

Superstorm Sandy – How did it happen and are we prepared for the future?

By Malcolm J. Bowman.

Hurricane Sandy was a sudden shock to our sense of security and complacency. The fury inflicted on life, property and infrastructure was enormous for coastal communities of the north-eastern seaboard, particularly in New York and New Jersey. Apart from the human loss of more than 80 lives, rebuilding could easily top \$100 billion when all the debts are settled.

What made Sandy so destructive, when it barely triggered a Category I Hurricane classification by the National Weather Service? Why, Sandy even dropped below hurricane status (based on a wind intensity scale) not long before it made landfall just south of Atlantic City NJ around 8 pm on October 29th, 2012. At this time, the National Hurricane Center referred to it as a “post-tropical cyclone” and stopped releasing hurricane advisories. But this lowering in status was no reflection of the destructive power this enormous storm still packed.

Sandy was unusual in several aspects. Firstly as Sandy moved northward, the storm began to take on some extra-tropical characteristics, such as a larger and more asymmetric wind field, with enormous dimensions – some 1,100 miles in diameter.

Second, a major deviation of the high-altitude jet stream, looping southwards known as a “blocking high”, forced the hurricane vortex to suddenly make a sharp turn to the left (westward), colliding with the New Jersey coast. A storm in the Atlantic northeast with such unusual properties has never before been documented in the meteorological literature.

But thirdly, what made Sandy so damaging was the timing of its landfall – the eye of the hurricane smashed into the Jersey coast at local high tide. On top of that, the moon that fateful night was full – leading to a higher than normal “spring tide”. The storm surge – an additional 9 feet or more of water piled up against the coast by furious winds and crashing ocean waves – was riding on top of this extra high tide. This



Village of Monster, Netherlands, taken from the top of a nourished natural sand dune, looking landwards. The ocean is to the left of the picture. The residents have traded the seaview for security.



extraordinary storm tide poured into harbors and inlets, swept across wide swaths of low lying beaches, eroded protective dunes everywhere, topped seawalls, ran into tunnels and stations and washed through empty streets.

This led to unprecedented damage to communities built too close to (and on) the beaches of New Jersey and New York. Seaside communities were devastated with the majority of fatalities concentrated in southeastern Staten Island. Severe flooding occurred in the business district of lower Manhattan with vital power outages lasting at least five days. The East River overflowed its banks. The surge continued up the Hudson and other rivers, inundating communities as it penetrated inland, unstoppable.

The new \$530 million showcase South Ferry subway station at The Battery, proudly opened in 2009, was completely destroyed. Three-and-a-half years later, the station lies in ruins. What made it worse was that the flooding was by seawater, not rain water. Sea salt is very corrosive and a powerful conductor of electricity – short circuiting and destroying all electronics, computer and switching systems in its path. It is estimated that it will cost about \$620 million to rebuild the station.

Interestingly, had Sandy made landfall either six hours earlier or six hours later, it would have

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been local low tide and even the same wind-and-wave generated surge would have produced a relatively harmless storm tide. With hurricanes, timing is everything! Curiously, the precipitation associated with Sandy was quite modest, especially compared with the 2011 Hurricane Irene's heavy rainfall, which quickly drained into swollen rivers, devastating communities in upstate New York and New England. Every storm has its own signature, "personality", and surprises!

Governor Andrew Cuomo has set up several commissions to study and report on the causes, damages and recommended remedies to prevent this type of catastrophe ever happening again. Mayor Michael Bloomberg has reinstated the New York Panel on Climate Change to assess the situation and make recommendations for the future protection of the City. The two Governors of New York and New Jersey petitioned Congress for \$61 billion for disaster relief. New York City Speaker Christine Quinn and US Senator Charles Schumer have urged Congress to release funds for already approved US Army Corps of Engineers projects to renourish depleted beaches with underwater sand vacuumed and pumped ashore by huge dredges.

I have just spent three days in the Netherlands learning how this flourishing European nation of 17 million citizens ably protects itself against the menaces of storm surges (about 26% of the country lies below sea level and another 29% susceptible to river flooding!). Much of the coastline is protected with wide, enhanced natural sand dunes, some 30' high. Major cities, seaports and industrial areas are protected by a system of seawalls and storm surge barriers.

In the province of Zeeland, I visited the famous Delta Project. The Delta Project is a complex system of dykes (levees), coastal sand dunes and built structures protecting cities, communities, industry, agriculture and vital infrastructure (the capital city Amsterdam is in places 6-12' below sea level – as is Rotterdam and Schiphol national airport – Europe's 4th busiest). The Delta project is one of the largest construction efforts in human history. The American Society of Civil Engineers even names it as one of the seven wonders of the modern world.

In January 1955 a devastating winter storm (a combination of a furious North Sea storm, a local high tide and a spring tide –

sound familiar?) broke through many of the existing dykes, built over centuries, flooding large portions of the country, drowning 1835 people, destroying thousands of homes and farms and causing untold misery. This tragedy was endured by a people who were still reeling from the devastation of World War II that had ended just nine years earlier.

The Dutch have vowed that they would never, ever, have to endure such a catastrophe again. So they have set themselves a very high security standard – they would build a coastal protection system that would endure a 1/1,000 year storm, and even in some localities a 1/10,000 year storm! (a 1/1,000 year storm is a storm so extreme it is likely to occur only once every 1,000 years –

this is not to say that it will be 1,000 years before one strikes; but that there is only a slight 1/1000 chance that it will occur in any given year).

In Rotterdam, the second largest seaport in the world, the Dutch government has funded the Rotterdam Climate Proof Program, a series of projects designed to manage, store, pump and even celebrate the existence of water everywhere. They are very much aware that they can never be complacent. And rising sea levels associated with climate change means the Dutch must ever be vigilant.

We in New York can learn much from the Netherlands' experience. Obviously, Metropolitan New York and Long



The storm surge barrier across the Oosterschelde estuary at work during a storm.

Island do not lie below sea level, but even so, it's worth remembering, and that much of the city's subway system, road tunnels and communication infrastructure do lie below sea level. New York sewers often back up during storm events. Two to three million people in the outer boroughs of Brooklyn and Queens live less than 6' above sea level. Another way of looking at the climate change challenge before us is to realize what the Netherlands is experiencing today will be New York's fate 75-100 years from now. We have the benefit of time to learn from the Dutch experience their skills and prepare ourselves for the worst.

Was Superstorm Sandy predictable? Well yes and no. Our Stony Brook Storm Surge Research Group has been predicting for years that New York City and Long Island are at significant risk of being flooded. Back in 2005, I wrote an Op-Ed piece for the New York Times entitled "A City at Sea" where I

predicted it was not a matter of “if”, but “when” New York City would be flooded. But we could not predict exactly when this would occur!

The city’s response has been to develop a plan of “resilience” – a protocol of “watchful waiting”. When extreme storms occur, the damage is assessed and repairs are made in such a way that the weak spots are strengthened. Subway entrance stairs are raised, critical switching systems in power plants are lifted out of harm’s way, hospital emergency power plants are taken out of the basements to higher levels, and vital communications infrastructure is thoroughly waterproofed. But one is tempted to say, cynically, that New York City is planning to be flooded! Our current culture is to recover from losses, not protect against them.

So was “watchful waiting” good enough? Obviously not. Super-storm Sandy simply overwhelmed existing protection measures. During that fateful evening of October 29th, I listened to news radio at home on my hand-cranked AM radio (the power had already gone off and stayed off for a week). In horror I mentally started checking off the boxes of critical infrastructure flooded—first the Hoboken train station, then the Brooklyn-Battery Tunnel, then the FDR Drive, then the South Ferry subway station (oh my, I warned the MTA about that in a National Geographic documentary a few years ago), then there goes the East River subway tunnels,

Our storm surge research group has been proposing for many years that serious consideration be given to the construction of storm surge barriers to protect Metro New York. The first and more expensive option would be a multi-purpose storm surge barrier stretching from Sandy Hook NJ to Breezy Pt, Far Rockaway. Sand dunes would need to be enhanced both ends to protect coastal communities of northern New Jersey, the Rockaways and Kennedy airport. A second barrier would need to be built across the upper East River to prevent surges originating in Long Island Sound from propagating through the East River into the Harbor. Space does not permit a discussion of the pros and cons of storm surge barriers, but suffice it to say that if such a system were now in place, little to no flooding would have occurred from Sandy in Metro New York. Perhaps this can be discussed in a future article.

And what about Long Island? Fortunately most people obeyed the orders to evacuate the south shore and no lives were lost. But terrible damage was inflicted on Breezy Pt, Long Beach and coastal communities all along the south shore in Nassau and Suffolk Counties.

So, what can be done to protect life and property on our fragile, sandy LI homeland? Augmenting sand dunes around the island by pumping offshore sand will be tedious, endless and expensive, and as the Dutch have found, likely to spoil the view for some. Coastal communities there have traded the ocean view for security. Tightening building codes and disallowing risky building

on exposed sandy foreshores is essential. But these are really the only sets of measures available that may strengthen the resilience of Long Island’s south shore in the short to medium term. In the long term (say 100 years from now) residents will simply have to abandon shoreline properties and gradually make a retreat to higher ground.

Even if the human race stopped all use of fossil fuels today (an impossibility), temperatures and sea level will rise for centuries because of the accumulated greenhouse gases already in the atmosphere (primarily CO₂ but also, menacingly, methane). As a matter of fact, globally we are increasing our use of fossil fuels beyond the worst case scenario envisioned by the Intergovernmental Panel on Climate Change (IPCC) in its 2007 report on the state of the planet. CO₂ is rising at an alarming 3.5% per year. We are moving into difficult, precarious territory as far as controlling runaway global warming.

It is imperative that we make controlling greenhouse gas emissions and development of renewable energy systems a national priority, supported by resources equal to those given to fighting global terrorism. Then the United States will lead the world in addressing the causes and not just the symptoms of global warning. In the meantime, if the Dutch can protect their precious, beautiful country, so can we! ☼

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Scale model of the Maeslant Barrier. The ocean is to the right and the port of Rotterdam is to the left of the image. The gates are shown in the storm (closed) position. During fair weather, the gates retract into “parking areas”.