Protecting our coastal economy
asbpa
and ecology for 80 years

Beach Replenishment and the Impact of Global Warming and Sea Level Rise

There is widespread agreement among scientists that global warming is causing a rise of sea level due primarily to the melting of continental ice packs (or glaciers). While the mechanisms behind global warming are complex and multifaceted, the root cause is often correlated to greenhouse gases that essentially allow the sun's radiation to penetrate the Earth's atmosphere but trap this same radiation near the Earth's surface. The emissions of greenhouse gases such as carbon dioxide from human activities including industrial processes, fossil fuel combustion, and changes in land use have exacerbated this "greenhouse effect." [1]

Global temperatures and sea levels have fluctuated often in historic and pre-historic times, which makes human-related contributions to global warming difficult to quantify. The National Research Council examined surface temperature records for the Earth over the last 2,000 years and concluded, *"Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. The changes observed over the last several decades are likely mostly due to human activities, but we cannot rule out that a significant part of these changes is also a reflection of natural variability. Human-induced warming and associated sea-level rises are expected to continue through the 21st century."*[2] In a more recent report requested by Congress, the NRC concluded that *"warming in the last few decades of the 20th century was unprecedented over the last thousand years."* [3] However, it also concluded that data was insufficient to draw conclusions that extended to a time period before 1600.

Although there are differences of opinion among scientists regarding the predicted short-term rate of sea-level rise expected for this century, the likely range of sea level increase[4] lies between 0.7 ft and 2.3 ft, with a plausible average of about 1.5 ft. This is about twice the rate of increase during the 20th Century. Predictions regarding future sea-level rise should be placed in the context that: (1) the scientific community has only presented a range of scenarios and has not agreed on specific numbers, and (2) relative sea levels will certainly rise (or even fall) at different rates in different areas depending on other factors not related to glacial melt and global warming. The potential for flooding of America's ocean and estuarine coasts is increasing due to both the impacts of sea-level rise and increased storms. With more than 50 percent of all Americans already living within a coastal county, these developments portend adverse impacts to human health and safety, the environment, and the infrastructure supporting significant portions of America's economy.

Founded in 1926, the American Shore & Beach Preservation Association (ASBPA) is dedicated to preserving, protecting and enhancing the beaches, shores and other coastal resources of America. For ocean shorelines, the ASBPA adopts an all-inclusive approach by seeking to employ a suite of tools to protect shorelines from rising seas and other forces. This toolbox may include shoreline armoring, retreat, sand bypassing and beach replenishment using sand obtained from

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[1] For a concise explanation of these dynamics, see "Planning for Sea Level Rise: U.S. Army Corps of Engineers Policy;" Kevin Knuuti; Conference Proceedings of "Solutions to Coastal Disasters '02;" American Society of Civil Engineers.
[2] "Climate Change Science: An Analysis of Some Key Elements;" The National Academies Press; 2001
[3] "Surface Temperature Reconstructions for the Last 2,000 Years;" The National Academies Press; 2006; emphasis added
[4] This represents the span of mid-range scenarios published in 2001 by the Intergovernmental Panel on Climate Change (IPCC).See http://www.ipcc.ch. The "high range" scenario is about 3 ft.

offshore or other remote locations. For moderately eroding shorelines, the ASBPA and scores of local communities across America have found beach replenishment – the placement of sand onto the beach from a source outside the eroding area – to be an appropriate solution. However, if sea level indeed rises by up to 2.3 feet within the next hundred years, some have questioned whether beach replenishment will continue to be an economic and environmentally wise choice to protect infrastructure, economies, and recreation opportunities along America's coasts.

ASBPA believes that in many areas, replenishment (also referred to as beach nourishment) is the most cost effective and environmentally acceptable approach to providing a buffer against the sea. Every replenishment project is designed to include a significant amount of sacrificial sand. This sacrificial sand is replaced at intervals of time as beaches are "re-nourished". The replenishment interval can be 5, 7, or in some cases 10 years or more depending upon the dynamics of a particular beach. Using the predicted annual rate of sea-level rise for the next 90 years is less than 0.03 foot per year[5], it is clear that sea-level rise will not overwhelm any particular replenishment project before its next scheduled infusion of sand. Even if the rate of sea-level rise is significantly higher than predicted, it is federal policy to design a beach replenishment project (e.g. the height, width, and length of beach) to account for the change in water elevation[6]. This may affect the volume of sand needed and the cost to place that sand on the beach. However, in most cases, the increase in cost to account for sea-level rise during the life of a beach project[7] will be insignificant in relation to the overall benefits provided by the beach.

Also, beaches respond to sea-level rise without our help because the elevation of the beach that lies above the high water mark (called the "berm") is developed by tides and waves. There is a reservoir of sand at the back of the beach to make up for any beach consumed by the rising ocean. Therefore, if the sea level rises, so will the beach berm by the same amount. The position of the shoreline, however, will move landward unless it is replenished with additional sand.

The alternatives to replenishment in response to this gradual rise in sea level are shoreline armoring or retreat. Shoreline armoring usually decreases aesthetics and does not preserve the sandy beach. Rather, the intersection between land and sea becomes one of steel or concrete rather than sand. Along developed coasts, the cost of retreat – that is, the abandonment of investments in coastal structures, businesses, housing, infrastructure, environmental resources, and recreational amenities – is almost unthinkable compared to the relatively low cost of maintaining a sandy beach. While either of these two alternatives may be the appropriate solution in certain circumstances, beach replenishment will remain the most physically effective, economically viable, environmentally sound method of storm protection for decades to come regardless of sea-level rise.

[5] 2.3 feet divided by 90 years.

[6] See Knuutti; *op cit.* for a discussion of Army Corps of Engineers policy for estimating and accounting for seal level rise in the planning of beach replenishment projects.

[7] "Life" as used here refers to the statutory maximum of 50 years for the period of federal fiscal participation in a beach replenishment project.