

THE SIEGE OF MIAMI

As temperatures climb, so, too, will sea levels.

BY ELIZABETH KOLBERT

*In the Miami area, the daily high-water mark has been rising almost an inch a year.*

The city of Miami Beach floods on such a predictable basis that if, out of curiosity or sheer perversity, a person wants to she can plan a visit to coincide with an inundation. Knowing the tides would be high around the time of the “super blood moon,” in late September, I arranged to meet up with Hal Wanless, the chairman of the University of Miami’s geological-sciences department. Wanless, who is seventy-three, has spent nearly half a century studying how South Florida came into being. From this, he’s concluded that much of the region may have less than half a century more to go.

We had breakfast at a greasy spoon

not far from Wanless’s office, then set off across the MacArthur Causeway. (Out-of-towners often assume that Miami Beach is part of Miami, but it’s situated on a separate island, a few miles off the coast.) It was a hot, breathless day, with a brilliant blue sky. Wanless turned onto a side street, and soon we were confronting a pond-sized puddle. Water gushed down the road and into an underground garage. We stopped in front of a four-story apartment building, which was surrounded by a groomed lawn. Water seemed to be bubbling out of the turf. Wanless took off his shoes and socks and pulled on a pair of polypropylene booties. As he stepped out

of the car, a woman rushed over. She asked if he worked for the city. He said he did not, an answer that seemed to disappoint but not deter her. She gestured at a palm tree that was sticking out of the drowned grass.

“Look at our yard, at the landscaping,” she said. “That palm tree was super-expensive.” She went on, “It’s crazy—this is saltwater.”

“Welcome to rising sea levels,” Wanless told her.

According to the Intergovernmental Panel on Climate Change, sea levels could rise by more than three feet by the end of this century. The United States Army Corps of Engineers projects that they could rise by as much as five feet; the National Oceanic and Atmospheric Administration predicts up to six and a half feet. According to Wanless, all these projections are probably low. In his office, Wanless keeps a jar of meltwater he collected from the Greenland ice sheet. He likes to point out that there is plenty more where that came from.

“Many geologists, we’re looking at the possibility of a ten-to-thirty-foot range by the end of the century,” he told me.

We got back into the car. Driving with one hand, Wanless shot pictures out the window with the other. “Look at that,” he said. “Oh, my gosh!” We’d come to a neighborhood of multi-million-dollar homes where the water was creeping under the security gates and up the driveways. Porsches and Mercedeses sat flooded up to their chassis.

“This is today, you know,” Wanless said. “This isn’t with two feet of sea-level rise.” He wanted to get better photos, and pulled over onto another side street. He handed me the camera so that I could take a picture of him standing in the middle of the submerged road. Wanless stretched out his arms, like a magician who’d just conjured a rabbit. Some workmen came bouncing along in the back of a pickup. Every few feet, they stuck a depth gauge into the water. A truck from the Miami Beach Public Works Department pulled up. The driver asked if we had called City Hall. Apparently, one of the residents of the street had mistaken the high tide for a water-main break. As we were

chatting with him, an elderly woman leaning on a walker rounded the corner. She looked at the lake the street had become and wailed, "What am I supposed to do?" The men in the pickup truck agreed to take her home. They folded up her walker and hoisted her into the cab.

To cope with its recurrent flooding, Miami Beach has already spent something like a hundred million dollars. It is planning on spending several hundred million more. Such efforts are, in Wanless's view, so much money down the drain. Sooner or later—and probably sooner—the city will have too much water to deal with. Even before that happens, Wanless believes, insurers will stop selling policies on the luxury condos that line Biscayne Bay. Banks will stop writing mortgages.

"If we don't plan for this," he told me, once we were in the car again, driving toward the Fontainebleau hotel, "these are the new Okies." I tried to imagine Ma and Pa Joad heading north, their golf bags and espresso machine strapped to the Range Rover.

The amount of water on the planet is fixed (and has been for billions of years). Its distribution, however, is subject to all sorts of rearrangements. In the coldest part of the last ice age, about twenty thousand years ago, so much water was tied up in ice sheets that sea levels were almost four hundred feet lower than they are today. At that point, Miami Beach, instead of being an island, was fifteen miles from the Atlantic Coast. Sarasota was a hundred miles inland from the Gulf of Mexico, and the outline of the Sunshine State looked less like a skinny finger than like a plump heel.

As the ice age ended and the planet warmed, the world's coastlines assumed their present configuration. There's a good deal of evidence—much of it now submerged—that this process did not take place slowly and steadily but, rather, in fits and starts. Beginning around 12,500 B.C., during an event known as meltwater pulse 1A, sea levels rose by roughly fifty feet in three or four centuries, a rate of more than a foot per decade. Meltwater pulse 1A, along with pulses 1B, 1C, and 1D, was,

most probably, the result of ice-sheet collapse. One after another, the enormous glaciers disintegrated and dumped their contents into the oceans. It's been speculated—though the evidence is sketchy—that a sudden flooding of the Black Sea toward the end of meltwater pulse 1C, around seventy-five hundred years ago, inspired the deluge story in Genesis.

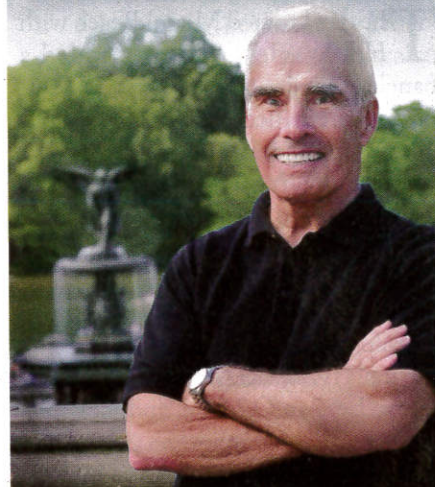
As temperatures climb again, so, too, will sea levels. One reason for this is that water, as it heats up, expands. The process of thermal expansion follows well-known physical laws, and its impact is relatively easy to calculate. It is more difficult to predict how the earth's remaining ice sheets will behave, and this difficulty accounts for the wide range in projections.

Low-end forecasts, like the I.P.C.C.'s, assume that the contribution from the ice sheets will remain relatively stable through the end of the century. High-end projections, like NOAA's, assume that ice-melt will accelerate as the earth warms (as, under any remotely plausible scenario, the planet will continue to do at least through the end of this century, and probably beyond). Recent observations, meanwhile, tend to support the most worrisome scenarios.

The latest data from the Arctic, gathered by a pair of exquisitely sensitive satellites, show that in the past decade Greenland has been losing more ice each year. In August, NASA announced that, to supplement the satellites, it was launching a new monitoring program called—provocatively—Oceans Melting Greenland, or O.M.G. In November, researchers reported that, owing to the loss of an ice shelf off northeastern Greenland, a new "floodgate" on the ice sheet had opened. All told, Greenland's ice holds enough water to raise global sea levels by twenty feet.

At the opposite end of the earth, two groups of researchers—one from NASA's Jet Propulsion Lab and the other from the University of Washington—concluded last year that a segment of the West Antarctic ice sheet has gone into "irreversible decline." The segment, known as the Amundsen Sea sector, contains enough water to raise global sea levels by four feet, and its melting could destabilize other parts of the ice

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sheet, which hold enough ice to add ten more feet. While the “decline” could take centuries, it’s also possible that it could be accomplished a lot sooner. NASA is already planning for the day when parts of the Kennedy Space Center, on Florida’s Cape Canaveral, will be underwater.

The day I toured Miami Beach with Hal Wanless, I also attended a panel discussion at the city’s Convention Center titled “Eyes on the Rise.” The discussion was hosted by the French government, as part of the lead-up to the climate convention in Paris, at that point two months away. Among the members of the panel was a French scientist named Eric Rignot, a professor at the University of California, Irvine. Rignot is one of the researchers on O.M.G., and in a conference call with reporters during the summer he said he was “in awe” of how fast the Greenland ice sheet was changing. I ran into him just as he was about to go onstage.

“I’m going to scare people out of this room,” he told me. His fellow-panelists were a French geophysicist, a climate scientist from the University of Miami, and Miami Beach’s mayor, Philip Levine. Levine was elected in 2013, after airing a commercial that tapped into voters’ frustration with the continual flooding. It showed him pre-

paring to paddle home from work in a kayak.

“Some people get swept into office,” Levine joked when it was his turn at the mike. “I always say I got floated in.” He described the steps his administration was taking to combat the effects of rising seas. These include installing enormous underground pumps that will suck water off the streets and dump it into Biscayne Bay. Six pumps have been completed, and fifty-four more are planned. “We had to raise people’s storm-water fees to be able to pay for the first hundred-million-dollar tranche,” Levine said. “So picture this: you get elected to office and the first thing you tell people is ‘By the way, I’m going to raise your rates.’”

He went on, “When you are doing this, there’s no textbooks, there’s no ‘How to Protect Your City from Sea Level Rise,’ go to Chapter 4.” So the city would have to write its own. “We have a team that’s going to get it done, that’s going to protect this city,” the Mayor said. “We can’t let investor confidence, resident confidence, confidence in our economy start to fall away.”

John Morales, the chief meteorologist at NBC’s South Florida affiliate, was moderating the discussion. He challenged the Mayor, offering a version of the argument I’d heard from Wanless—that today’s pumps will be submerged by the seas of tomorrow.

“Down the road, this is just a Band-Aid,” Morales said.

“I believe in human innovation,” Levine responded. “If, thirty or forty years ago, I’d told you that you were going to be able to communicate with your friends around the world by looking at your watch or with an iPad or an iPhone, you would think I was out of my mind.” Thirty or forty years from now, he said, “We’re going to have innovative solutions to fight back against sea-level rise that we cannot even imagine today.”

Many of the world’s largest cities sit along a coast, and all of them are, to one degree or another, threatened by rising seas. Entire countries are endangered—the Maldives, for instance, and the Marshall Islands. Globally, it’s estimated that a hundred million people live within three feet of mean high tide and another hundred million or so live within six feet of it. Hundreds of millions more live in areas likely to be affected by increasingly destructive storm surges.

Against this backdrop, South Florida still stands out. The region has been called “ground zero when it comes to sea-level rise.” It has also been described as “the poster child for the impacts of climate change,” the “epicenter for studying the effects of sea-level rise,” a “disaster scenario,” and “the New Atlantis.” Of all the world’s cities, Miami ranks second in terms of assets vulnerable to rising seas—No. 1 is Guangzhou—and in terms of population it ranks fourth, after Guangzhou, Mumbai, and Shanghai. A recent report on storm surges in the United States listed four Florida cities among the eight most at risk. (On that list, Tampa came in at No. 1.) For the past several years, the daily high-water mark in the Miami area has been racing up at the rate of almost an inch a year, nearly ten times the rate of average global sea-level rise. It’s unclear exactly why this is happening, but it’s been speculated that it has to do with changes in ocean currents which are causing water to pile up along the coast. Talking about climate change in the Everglades this past Earth Day, President Obama said, “Nowhere is it going to have a bigger impact than here in South Florida.”



“Cherish this moment, because clearly our parents are getting a divorce.”

The region's troubles start with its topography. Driving across South Florida is like driving across central Kansas, except that South Florida is greener and a whole lot lower. In Miami-Dade County, the average elevation is just six feet above sea level. The county's highest point, aside from man-made structures, is only about twenty-five feet, and no one seems entirely sure where it is. (The humorist Dave Barry once set out to climb Miami-Dade's tallest mountain, and ended up atop a local garbage dump nicknamed Mt. Trashmore.) Broward County, which includes Fort Lauderdale, is equally flat and low, and Monroe County, which includes the Florida Keys, is even more so.

But South Florida's problems also run deeper. The whole region—indeed, most of the state—consists of limestone that was laid down over the millions of years Florida sat at the bottom of a shallow sea. The limestone is filled with holes, and the holes are, for the most part, filled with water. (Near the surface, this is generally freshwater, which has a lower density than saltwater.)

Until the eighteen-eighties, when the first channels were cut through the region by steam-powered dredges, South Florida was one continuous wetland—the Everglades. Early efforts to drain the area were only half successful; Northerners lured by turn-of-the-century real-estate scams found the supposedly rich farmland they'd purchased was more suitable for swimming.

"I have bought land by the acre, and I have bought land by the foot; but, by God, I have never before bought land by the gallon," one arrival from Iowa complained.

Even today, with the Everglades reduced to half its former size, water in the region is constantly being shunted around. The South Florida Water Management District, a state agency, claims that it operates the "world's largest water control system," which includes twenty-three hundred miles of canals, sixty-one pump stations, and more than two thousand "water control structures." Floridians south of Orlando depend on this system to prevent their lawns from drowning and their front steps from becoming docks. (Basement flooding isn't an issue in South Florida, because

no one has a basement—the water table is too high.)

When the system was designed—redesigned, really—in the nineteen-fifties, the water level in the canals could be maintained at least a foot and a half higher than the level of high tide. Thanks to this difference in elevation, water flowed off the land toward the sea. At the same time, there was enough freshwater pushing out to prevent saltwater from pressing in.

Owing in part to sea-level rise, the gap has since been cut by about eight inches, and the region faces the discomfiting prospect that, during storms, it will be inundated not just along the coasts but also inland, by rainwater that has nowhere to go. Researchers at Florida Atlantic University have found that with just six more inches of sea-level rise the district will lose almost half its flood-control capacity. Meanwhile, what's known as the saltwater front is advancing. One city—Hallandale Beach, just north of Miami—has already had to close most of its drinking wells, because the water is too salty. Many other cities are worried that they will have to do the same.

Jayantha Obeysekera is the Water Management District's chief modeller, which means it's his job to foresee South Florida's future. One morning, I caught up with him at a flood-control structure known as S13, which sits on a canal known as C11, west of Fort Lauderdale.

"We have a triple whammy," he said. "One whammy is sea-level rise. Another whammy is the water table comes up higher, too. And in this area the higher the water table, the less space you have to absorb storm water. The third whammy is if the rainfall extremes change, and become more extreme. There are other whammies probably that I haven't mentioned. Someone said the other day, 'The water comes from six sides in Florida.'"

A month after the super blood moon, South Florida experienced another series of very high tides—"king tides," as Miamians call them. This time, I went out to see the effects

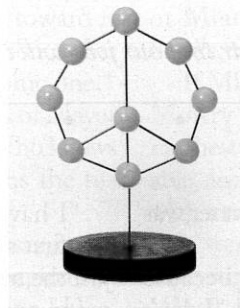
with Nicole Hernandez Hammer, an environmental-studies researcher who works for the Union of Concerned Scientists. Hammer had looked over elevation maps and decided that Shorecrest, about five miles north of downtown Miami, was a neighborhood where we were likely to find flooding. It was another hot, blue morning, and as we drove along, in Hammer's Honda, at first it seemed that she'd miscalculated.

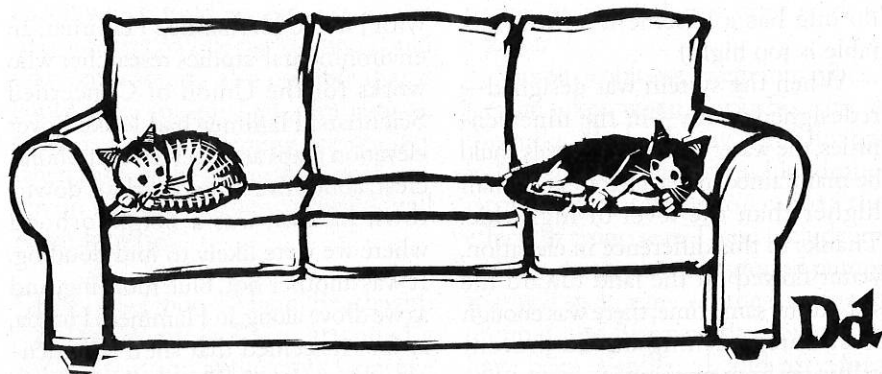
Then, all of a sudden, we arrived at a major intersection that was submerged. We parked and made our way onto a side street, also submerged. We were standing in front of a low-slung apartment building, debating what to do next, when one of the residents came by.

"I've been trying to figure out: Where is the water coming from?" he said. "It'll be drying up and then it'll be just like this again." He had complained to the building's superintendent. "I told him, 'Something needs to be done about this water, man.' He says he'll try to do something." A cable-repair truck trailing a large wake rolled by and then stalled out.

The water on the street was so deep that it was, indeed, hard to tell where it was coming from. Hammer explained that it was emerging from the storm drains. Instead of funnelling rainwater into the bay, as they were designed to do, the drains were directing water from the bay onto the streets. "The infrastructure we have is built for a world that doesn't exist anymore," she said.

Neither of us was wearing boots, a fact that, as we picked our way along, we agreed we regretted. I couldn't help recalling stories I'd heard about Miami's antiquated sewer system, which leaks so much raw waste that it's the subject of frequent lawsuits. (To settle a suit brought by the federal government, the county recently agreed to spend \$1.6 billion to upgrade the system, though many question whether the planned repairs adequately account for sea-level rise.) Across the soaked intersection, in front of a single-family home, a middle-aged man was unloading groceries from his car. He, too, told





"Every day I live in fear that our jobs will be replaced by pillows."

us he didn't know where the water was coming from.

"I heard on the news it's because the moon turned red," he said. "I don't have that much detail about it." During the past month, he added, "it's happened very often." (In an ominous development, Miami this past fall experienced several very high tides at times of the month when, astronomically speaking, it shouldn't have.)

"Honestly, sometimes, when I'm talking to people, I think, Oh, I wish I had taken more psychology courses," Hammer told me. A lot of her job involves visiting low-lying neighborhoods like Shorecrest, helping people understand what they're seeing. She shows them elevation maps and climate-change projections, and explains that the situation is only going to get worse. Often, Hammer said, she feels like a doctor: "You hear that they're trying to teach these skills in medical schools, to encourage them to have a better bedside manner. I think I might try to get that kind of training, because it's really hard to break bad news."

It was garbage-collection day, and in front of one house county-issued trash bins bobbed in a stretch of water streaked with oil. Two young women were surveying the scene from the driveway, as if from a pier.

"It's horrible," one of them said to us. "Sometimes the water actually smells." They were sisters, originally from Colombia. They wanted to sell the house, but, as the other sister observed, "No one's going to want to buy it like this."

"I have called the city of Miami," the first sister said. "And they said it's just the moon. But I don't think it's the moon anymore."

After a couple of minutes, their mother came out. Hammer, who was born in Guatemala, began chatting with her in Spanish. "Oh," I heard the mother exclaim. "*Dios mío! El cambio climático!*"

Marco Rubio, Florida's junior senator, who has been running third in Republican primary polls, grew up not far from Shorecrest, in West Miami, which sounds like it's a neighborhood but is actually its own city. For several years, he served in Florida's House of Representatives, and his district included Miami's flood-vulnerable airport. Appearing this past spring on "Face the Nation," Rubio was asked to explain a statement he had made about climate change. He offered the following: "What I said is, humans are not responsible for climate change in the way some of these people out there are trying to make us believe, for the following reason: I believe that climate is changing because there's never been a moment where the climate is not changing."

Around the same time, it was revealed that aides to Florida's governor, Rick Scott, also a Republican, had instructed state workers not to discuss climate change, or even to use the term. The Scott administration, according to the Florida Center for Investigative Reporting, also tried to ban talk of sea-level rise; state employees were sup-

posed to speak, instead, of "nuisance flooding." Scott denied having imposed any such Orwellian restrictions, but I met several people who told me they'd bumped up against them. One was Hammer, who, a few years ago, worked on a report to the state about threats to Florida's transportation system. She said that she was instructed to remove all climate-change references from it. "In some places, it was impossible," she recalled. "Like when we talked about the Intergovernmental Panel on Climate Change, which has 'climate change' in the title."

Scientists who study climate change (and the reporters who cover them) often speculate about when the partisan debate on the issue will end. If Florida is a guide, the answer seems to be never. During September's series of king tides, former Vice-President Al Gore spent a morning sloshing through the flooded streets of Miami Beach with Mayor Levine, a Democrat. I met up with Gore the following day, and he told me that the boots he'd worn had turned out to be too low; the water had poured in over the top.

"When the governor of the state is a full-out climate denier, the irony is just excruciatingly painful," Gore observed. He said that he thought Florida ought to "join with the Maldives and some of the small island states that are urging the world to adopt stronger restrictions on global-warming pollution."

Instead, the state is doing the opposite. In October, Florida filed suit against the Environmental Protection Agency, seeking to block new rules aimed at limiting warming by reducing power-plant emissions. (Two dozen states are participating in the lawsuit.)

"The level of disconnect from reality is pretty profound," Jeff Goodell, a journalist who's working on a book on the impacts of sea-level rise, told me. "We're sort of used to that in the climate world. But in Florida there are real consequences. The water is rising right now."

Meanwhile, people continue to flock to South Florida. Miami's metropolitan area, which includes Fort Lauderdale, has been one of the fastest growing in the country; from 2013

to 2014, in absolute terms it added more residents than San Francisco and, proportionally speaking, it outdid Los Angeles and New York. Currently, in downtown Miami there are more than twenty-five thousand new condominium units either proposed or under construction. Much of the boom is being financed by “flight capital” from countries like Argentina and Venezuela; something like half of recent home sales in Miami were paid for in cash.

And just about everyone who can afford to buy near the water. Not long ago, Kenneth Griffin, a hedge-fund billionaire, bought a penthouse in Miami Beach for sixty million dollars, the highest amount ever paid for a single-family residence in Miami-Dade County (and ten million dollars more than the original asking price). The penthouse, in a new building called Faena House, offers eight bedrooms and a seventy-foot rooftop pool. When I read about the sale, I plugged the building’s address into a handy program called the Sea Level Rise Toolbox, created by students and professors at Florida International University. According to the program, with a little more than one foot of rise the roads around the building will frequently flood. With two feet, most of the streets will be underwater, and with three it seems that, if Faena House is still habitable, it will be accessible only by boat.

I asked everyone I met in South Florida who seemed at all concerned about sea-level rise the same question: What could be done? More than a quarter of the Netherlands is below sea level and those areas are home to millions of people, so low-elevation living is certainly possible. But the geology of South Florida is peculiarly intractable. Building a dike on porous limestone is like putting a fence on top of a tunnel: it alters the route of travel, but not necessarily the amount.

“You can’t build levees on the coast and stop the water” is the way Jayantha Obeysekera put it. “The water would just come underground.”

Some people told me that they thought the only realistic response for South Florida was retreat.

“I live opposite a park,” Philip Stoddard, the mayor of South Miami—also a city in its own right—told me. “And there’s a low area in it that fills up when it rains. I was out there this morning walking my dog, and I saw fish in it. Where the heck did the fish come from? They came from underground. We have fish that travel underground!”

“What that means is, there’s no keeping the water out,” he went on. “So ultimately this area has to depopulate. What I want to work toward is a slow and graceful depopulation, rather than a sudden and catastrophic one.”

More often, I heard echoes of Mayor Levine’s Apple Watch line. Who knows what amazing breakthroughs the future will bring?

“I think people are underestimating the incredible innovative imagination in the world of adaptive design,” Harvey Ruvin, the Clerk of the Courts of Miami-Dade County and the chairman of the county’s Sea Level Rise Task Force, said when I went to visit him in his office. A quote from Buckminster Fuller hung on the wall: “We are all passengers on Spaceship Earth.” Ruvin became friendly with Fuller in the nineteen-sixties, after reading about a plan Fuller had drawn up for a floating city in Tokyo Bay.

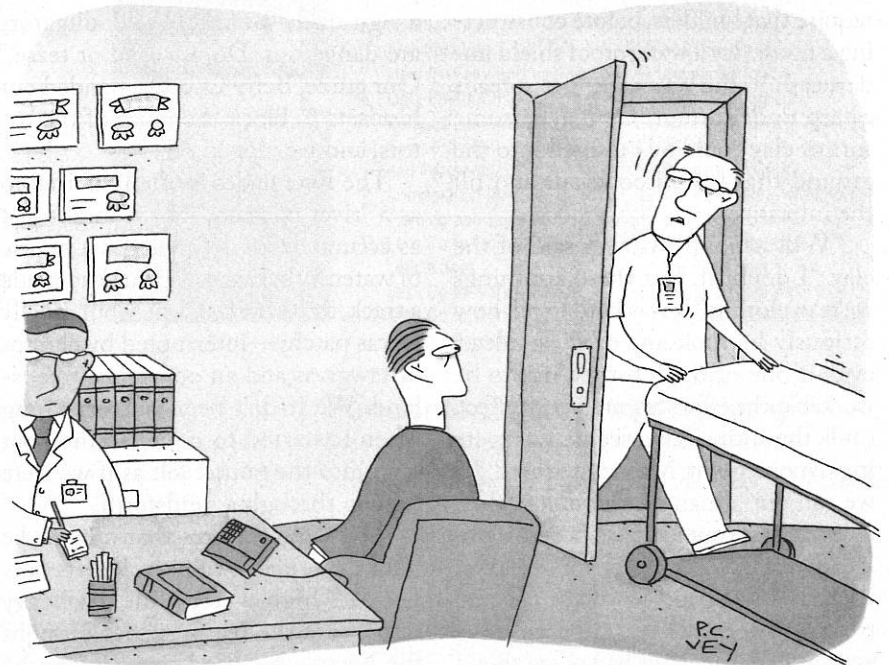
“I would agree that things can’t con-

tinue exactly the way they are today,” Ruvin told me. “But what we will evolve to may be better.”

I keep telling people, “This is my patient,” Bruce Mowry, Miami Beach’s city engineer, was saying. “I can’t lose my patient. If I don’t do anything, Miami Beach may not be here.” It was yet another day of bright-blue skies and “nuisance flooding,” and I was walking with Mowry through one of Miami Beach’s lowest neighborhoods, Sunset Harbour.

If Miami Beach is on a gurney, then Mowry might be said to be thumping its chest. It’s his job to keep the city viable, and since no one has yet come up with a smart-watch-like breakthrough, he’s been forced to rely on more primitive means, like pumps and asphalt. We rounded a corner and came to a set of stairs, which led down to some restaurants and shops. Until recently, Mowry explained, the shops and the street had been at the same level. But the street had recently been raised. It was now almost a yard higher than the sidewalk.

“I call this my five-step program,” he said. “What are the five steps?” He counted off the stairs as we descended: “One, two, three, four, five.” Some restaurants had set up tables at the bottom,



“You the guy who donated his body to science?”

next to what used to be a curb but now, with the elevation of the road, is a three-foot wall. Cars whizzed by at the diners' eye level. I found the arrangement disconcerting, as if I'd suddenly shrunk. Mowry told me that some of the business owners, who had been unhappy when the street flooded, now were unhappy because they had no direct access to the road: "It's, like, can you win?"

Several nearby streets had also been raised, by about a foot. The elevated roadbeds were higher than the driveways, which now all sloped down. The parking lot of a car-rental agency sat in a kind of hollow.

I asked about the limestone problem. "That is the one that scares us more than anything," Mowry said. "New Orleans, the Netherlands—everybody understands putting in barriers, perimeter levees, pumps. Very few people understand: What do you do when the water's coming up through the ground?"

"What I'd really like to do is pick the whole city up, spray on a membrane, and drop it back down," he went on. I thought of Calvino's "Invisible Cities," where such fantastical engineering schemes are the norm.

Mowry said he was intrigued by the possibility of finding some kind of resin that could be injected into the limestone. The resin would fill the holes, then set to form a seal. Or, he suggested, perhaps one day the city would require that builders, before constructing a house, lay a waterproof shield underneath it, the way a camper spreads a tarp under a tent. Or maybe some sort of clay could be pumped into the ground that would ooze out and fill the interstices.

"Will it hold?" Mowry said of the clay. "I doubt it. But these are things we're exploring." It was hard to tell how seriously he took any of these ideas; even if one of them turned out to be workable, the effort required to, in effect, caulk the entire island seemed staggering. At one point, Mowry declared, "If we can put a man on the moon, then we can figure out a way to keep Miami Beach dry." At another, he mused about the city's reverting to "what it came from," which was largely mangrove swamp: "I'm sure if we had poets, they'd be writing about the swallowing of Miami Beach by the sea."

We headed back toward Mowry's office around the time of maximum high tide. The elevated streets were still dry, but on the way to City Hall we came to an unreconstructed stretch of road that was flooding. Evidently, this situation had been anticipated, because two mobile pumps, the size and shape of ice-cream trucks, were parked near the quickly expanding pool. Neither was operating. After making a couple of phone calls, Mowry decided that he would try to switch them on himself. As he fiddled with the controls, I realized that we were standing not far from the drowned palm tree I'd seen on my first day in Miami Beach, and that it was once again underwater.

About a dozen miles due west of Miami, the land gives out, and what's left of the Everglades begins. The best way to get around in this part of Florida is by airboat, and on a gray morning I set out in one with a hydrologist named Christopher McVoy. We rented the boat from a concession run by members of the Miccosukee tribe, which, before the Europeans arrived, occupied large swaths of Georgia and Tennessee. The colonists hounded the Miccosukee ever farther south, until, eventually, they ended up with a few hundred mostly flooded square miles between Miami and Naples. On a fence in front of the dock, a sign read, "Beware: Wild alligators are dangerous. Do not feed or tease." Our guide, Betty Osceola, handed out headsets to block the noise of the rotors, and we zipped off.

The Everglades is often referred to as a "river of grass," but it might just as accurately be described as a prairie of water. Where the airboats had made a track, the water was open, but mostly it was patchy—interrupted by clumps of sawgrass and an occasional tree island. We hadn't been out very long when it started to pour. As the boat sped into the rain, it felt as if we were driving through a sandstorm.

The same features that now make South Florida so vulnerable—its flatness, its high water table, its heavy rains—are the features that brought the Everglades into being. Before the drainage canals were dug, water flowed from Lake Okechobee, about seventy

miles north of Miami, to Florida Bay, about forty miles to the south of the city, in one wide, slow-moving sheet. Now much of the water is diverted, and the water that does make it to the wetlands gets impounded, so the once continuous "sheet flow" is no more. There's a comprehensive Everglades restoration plan, which goes by the acronym CERP, but this has got hung up on one political snag after another, and climate change adds yet one more obstacle. The Everglades is a freshwater ecosystem; already, at the southern margin of Everglades National Park, the water is becoming salty. The sawgrass is in retreat, and mangroves are moving in. In coming decades, there's likely to be more and more demand for the freshwater that remains. As McVoy put it, "You've got a big chunk of agriculture, a big chunk of people, and a big chunk of nature reserve all competing for the same resources."

The best that can be hoped for with the restoration project is that it will prolong the life of the wetland and, with that, of Miami's drinking-water system. But you can't get around geophysics. Send the ice sheets into "irreversible decline," as it seems increasingly likely we have done, and there's no going back. Eventually, the Everglades, along with Shorecrest and Miami Beach and much of the rest of South Florida, will be inundated. And, if Hal Wanless is right, eventually isn't very far off.

To me, the gunmetal expanse of water and grass appeared utterly without markers, but Osceola, who could read the subtlest of ridges, knew exactly where we were at every moment. We stopped to have sandwiches on an island with enough dry land for a tiny farm, and stopped again at a research site that McVoy had set up in the muck. There was a box of electrical equipment on stilts, and a solar panel to provide power. McVoy dropped out of the boat to collect some samples in empty water-cooler bottles. The rain let up, and then started again. ♦

O PIONEERS DEPARTMENT

From the Oak Harbor (Wash.) Whidbey News-Times.

At 6:34 p.m., a Tee Place resident reported that a tortoise was missing. It responds to "Dexter."