

A blue-tinted photograph of a stormy sea with a control tower in the background. The sky is overcast and the water is turbulent with white-capped waves. A control tower with several windows is visible in the middle ground. In the foreground, there's a dark railing or structure. The overall mood is somber and dramatic.

Turn Back

By Samuel Greengard



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Nation
looks to
engineering
to address
the threat
of rising
sea levels

TIDES

TORSTEN JENSEN/GETTY IMAGES

It's difficult to open a newspaper or read social media without seeing a mention of how something is affecting the environment. Yet, beyond all the discussions, arguments and political viewpoints concerning the role humans play in this, one simple fact stands out: sea levels are on the rise and coastal areas are increasingly affected by tidal flooding, and engineers are being called upon to do something about it. >>

Storm surge from Superstorm Sandy destroyed scores of homes in Mantoloking, N.J.



MARIO TAMAGETTY IMAGES

The entire east coast of the United States is particularly vulnerable as rising sea levels could impact—and perhaps even displace—between 20 to 30 million people spanning 20 cities with populations over 100,000, according to a report in the journal *Proceedings of the National Academy of Sciences*. Those cities include Boston, Miami, Virginia Beach, Sacramento, New Orleans, Jacksonville and New York.

Research shows that sea levels across the Northeast Coast rose nearly four inches between 2009 and 2010. Along the coast from Boston to North Carolina, sea levels are rising three to four times faster than the global average.

The evidence is irrefutable. “We have a very precise global view of sea level change based on nearly

23 years of satellite altimeter measurements,” says R. Steven Nerem, a professor of aerospace engineering at the University of Colorado.



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MICHAEL McMAHON
HDR ENGINEERING

He pointed to a 2014 study conducted by the National Oceanic and Atmospheric Administration (NOAA), which found that at 45 tide gauges around the Atlantic and Gulf of Mexico coasts, the frequency of flooding had increased at 41 locations. Moreover, the rate of increase was accelerating at 28 of the locations.

“The loss of ice from Greenland, Antarctica and mountain glaciers contributes to about one-third of the increase. We also are witnessing a thermal expansion of the oceans, which further contributes to sea level rise,” Nerem says.

Taking Action

“The undisputed fact is that sea levels are not going down,” says Michael McMahon, senior hydro-meteorologist at HDR Engineering. “It means that for many U.S. east coast cities there are only two options...move the city further from the coast, or build enormous sea walls.”

HDR is working with New York City on its plan to make city buildings and infrastructure more resilient against the effects of rising tides and storm surges. Flooding after Superstorm Sandy left 43 dead and more than \$19 billion in damage. New York City’s \$20-billion resiliency plan calls for a complex system of permanent levees, storm barriers and other defenses.

James Schlaman, director of water resources at Black & Veatch says the slow and incremental nature of the ice melt in the Polar Regions means that a rise in sea levels may not be entirely apparent in some areas until a major storm surge occurs. At that point, severe flooding could wreak havoc on infrastructure, including freshwater systems.

“The bottom line is that there are a lot



Hatch Mott MacDonald was retained to develop the Mantoloking Sea Wall, the largest and longest coastal resilience sheeting project ever constructed in New Jersey.

of different potential scenarios, but all of them lead to varying levels of problems.” Schlaman said. “We must recognize and address the reality that rising sea levels will touch a lot of people’s lives and have a major impact on infrastructure.”

Schlaman says Black & Veatch is working with officials in California, Louisiana and elsewhere to develop plans and projects, including dual-feed pump stations, seawalls and emergency generation systems.

Hatch Mott MacDonald CEO Nick DeNichilo notes that coastal flooding can set off a chain reaction of disastrous events such as power failures; flooded tunnels, rail lines and subways; and an array of other problems, including an inability to obtain fuel or buy food during a major storm like Sandy or Katrina.



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BLACK & VEATCH

To combat rising sea levels, he says, the emphasis must be on adaption and resilience. “There is a need for coastal communities to focus on greater resilience and better protections in order to ensure a more sustainable future. This means addressing wide-ranging issues, including erosion control and stabilizing shorelines, building natural barriers, protecting structures from flooding, preventing the leaching of salt water into fresh groundwater, guarding freshwater supplies, and aiding utilities that can be impacted by flooded coastlines.”

Hatch Mott MacDonald is involved in several projects aimed at mitigating the effects of sea level rise. Among them: designing and constructing a new sea wall along three-and-a-half miles of oceanfront in

Mantoloking, N.J. It’s the largest and longest coastal resilience sheeting project ever constructed in New Jersey. The project, which will replenish the

This property in Ft. Lauderdale experiences periodic, non-storm-related flooding several days a year. By 2019, model projections show that this property will experience more than 14 flood days per year.



oceanfront with 200-foot-wide beaches and dunes with a crest elevation of 22 feet, will protect about 8,000 homes.

The company is also working with New York City to assess and possibly reinforce the Triborough Bridge and tunnels in the city.

McMahon noted how storm water discharge becomes a major issue as sea levels rise. “During a heavy rain, all the storm water is supposed to be dumped into the ocean, but when you have rising tides, getting storm water into the ocean becomes problematic,” he says.

Addressing this unfolding problem is nothing short of daunting. At the heart of the issue is the historic federal struggle to adequately fund existing infrastructure improvements, let alone develop new infrastructure designed to protect high-risk coastal areas as sea levels rise.

Cities/States React

Several U.S. cities and states are realizing their vulnerability and beginning to take action. The major problem so far has been

nuisance flooding occurring on a far more frequent basis—particularly in South Florida and low-lying areas such as the Chesapeake Bay. Flooding can overwhelm drainage systems; contaminate freshwater supplies, block roads, cause erosion, and damage buildings that aren't meant to be exposed to salt water.

“We are seeing water in the streets of Miami, Fort Lauderdale and other areas when there is no rain or no storm,” says Albert Slap, founder and CEO of Coastal Risk Consulting, which provides detailed flood forecasts down to the parcel level for communities and other entities.

Slap notes that Fort Lauderdale is looking to develop a detailed model to better understand flood-prone



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COASTAL RISK
CONSULTING

areas, depth of flooding, frequency of flooding and when flooding is more likely to occur. Already, the city has identified 16 areas that require adaption and 38 capital projects aimed at flood management and resilience; while Miami has authorized a five-year, \$300 million plan to install 60 pumps in Miami Beach.

Meanwhile, Boston Mayor Martin J. Walsh is focusing on a regional approach to rising sea levels by announcing a multi-city living-with-water summit. Among the key areas that will be affected by rising sea levels: the city's Logan Airport.

Kathleen White, who leads the U.S. Army Corps of Engineers' (USACE) Climate Preparedness and Resilience Community of



The city of Miami Beach is installing drainage pipes and storm water pumps meant to keep rising sea levels from inundating low-lying areas.

JOE RAEDLE/GETTY IMAGES

Practice, says that engineering solutions typically revolve around several approaches: constructing sea or flood walls; building or raising levees; installing pumping systems; developing secondary or backup power supplies; reinforcing bridges, tunnels and subway systems; and upgrading both freshwater and wastewater treatment sites.

Because most of these projects require large capital investments, White says that government officials and engineers must consider a variety of options, including adapting natural habitats, retrofitting existing infrastructure and building new systems.

“There is a need to prepare for rare and catastrophic events but also to address more frequent problems,” she says. Among other things, USACE is working to quantify the benefits of various approaches, including natural defenses like protecting wetlands and building sand berms.

White says that one of the challenges is simply the differences in geography and tidal conditions in different locations as there cannot be a one-size-fits-all approach. “From an engineering perspective, it’s necessary to consider both the frequency and severity of events, including low-energy and high-energy-type events. It’s important to make smart investments that take risk and potential damage into account when determining the types of solutions that can be put into place and how much they cost.”

McMahon predicted that the U.S. would follow the lead of the Netherlands regarding future investment in resiliency against rising tides. With much of its land mass below sea level,



Pedestrians walk through Miami Beach’s city streets, which flooded in September 2015 due to a combination of rising sea levels and seasonal high tides resulting from lunar orbit.

MARIO TAMIA/GETTY IMAGES



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NICK DENICHILO
HATCH MOTT MACDONALD

the Netherlands has been battling the sea for centuries. Today, the country is protected by a sophisticated network of channels, locks and surge barriers that theoretically would only be breached by a one-in-10,000-year storm and is a world model for best defending against the sea.

“The U.S. is slowly finding itself in a similar place as the Netherlands—when building barriers against the rising tide is the only recourse,” McMahon said. “All it takes is that one monumental, game-changing event to generate the needed emphasis.”

Rather than becoming bogged down by the politics, DeNichilo says: “If we do not begin to address these needs and take a life-

cycle approach, we are likely to face even steeper costs, along with loss of property and life, in the future. The grand challenge is to recognize that we are subjecting our infrastructure to these events and that we’re going to have to make major capital investments in order to deal with sea level rise.”

Schlaman believes efforts to combat rising sea levels must involve mitigation plans that cross traditional silos and boundaries. “Many of these potential problems and challenges transcend any one agency or government entity. A more holistic and comprehensive approach is essential,” he says.

“There’s also a need to move from reactive to proactive. Many communities are still in a state of complacency because this is a somewhat insidious issue. They are going to see sea level change sneak up on them because they haven’t yet been impacted by an event.” ■

Samuel Greengard is a technology writer based in West Linn, Ore.