

NewScientist Environment

Storm surges threaten US economic heartlands

05 June 2006

NewScientist.com news service

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THE next time a Katrina-like hurricane strikes, it could be the Big Apple, not the Big Easy, that finds itself underwater. The New York area hasn't experienced a hurricane since 1985, and Manhattan a direct hit since the 1800s. Yet forecasters say because we're midway through a roughly 25-year cycle of warm waters in the Atlantic Ocean, conditions are ripe for a major hurricane to hit the north-east coast of the US within the next few years.



"The east coast, and the north-east in particular, is overdue for a hurricane statistically," says Michael Wyllie, meteorologist in charge at the National Weather Service in Upton, New York. "Since we haven't had [a hurricane in New York] for a while, [the population] has become complacent. They don't believe that something like that can happen here."

When hurricanes strike, the low pressure and high winds drive a dome of water, called a storm surge, onto land. If a major hurricane struck close to New York City, the storm surge could raise the local sea level by 8 metres, swamping the financial district in lower Manhattan and parts of Brooklyn, as well as areas of Jersey City. The subway, some road and rail tunnels, and La Guardia and John F. Kennedy airports would be flooded. In total, more than 250 square kilometres could be affected, forcing 2.2 million people to evacuate in New York City alone.

"Our basic philosophy is that there's very little we are going to be able to do to stop the surge. What we

want to do is to minimise the damage that's going to occur," says Maryann Marrocolo, assistant commissioner for planning for the New York City Office of Emergency Management. So city officials are focusing on raising public awareness, fortifying infrastructure, and planning evacuation and recovery efforts.

Yet some scientists say a storm surge could be held back. By building rotating flood barriers as much as 1.6 kilometres long and rising at least 8 metres above the normal high-water level, it may be possible to spare much of the city. Physical oceanographer Malcolm Bowman and his colleagues at Stony Brook University on Long Island, New York, have proposed a plan to build four such barriers at key locations around Upper New York Bay (see Map). Three barriers would shelter most of the upper bay, including Manhattan. The fourth, with the aid of some sea walls, would protect Jamaica Bay and Kennedy airport. Bowman says they would keep the water out of half the area vulnerable to flooding, including Manhattan, Jersey City and parts of Brooklyn.

It would be an enormous undertaking. "This is on the scale of the Hoover dam," Bowman says. The barriers would be akin to the one on the river Thames, downstream from central London, that protects the city from flooding by exceptionally high tides. The 523-metre-long Thames barrier, completed in 1982, took eight years and £1.3 billion to build, but it is dwarfed by Bowman's plan. Each of the four New York barriers would span up to 1.6 kilometres, and estimates of the possible cost start at tens of billions of dollars.

Even this huge price tag need not rule the project out. The damage from a severe hurricane ploughing through Manhattan could amount to as much as \$300 billion, according to estimates based on simulations by the Federal Emergency Management Agency, not counting indirect impacts on the nation's economy.

The response to Bowman's proposal has, however, been lukewarm. "That's so far beyond the scope of what we can accomplish," Marrocolo says. The Regional Plan Association, an organisation of political leaders in 31 counties in New York, New Jersey and Connecticut, held its annual strategy meeting for the region last month, but Jennifer Cox, RPA's director of geography programmes, says that discussion at the meeting involved no firm plans to build such a structure.

The fact that the barriers would protect some people but not others doesn't help with the politics of such an expensive, publicly funded project. The southern shores of Brooklyn and Staten Island would remain vulnerable, as would the often battered southern coast of Long Island. Some scientists raise other objections. An inherent problem, says Klaus Jacob, a senior research scientist at Columbia University in New York City, who analysed Bowman's proposal for the New York Academy of Sciences, is that sooner or later a storm big enough to swamp the barriers will come along. If people forgo other safety measures because they feel protected by the barriers, it could lead to an even bigger calamity.

Even if no one is ready to start building, all levels of government continue to fund research on the ideas. Bowman plans to apply for an upcoming grant of around \$3 million from the New York City Department of Environmental Protection, which he would use to conduct preliminary engineering studies for the barriers.

If other cities' experiences are any guide, it would take a major flood for people to rally behind a barrier system. In London, the trigger was a calamitous flood in 1953, and even then construction of the Thames barrier didn't begin for 21 years. For New York, a flood is looking increasingly likely. Sea levels in the area have been rising more than 2 centimetres per decade due to the tilting and settling of the land mass after the retreat of the glaciers at the end of the last ice age. And climate change is predicted to make the increase in sea level accelerate. The higher the sea level, the less potent a storm would have to be to cause a catastrophic flood.

The Gulf Coast

The coast of Louisiana is sinking into the Gulf of Mexico, and saving it will be "one of the top five engineering projects of this century", says environmental engineer Vincent Neary of Tennessee Tech University, Cookeville.

Flood-control structures have for years starved the delta of vital new sediment, allowing encroachment by the sea. Then hurricane Katrina came along and did 50 years of damage in a couple of nights, converting 189 square kilometres of wetlands east of the Mississippi to open water. That's more than the 155 square kilometres previously expected to be lost by 2050.

To stem the loss, engineers must resupply the wetlands with sediment without obstructing river navigation and exacerbating the flood risk. Past plans have failed as a result of politics, lack of funds

and competing priorities, says Charles Groat, a former director of the US Geological Survey. For example, when Katrina hit, the Army Corps of Engineers was still 12 years from completing flood protection structures for New Orleans that were planned after hurricane Betsy in 1965.

This week, a group of scientists led by Denise Reed, a geologist at the University of New Orleans, has been presenting its ideas to Louisiana governor Kathleen Blanco. Neary says sediment-laden water could be diverted from the Mississippi south of New Orleans. This month, the Corps of Engineers will also deliver a new plan.

Flood-proofing New Orleans and the coast might cost anything up to \$100 billion, and whether either plan will get the go-ahead remains in doubt. One reason for this can be found in a scathing report on past plans, published last week by the independent levee investigation team headed by Raymond Seed of the University of California, Berkeley: "Flood control for developed urban areas comes in last [because] it doesn't make money for anyone."

Jeff Hecht

Sacramento Valley

"There are two kinds of levees: those that have failed and those that will." It is an adage that Sacramento would do well to heed, as California's capital city is reckoned by experts to be in greater danger of flooding than New Orleans was before Katrina.

Much of the city lies below the flood level of the Sacramento river, and is protected only by ageing levees of uncertain strength. In the path of any floods lie 250,000 people and 140,000 structures. Potential damage is estimated at \$25 billion. Beyond the city, the river runs 120 kilometres through a flat delta of farmland to San Francisco Bay. The Sacramento river and the San Joaquin that joins it also provide drinking water for 23 million Californians and irrigation for farms that produce half the nation's fruit and vegetables. The ground in the delta has subsided up to 8 metres below sea level, and the tidal rivers are held above the land by massive dirt levees. If those levees failed, the salty San Francisco Bay water could pour deep into the delta, contaminating the water supply and causing \$40 billion in damage.

The state of California has been slowly bolstering Sacramento's levees over the past two decades, and Governor Arnold Schwarzenegger has allocated \$500 million for the 4000 kilometres of levees in Sacramento and the delta in next year's proposed budget. The state is also beginning to modify the Folsom dam above Sacramento to stem storm flows more effectively, but that would still leave the area with a relatively low flood protection compared with other cities in the country, says Rod Mayer, California's flood-control chief. Improving the delta levees, which are vulnerable to damage by earthquake, could cost another \$10 billion. Meanwhile, sea levels are rising, the land continues to subside, and houses keep being built behind the levees as California's population increases.

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From issue 2554 of New Scientist magazine, 05 June 2006, page 8