International Center for Enterprise Preparedness (InterCEP)

Ever Rising Tides: Projected Impacts of Sea Level Rise in Coastal Urban Areas

Web Forum Summary

On November 12, 2015, Michael Bruno, Dean of the Schaefer School of Engineering and Science at the Stevens Institute of Technology, discussed sea level rise and its relevance and potential impacts to coastal urban areas.

According to records, sea level is rising. The data for New York City and Sandy Hook indicate that over the last one hundred years sea level has risen on average 3 mm per year. This is about one foot over one hundred years. Although these figures don’t seem that high, they can have a very significant impact on coastal infrastructure such as the Hudson River Waterfront Walkway in New Jersey. This means that new projects need to take this change into account. For a project with a 50 year design life, such as a beach nourishment project, it is necessary to incorporate a six inch sea level rise into the design. But sea level rise is not uniform. The most accurate current satellite measurements suggest a global average of 2 mm rise per year. The figure below shows regional trends for long term relative sea level changes in the U.S.

![Image source: National Oceanic and Atmospheric Administration (NOAA).](image-url)
From a climate change perspective sea level rise is driven by increasing temperatures that result in the thermal expansion of water in the ocean and the melting of glaciers over land. A 1 degree Celsius increase in ocean temperatures is equivalent to about 2 feet of sea level rise. However, the surface temperature changes observed around the world show a significant amount of variability, from zero in some parts to over 2 degrees Celsius in the arctic region. One driver of rapid temperature change in the arctic is the change in sea ice cover. A reduction in sea ice means less radiation from the sun is reflected back out into space and more of it is absorbed by the ocean.

An important factor to consider when discussing sea level rise is the impact of natural and anthropogenic factors that result in the subsidence and compaction of soil. Activities such as the removal of underground oil and water, paving and building can change the position of land relative to a position in space. Oftentimes these changes make areas more susceptible to sea level rise. Subsidence and compaction have been observed and measured in many different locations, including San Francisco and Long Beach, in California, Louisiana, and Tokyo, Japan.

In terms of the impacts of sea level rise to homeowners and businesses in coastal and low-lying areas, it is important to consider that even relatively small increases in sea level can erode dunes and other features that protect coastal areas, increasing their vulnerability to storms and changes in the ocean. These changes could result in damages to the built environment and the need for relocating important structures. For example, in 1999, the Cape Hatteras Light Station, which includes seven structures in North Carolina, were relocated due to the threat of shoreline erosion. There are many areas in states such as Florida and Louisiana that are at risk from sea level rise and where such measures might be needed.

The scale of the problem is very significant. A majority of the world’s mega cities, for example, were built on or near a coastline due to transportation and trade needs. These are metropolitan areas of 10 million people or more and they are now more vulnerable to extreme storms and sea level rise. Adaptation measures to address concerns about sea level rise include improved house designs and beach nourishment projects. The latter kind of project are also affected during extreme storms such as Hurricane Sandy and they can suffer from erosion, but these beach nourishment projects can absorb the energy of waves and surge and save homes and critical infrastructure in close proximity to the coastline that would otherwise be at greater risk. Similarly, vegetated dunes and other features can be impacted during extreme weather events but they protect homes and infrastructure.

The goal of resilience efforts is to help communities live with threats such as sea level rise and to be able to grow and improve despite these threats. This requires learning to respond to these threats, which can be accomplished by improving our ability to monitor and to learn from the data that is being collected and analyzed. This information also allows for a more accurate way to anticipate problems an respond to them.

It is important to note that policy makers and planners should focus on the function of critical infrastructure, not on the preexisting systems, including transportation, energy and health care. Systems should be configured to be able to continue to provide services even if components such as electric power fail.
Researchers at Stevens Institute of Technology are currently running models and dovetailing real-time data to improve the resolution of ocean forecasts and to provide 72 hour warnings for events that could threaten airports and tunnels in the region. This is being done in collaboration with the Port Authority of New York and New Jersey.

Another area where important work is being carried out is in the restoration of natural ecosystems that were damaged or lost due to urban development and other causes. There are opportunities to recover wetland areas and to re-create salt marshes and other natural features that have been shown to provide natural buffers to reduce the impact of wave erosion and surge. The same is true of restoring oyster reefs.

An important challenge with sea level rise is how to use the knowledge being generated and how to communicate it so that communities and individuals can use it to inform decisions. Better communication can allow for improved design of critical infrastructure systems that will be in place for many decades. New research and improved communication can also allow communities to better assess when to rebuild and when to relocate after a severe storm or natural disaster, especially for communities in areas that are at high risk for flooding and storm damage.

In terms of obtaining data and information about sea level rise, the National Oceanic and Atmospheric Administration (NOAA) is a leader and has been monitoring the ocean and U.S. coasts for many decades. The National Aeronautics and Space Administration (NASA) is also providing critical satellite information. The U.S. Army Corps of Engineers also has a lot of experience with respect to design and building around most communities of regions of the country and can share their knowledge and expertise. The Intergovernmental Panel on Climate Change (IPCC) under the auspices of the United Nations (UN) consists of scientists from all over the world and their reports are among the best sources of information about what is happening at the international level.

Additional Resources:

- Stevens Institute of Technology – Davidson Laboratory: http://www.stevens.edu/ses/davidson
- National Aeronautics and Space Administration (NASA) – Sea Level: http://climate.nasa.gov/vital-signs/sea-level/
- Intergovernmental Panel on Climate Change (IPCC): http://ipcc.ch/