

**Our Ocean Backyard — *Santa Cruz Sentinel* columns by Gary Griggs, Director, Institute of Marine Sciences, UC Santa Cruz.**

**#118 November 3, 2012**

**Superstorms and Storm Surges**

A hurricane with the innocuous name of Sandy ravaged the Eastern seaboard of the U.S. on Monday, battering the coastline, leaving cities flooded, and millions without power. In many areas, cell phone communication was down. The New Jersey coast was devastated and New York City was again at ground zero as one of the hardest hit regions.

The storm surge pushed water levels up to a record-breaking 13.88 feet above low tide level at Battery Park, on the southern tip of Manhattan. Water flooded subways, tunnels, streets and parking garages, and literally flowed into the construction site at Ground Zero like a flood. Joseph Lhota, the Chairman of the Metropolitan Transit Authority of New York City referred to it as the most devastating disaster the subway system has experienced in its 108-year history. As of Thursday, at least 88 people had died in the U.S. as a result of the superstorm.

We usually think of Atlantic City as a summer resort town, but it was transformed into a river Monday night when high tide put 85 percent of the city underwater. Hundreds of feet of boardwalk washed away and many oceanfront homes were seriously damaged or completely destroyed; many were torn off their foundations and carried inland.

Over the past century, while the number of hurricane related deaths in the U.S. has decreased, the cost of damages has dramatically increased (Hurricanes Irene, 2011 >\$10 billion; Wilma, 2005 >\$23 billion; Ike 2008, >\$30 billion; and Katrina, 2005, >\$90 billion). Eight of the eleven most costly hurricanes in the U.S. occurred between 2004 and 2011. And its pretty certain that damage from Sandy will be in the billions of dollars.

The reduction in death toll is at least partly due to our improved ability to predict the landfall location, communicate to the public and evacuate at-risk populations. Increased property losses, however, reflect rapidly growing coastal populations, more construction in hazardous locations, and more expensive buildings. Atmospheric pressure, wind speed, height of storm surge, hurricane path, coastal

topography and elevations, and intensity of development all affect the impact of any individual hurricane.

While the east coast was preparing for the arrival of what may have been the largest storm to ever hit the New York/New Jersey coastline, we were enjoying a warm sunny weekend. Their ocean backyard can be much more treacherous and unforgiving than ours along Monterey Bay.

One major difference between our two coasts is that we don't get hurricanes; nor do we get the associated storm surges that typically wreak the most havoc, flooding subways, tunnels and neighborhoods and washing away homes, businesses, highways and beaches. Given a choice between several hurricanes (each accompanied by strong winds and storm surges) every year on the East Coast to the occasional earthquake and a big El Niño every 8 to 10 years here on the West Coast, I'd personally take my chances right here.

Storm surges are produced by the low atmospheric pressure and high winds that accompany hurricanes. Under normal conditions, the pressure of the atmosphere pushes down on the water surface, keeping the sea at a normal height.

But when a low-pressure disturbance moves over an area of ocean, the pressure on the sea surface is reduced and the height of the ocean rises. Coupled with 50 to 100 mile per hour winds, this results in seawater literally piling up against the shoreline, as it did on Monday, from the Carolinas to New England.

If the mound of seawater enters a bay, inlet, harbor or river channel, the water is funneled into a smaller space and can rise even higher. To make matters worse, Sandy arrived during a full moon, which produces the highest and lowest tides, elevating the sea surface even higher. In Manhattan, the peak of the storm surge coincided precisely with high tide. This was just plain bad luck.

The Gulf and Atlantic coasts have a long and deadly hurricane history, although there are some that stand out above others. The worst recorded natural disaster in U.S. history was a hurricane that made landfall with winds of 145 mph at Galveston, Texas on September 8, 1900. Galveston is built on a sandy barrier island with a maximum elevation of just over 8 feet. The storm surge reached a height of 15 feet, sweeping completely over the island. Between 6000 and 8000 people lost their lives.

Hurricane Camille barreled into the Mississippi and Louisiana coast in 1969, with a storm surge of over 24 feet, total losses of \$10 billion (2011 dollars) and 259 lives. Katrina in 2005 had a maximum storm surge of 25 feet at New Orleans and took over 1800 lives.

In 1983, during what was probably our most damaging El Niño of the past century, sea levels were elevated above normal tides along the central coast by about 12 inches for several months. Maximum storm surges along the California coast might be a foot, but compared to hurricane surges of 10 to 25 feet, we live in paradise.

We cannot yet answer the specific question of whether climate change made Hurricane Sandy more likely to occur. What is already clear, however, is that climate change very likely made Sandy's impacts worse than they would otherwise have been.

While power has not yet been restored, telephones are still down, and the damage has not been completely assessed, state officials are already requesting that the Corps of Engineers talk to them about the best way to rebuild the New Jersey shore. Understandably there is a natural urge and compassionate desire to help out those who have lost homes and businesses. But within the last 14 months, two hurricanes have now hit the mid-Atlantic shoreline. Perhaps this is also a good time to take a longer view and also think carefully about the future risks of rebuilding directly on the shoreline.