Rising Seas

As the planet warms, the sea rises. Coastlines flood. What will we protect? What will we abandon? How will we face the danger of rising seas?

By Tim Folger

By the time Hurricane Sandy veered toward the Northeast coast of the United States last October 29 (2013), it had mauled several countries in the Caribbean and left dozens dead. Faced with the largest storm ever spawned over the Atlantic, New York and other cities ordered mandatory evacuations of low-lying areas. Not everyone complied. Those who chose to ride out Sandy got a preview of the future, in which a warmer world will lead to inexorably rising seas.

A profoundly altered planet is what our fossil-fuel-driven civilization is creating, a planet where Sandy-scale flooding will become more common and more destructive for the world's coastal cities. By releasing carbon dioxide and other heat-trapping gases into the atmosphere, we have warmed the Earth by more than a full degree Fahrenheit over the past century and raised sea level by about eight inches. Even if we stopped burning all fossil fuels tomorrow, the existing greenhouse gases would continue to warm the Earth for centuries. We have irreversibly committed future generations to a hotter world and rising seas.

In May the concentration of carbon dioxide in the atmosphere reached 400 parts per million, the highest since three million years ago. Sea levels then may have been as much as 65 feet above today's; the Northern Hemisphere was largely ice free year-round. It would take centuries for the oceans to reach such catastrophic heights again, and much depends on whether we manage to limit future greenhouse gas emissions. In the short term scientists are still uncertain about how fast and how high seas will rise. Estimates have repeatedly been too conservative.

Global warming affects sea level in two ways. About a third of its current rise comes from thermal expansion—from the fact that water grows in volume as it warms. The rest comes from the melting of ice on land. So far it's been mostly mountain glaciers, but the big concern for the future is the giant ice sheets in Greenland and Antarctica. Six years ago the Intergovernmental Panel on Climate Change (IPCC) issued a report predicting a maximum of 23 inches of sea-level rise by the end of this century. But that report intentionally omitted the possibility that the ice sheets might flow more rapidly into the sea, on the grounds that the physics of that process was poorly understood.

As the IPCC prepares to issue a new report this fall, in which the sea-level forecast is expected to be slightly higher, gaps in ice-sheet science remain. But climate scientists now estimate that Greenland and Antarctica combined have lost on average about 50 cubic miles of ice each year since 1992—roughly 200 billion metric tons of ice annually. Many think sea level will be at least three feet higher than today by 2100. Even that figure might be too low.

…“The concern is that if the acceleration continues, by the time we get to the end of the 21st century, we could see sea-level rise of as much as six feet globally instead of two to three feet.”…

One of the biggest wild cards in all sea-level-rise scenarios is the massive Thwaites Glacier in West Antarctica. Four years ago NASA sponsored a series of flights over the region that used ice-penetrating radar to map the seafloor topography. The flights revealed that a 2,000-foot-high undersea ridge holds the Thwaites Glacier in place, slowing its slide into the sea. A rising sea could allow more water to seep between ridge and glacier and eventually unmoor it…If the Thwaites Glacier breaks free from its rocky berth, that would liberate enough ice to raise sea level by three meters—nearly ten feet.

…By the end of the century a hundred-year storm surge like Sandy’s might occur every decade or less…

New Orleans may be safe for a few decades, but the long-term prospects for it and other low-lying cities look dire. Among the most vulnerable is Miami. “I cannot envision southeastern Florida having many people at the end of this century,” says Hal Wanless, chairman of the department of geological sciences at the University of Miami. We’re sitting in his basement office, looking at maps of Florida on his computer. At each click of the mouse, the years pass, the ocean rises, and the peninsula shrinks. Freshwater wetlands and mangrove swamps collapse—a death spiral that has already started on the southern tip of the peninsula. With seas four feet higher than they are today—a distinct possibility by 2100—about two-thirds of southeastern Florida is inundated. The Florida Keys have almost vanished. Miami is an island.

Sea-level rise has already begun to threaten Florida’s freshwater supply. About a quarter of the state’s 19 million residents depend on wells sunk into the enormous Biscayne aquifer. Salt water is now seeping into it from dozens of canals that were built to drain the Everglades. For decades the state has tried to control the saltwater influx by building dams and pumping stations on the drainage canals. These “salinity-control structures” maintain a wall of fresh water behind them to block the underground intrusion of salt water. To offset the greater density of salt water, the freshwater level in the control structures is generally kept about two feet higher than the encroaching sea.

Using fresh water to block the salt water will eventually become impractical, because the amount of fresh water needed would submerge ever larger areas behind the control structures, in effect flooding the state from the inside. “With 50 centimeters [about 20 inches] of sea-level rise, 80 percent of the salinity-control structures in Florida will no longer be functional,” says Wanless. “We’ll either have to drown communities to keep the freshwater head above sea level or have saltwater intrusion.” When sea level rises two feet, he says, Florida’s aquifers may be poisoned beyond recovery. Even now, during unusually high tides, seawater spouts from sewers in Miami Beach, Fort Lauderdale, and other cities, flooding streets.

Unless we change course dramatically in the coming years, our carbon emissions will create a world utterly different in its very geography from the one in which our species evolved. “With business as usual, the concentration of carbon dioxide in the atmosphere will reach around a thousand parts per million by the end of the century,” says Gavin Foster, a geochemist at the University of Southampton in England. Such concentrations, he says, haven’t been seen on Earth since the early Eocene epoch, 50 million years ago, when the planet was completely ice free. According to the U.S. Geological Survey, sea level on an iceless Earth would be as much as 216 feet higher than it is today. It might take thousands of years and more than a thousand parts per million to create such a world—but if we burn all the fossil fuels, we will get there.

No matter how much we reduce our greenhouse gas emissions, Foster says, we’re already locked in to at least several feet of sea-level rise, and perhaps several dozens of feet, as the planet slowly adjusts to the amount of carbon that’s in the atmosphere already.

By the next century, if not sooner, large numbers of people will have to abandon coastal areas in Florida and other parts of the world. Some researchers fear a flood tide of climate-change refugees. “From the Bahamas to Bangladesh and a major amount of Florida, we’ll all have to move, and we may have to move at the same time,” says Wanless. “We’re going to see civil unrest, war. You just wonder how—or if—civilization will function. How thin are the threads that hold it all together? We can’t comprehend this. We think Miami has always been here and will always be here. How do you get people to realize that Miami—or London—will not always be there?”