# National Assessment of Coastal Vulnerability to Future Sea-Level Rise

## Coastal Changes due to Sea-Level Rise

One of the most important problems in applied coastal geology today is determining the physical response of the coastline to sea-level rise. Prediction of shoreline retreat and land loss rates is critical to planning future coastal management strategies. To date, long-term planning for the Nation's shoreline has been done piecemeal, if at all (National Research Council, 1990, 1995). Consequently, entire communities are being developed without adequate consideration of the potential costs of erosion, flooding, and storm damage related to sea-level rise.

Recent estimates based on global climate models (Wigley and Raper, 1992) suggest an increase in sea level of between 15 and 95 centimeters (cm) by 2100, with a "best guess" of 50 cm (IPCC, 1995). This is more than double the rate of sea-level rise for the past century (Douglas, 1997; Peltier and Jiang, 1997). Thus, sea-level rise will have a large sustained impact on coastal evolution in the future and will occur as both population and infrastructure in coastal regions are projected to increase.

## Variables Affecting Coastal Vulnerability

Predicting future coastal evolution and vulnerability to change is difficult because many factors are involved. No standard method is used by scientists to predict coastal change. In order to address these problems, the U.S. Geological Survey (USGS) is implementing a fairly simple classification of the relative vulnerability of different U.S. coastal environments to future rises in sea level (fig. 1). The vulnerability classification is based on the relative contributions and interactions of six variables:

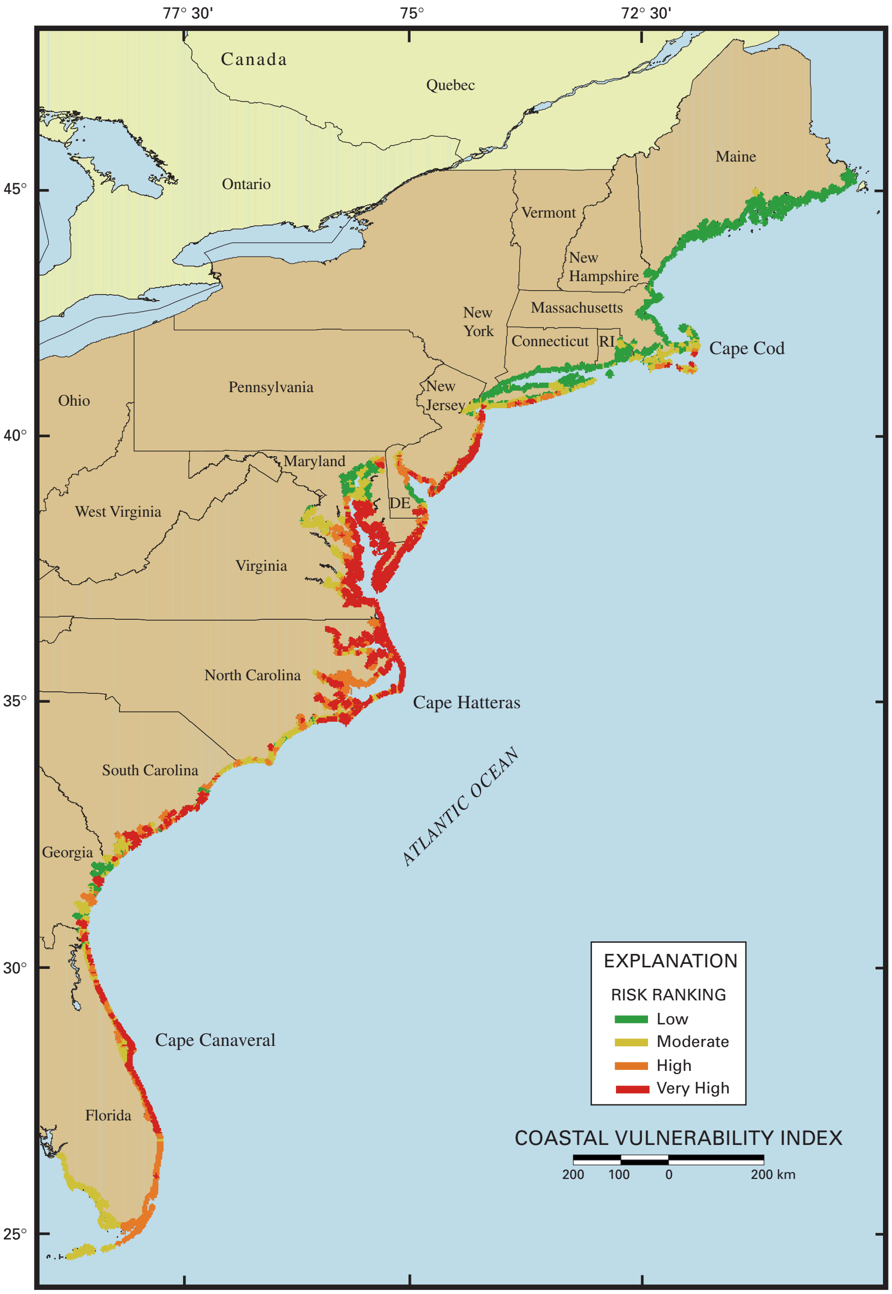


**Figure 1.** Map of the Coastal Vulnerability Index (CVI) for the U.S. East Coast showing the relative vulnerability of the coast to changes due to future rises in sea level. Areas along the coast are assigned a ranking from low to very high risk, based on the analysis of physical variables that contribute to coastal change. From Thieler and Hammar-Klose (2000).

1. Tidal range, which contributes to inundation hazards.
2. Wave height, which is linked to inundation hazards.
3. Coastal slope (steepness or flatness of the coastal region), which is linked to the susceptibility of a coast to inundation by flooding and to the rapidity of shoreline retreat.
4. Shoreline erosion rates, which indicate how fast a section of shoreline has been eroding.
5. Geomorphology, which indicates the relative erodibility of a section of shoreline.
6. Historical rates of relative sea-level rise, which correspond to how the global (eustatic) sea-level rise and local tectonic processes (land motion such as uplift or subsidence) have affected a section of shoreline.

## Coastal Vulnerability Index

The USGS rating system classifies the data variables according to risk. A mathematical formula allows scientists to relate the different types of data to each other and to calculate an index value. This coastal vulnerability index (CVI) value yields a relative ranking of the possibility that physical change will occur along the shoreline as sea level rises. For example, along the U.S. East Coast, high-vulnerability areas are typically barrier islands having small tidal ranges, large waves, a low coastal slope, and high historical rates of sea-level rise, such as the Mid-Atlantic Coast (fig. 2). Coasts having rocky cliffs (steep coastal slopes), large tidal ranges, and low historical rates of sea-level rise, such as most of the Maine shoreline (fig. 3), are represented as least vulnerable and have a low CVI value. The distribution of vulnerability ranges for the U.S. East Coast is shown in figure 4.

## National Assessment

The USGS is conducting a national assessment of coastal vulnerability to future sea-level rise by using simple, objective criteria; the assessment for the U.S. East Coast has been released (Thieler and Hammar-Klose, 2000). More detailed investigations of the impact of sea-level rise are needed in order to forecast coastal change with a degree of certainty that is useful for the management of coastal resources.

**Figure 2.** Rodanthe, North Carolina, during the “Halloween Storm” of 1991. The low coastal slope, barrier island morphology, small tidal range, and large waves make this high-vulnerability area particularly susceptible to flooding and overwash. Photograph courtesy of H.C. Miller, U.S. Army Corps of Engineers.

**Figure 3.** West Quoddy Head, Washington County, Maine. The rocky cliffs (steep slopes) of the Maine coast and the large tidal range lead to an index designation of very low risk. Photograph courtesy of the Maine Department of Conservation.

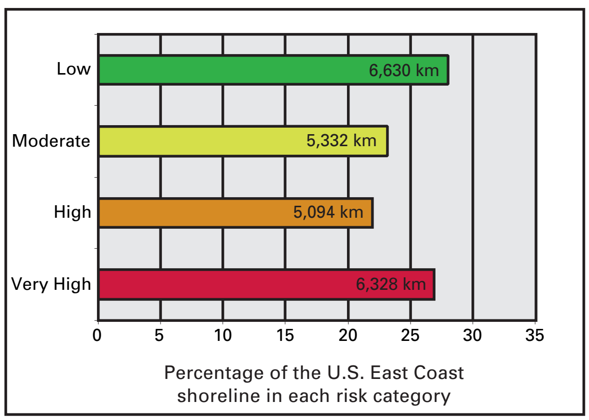


**Figure 4.** A total of 23,384 kilometers of shoreline is ranked for the U.S. East Coast. Of this total, 27 percent of the mapped shoreline is classified as being at very high risk due to future sea-level rise, 22 percent is classified as high risk, 23 percent as moderate risk, and 28 percent as low risk.

## References

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