Barrier Island Migration

These barrier islands retreated or migrated northward as the ocean continued rising. There is some debate about how the barriers actually moved. Some research suggests that the barriers slowly drowned in place and then "jumped" or "skipped" landward to a new position coinciding with the new position of the shoreline. More recent studies indicate the islands move in a more continuous process where sand is transported across the island from the ocean to the bay, allowing the island to migrate landward. There are three primary ways that sand can be transported across a barrier island: inlet formation, overwash processes and eolian (or wind) transport. On Long Island's south shore, the inlets are actually far more important than either overwashes or the wind in terms of moving sand landward and driving barrier migration. The flood tidal shoals created by historical inlets provide the platform that allows the island to maintain itself while moving landward over time in response to rising sea level *(Figure 14).* Regardless of the actual mechanisms by which the barriers move in response to the rise in sea level, they have moved landward over the historical time frame of thousands of years.

However, the rate at which the barriers migrate varies along the south shore when one considers shorter time scales on the order of centuries. Geologic evidence indicates that the central portion of Fire Island between Ocean Beach and Watch Hill has not migrated for the last 750 to 1,300 years. This section of the island has experienced erosion on the ocean and bay shorelines, but the position of the island has remained in the same location. Interestingly, there is no evidence of historic inlets in this area over the last several centuries *(Figure 15).* The stable location and absence of historic inlets in this area suggest that barrier migration may not be a continuous process over timescales of a thousand years or less. Further to the east, the barriers are more mobile and one can find evidence of barrier island rollover processes such as old flood shoals in the bay that were associated with inlets that have opened and closed naturally over the last several hundred years.

Sea Level Rise and the Future

Along the New York coast, sea level is not only rising, the land is also slowly sinking, or subsiding due to geologic processes. The rise in the water level in relation to the land surface due to the sinking of the land and the raising of the sea is known as relative sea level rise. In our area, the average rate of relative sea level has been about a tenth of an inch per year, or about one foot per century. As can be seen in Figure 16, there are considerable monthly, yearly and decadal fluctuations in the elevation of the water. Short-term changes in sea level caused by storms are much larger than those associated with the long-term trends. Daily tides change sea level by two to five feet and storms with return periods of 30 years can raise water levels four to six feet above normal elevations in just a few hours.

It is not known exactly how much of the erosion we see on the south shore is directly attributable to the slow rise of relative sea level. Calculations based on measurements of beach changes going back to the 1950s show that the sea level increase might account for less than one foot per year of erosion and even this may be an overestimate. Studies also show that the changes a beach may go through in a

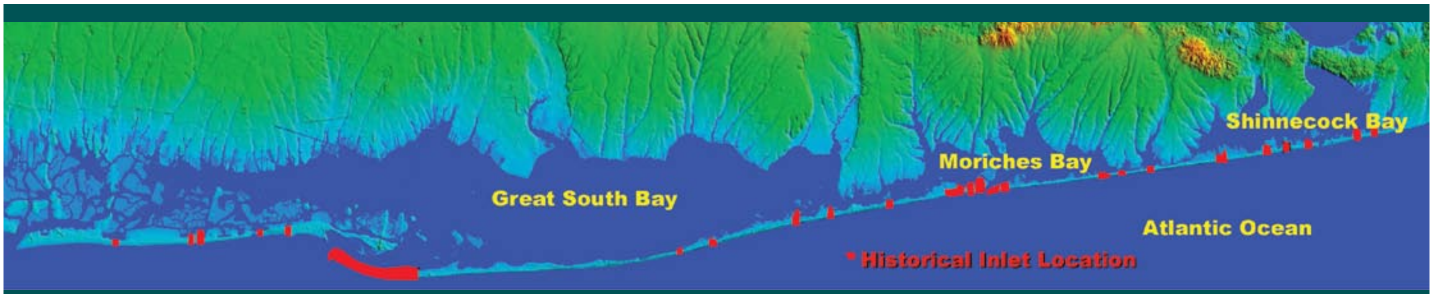

Figure 15. Locations of historical inlets along the south shore dating back to the 1700s. (Data from Taney 1961 and Leatherman and Allen 1985)

single month can be over 200 times more than that expected from relative sea level rise alone. In terms of our most severe erosion problems, long-term sea level rise is of secondary importance compared to other factors acting on shorter, decadal time scales.

Long-term relative sea level rise is important, however, in that it ultimately controls the position of the shoreline. An increasing sea level means we will be faced with erosion problems for the foreseeable future. There is a growing consensus that human activities are contributing to global warming, which in turn can increase the rate at which the oceans will rise. While there is considerable uncertainty regarding the magnitude and timing of this increase, the most likely scenarios indicate the rate of sea level rise may double over the next 100 years. In 50 years this could result in water levels that are a foot higher than present (as compared to half of a foot if the present rate of rise did not change).

From a planning perspective of 30 to 50 years, the biggest impact of an increased rate of relative sea level rise will be the submergence of the flat, low lying areas around the bays on the south shore. Communities in these areas could be subject to increased flooding. Coastal wetlands may also be affected by long-term sea level rise. Salt marshes, one of the most productive ecosystems on earth, are very sensitive to the position of sea level. Fine-grained material deposited in the marshes raises the surface, keeping it in the same relative position to a rising sea surface. If sea level rises faster than the sediments can be supplied, marshes could be flooded and replaced by open water. If deposition and sea level rise are in balance, some marshes may be able to migrate landward if there is room for them to retreat. Retreat will probably not be possible if the slope of the land behind the marsh is too steep or the path is blocked by structures such as roads, seawalls, or houses.

On time scales of hundreds to thousands of years, increased sea level rise could accelerate the migration of barriers landward or even lead to their disappearance altogether if the rise is very fast. The projected increases in sea level could make sections of the ocean coast more vulnerable to erosion over time. However, over planning time frames of 30 to 50 years, even increased sea level rise would not significantly change the actual observed rates of shoreline change in those areas experiencing the most severe erosion. On these time scales, sea level rise is of secondary importance compared to other factors in controlling what happens on the coast. The frequency and intensity of the storms, discussed above, and the supply of sand in the system available for building the beaches play a far bigger role in shaping the coast. In most cases, our most severe erosion problems are caused by disruptions in the transport of sand, due to either natural processes or human activities.

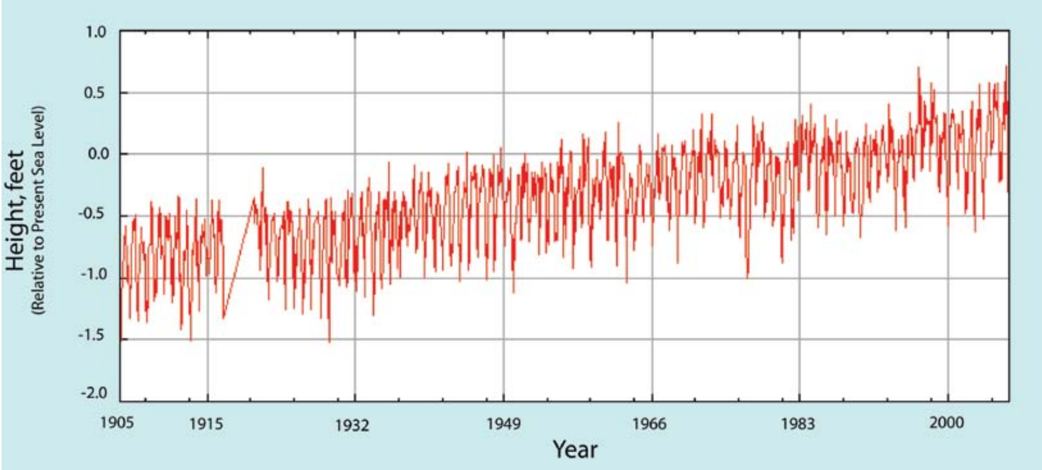

Figure 16. Monthly mean sea level measured by a tide gauge in New York City. Sea level has been rising at a rate of about one foot per century in this area. (Data from: NOAA NOS Battery Tide Gauge, *http://tidesandcurrents.noaa.gov*)