The Acts of God Algorithm

Why the insurance industry is headed for the perfect storm

By Art Jahnke

IN SUMMER 2007, Michael Lewis, author of *Liar's Poker*, *Moneyball*, and eleven other books, was researching a story for the *New York Times Magazine* about a math whiz who applied his genius to the relatively new business of buying and selling catastrophe bonds, basically betting on the likelihood of a natural disaster wiping billions of dollars worth of homes and businesses off the map. Lewis's subject, John Seo, was a compelling character. Brilliant and successful, Seo was also modest enough to tell Lewis that if he wanted to write about someone who had radically changed the business of catastrophic risk assessment, he should track down a woman named Karen Clark.

MATH PROBLEMS
For Karen Clark, the mathematical formulas used to predict the destruction caused by hurricanes are far more captivating than the storms themselves.

The *Times* story, which received an honorable mention from the Gerald Loeb Awards, given to journalists contributing to the understanding of business, finance, and the economy, ended up being as much about Clark as it was about Seo. It was the first time people outside the arcane business of catastrophic risk assessment had heard of Clark, and it was the second most redeeming moment of her twenty-eight-year career. The most redeeming moment was much more expensive.

In August 1992, when Hurricane Andrew was spinning toward south Florida, most experts in the "cat" risk assessment business were advising their insurance company clients to expect damages in the low hundreds of millions of dollars. Lloyd's of London, more adventurous than most, suggested that the storm could cost insurers as much as $6 billion. Clark, whose five-year-old company, Applied Insurance Research, thought they all had their heads in the sand. Her computer models, which had relatively little traction in the industry, put the potential damage at $13 billion — more if the overeager builders of south Florida had cut corners on local building codes.

"When they heard the number, the phone started ringing off the hook," recalls Clark (GRS'82, GSM'82). "People said it was crazy."

Six months later, she says, the official corporate price tag of the storm that killed fifteen people and left 250,000 Florida residents homeless came in: $15.5 billion. Eleven insurance companies went

WHEN CLARK'S models put the potential damage of Hurricane Andrew at $13 billion, people said it was crazy.

PHOTOGRAPHS BY MELODY KOMYEROV

belly up, and those that didn't are now required to use the kind of computer modeling pioneered by Clark. Almost twenty years later, Clark is respected, rich, and still worried that insurance companies have their heads in the sand.

SAFETY IN NUMBERS

The easygoing Clark has built two companies and changed an industry doing something she loves: crunching numbers. The real-world devastation those numbers attempt to predict — shredded house trailers, capsized SUVs, million-dollar homes tumbling toward the Pacific, the kind of natural disasters Hollywood has turned into a lucrative genre — remain on the periphery of Clark's vision. Far more captivating are the algorithms that foretell the bedlam.

"I always liked the math," Clark says. "I liked the statistics and computer science. I really enjoyed getting some data, putting it in a computer, developing some algorithms, and trying to come up with some information that made sense."

After graduating from BU in 1982 with master's degrees in business and in economics, her first job interview was at Boston-based insurance company Commercial Union. "They had a small internal consulting group that was trying to build decision-making models," she recalls. "They take in premiums and pay out claims, and they were trying to get a better view of what their claims would be."

The job was, she admits, an odd choice for someone with a degree in economics, but it promised an abundance of mathematical challenges. Clark couldn't say no.

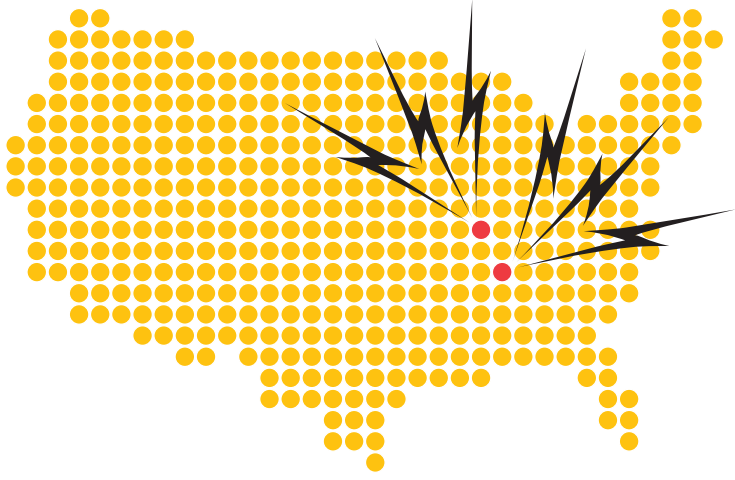
Initially, she says, the modeling was all about insurance business cycles; catastrophic risk hadn't entered the equations. But it happened that Commercial Union had been selling a great many insurance policies on coastal properties, the kind of properties that would cost the company money if a good-sized hurricane hit the Northeast. When the salespeople were told they had reached their "cap," based on the probable maximum loss the company could bear, they looked for a way out.

"This was something nobody really cared about until the field underwriters couldn't write any more business," says Clark. "When that happened, somebody said, 'Hey, where did these caps come from?' and the answer was that they came from some people sitting around in a room and saying, 'This is the number.' They weren't scientifically based. Finally, someone said, 'We need a better approach to figuring out how much business we can write in these coastal counties without exposing us to a loss we can't handle.'"

The task of determining that better approach fell to Clark, who had the novel idea of adding scientific data to the computations that had previously been based solely on claims data.

"Once I started digging, I found that there was quite a bit of science available about what hurricanes do when they hit landfall," says Clark. "There are things you can put into a model, on the meteorology and on what kind of damage you could expect to certain kinds of buildings if you reached a certain wind speed. But those two main

North America's Biggest Threat



California is not indisputably the most likely location for the most disastrous earthquake yet to come to North America. Some experts are keeping a wary eye on a little-known seismic fault line running from New Madrid, Missouri, southwesterly for 150 miles.

In 1811 and 1812, movement of the New Madrid fault caused the largest earthquakes recorded in North America, some possibly as large as magnitude 8. If there were an event on that fault, says catastrophic risk expert Karen Clark, the most exposed cities would be Memphis, Tennessee, and St. Louis, Missouri. She warns that the geology of the region would cause seismic waves to travel greater distances than quakes in California.

"What's the return period of a quake like that of 1812?" Clark asks. "We don't know. It could be anywhere from 500 to 1,500 years. What would be the damages? We can't say. The models are limited by the lack of scientific data." AJ

pieces of the model are built by two different types of people: scientists on one hand, and engineers on the other. What I did was bring these disciplines together."

COMPUTERS TO THE RESCUE

Clark wasn't the only mathematician who was trying to bring science into risk assessment. At Travelers Insurance, analysts had devised a methodology to predict the damages of one storm on a particular portfolio of properties. But the Travelers model, Clark says, failed to consider the probability that the storm would occur.

"It doesn't help me much if you tell me there's a cat 4 coming up Chesapeake Bay, and if it goes on to New England, my losses are going to be $2 billion," she says. "In order to price insurance, I need to know if this is a one-in-ten-year event or a one-in-a-hundred-year event or a one-in-a-thousand-year event. That's what I had to develop."

WEB EXTRA
A video of Karen Clark talking about why the worst is yet to come is at bu.edu/bostonia.

Clark did that by researching the history of hurricanes. She found that in Florida, where there was a hurricane roughly every other year, a 100-year perspective revealed periods of low frequency and periods of high frequency. In the Northeast, things were very different: in the last century, only nine hurricanes had made landfall north of Long Island.

"All computer modeling is built on historical data," says Clark. "But instead of going to the claims data or loss data, I started with historical meteorological data. That gives you a lot more information to work with than the five or ten years that insurance companies typically use. I also used engineering data. I found information about what kind of damage had occurred to different types of structures — high-rise, commercial, wood-frame — and I built that into the model. The final piece was to take all of the information and create actual events and superimpose them on the property values that are exposed today."

Clark's big idea, adding science to the pot, was new, she says, but even had it been considered a decade earlier, putting it into practice would have been impossible. All of her modeling was made possible by computing power.

"When I bought my first computer in 1989, it had one gigabyte of hard drive and it cost $60,000," says Clark. "All of my data was on tapes, and I'd have to drive over to some building where they had a bank of IBM mainframes. It took forever to do 100 simulations. Now you can do a million simulations in no time."

At Commercial Union, the potential of Clark's efforts went unrealized, and perhaps unappreciated. In 1985, her business unit was downsized out of existence. Clark believes her career was rescued because she had just published a paper arguing that the insurance industry was headed for a perfect storm. On one hand, she wrote, insurance companies had no idea how much they could lose from a single huge storm, largely because the 1970s and 1980s had seen fewer storms than previous decades. On the other hand, the wealth and mobility of Americans had allowed them to relocate in dangerously high numbers to scenic shoreline developments.

"That's a risk that still grows every year," Clark says today. "We love to live on the coast. We love to live in beautiful California along fault lines. We are building our highest valued properties in our most vulnerable areas."

Her paper attracted the attention of a large insurance broker, who wanted Clark to join his company. She had a better idea. She would start her own firm, financed to a large extent with fees the broker would pay her as a client.

Her company, Applied Insurance Research, or A.I.R., got off the ground in 1987, hiring the kind of people insurance companies were not in the habit of hiring: scientists and engineers. Her computer models produced estimates of damage from hurricanes, but they were estimates that few insurance companies wanted to hear.

"My model showed losses much higher than companies were anticipating," says Clark. "Not many companies believed it, but they weren't really keeping track of their exposure. What finally changed this was not the model. It was Hurricane Andrew."

GAINING GROUND

Clark's credibility, and her business, grew steadily through the 1990s. Reinsurance companies, as well as rating agencies like Standard & Poor's and Moody's, eventually required insurance companies to use catastrophe models to compute their potential losses. "By 2000," she says, "it was institutionalized."

In 2000, Clark was chosen by *Business Insurance* as one of the Top 100 Women in the Insurance Industry. The next year, she was named Woman of the Year by the Association of Professional Insurance Women. In 2002, she sold her company to ISO Risk Management Services, which renamed it AIR Worldwide Corporation and kept her on as president and CEO.

James Stanard, a former CEO of Renaissance Holdings, one of the world's largest property catastrophe reinsurers, says the models developed by Clark have

"WE LOVE to live on the coast. We are building our highest valued properties in our most vulnerable areas."

become so standard that "they are almost like agency ratings." One of her early clients, Stanard says her work helped his company deliver the highest return on equity in the business for ten years in a row.

"She was the most important person when it comes to introducing catastrophe modeling," says Stanard, cofounder and chairman of the reinsurance intermediary TigerRisk Partners. "And she is not a one-shot deal. Karen has been moving the field forward for decades, and she's still doing it."

In 2007, Clark received the *Review Worldwide Reinsurance* Awards Lifetime Achievement Award, recognizing an individual who has made the most outstanding long-term contribution to the reinsurance industry. That same year, her noncompete clause with ISO expired, and Clark started Karen Clark & Company.

The Boston-based company recently launched a Web site that helps homeowners manage their households, get estimates from contractors and service providers for home improvements and repairs, determine how much insurance they need, and solicit quotes on that coverage from several leading insurers. It also sells a hand-held device that helps insurance companies collect and upload information about properties, as well as software that helps reinsurers rate the reliability of insurance company data and risk estimates.

The common theme of those products: helping people get better information and put it to better use. Unfortunately, says Clark, the former doesn't guarantee the latter. Having watched for two decades as the insurance industry adopted her models, she now worries about the way those models are used.

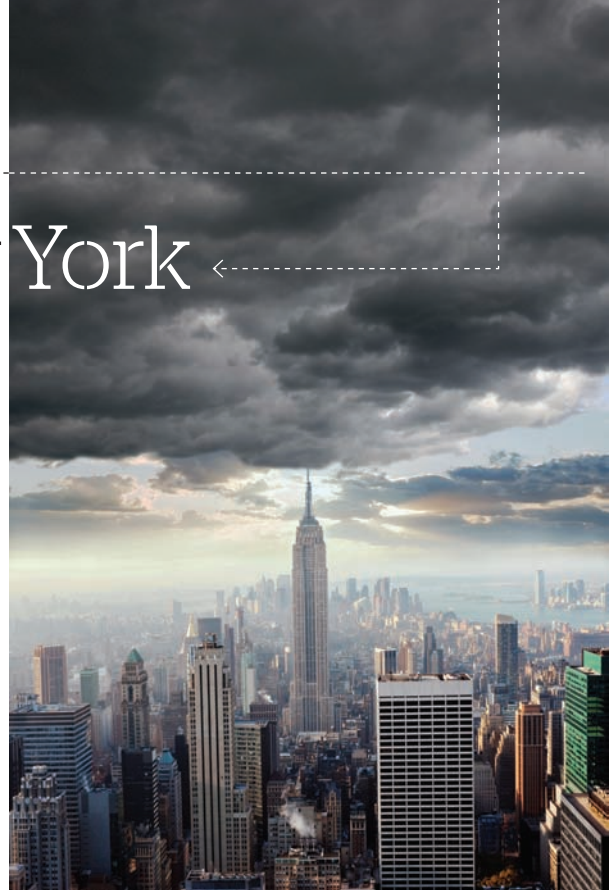
"Companies are overrelying on them," she warns. "They think the models are giving them answers to the penny, instead of highly uncertain numbers. For example, an insurance company will use a catastrophe model to determine your homeowner's premium if you live in a coastal or seismically active area. So the company may say that they need to charge you $500 for hurricane risk. If the models are updated with new information, the loss estimate will change, so they may say that your premium shouldn't have been $500. It should have been $300. Or $700. What they are doing doesn't work, because I'm basing the model on a longer-term view that should have more stability and shouldn't be used for pinpoint estimates. A more effective use is to find robust and reasonable ranges — $250 to $650 — then pick some number that they are comfortable with as a company, so you can have some stability. The models are blunt tools, and the companies are using them as precision instruments."

The New York Nightmare

What would happen if a category 3 storm, like the one that hit New England in 1938, were to make landfall just east of New York City today?

Insured losses	**$50 BILLION**
Losses from storm surge damage	**$25 BILLION**
Total economic losses	**$100 BILLION**
People to be moved to safety	**THREE MILLION**
Time needed to move people	**EIGHTEEN HOURS FOR FIRST MILLION**

SOURCE: AIR WORLDWIDE CORPORATION



STUCK IN FIRE WORLD

An even greater problem, according to Clark, is that insurance companies are not collecting the right information. They're stuck, she says, "in Fire World."

"The insurance industry grew up in the middle of the last century, when the main risk was fire," says Clark. "Today your house is still classified for its combustibility. The data collected on commercial properties are things like sprinkler systems and fire extinguishers. What's wrong with that, from a business perspective, is that insurance companies now pay out about $9 billion to $10 billion in fire losses each year, but they are paying close to $30 billion for hurricanes, earthquakes, and winter storms. Companies are not collecting information that would indicate how susceptible buildings are to catastrophe. They need to start collecting things like roof type, roof age, and foundation type."

Clark doesn't expect a departure from Fire World anytime soon. "They've got hundreds of millions invested in systems, statistical plans, and collection processes," she says. "They've got enormous IT systems all built around fire risk. It's not the kind of thing that's going to change overnight."

And that's a problem. In the wake of Katrina and other disasters, she says, it's clear that a natural catastrophe could send us a bill in excess of $200 billion. The insurance industry will pay about half, and we — homeowners, business owners, and taxpayers— will have to pick up the rest of the tab.

"It's not a question of if," says Clark. "It's a question of when." ■