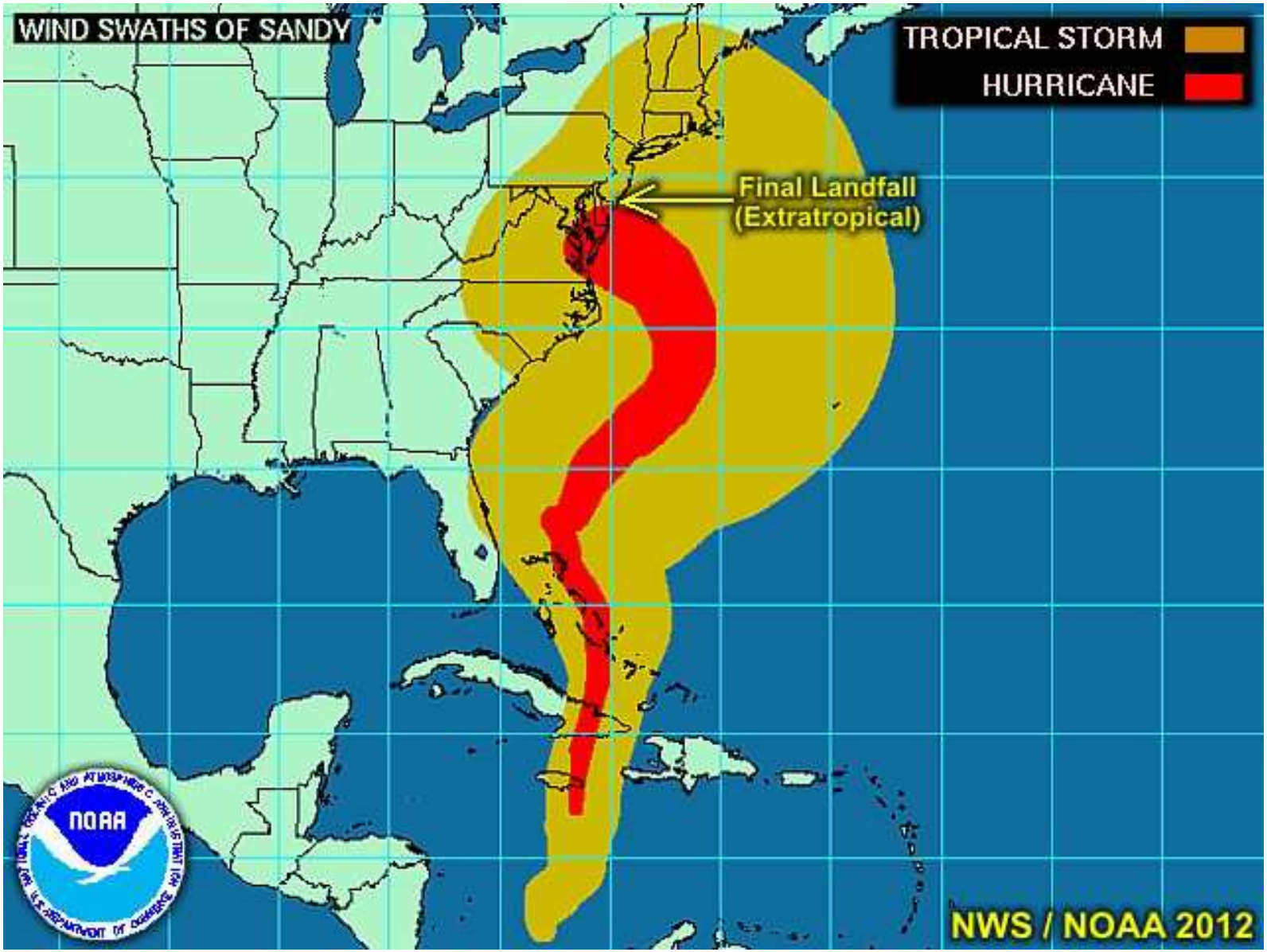
Superstorm Sandy's Catastrophic Flooding of Metropolitan New York: Can we Continue to Live at the Edge of the Sea?

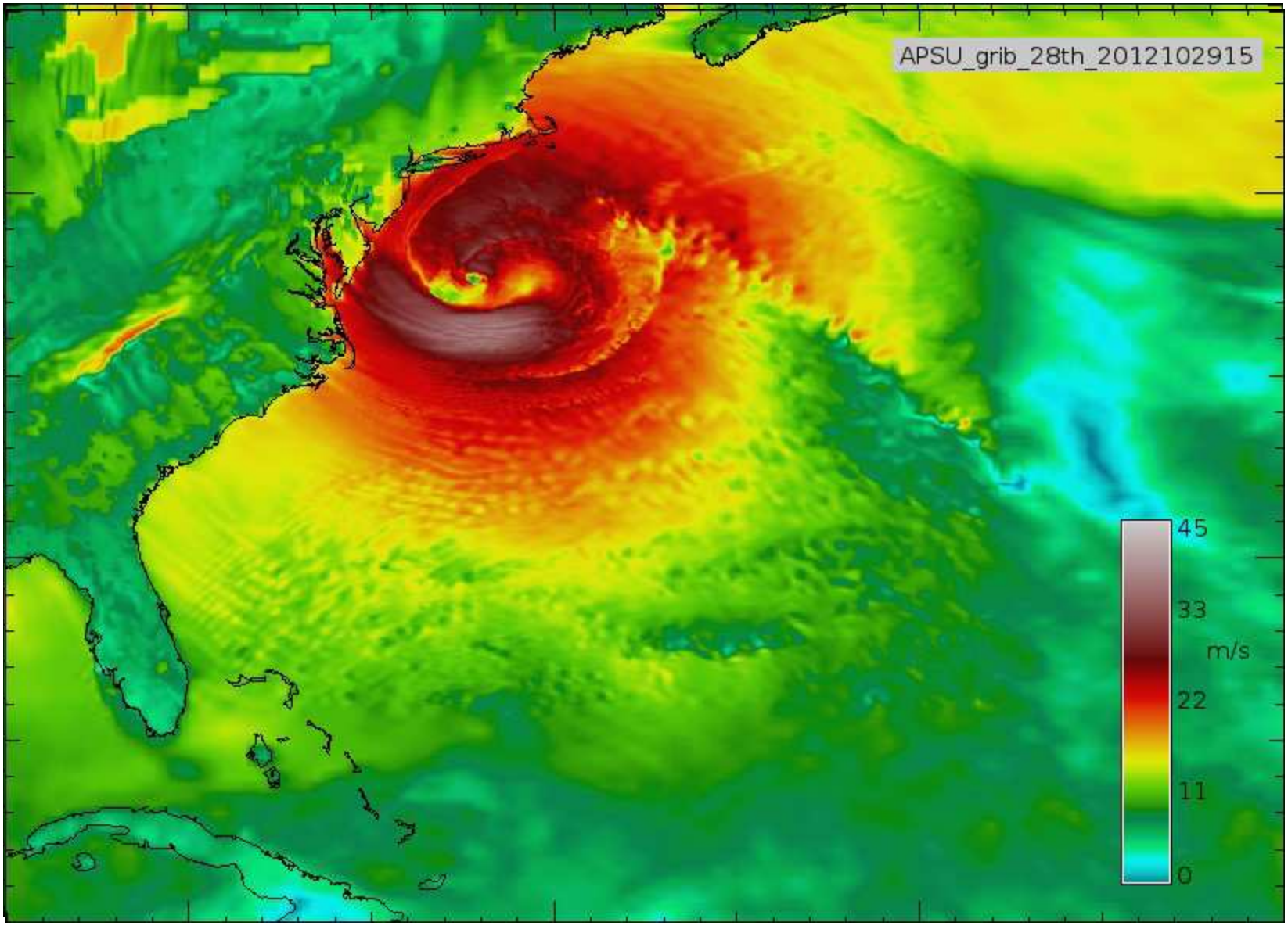
Malcolm J. Bowman

School of Marine & Atmospheric Sciences, Stony Brook University

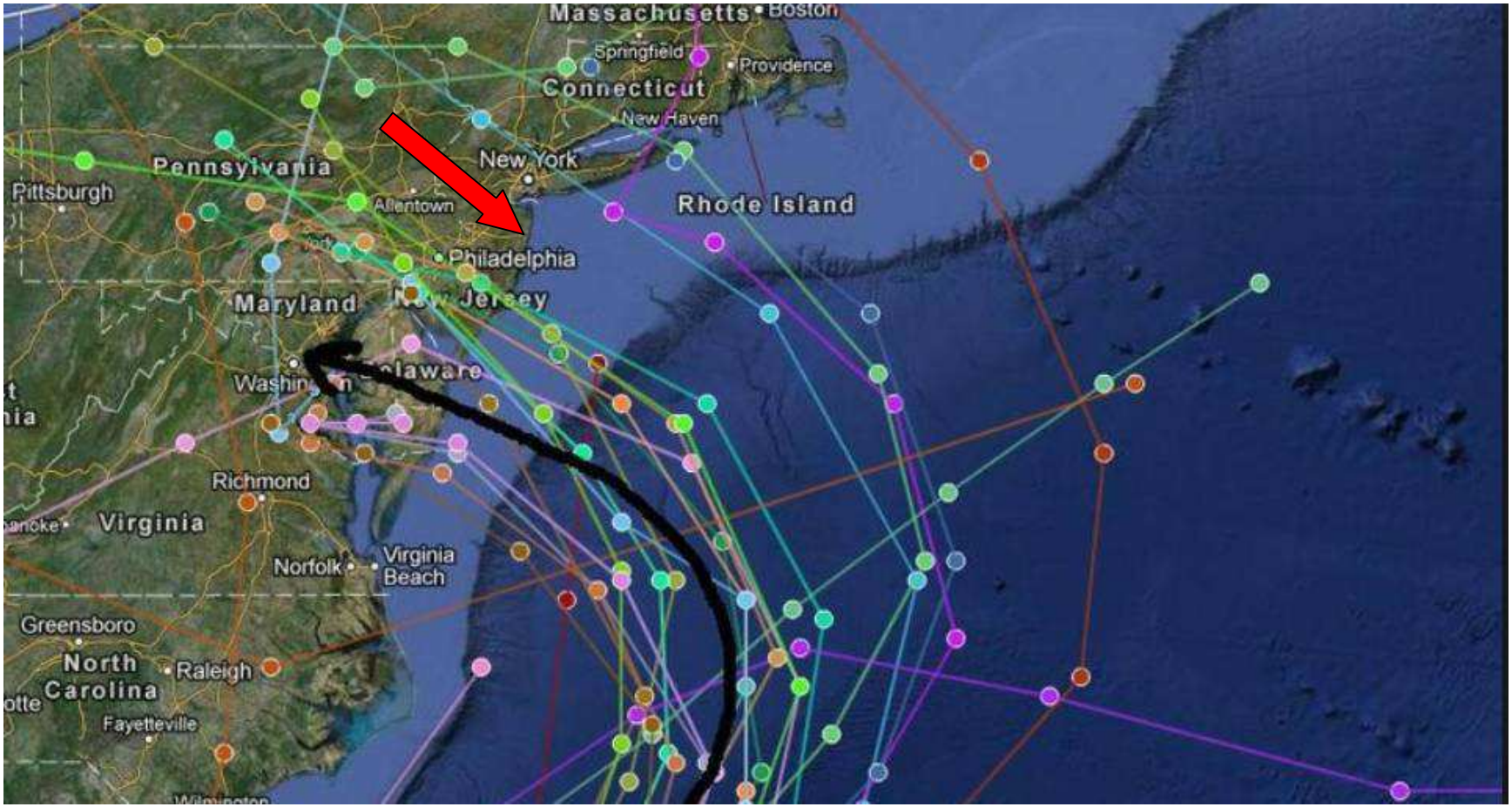
Long Island Regional Planning Council, 15 February 2017



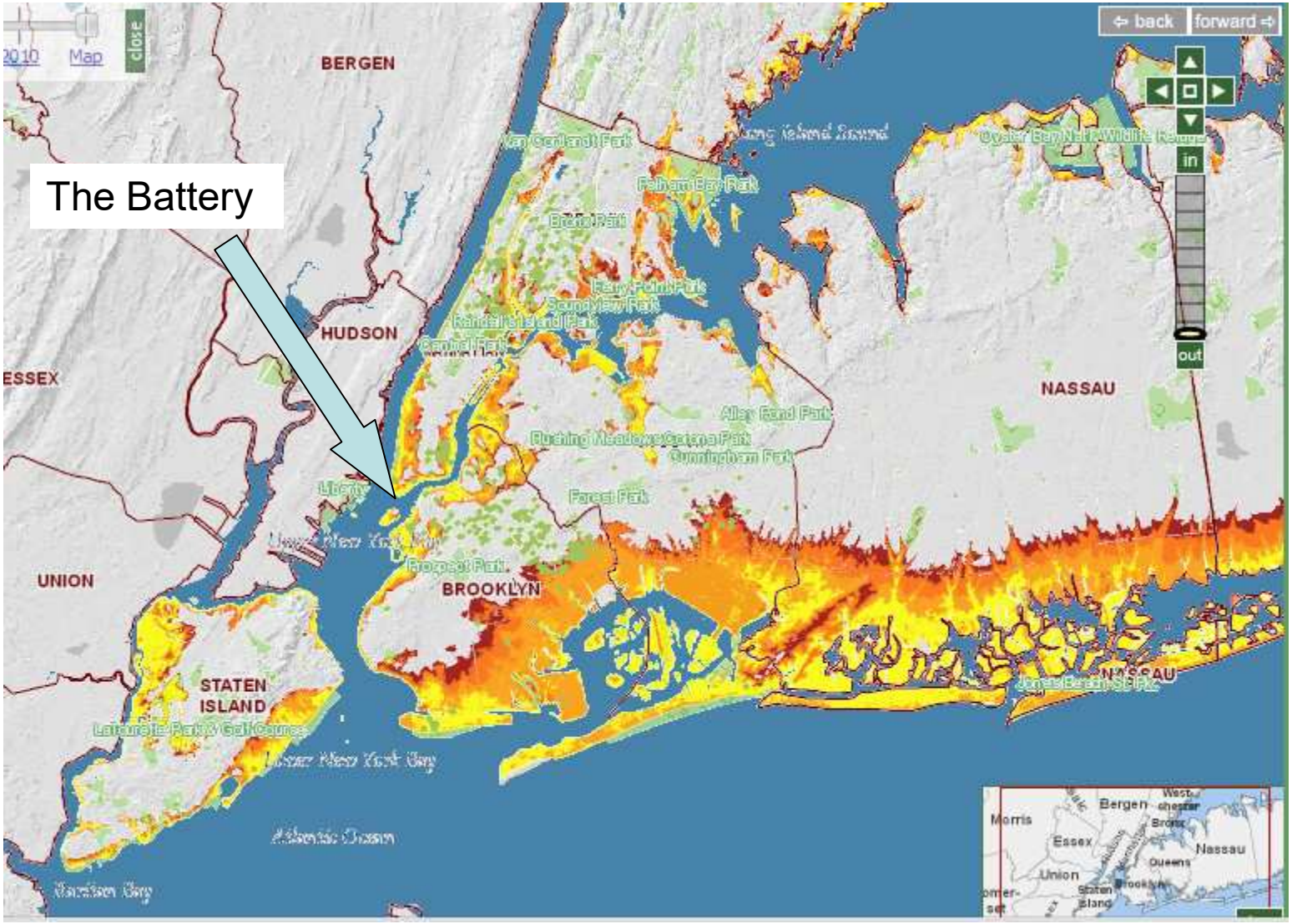
Path of Superstorm Sandy, the second most damaging storm in US history.



Data courtesy of Fuqing Zhang, Penn State U; graphics by Hamish Bowman.

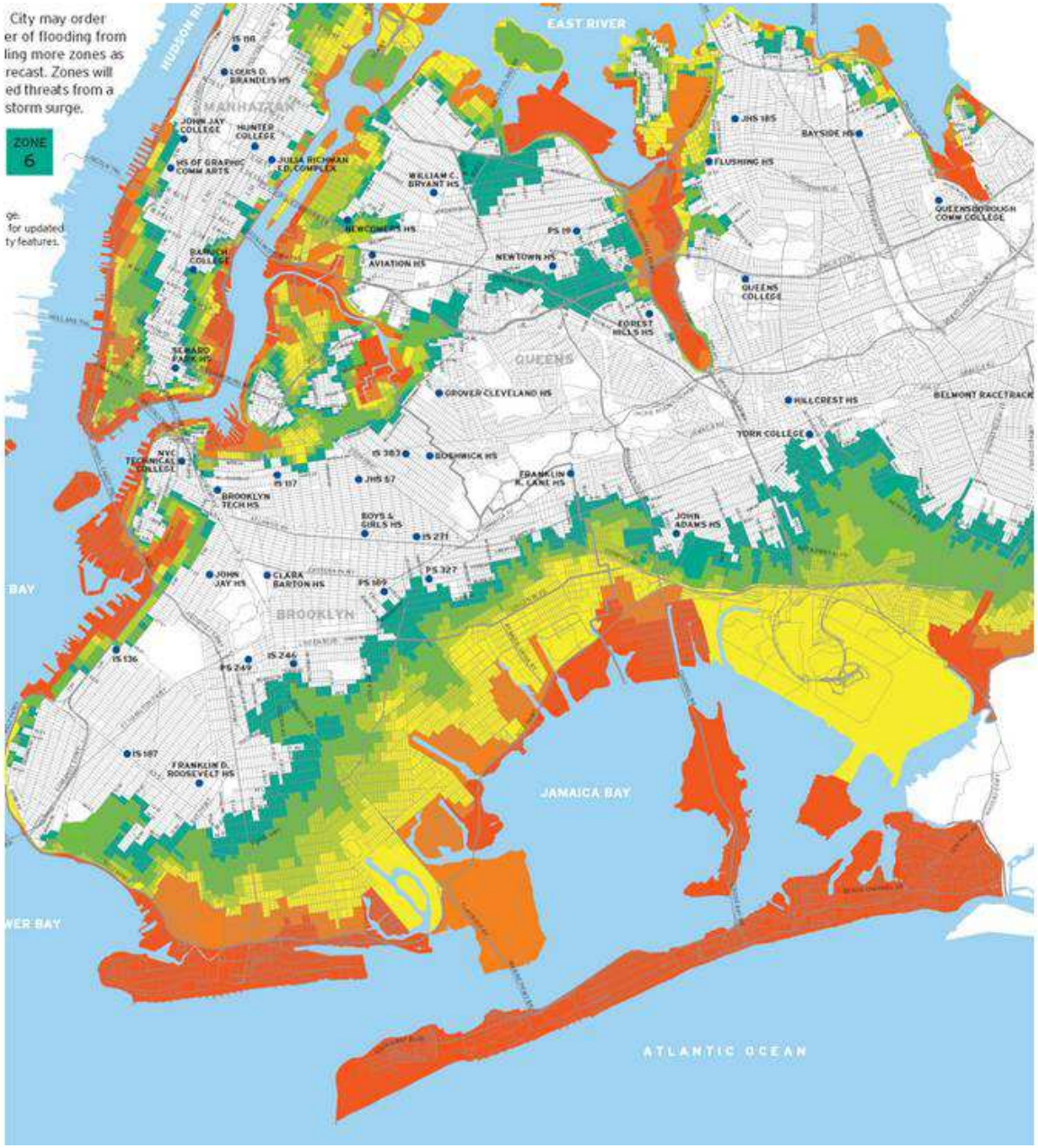


Two days before the hurricane struck, the predictions were still very uncertain about the exact location of landfall. All of these predictions were inaccurate.



Flood risk map based on SLOSH model for hurricanes category 1-4 for New York City and western Long Island Sound. Note the State of NJ is left out.

http://www.harborestuary.org/aboutestuary-climatechange-tides.htm

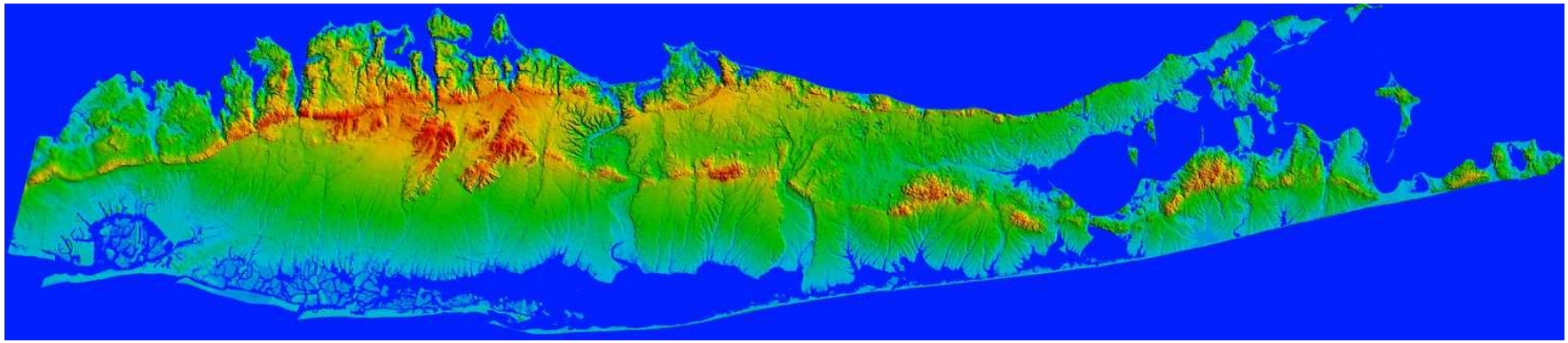


A hurricane evacuation map released by the City of New York covers flood zones that include 37 percent of the city's population.

Evacuation zones are divided into 1 through 6 for a total of 2.99 million residents.

Note that this map does not address the needs of millions of people living in northern New Jersey and southwestern Long Island.

http://www.brownstoner.com/blog/category/flooding/



Digital terrain map of Long Island constructed from Shuttle radar. Long Island is a terminal moraine with extensive areas of low-lying land, particularly along the south shore, which consists of a series of barrier beaches and bar-built estuaries (courtesy Gilbert Hanson, Dept of Geosciences, SBU).

Ground Zero

Entrance to Brooklyn Battery tunnel under New York Harbor

Breezy Point, Far Rockaway. Severe flooding and 115 burned out houses.

Destroyed Houses, South Shore Long Island

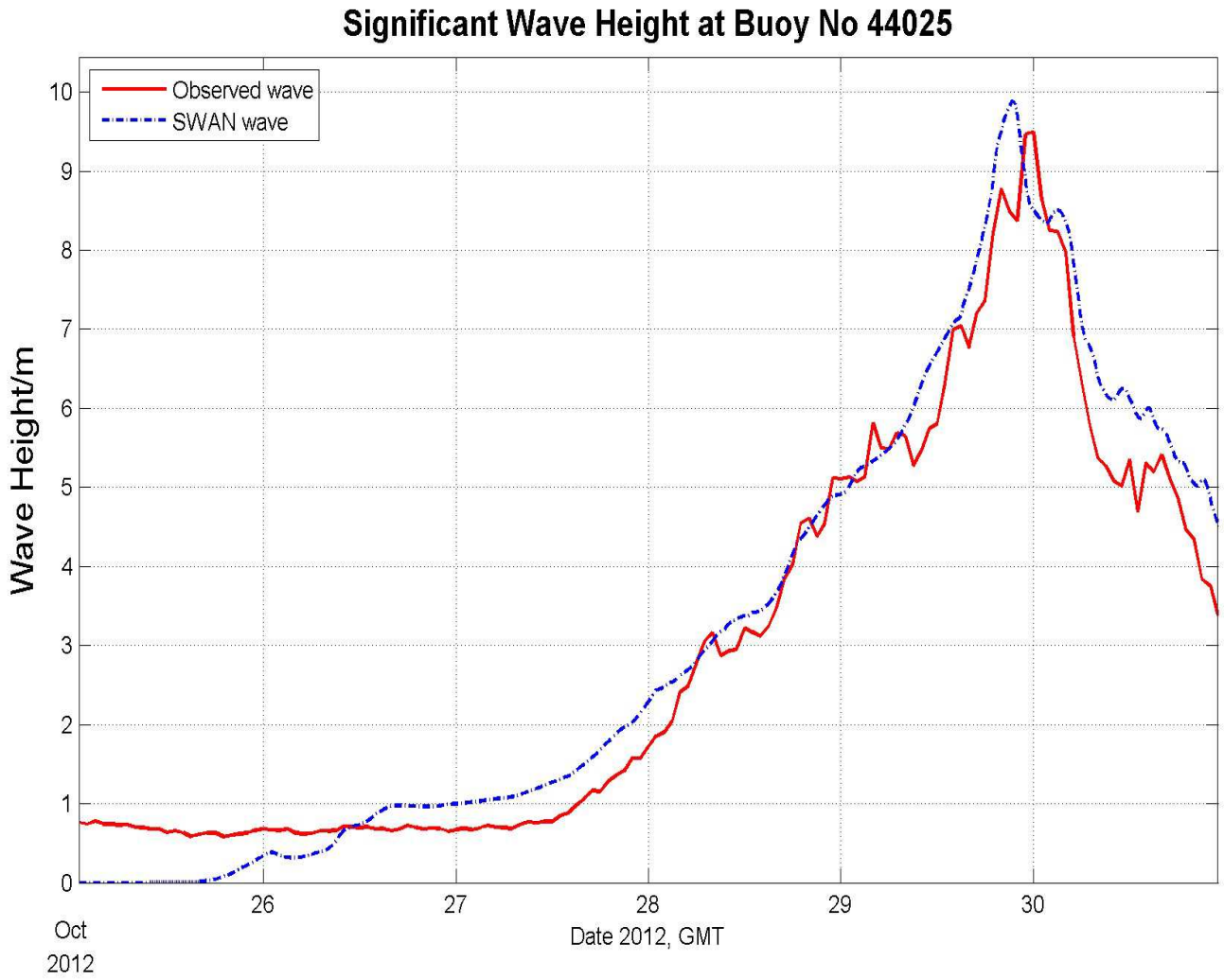
House on Traffic Ave, Ocean Beach, Fire Island National Seashore, slated for removal by US Army Corps of Engineers for demolition, along with 40 others.

“New” Old Inlet, Fire Island National Seashore

National Oceanic and Atmospheric Administration's

National Data Buoy Center

Center of Excellence in Marine Technology



Huge waves pounded on the south shore of Long Island.

SoMAS
School of Marine and Atmospheric Sciences

Stony Brook Storm Surge Research Group

Stony Brook University

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  - Cape May, NJ
  - Lewes, DE
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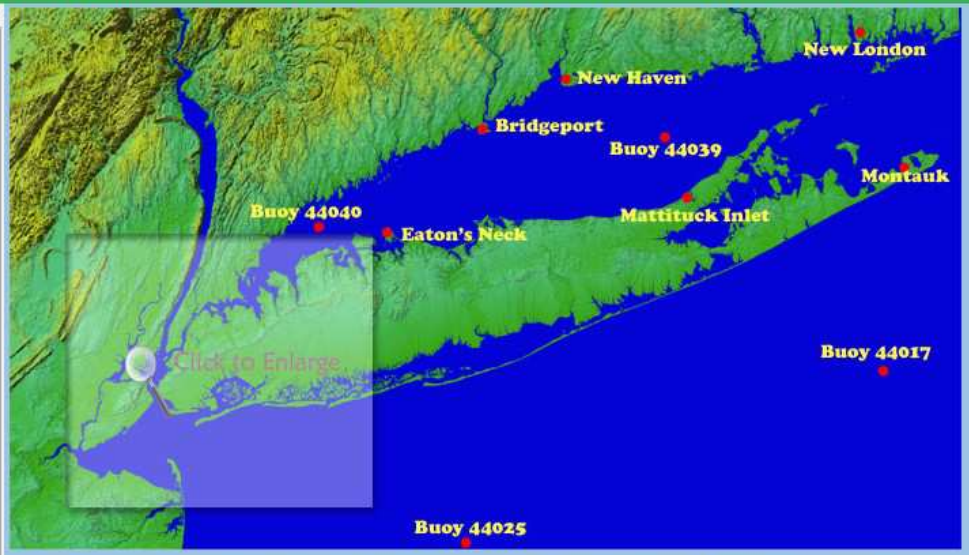
- Maximum Surge



Water level predictions from coupled MM5-ADCIRC models running at 12 km and reduced-resolution, respectively. The Stony Brook MM5 model, a mesoscale weather forecasting model, produces 60 hour predictions in about 120 minutes, twice a day. Wind speed and sea-level pressure predictions are then used to drive the ADCIRC storm surge ocean model over the same 60 hour period. The routine repeats every 12 hours, updating the forecasts.

Times are shown in Eastern Standard Time.

The Stony Brook Storm Surge Research Group is developing a real-time weather and ocean storm surge prediction system which can be used for a variety of purposes. Such uses include hurricane and nor 'easter flooding predictions and alerts, water quality and effluent dispersion, the feasibility of building storm surge barriers to protect the New York Metropolitan region from storm damage and coastal flooding in an era of global climate change and rising sea level.

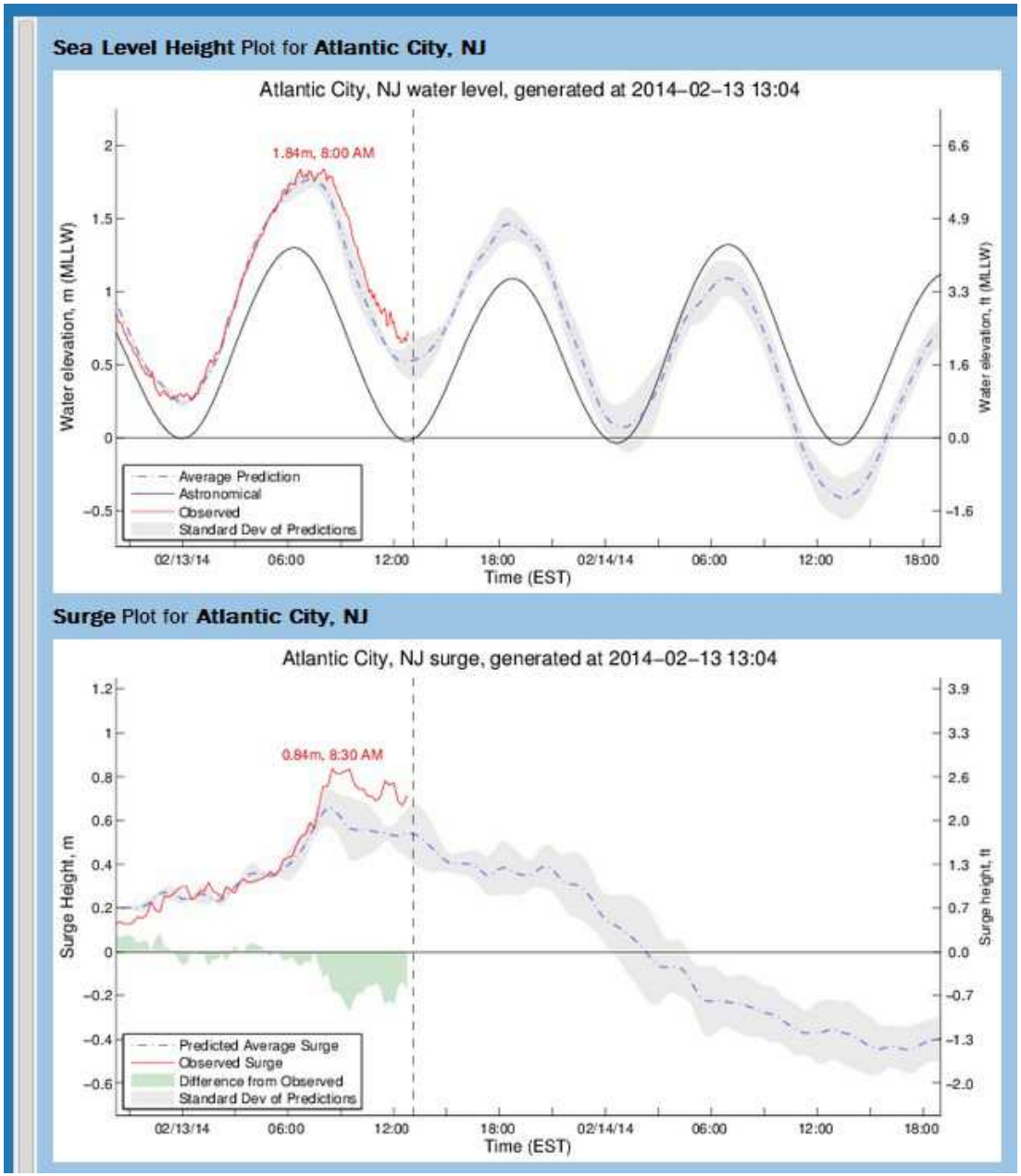
Disclaimer: *This model is under development and predictions for sea level height are for research purposes only. They should never be used for navigational purposes or emergency planning under any circumstances.*

DEP

HydroQual

Sea Grant New York

The Eppley Foundation for Research, Inc.



Stony Brook Storm Surge Model System

http://stormy.msrc.sunysb.edu

Ensemble winds derived from

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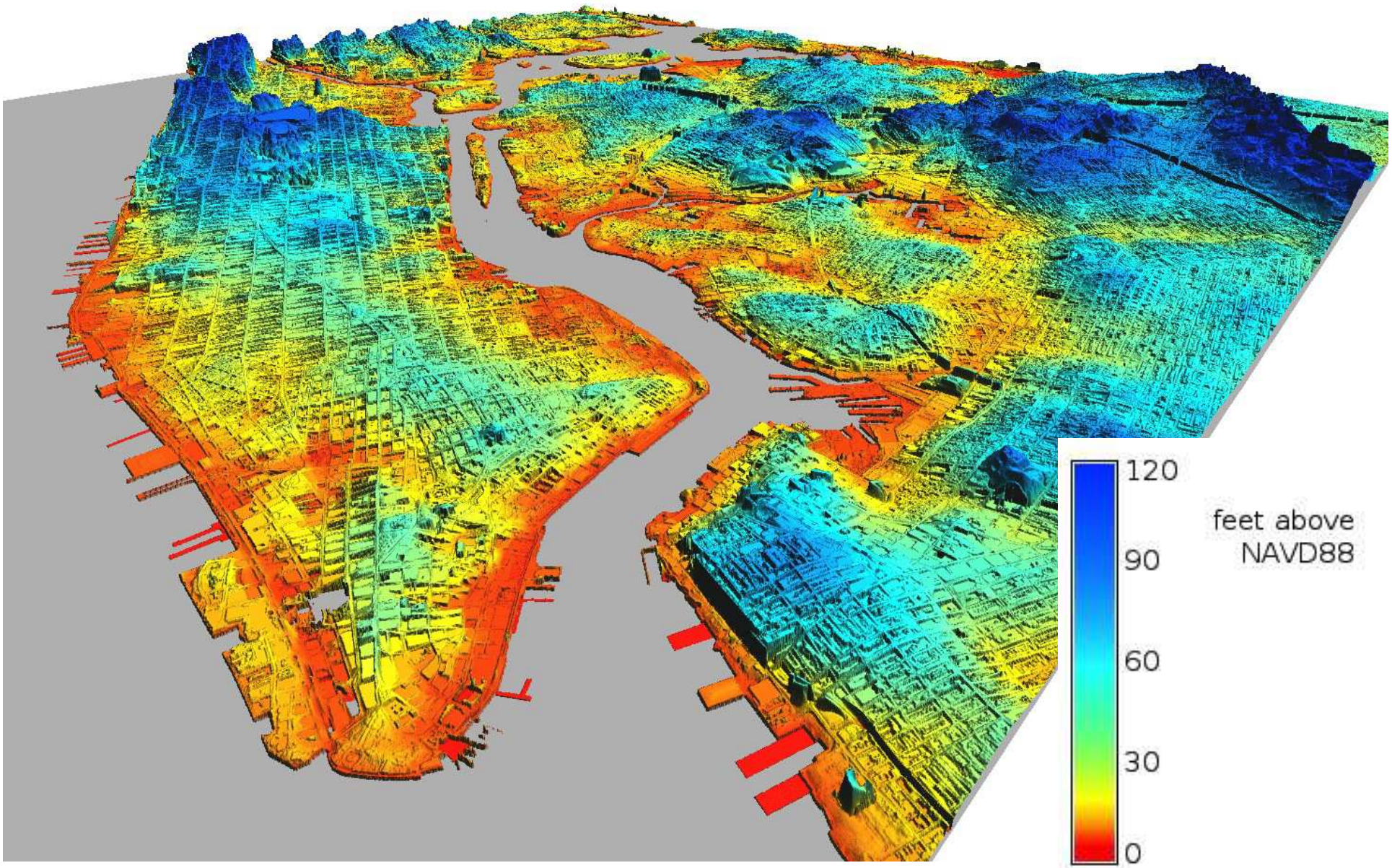
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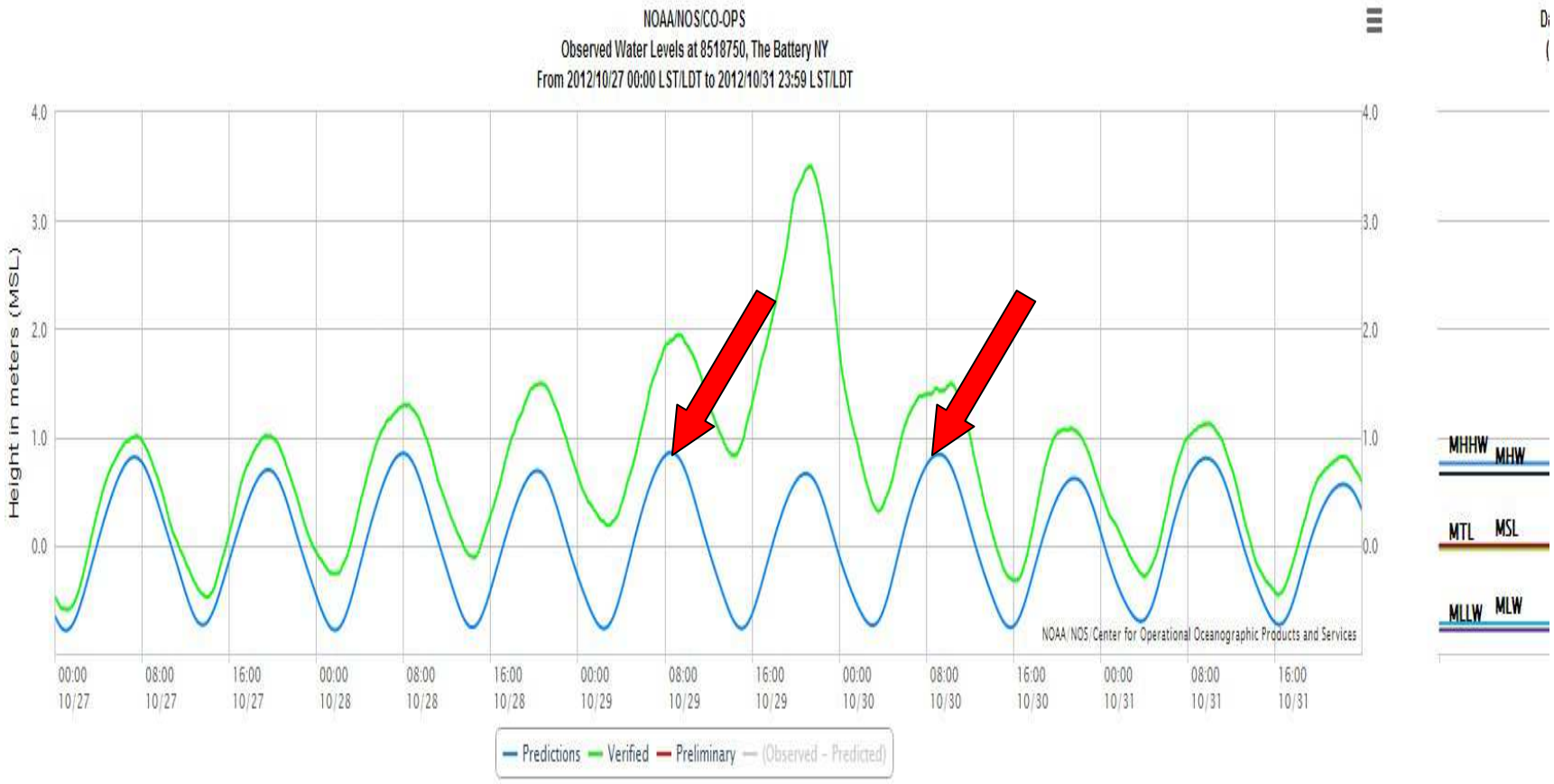

Q: Was Sandy a worst case scenario? A: No!

Effect of diurnal inequality. The Sandy peak tide was not the highest of the day.

In Wake of Sandy, NOAA Alters Hurricane Warning Policy

Published: April 4th, 2013 , Last Updated: April 4th, 2013

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By Andrew Freedman

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Ahead of the 2013 Atlantic Hurricane Season and in the wake of Hurricane Sandy, the Natic
announced Thursday that it is changing its policy on the issuance of tropical storm and h
warnings. The changes will give forecasters more flexibility in issuing hurricane warn
authority for issuing such warnings.

Beginning on June 1, the agency will be permitted to leave watches and warr
ransitions into a post-tropical cyclone, which technically speaking is a d
pical origins, provided that the storm still poses "a significant thre

HURRICANE SANDY

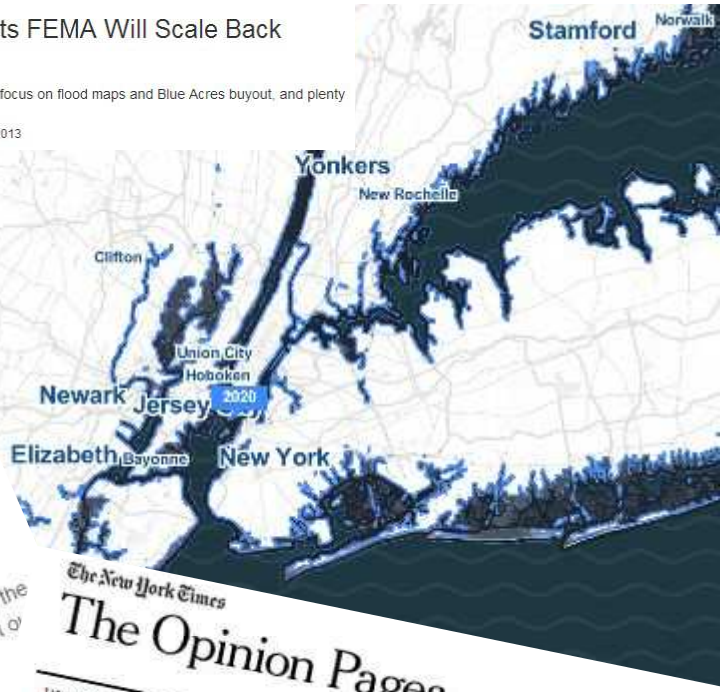
Government

UPDATE: Christie Predicts FEMA Will Scale Back Flood Maps

Governor provides update on rebuilding, with focus on flood maps and Blue Acres buyout, and plenty of anecdotes

By Catherine Galioto | Email the author | March 22, 2013

Maps Basics Researc



Surging Seas

Sea level rise analysis by CLIMATE CENTRAL

Rising Seas a Real Threat to New Jersey

By Ben Strauss & Robert Kopp
July 10, 2012

Note: First published in

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Fire Island National Seashore Continues Wilderness Breach Evaluation

A view of the 250- to 230-foot-wide breach at Old Inlet on Fire Island, as it appeared on November 10, 2012.
NPS Photo/Abell

Barrier Island Dynamics
A constantly changing shoreline is one of the natural features of Fire Island. Read More »

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The New York Times

The Opinion Pages

WORLD U.S. N.Y. / REGION BUSINESS TECHNOLOGY SCIENCE HEALTH

OP-ED COLUMNIST

A New Manhattan Project

By BILL KELLER
Published: November 11, 2012 | 253 Comments

n the monster storm struck, my colleagues at The Times's Room
Debate desk asked an array of experts whether New York should
d protective barriers against the next one. The answers covered,
don the expression, the waterfront: Do something big! ("Worth
Investment") Do something small! ("Big Projects, Big Problems")
nothing much! ("Low on the List of Life-Saving Ideas") Think
out doing, well, something! ("A Wake-Up Call to Consider the
tions")

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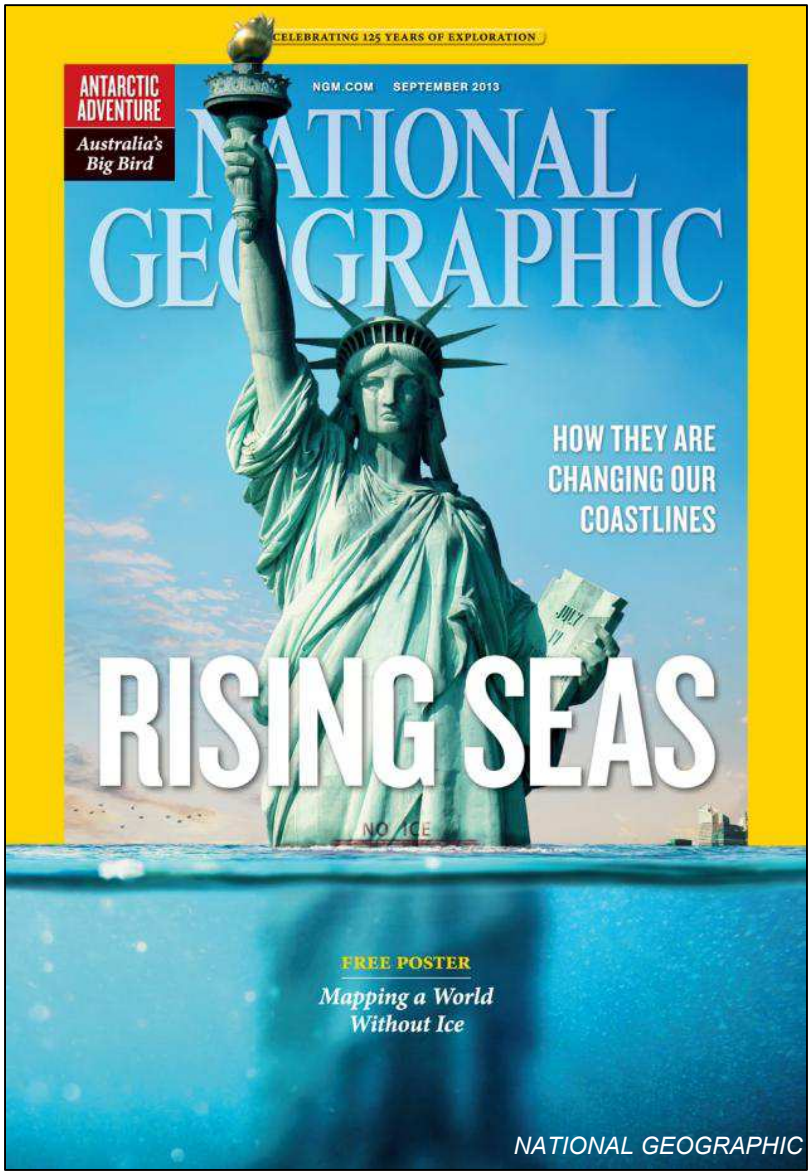
Sea-Level Rise



- More than 8 million people live in areas at risk of coastal flooding. Along the U.S. Atlantic Coast alone, almost 60 percent of the land that is within a meter of sea level is planned for further development, with inadequate information on the potential rates and amount of sea level rise.

- Range of rise varies from low end (12 in.), to high end (6 ft) over a 100-year period.

- USACE contributed to the Sea Level Rise Tool for Sandy Recovery to create a set of map services to help communities, residents, and other stakeholders consider risks from future sea level rise in planning for reconstruction following Hurricane Sandy.

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BRIEFING

MAPS: A 'horrifying' three-day heatwave continues on Australia's east coast today

PAUL COLGAN
FEB 10, 2017, 4:04 AM

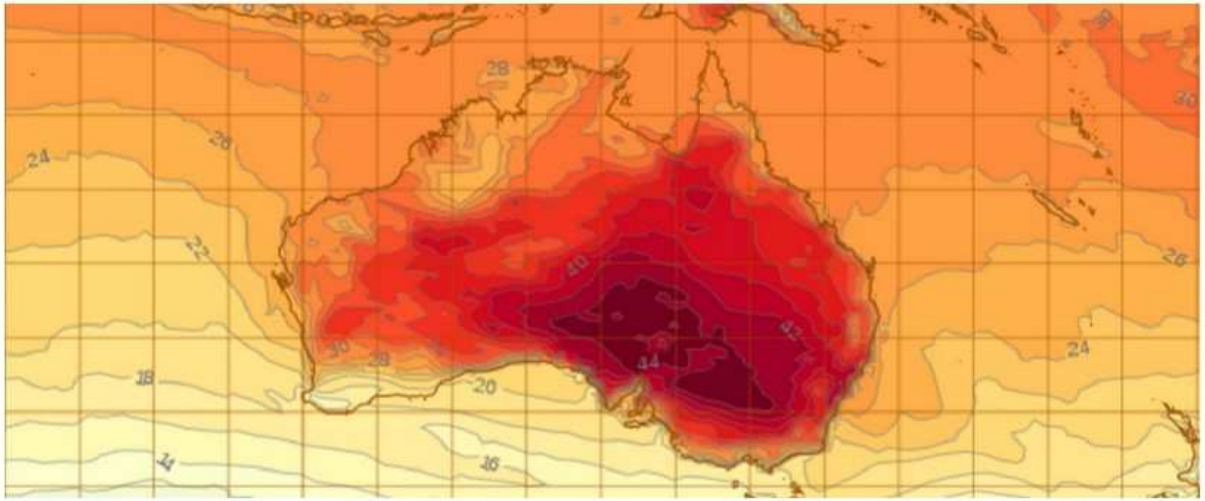
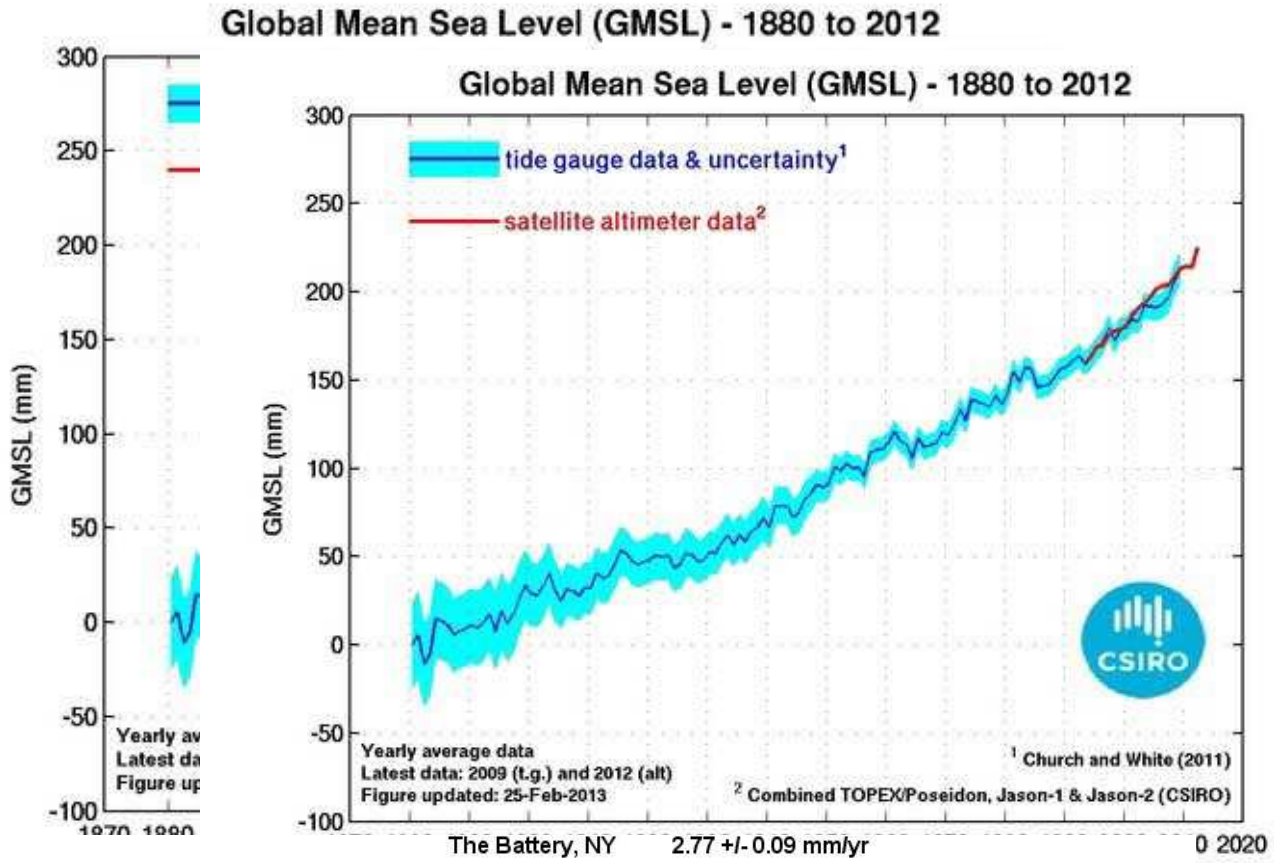
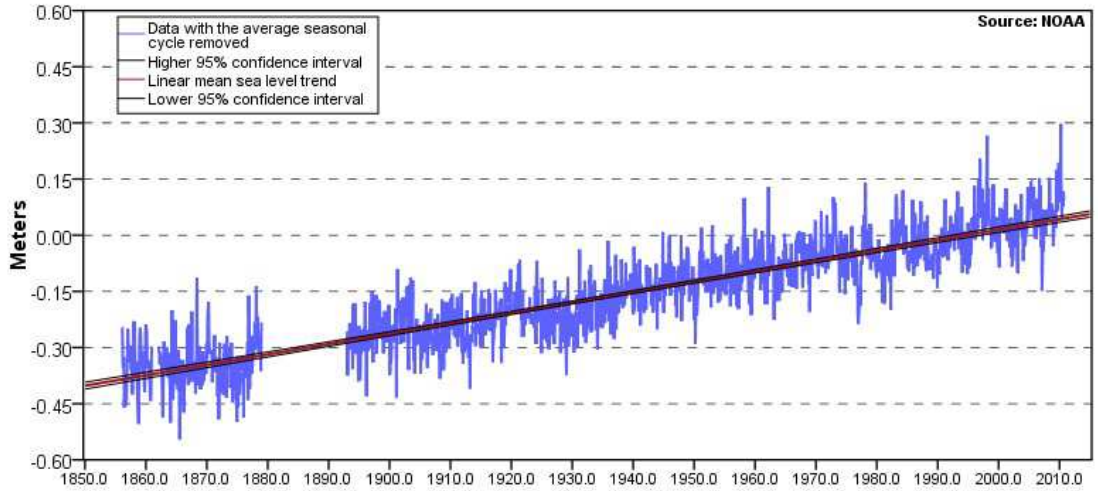


Image: Bureau of Meterology.

A bruising heatwave described by one climate researcher as "horrifying" is moving across Australia, with extreme conditions expected across much of South Australia and the eastern states.

The Bureau of Meteorology is warning of high temperatures and humid nights through Friday, Saturday, and Sunday, especially around Sydney and north to the Queensland-NSW border. A





Historically, how quickly is global sea level rising?

And what about the future?

Battery, New York City

16 Thursday, November 15, 2012 — DAILY NEWS NYDailyNews.com

SANDY: PICKING UP THE PIECES

NEVER AGAIN!

Dutch model could stormproof city

BY JASON SHEFTELL
NEW YORK DAILY NEWS

HOW CAN we prevent this from happening again?

That's the question on the lips of those from New York's hardest-hit streets. City architects and officials have been trying to answer that question and consider ways to protect New York from another storm of Sandy's magnitude since her waters receded.

"Rather than looking to short-term housing solutions, consider long-term/permanent housing solutions to reduce the number of moves and disruptions to lives of families," says Michelle Whetten, VP & market leader, Gulf Coast, Enterprise Community Partners.

Stephen M. Sweeney, president of the New Jersey Senate, agrees. "We just can't rebuild it the way it was. The worst thing to do is to have this experience and not learn from it."

In addition to preparing for future storms with hurricane kits and home generators, we can look to nations like the Netherlands, which has experienced deadly floods for eight centuries, for innovative solutions.

Jackson Heights-based architect Haiko Cornelissen grew up below sea level in Amsterdam. He took note as his country employed flood-prevention measures in harbors, along the coastline and in various housing styles constructed specifically to survive water disasters.

Acting fast after Sandy, Cornelissen has set up the website NL4US.com, which offers safe and sustainable solutions for rebuilding in flood-prone areas in the United States.

Concepts including amphibious houses and anti-flood systems around bridges are described in detail. Speaking to engineers in his home country, the architect considered cost, time, building codes and location before lending his thoughts.

"We've experienced flooding in the Netherlands for centuries," says Cornelissen, whose Queens apartment was recently highlighted by the Guggenheim Museum in a tour of local homes. "The ideas are here for New York, but the themes also can help in New Orleans, Florida and the West Coast such as Seattle and San Francisco. This is a platform for solutions."

The estimated cost of some of the systems he suggests for protecting the harbor are upward of $6 billion per feature, but that figure could be a fraction of future damages.

"The total cost of the storm could be as high as $30 billion. To secure New York Harbor and certain waterways could cost $18 billion or so," says Cornelissen, who has worked for top global architects Rem Koolhaas and Steven Holl.

Here's how some of those Dutch innovations would look around Manhattan with explanations on how each would work in a future flood.

Haiko Cornelissen

1. Amphibious Houses

"This type of house looks and acts like any other typical house, except in times of flooding, says Cornelissen. "When the area floods, the amphibious house floats on the water, held in place by guides, and continues to function thanks to the flexible utilities. The amphibious house is more a new type of construction than a new type of house."

Add solar energy, says Cornelissen, and the amphibious house can operate off the grid, or on its own even in power outages.

2. Floating Houses in Battery Park

According to Cornelissen, the "floating communities in Amsterdam activate the waterfront with prime location apartments that have the most amazing views in the city while they remain safe from flooding." Here, they placed the floating houses built in Amsterdam near Battery Park to demonstrate how the concept might work locally.

3. Verrazano-Narrows Bridge and New York City Harbor flood prevention

Experts and politicians including Gov. Cuomo recently agreed that bold steps are needed to protect the city from flooding in the future.

The Dutch government took a bold step in the 1950s to preserve the Netherlands' southern end with an unprecedented flood protecting infrastructure called Delta Works.

Based on the Dutch example, the Storm Surge Research Group at Stony Brook recommended in 2004 to use a similar solution with movable barriers around the New York Harbor, including under the Verrazano-Narrows Bridge.

"Thinking along these lines, I combined the Verrazano with the Maeslantkering, a barrier that protects Rotterdam, the busiest harbor of Europe," Cornelissen says. "The Maeslantkering completed the Delta Works after four decades of building the complete flood protection infrastructure. The area has not flooded since.

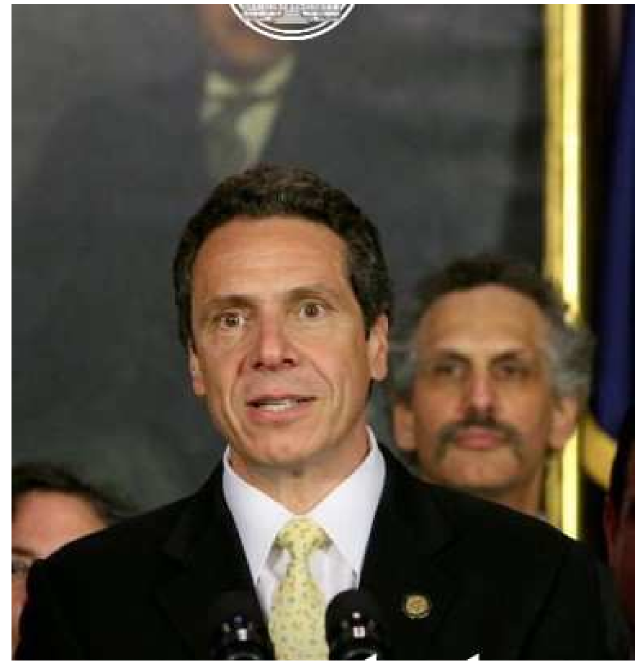
"While the Bloomberg administration has aggressively promoted waterfront development in the city, the New York waterfronts are now the areas hit hardest by the recent storms," says the architect.

"Therefore one alternative to promote waterfront development is to use floating houses as seen in new parts of Amsterdam."

jsheftell@nydailynews.com

For more info, go to NL4US.com or haikocornelissen.com

http://www.pressdisplay.com/pressdisplay/viewer.aspx

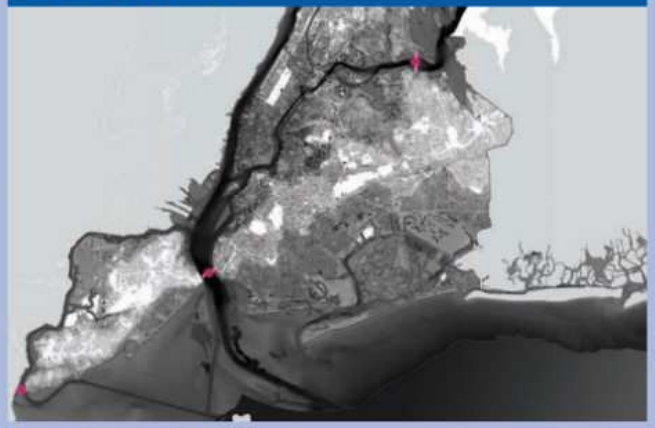


Governor Cuomo states the need for a new paradigm – let's stop arguing about climate change and let's move ahead and develop bold new approaches, including regional storm surge barriers…

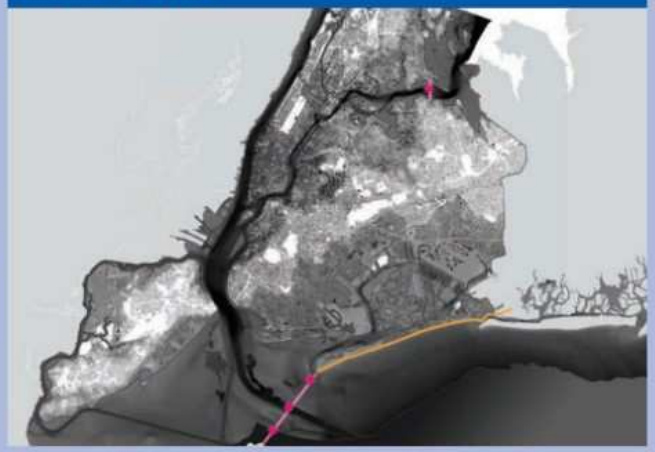
Harborwide Storm Surge Barriers

A variety of observers have raised the idea of harborwide storm surge barriers in response to the threat of coastal storms faced by New York City. One proposal that has been put forth, for example, calls for a three-part design, consisting of closure gates at the Narrows, the Arthur Kill, and the upper reaches of the East River. A second proposal would require two barriers, one at the upper reaches of the East River and one connecting Sandy Hook, NJ with the Rockaway Peninsula. In each case, the closure gates would be navigable channel openings, allowing ship traffic and water to flow through under ordinary circumstances. During storm events, however, the gates would be closed, in theory, blocking surge waters. To make either of these proposals work, a series of levees extending out from the closure gates would need to be constructed to ensure that displaced water is not simply pushed into low-lying areas adjacent to the closure gates. (*See map: Alternative 1: Three Barriers; See map: Alternative 2: Two Barriers*)

Alternative 1: Three Barriers

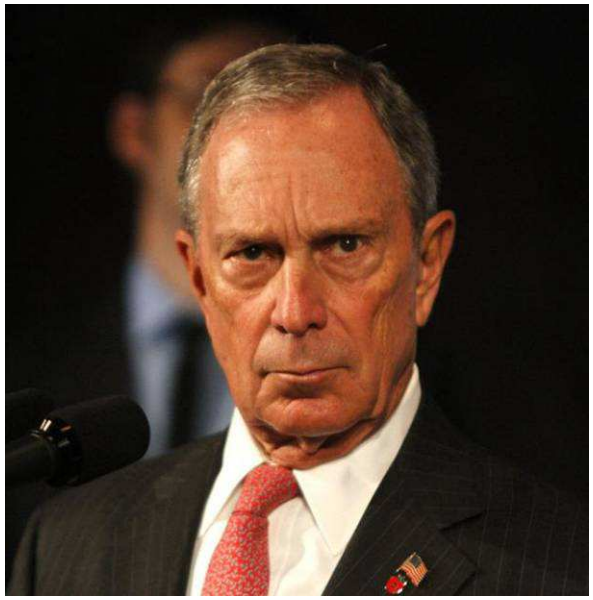


Alternative 2: Two Barriers



For some observers, the idea of constructing a single piece of engineering offers the appeal of seeming simplicity, as compared to a suite of a more targeted, localized protections. However, the construction of such harborwide storm surge barriers actually presents many complications:

- First, such a system of barriers would be extraordinarily expensive—perhaps costing $20 to $25 billion to build, with substantial operating and maintenance costs—substantially more than the City's proposed Phase 1 coastal protection initiatives and substantially more than any source of funding currently identified.
- Second, harborwide barriers would require a design, approval, and construction process that could, based on past experience with major in-water engineering projects in the New York City area and elsewhere around the globe, take two to three decades to complete.
- Third, the possible hydrodynamic and environmental impacts (on fish migration, siltation, river flow, and water quality) of harborwide barriers are likely to be substantial, are not yet known, and would require extensive study, potentially derailing or requiring substantial redesign of the project. These impacts also could be the subject of lawsuits—which have, in New York's relatively recent past, led to the cancellation of major in-water projects.
- Fourth, as mentioned above, to make a project such as this work, there likely would need to be massive levees (20 feet or more above grade) along adjacent coastal areas, including on the Rockaway Peninsula and possibly Coney Island and Staten Island, depending on which barrier option is chosen. These levees would have dramatic impacts on the character of the beaches and adjacent neighborhoods that may prove to be highly disruptive.
- Fifth, any barriers would create an "insiders/outsiders" dynamic, with only those behind the barriers receiving maximum protection, leaving densely developed communities along the South and North Shores of Long Island and the Jersey Shore outside the protected zone.
- Sixth, a harborwide barrier project may also cause additional flooding in areas outside the barriers (especially in tighter waterways, such as the Upper East River), thus making those communities more vulnerable than they would be without such barriers.
- Seventh, and finally, since the barriers would be open most of the time (to allow navigation), it would represent a major public investment that would end up doing nothing to address the growing problem of rising sea levels.

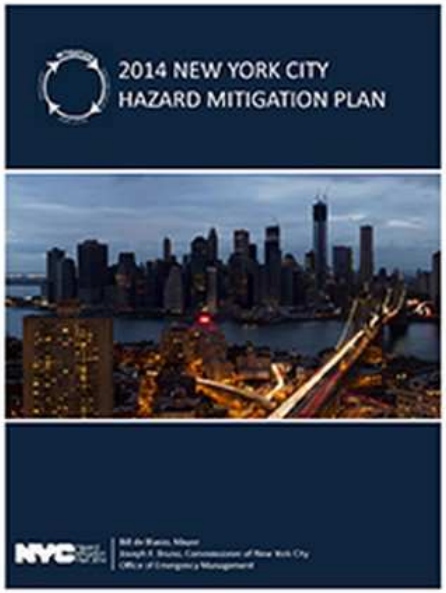


Meanwhile Mayor Bloomberg said: No! Stony Brook's regional storm surge systems are too expensive.

Resilience is the way to go……

← The seven deadly sins.

Emergency Planning: Hazard Mitigation Plan



Mayor Bill Deblazio continues the momentum and ideas of Bloomberg's philosophy of resilience….

Presenting the Final 2014 New York City Hazard Mitigation Plan

The New York City Office of Emergency Management (OEM), in partnership with the Department of City Planning (DCP), is pleased to announce the official adoption of the 2014 New York City Hazard Mitigation Plan (HMP). The preparation of the HMP demonstrates New York City's continued commitment to understanding our risk from a range of hazards, and identifying strategies to reduce the effects of these hazards on New York City's environment. The 2014 HMP serves as an update to the 2009 New York City Natural Hazard Mitigation Plan.

The HMP was approved by New York State Division of Homeland Security and Emergency Services (NYS DHSES) and FEMA on March 21, 2014, and officially adopted by the City of New York on April 15, 2014.

The New York Times

MAGAZINE

121 COMMENTS

How to Think Like the Dutch in a Post-Sandy World

By RUSSELL SHORTO APRIL 9, 2014

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In December 2012, Shaun Donovan, the secretary of Housing and Urban Development, was on vacation in Berlin when he decided to detour to the Netherlands. He wanted to get a firsthand sense of the famed Dutch approach to water management. Hurricane Sandy struck six weeks before, and in the aftermath, President Obama asked him to lead a task force, whose objective was not just to rebuild but also to radically rethink the region's infrastructure in light of climate change.

In the Netherlands, a man named Henk Ovink offered to be Donovan's guide. Ovink was the director of the office of Spatial Planning and Water Management, meaning, essentially, that it was his job to keep the famously waterlogged country dry. As he learned about various Dutch innovations, Donovan was struck by the fact that Ovink looked at water as much in cultural as in engineering terms, which was a function of the centuries-old need of the Dutch to act together for protection.

For his part, Ovink said it dawned on him during Donovan's visit that the post-Sandy turmoil in the U.S. was an opportunity. Dutch water-management experts have done such a good job of protecting their country that they rarely get to practice with water crises — whereas America was facing something monumental that as a culture it didn't yet grasp. When Donovan arrived back in the U.S., he opened an email from Ovink that said, in effect, "I hope this isn't too forward, but could I come work with you?"

Henk Ovink, a Dutch water-management expert, is trying to persuade Americans to approach water the way the Dutch do. Olivia Locher for The New York Times

Henk Ovink. This man likes to get wet.

http://www.nytimes.com/2012/11/04/nyregion/protecting-new-york-city-before-next-time.html?pagewanted=all

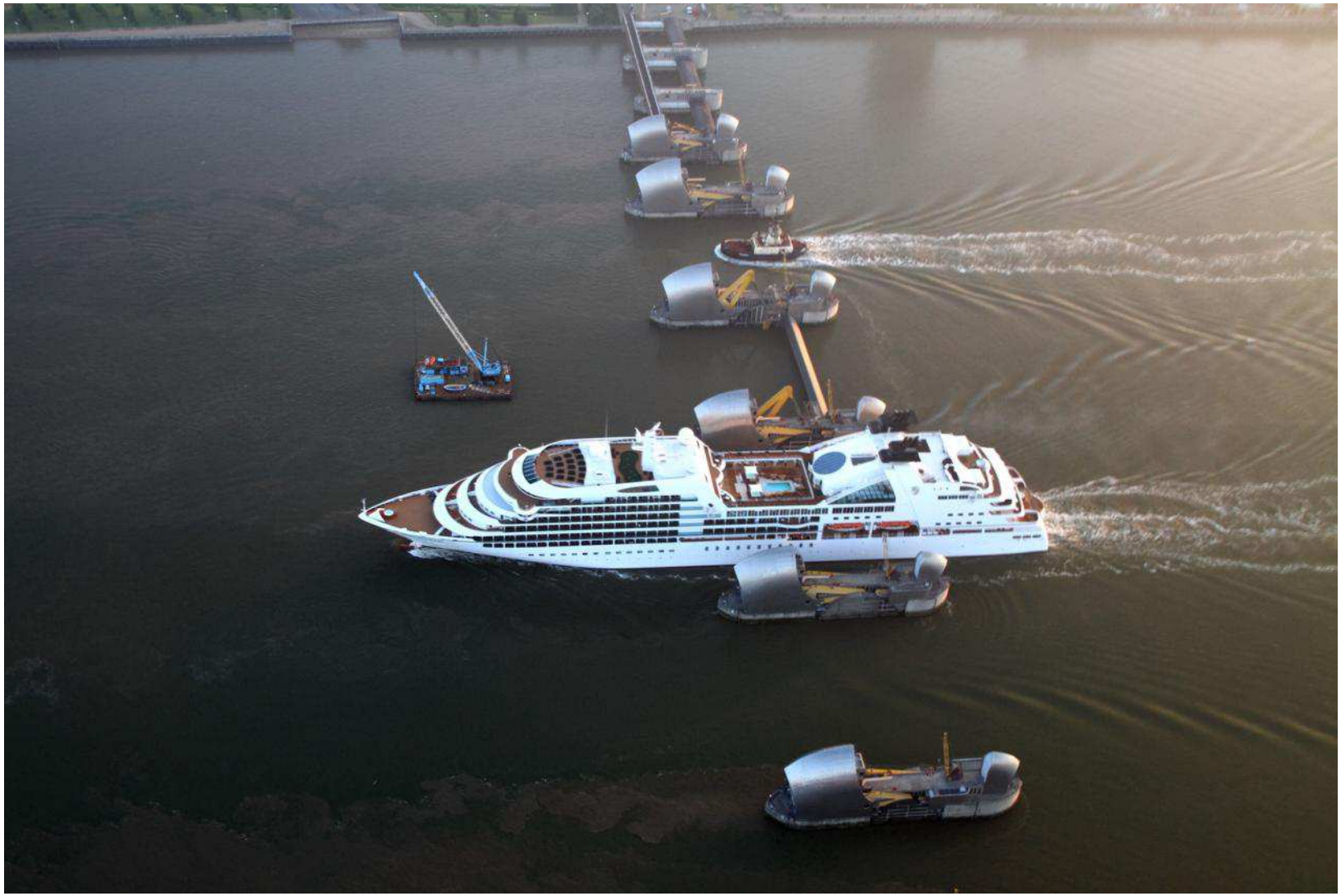
Science fiction…….

Fig. 1 "Lego Wall planned for NYC business district".

Physical Resiliency

New infrastructure can help reduce the risk to our neighborhoods, critical services, businesses, and vulnerable populations.

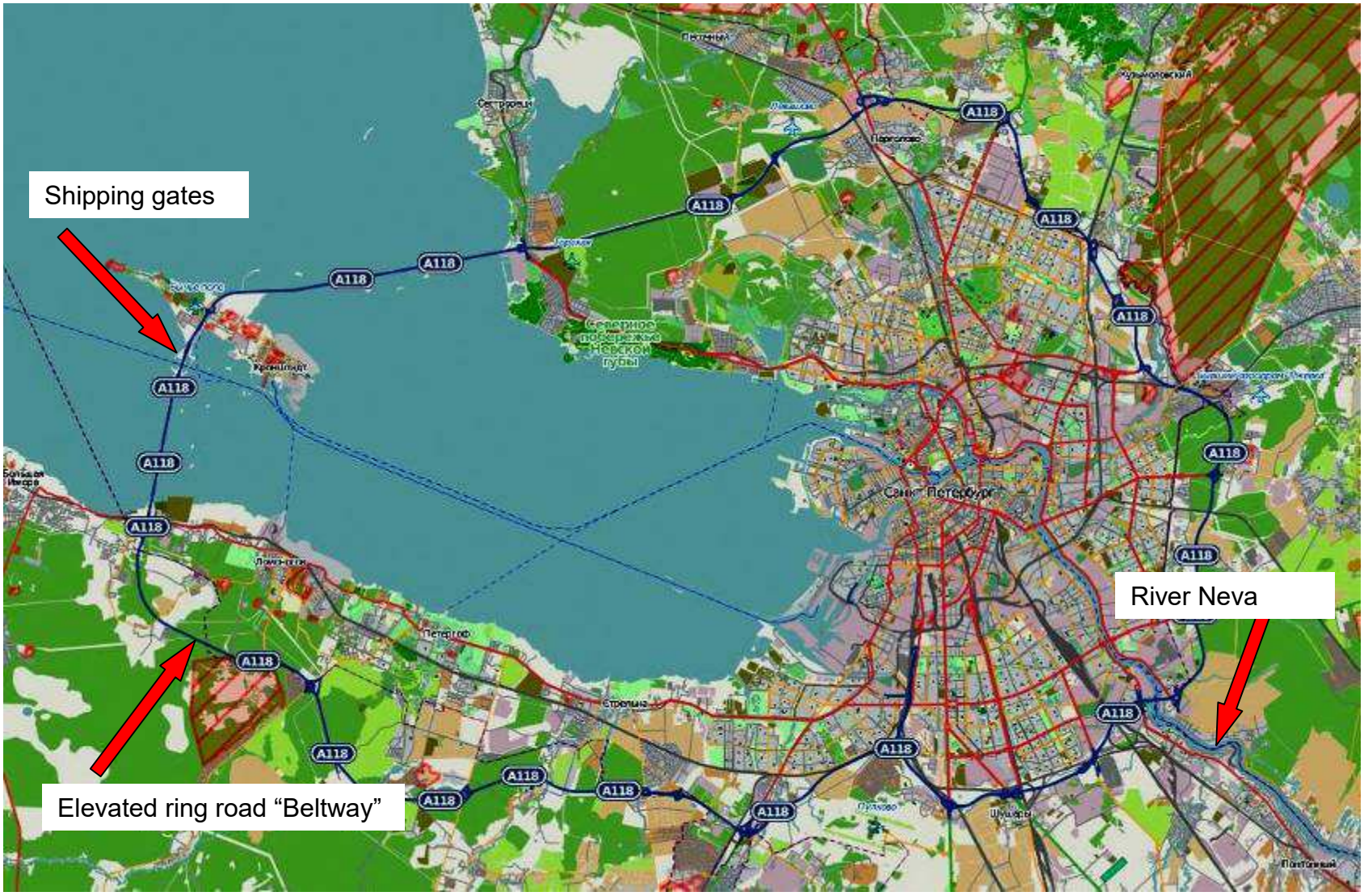
Integrated Flood Protection Systems



The Thames River Barrier was opened in 1982 and has been used many times to prevent the City of London from being flooded.

View of a segment of the Delta Project, the Netherlands. The system is composed of a mixure of elevated natural sand dunes, tidal gates (normally open), elevated highways and shipping gates <http://www.deltawerken.com/English/10.html?setlanguage=en>. The image is taken during flooding (incoming) tides.

Fig. 2: Dutch storm surge barrier at Maeslant



Plan view of St Petersburg, Russia, storm surge protection system, consisting of elevated multi-lane highways (blue), harbor barriers with sluice gates (blue) and shipping gates (left red arrow).

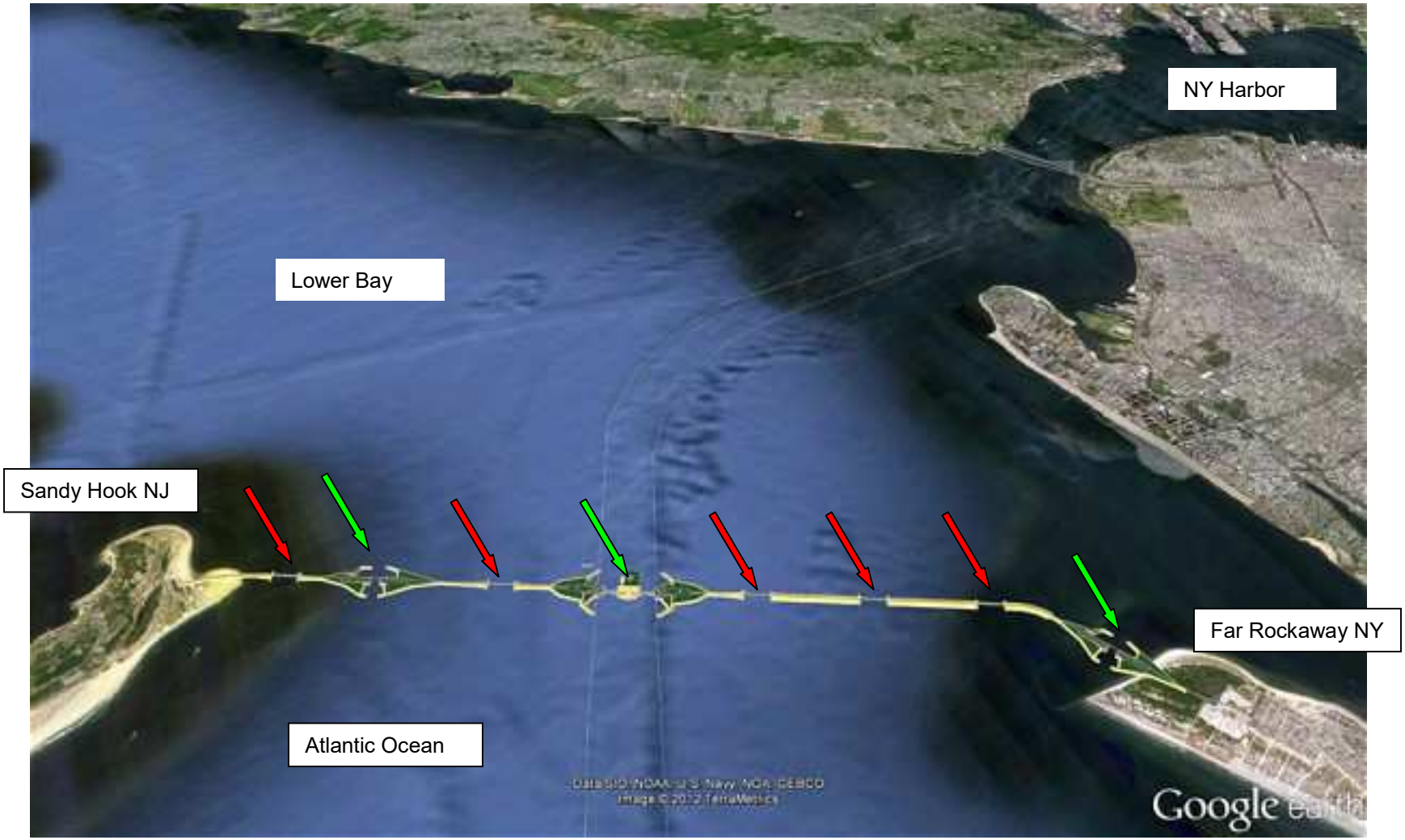
Left: Main shipping channel with gates under construction; the highway tunnels under the channel.

Above: Sluice gates designed to allow free flow of tides and the river discharge in fair weather.

Taintor gates in open position at the St Petersburg storm barrier system.

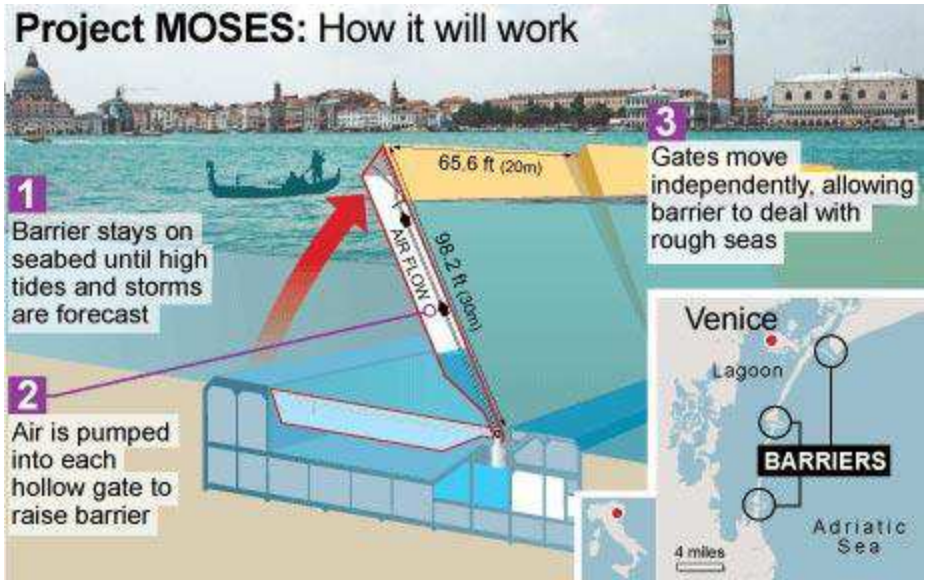
Taintor gates in closed position at the St Petersburg storm barrier system.

Schematic diagram for location of the Outer Harbor Gateway (red arrow) with enhanced extension dunes (green) and storm surge barriers (red line) to protect NY City. A second barrier would be necessary across the upper East River (red arrow) to block surges from penetrating from western Long Island Sound into the Harbor. Note the outer gateway (with extension) protects Manhattan, JFK airport, the outer boroughs of Staten Island, Brooklyn & Queens, Port Elizabeth, Newark Airport, LaGuardia Airport and all points within the ring of protection.

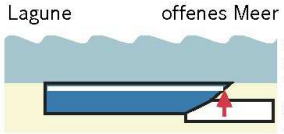


Artist's impression of the proposed New York Outer Harbor Gateway, stretching 5 miles across the Sandy Hook – Far Rockaway transect. The red arrows show locations of sluice gates to allow free flow of the tides (next slide). The green arrows point to the three shipping gates (second slide on).

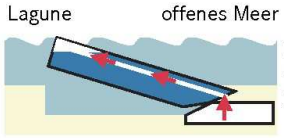
Flooding in St Mark’s Square, Venice – and still the tourists come!



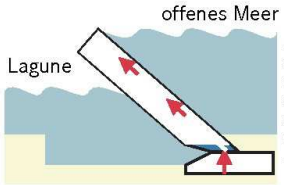
Mose teilt das Meer



Das rund 28 Meter hohe, hohle Fluttor liegt mit Wasser gefüllt flach auf dem Meeresgrund.



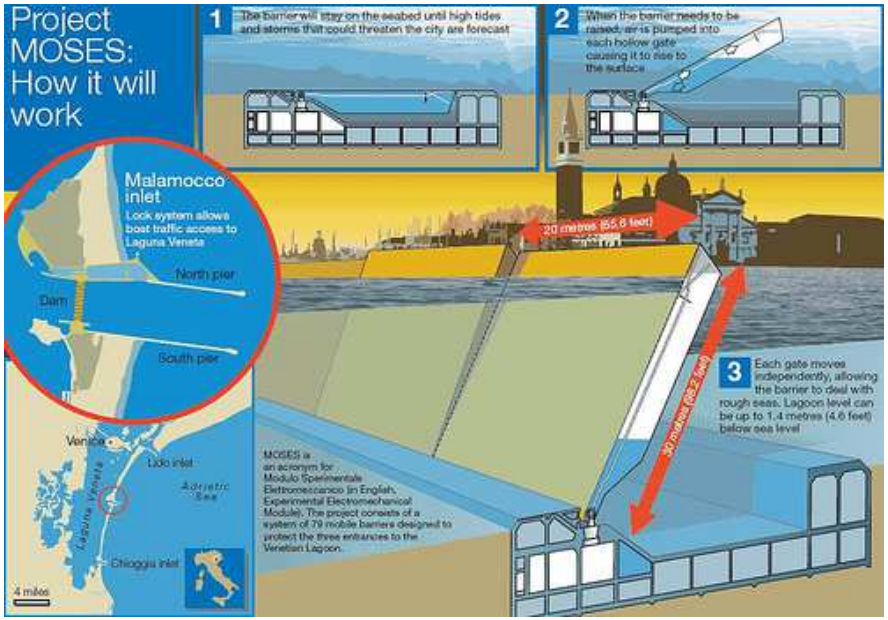
Bei Ansteigen des Meeresspiegels wird Druckluft in das Tor gepresst.

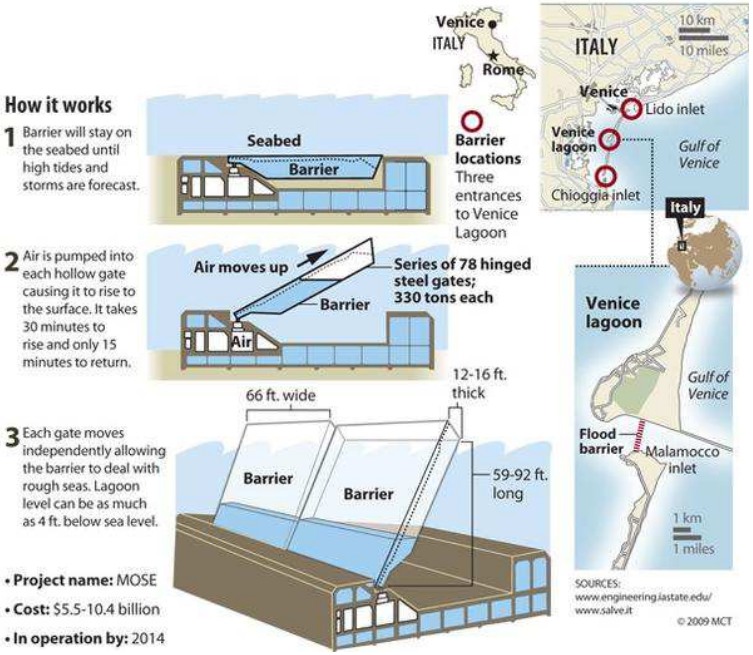


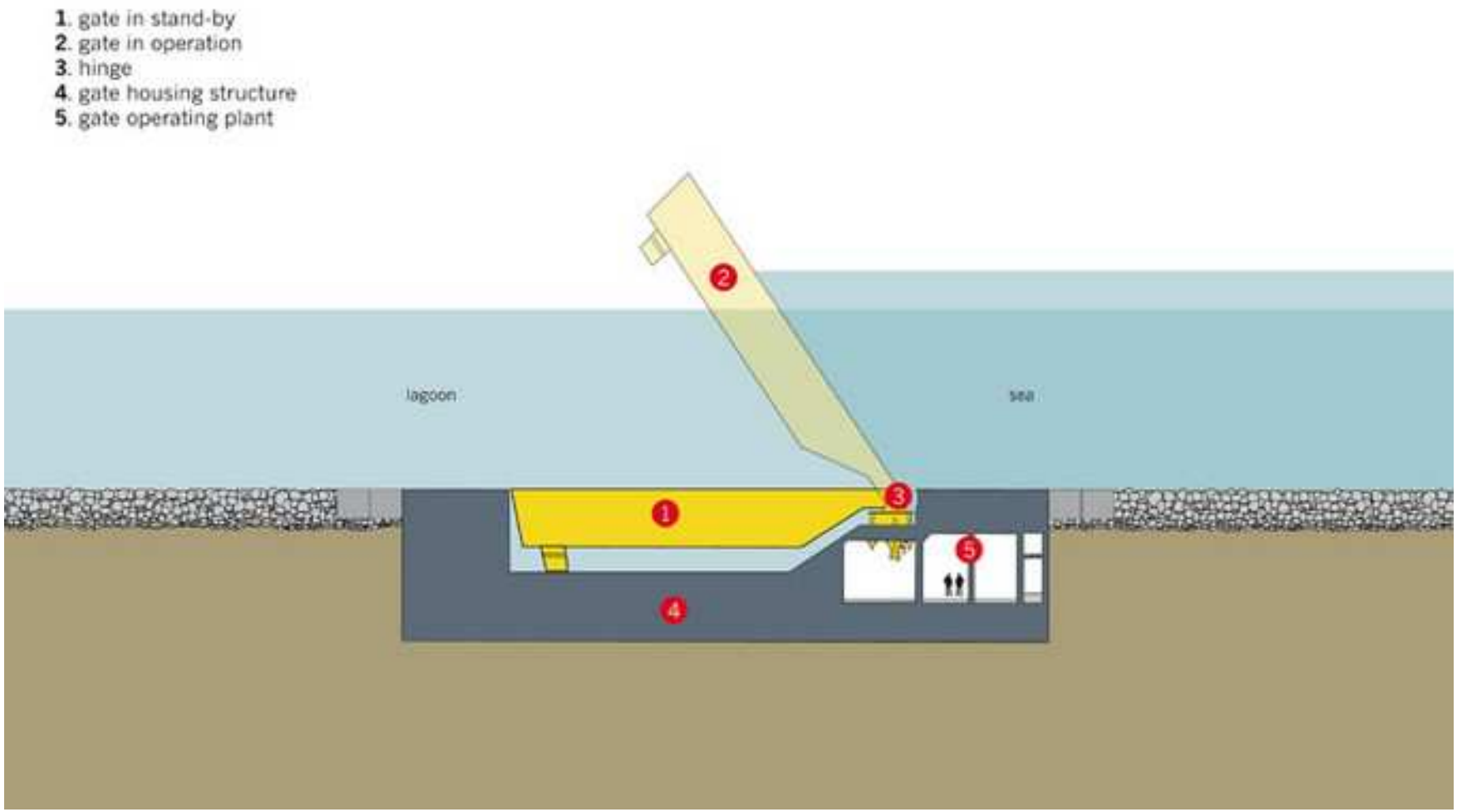
Durch den Auftrieb steigt das Tor nach oben und schafft eine Barriere zwischen dem offenem Meer und der Lagune.

BZ-Grafik/zel

Quelle: Mose







Once complete, MOSE will provide three barriers across the Lido, Malamocco and Chioggia inlets to the Venetian Lagoon that will temporarily isolate its waters from the Adriatic Sea during high tides.

Control room of the MOSE Project – located in the famous Arsenale.

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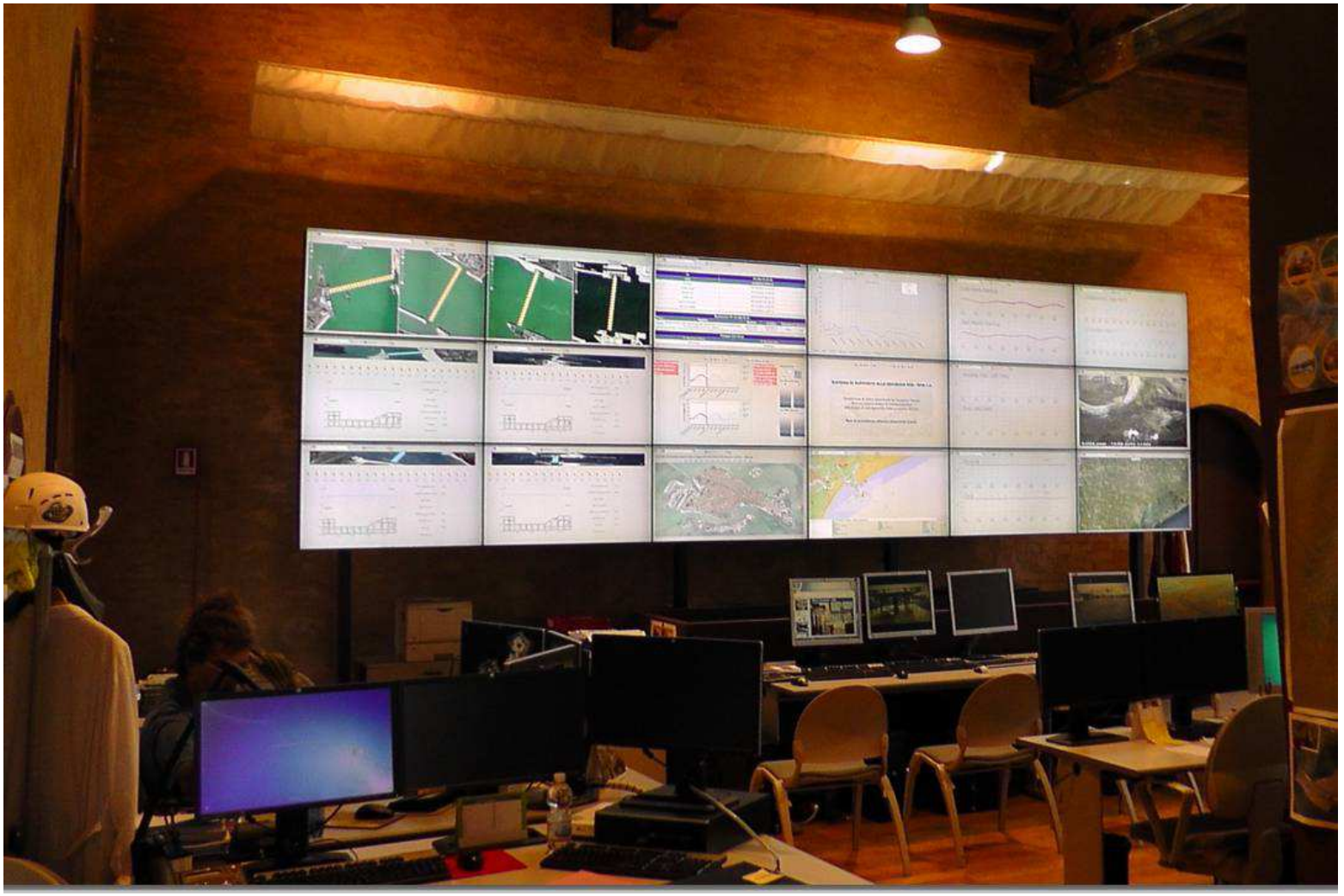


Developing a Threat Index

Take our cue from the Europeans. Decide that the wreckage of Sandy must never happen again. Determine to protect Metro New York against a 1/1,000 storm. Make this the gold standard. Plug in various suggestions solutions and migitations appropriate to a descending scale of threats.

Threat	Response
1/1000 yr storm	Storm surge barriers, enhanced sand berms
1/500 year storm	Storm surge barriers, enhance sand berms
1/250 year storm	New building codes, raise all critical systems
1/100 year storm	Build better resilience, retire old building codes
1/25, 1/50 year storms	Enhance wetlands, oyster beds, local barriers

The New York Times

A City at Sea

By Malcolm J. Bowman
Published: September 25, 2005

But many questions remain. Such barriers would represent an engineering project of a scale rarely contemplated in the United States. The cost would be in the billions of dollars. Communities outside the barriers would remain exposed and unprotected, including Kennedy International Airport and Long Island's south shore. Wind, rain and upland flooding damage would still have to be endured.

The New York Times

November 11, 2012

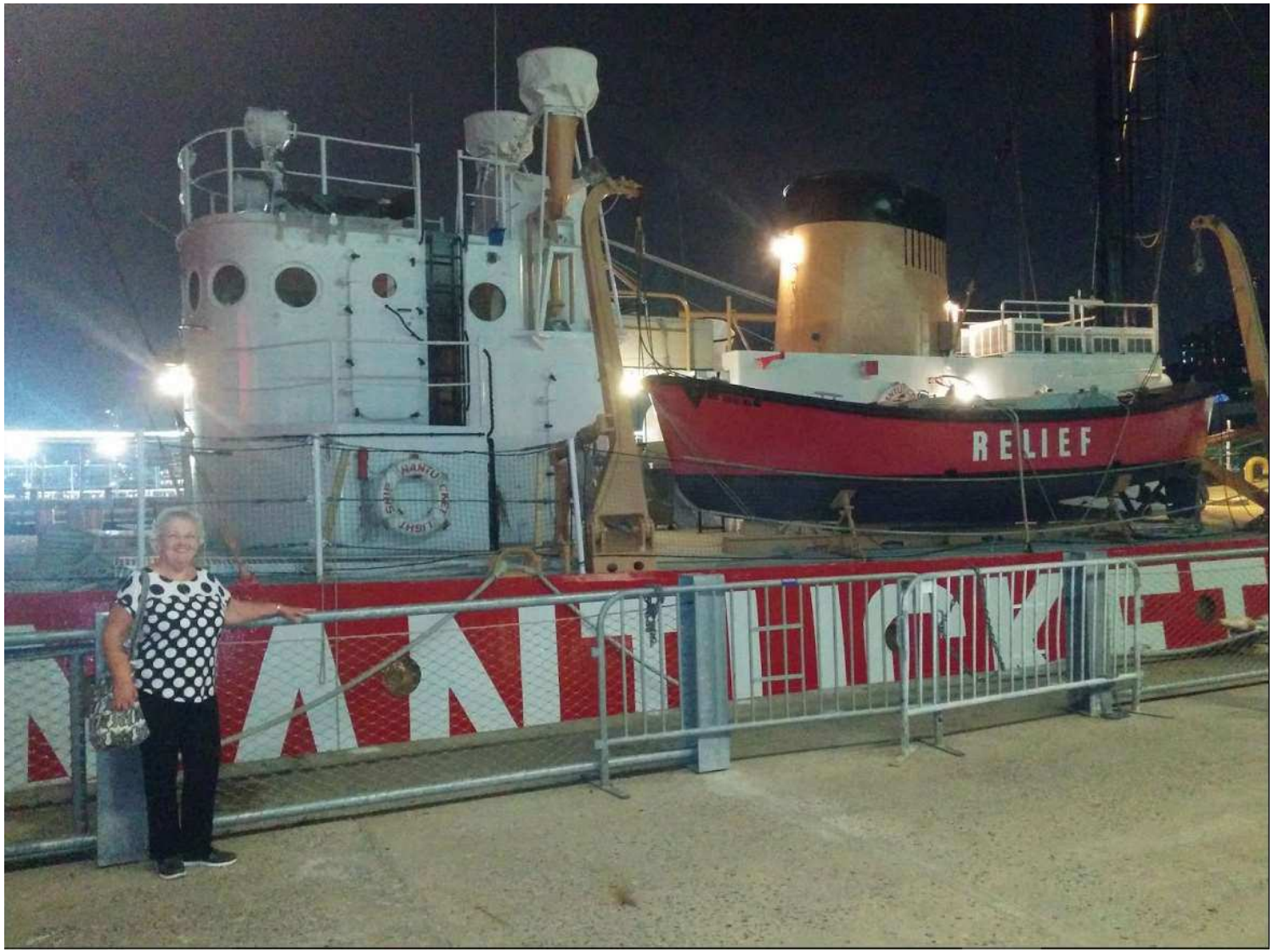
A New Manhattan Project

By BILL KELLER

The original Manhattan Project mobilized 130,000 people, cost the 2012 equivalent of $25 billion and gave us, for better or for worse, the atom bomb. A new Manhattan Project could cost as much, might well employ as many people (jobs!) and would give us another century or two of America's greatest metropolis. Because that's what it's really about. When Malcolm Bowman asks offhandedly, "How long do we want New York City to last?," he is not dealing in hyperbole. He is just asking the right question.

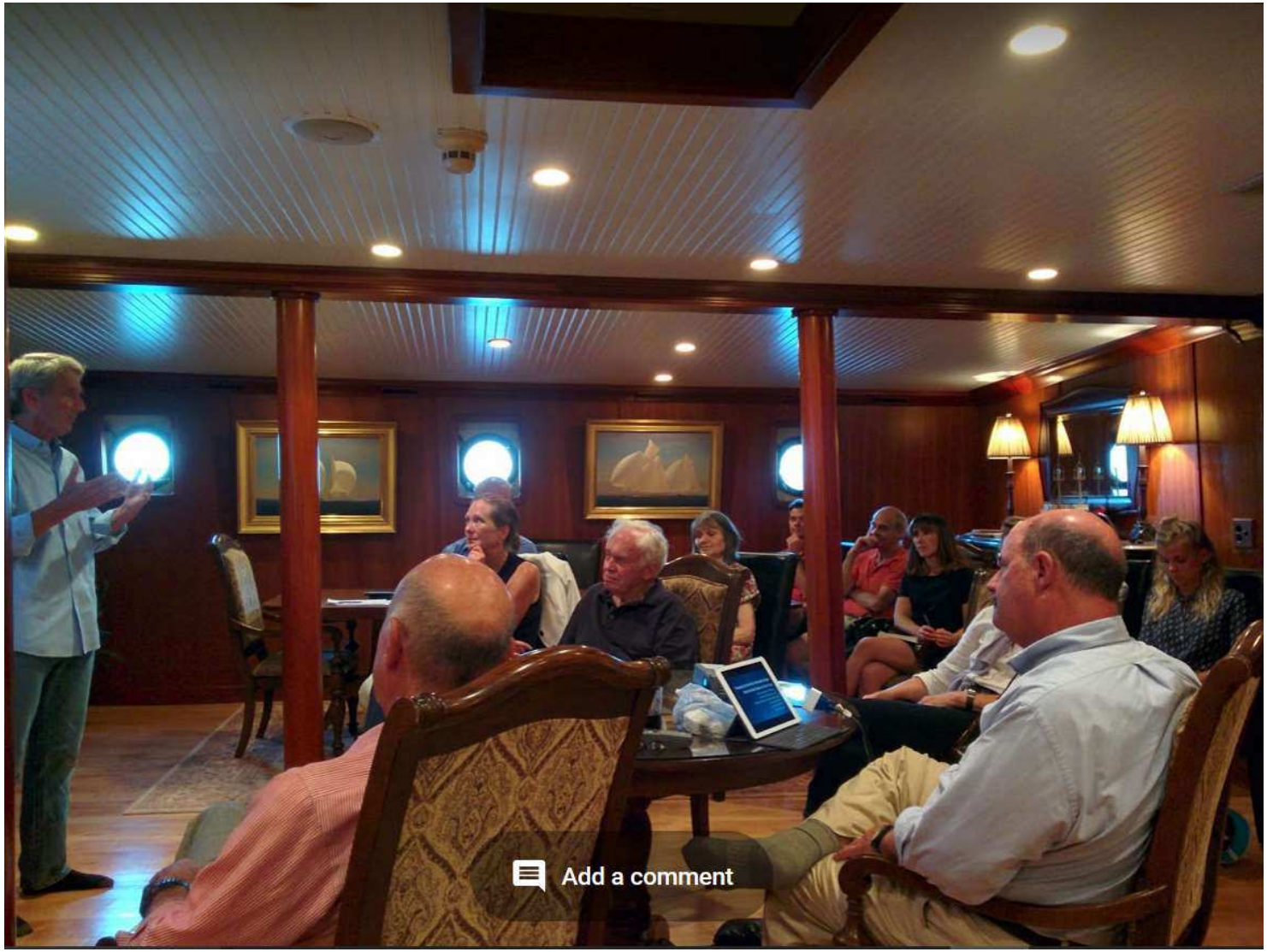
The Odyssey II: planned circumnavigation of the 48 lower states to advocate for a national imperative to rebuild the country's harbor infrastructure.

Nantucket Lightship WVL-612 moored at at Straight Wharf on Nantucket Island. Owned by Mr. William Golden of Princeton NJ.



The lightship has been restored and refitted to the highest standards for the purpose of leasing and advocacy presentations.

Lightship Nantucket WLV-612 moored at World Financial Center, NY City.



Mr William Golden (left) introduces Prof Robert Yaro, former President of the Regional Plan Association (right) at the kick off of the advocacy campaign.

Planning for Odyssey II 2017

- THE END