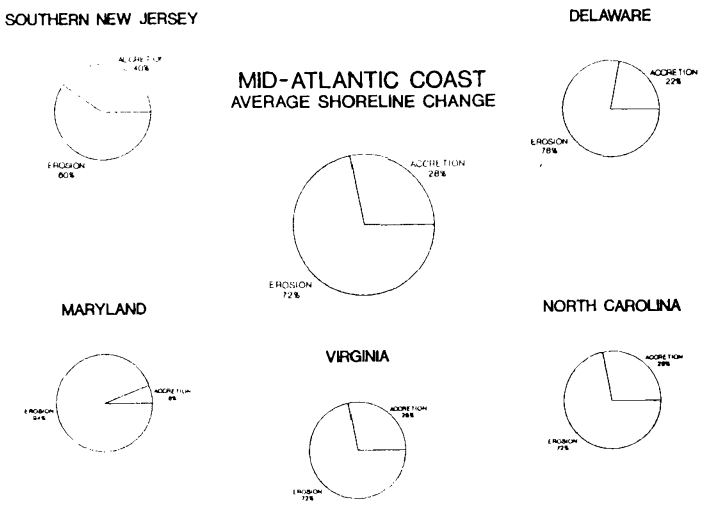

Figure 5. CEIS shoreline data for the mid-Atlantic coast.

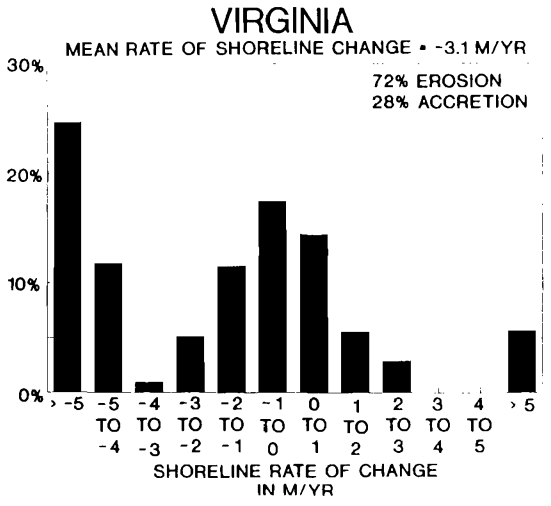

Figure 6. Histogram of CEIS shoreline change data for the state of Virginia.

ment north of the Bay (Figure 8), or the Virginia barrier islands, high erosion rates dominate, with an average rate of change of −5.37 m/yr. This pattern of extreme rates of erosion and accretion clearly reflects the well-recognized "rotational" history of many of the Virginia barrier islands. Erosion is predominant along the southern portions of the islands and accretion is predominant along the northern sections.

SUMMARY

The Coastal Erosion Information System contains geographically referenced data on the rates of shoreline change of the U.S. shorelines and associated attributes. The data has been collected from many different sources throughout the country. There is no standard method for shoreline delineation or for rate calculation. The data spans a wide range of temporal

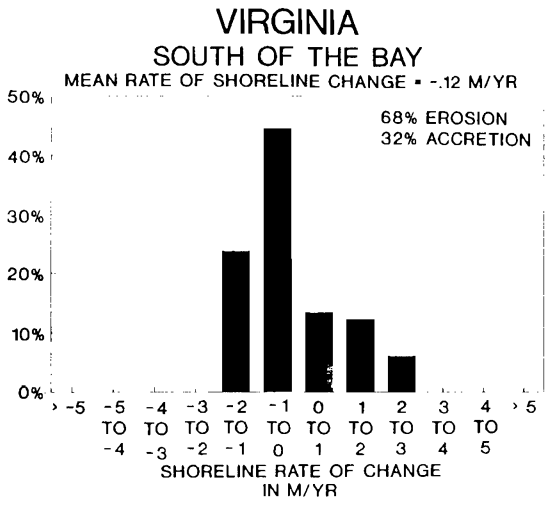

Figure 7. Histogram of CEIS shoreline change data for the Virginia coast south of the Chesapeake Bay.

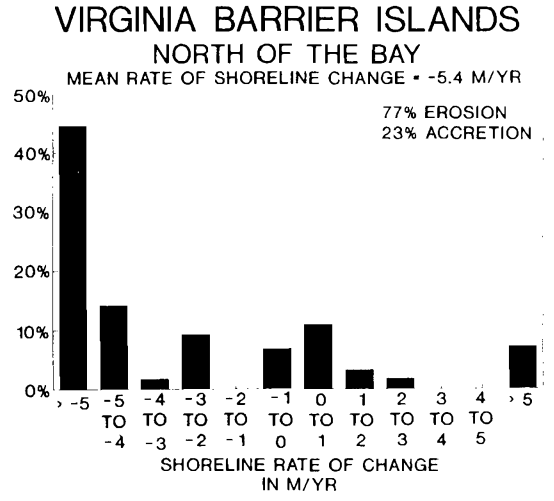

Figure 8. Histogram of CEIS shoreline change data for the Virginia coast north of the Chesapeake Bay—the Virginia barrier islands.

periods.

Analysis of the data for the mid-Atlantic coast indicates that 72% of the region's shorelines have been eroding, while only 28% have a history of accretion. When these trends are examined in relation to the geomorphology of the coast, it is apparent that the most severe erosion and accretion occurs near inlets, capes, and in the vicinity of stratifying structures.

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