Beach Replenishment

Background

Beach replenishment (or beach nourishment) is the placement of large quantities of sand on an eroding beach to advance the shoreline seaward and increase its elevation as well as to construct dunes. These engineered beaches and dunes act as a barrier against wind and wave attack and are designed to absorb much of the storm energy before it can reach buildings and infrastructure. Additionally, the replenished material reintroduces sand originally displaced from the sediment budget. Typically, an engineered beach and dune design includes periodic nourishment to replace the sand that has been eroded from the engineered beach and dune design template – often into offshore bar systems and alongshore. Fortunately, sand transported outside of the design template can still benefit the project, as it can dampen the wave energy as it approaches the shoreline. Essentially, the periodic nourishment subsequently added to beaches is used as a surrogate for quantities of sand lost from beaches due to erosion. Secondary benefits of beach replenishment include providing added recreational area and, in some cases, reintroducing environmental habitat for endangered species.

New Jersey's beaches are a vital recreational resource as well as a buffer between ocean waves and landward development. As a result, the state has an interest in maintaining its beaches for public recreational use and shore protection. Interest in shore protection in New Jersey began in the mid-1800s. The state's shorelines, being within easy reach of the burgeoning populations of New York City and Philadelphia, were the first to experience intense barrier-island development. Oceanfront dunes were often leveled or developed upon and freshwater ponds between dunes were filled to create building lots. Rapid development ensued without awareness of coastal hazards, storm vulnerability, or beach erosion. A period of intense storm and hurricane activity between 1915 and 1921, in which three hurricanes and four tropical storms passed within several nautical miles of the coasts of New Jersey, highlighted the sensitivity of newly-developed shore regions to beach erosion. Soon thereafter, the early versions of coastal engineering projects such as groins, revetments and bulkheads were built to armor the coast, trap sand, and slow the erosion process. Millions of dollars were spent on uncoordinated and often inappropriate erosion-control structures that frequently produced results that were ineffective, and in some cases, counterproductive.[1] Piecemeal approaches often aggravated the problem on adjacent shorelines. The state began approaching shore protection on a regional basis within areas affected by similar coastal processes with the development of the Shore Protection Master Plan in 1981.[2] This approach considers the potential for any one shore erosion control program to adversely affect another.

Island Beach State Park, 2012 (NJDEP)

Many programs within the New Jersey Department of Environmental Protection (DEP) are charged with managing coastal resources such as surf clam and shorebird habitats, minimizing impacts from development on these resources, and minimizing development in hazard areas. Together, these programs comprise DEP's Coastal Management Program.[3] The Coastal Management Program is comprised of a network of offices within the DEP that serve distinct functions, yet share responsibilities that influence the state of New Jersey's coast. One component that supplements New Jersey's Coastal Management Program is the Engineering and Construction Program's Division of Coastal Engineering, which manages shore protection and storm damage reduction projects that protect the resource areas as well as the developed areas. The Division of Coastal Engineering is responsible for administering shore protection projects associated with the protection, stabilization, restoration or maintenance of the shore that are consistent with the Shore Protection Master Plan as well as the policies and guidelines of the Coastal Management Program. To successfully and efficiently administer these projects, the Shore Protection Fund was created to provide a stable funding source which provides money to finance these projects. The Division of Land Use Regulation, one arm of the Coastal Management Program, implements these protections through several different permitting programs, including the Coastal Area Facility Review Act (CAFRA) and Waterfront Development Law.

New Jersey's beaches play a critical role in protecting people and property from coastal storm hazards. Due to its geography, New Jersey is in the path of hurricanes (tropical storms) and nor'easters (extratropical storms). Beaches act as a buffer between the surf and the homes, businesses, and infrastructure along the coast. In

addition, beaches provide recreation for beachgoers and fishermen and help support a multibillion dollar tourism industry. In 2017, the total economic impact of travel and tourism was $42.9 billion to the state. In addition, 6.9 percent of the total employment in the state was supported by travel and tourism spending. In 2017, tourism generated $4.8 billion in state and local government taxes. A regional breakdown of tourism shows that 16.3 percent of total tourism direct sales occur in Atlantic County, with the Southern Shore Region (Cape May and Cumberland counties) and the Shore Region (Monmouth and Ocean counties), contributing 15.6 percent and 17 percent respectively.[4]

Attention to shoreline management is becoming more important as the sea level along the New Jersey coast rises due to climate change and subsidence (see Climate Change in New Jersey: Trends in Temperature and Sea Level, in this Environmental Trends series). Rising seas are likely to accelerate beach erosion and coastal inundation.

While past examination of shoreline positions along the Atlantic Ocean in New Jersey from 1836 to 1985 reveals the trend of shoreline erosion, notable advances in shoreline position and increases in sand volumes have been documented statewide since the inception of the Coastal Storm Damage Reduction and Coastal Storm Risk Management projects, as documented by the New Jersey Beach Profile Network conducted for the Department by Stockton University.[5]

Historically, New Jersey built seawalls, groins and jetties as a defense against beach erosion. Today, in most cases, beach replenishment is preferred to hard structures such as seawalls and bulkheads, because it provides the basis for restoration of landforms and biota, and for recovery of lost environmental heritage. Coastal sand dunes are an integral part of a well-planned coastal defense system. Coastal sand dunes provide habitat for a variety of species in addition to acting as reservoirs of sand to help maintain beach equilibrium and preserve the ability of the beach to respond naturally to storm events. They are vitally important during moderate to large storms when the dissipation created by the sand bars is insufficient to prevent the waves from attacking the beach berm.[6]

Status and Trends

Replenishment of beaches with sand that is pumped or dredged from bay areas and from the ocean floor began in the 1930s. The quantities of sand placed on beaches and the associated costs have been collected through a comprehensive research project that covers twenty coastal states. The Program for the Study of Developed Shorelines at Western Carolina University provided the long-term data evaluated for this report.[7] These data are shown in Figures 1 and 2, "Beach Replenishment Volumes, New Jersey" and "Beach Replenishment Expenditures, New Jersey." The NJDEP's Engineering and Construction Program provided a five-year summary of the data, from FY2014 through FY2018 (projected), shown in the last bar of each figure.

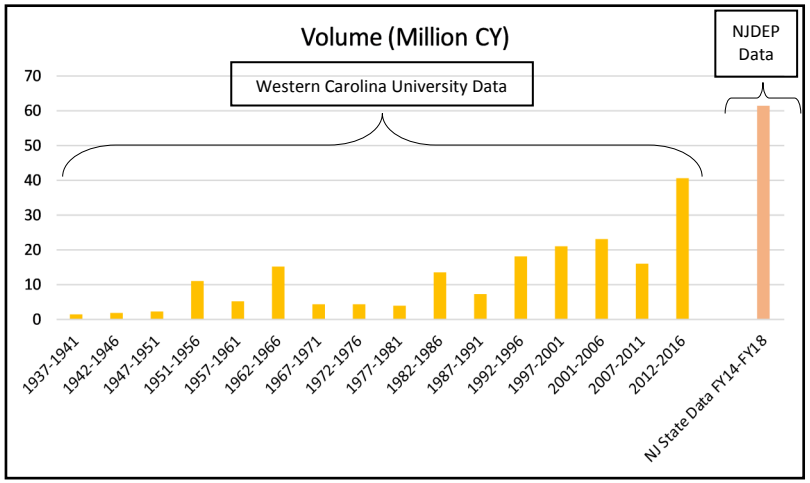

Figure 1. Beach Replenishment Volumes, New Jersey

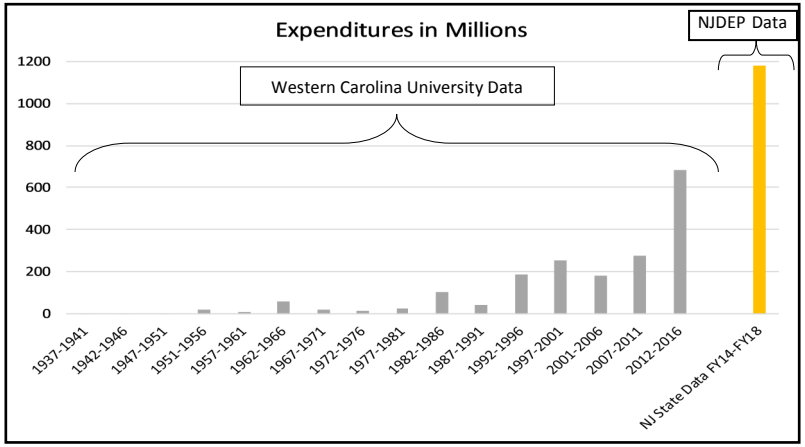

Figure 2. Beach Replenishment Expenditures, New Jersey

Outlook and Implications

The data shown in these charts indicate a trend of both increasing quantities of sand deposited per decade, and increasing constant-dollar costs per decade for the replenishment efforts. The last bar in each graph depicts data collected by NJDEP's Division of Coastal Engineering and indicates that the West Carolina University data may not represent all projects that NJDEP's state data is counting.

The cost of protecting threatened property and undeveloped coastlines from sea-level rise in the mid-Atlantic through 2100 is estimated to be in excess of $20 billion.[6] While there is some concern that less funding may be available in the future for beach replenishment projects, DEP and the U.S. Army Corps of Engineers as well as other state and federal agencies are working on regional sediment management initiatives identifying additional suitable sand sources to ensure these projects continue to be sustainable and perform as designed. Additionally, proper operations and maintenance in between periodic nourishment cycles are vital to the success of these projects.

It is likely that rising sea level, coupled with the increased intensity of storms predicted by models of climate change, will result in flooding and beach erosion that will worsen over time. Adequate periodic nourishment funding and timely post-storm repairs would be needed to maintain usable beaches and provide shore protection. Increased preparedness for floods and coastal damages also will be required.

More Information

www.nj.gov/dep/shoreprotection/
www.nj.gov/dep/cmp/czm_program.html
www.nap.usace.army.mil/index.htm
www.state.nj.us/commerce/Tourism.shtml

References

[1]Hillyer, Theodore M., 1996, *Shoreline Protection and Beach Erosion Control Study Final Report: An Analysis of the U.S. Army Corps of Engineers Shore Protection Program*, Shoreline Protection and Beach Erosion Task Force, U.S. Army Corps of Engineers, Prepared for the Office of Management and Budget, 383 pp. https://www.iwr.usace.army.mil/portals/70/docs/iwrreports/96-ps-1.pdf, Accessed 6/26/2018.

[2]NJ Department of Environmental Protection (NJDEP), 1981, New Jersey Shore Protection Plan, Volumes I and II, NJDEP, Trenton, NJ.

[3]State of New Jersey, Department of Environmental Protection, Land Use Management; http://www.state.nj.us/dep/cmp/index.html#njcmp, Accessed 6/26/2018.

[4]Tourism Economics, "The Economic Impact of Tourism in New Jersey". http://www.visitnj.org/sites/default/master/files/2016-nj-eco nomic-impact.pdf, Accessed 12/18/2017.

[5]Farrell, Stewart, K. McKenna, S. Hafner, B Smith, C. Robine, H. Pimpinelli, N. DiCosmo, C. Tracey, I. Beal, A. Ferencz, M. Gruver, and M. Suran, 2017, *An Analysis of Thirty Years' Study of Sand Redistribution and Shoreline Changes in New Jersey's Four Coastal Counties Raritan Bay, the Atlantic Coast, and Delaware Bay Fall 1986 Through Fall 2016, Volumes 1-4*, Stockton University Coastal Research Center, 691 pp. https://stockton.edu/coastal-research-center/njbpn/reports.html, Accessed 6/27/2018.

[6]Titus, James G., R.A. Park, S.P. Leatherman, J.R. Weggel, M.S. Greene, P.W. Mausel, S. Brown, C. Gaunt, M. Trehan, and G. Yohe, 1991, Greenhouse Effect and Sea Level Rise: The Cost of Holding Back the Sea. *Coastal Management,* 19, pp. 171-204.

[7]Coburn, Andrew, 2009, Program for the Study of Developed Shorelines, Western Carolina University; personal communication A. Coburn with M. Aucott, NJDEP, December, 2009.