Science & Technology

Diet for a Warm Planet

Columbians work to stem the tide of climate change.

By
Beth Kwon
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A nondescript office above a diner in Upper Manhattan might seem an unlikely command post in the battle against global warming. But from his Broadway and 112th Street base, below which students and tourists gather at Tom's Restaurant, climatologist James Hansen issues a dire message: climate change is upon us, and something must be done.

"We're getting close to a tipping point," says Hansen, who is director of NASA's Goddard Institute for Space Studies, a unit of Columbia's Earth Institute. "If we go another ten years without addressing the problem, it's going to be too late. We'll lose all of the sea ice in the Arctic, and over time this century will see rapid sea-level rise. We need to start doing something now."

Hansen was one of the first scientists to caution policymakers about the dangers of global warming. He testified before Congress as early as 1988, stating that the Earth was in an actual long-term warming trend that was likely caused by increasing human-made greenhouse gases. Since then, he has advocated improving fuel efficiency in cars and developing renewable energy resources to lessen our dependence on fossil fuels. His efforts have also been attended by controversy: in published interviews this year, Hansen said that NASA has tried to influence his public statements and that the Bush administration has edited press releases by federal agencies in order to de-emphasize the human role in global warming.

But even the Bush administration is beginning to show grudging signs of acceptance, Hansen suggests. "I don't think there's much issue there any longer," he says. "The amount of the warming is very consistent with what is calculated and

expected given the human contribution. In the last 30 years the rate of warming has been so fast that there's no other explanation."

The method Hansen uses to reach his conclusions is known as climate modeling, the use of computer simulations of the Earth's past and present climate states to predict what will happen in the future. A record of the planet's climate, constructed from indicators like carbon dioxide content in Antarctic ice cores, plant fossil records, and historical tree growth, shows that weather patterns are variable. But the scientific community has reached a consensus that the Earth is heating up in large part because of humans.

"The story has become a lot clearer in the last five years," Hansen says. "There isn't much basis for the deniers to continue to deny it, even though they do, of course. But it's now clear that the world really is getting warmer, and at the rate we expect it to, based on the rate at which we're putting carbon dioxide into the atmosphere."

Indeed, 19 of the hottest years on record have occurred since 1980, and last year was one of the warmest in a century. If the burning of fossil fuels continues at the current rate, carbon levels could at least double by 2100, according to the Intergovernmental Panel on Climate Change (IPCC), established by the World Meteorological Organization and the United Nations Environment Programme. The consequences are by now well known: glaciers melt and sea levels rise. Warmer ocean waters stir up more intense hurricanes. Dry areas get drier. And with these changes comes an incalculable cost in property and lives.

Hansen is one of dozens of Columbia scientists and researchers addressing this enormous issue. Many are affiliated with the Earth Institute, headed by Jeffrey Sachs, Quetelet Professor of Sustainable Development and professor of health policy and management. Kevin Conrad, Meredith Nettles, Göran Ekström, and Cynthia Rosenzweig are several Columbians who are making important contributions to our understanding of climate change. In their very different ways, they tell us what we're up against and what can be done about it.

Saving the Forest for the Trees

Kevin Conrad '05BUS grew up in the rain forest, but even as a kid he had a head for business. "I would capture bugs and birds and sell them, but I always did it in a

sustainable way," says Conrad, the director of the Coalition for Rainforest Nations and an associate professor at the School for International and Public Affairs (SIPA). His dad was a linguist stationed in the middle of the Arapesh tribe in Papua New Guinea, the one made famous by Margaret Mead '23BC, '28GSAS, '64HON and from whom Conrad says he learned about ecological balance. Now, with the rain forests endangered by unchecked logging and agriculture, Conrad is trying to find middle ground again between money and the environment. His target: the Kyoto Protocol.

Conrad first read the protocol in 2003 when he met with Sir Michael Somare, Papua New Guinea's prime minister, whom he had known since he was young through his father. Somare had a problem. One of the country's biggest revenue sources is the tropical hardwoods of its forests; yet if the country sells them off, the land on which its livelihood depends is destroyed. Conrad asked himself how communities could develop a revenue stream without cutting down their forests. By then, he had long left the rain forest, graduated from the University of Southern California, and was enrolled in Columbia's Executive MBA program. He took on the dilemma for his student thesis.

According to the IPCC, deforestation accounts for up to 30 percent of world carbon output, owing primarily to carbon emissions from burning. Deforestation also creates a feedback loop: a cleared field absorbs much less carbon than does a healthy forest. On top of that, the foresting industry is emblematic of major imbalances in trade. In a New York Times editorial earlier this year, Don Melnick, Thomas Hunt Morgan Professor of Conservation Biology and executive director of the Center for Environmental Research and Conservation (CERC), wrote that a community in Papua New Guinea receives about $13 a cubic meter of wood that, when cut and sold in an industrialized city such as New York, sells for more than $3,000.

The issue of deforestation was written into the Kyoto Protocol, an addition to the United Nations Framework Convention on Climate Change (UNFCCC) drafted in 1997. But by the time the accord was ratified in 2004, deforestation had been removed for various political reasons. The final version called for a reduction of greenhouse gas emissions to 5 percent below 1990 levels by 2012. The United States, which is responsible for 25 percent of world carbon output, signed the treaty, but it required ratification by the Senate. Former President Bill Clinton didn't submit it to the Senate, knowing it wouldn't win the required two-thirds majority vote. This was in part because it would put the U.S. at an economic disadvantage, and it also didn't hold developing countries responsible for their emissions, which are projected

to be almost triple the amount from the U.S. and the European Union by 2050. Clinton's successor, George W. Bush, has been firmly opposed to the accord largely for the same reasons.

Conrad is a businessman, and his solution is financial. "The U.S. isn't playing because we say it's going to hurt our economy," he says. "Developing countries aren't playing because it's going to hurt their economies." To bridge the divide, Conrad is proposing that developing countries cut emissions in exchange for financial incentives for reducing deforestation. This way, the rain forests would be protected, and developing nations would take responsibility for their carbon dioxide emissions.

Acting on this insight, Conrad enlisted support from Columbia faculty to convince Prime Minister Somare to take the lead and call for an alliance of countries to tackle the issue. By last May, the Coalition for Rainforest Nations had taken shape. University Professor Joseph Stiglitz was pivotal in lobbying for the group, whose board includes Geoffrey Heal, Paul Garrett Professor of Public Policy and Business Responsibility; Sachs, head of the Earth Institute; Wallace Broecker, Newberry Professor of Earth and Environmental Sciences; and Melnick of CERC.

"Columbia provided the intellectual capacity to get a head of state to go against the grain and speak out," Conrad says. The Coalition is composed of 15 countries representing the major rain forest regions, including Amazonia, the Congo Basin, the Pacific, Central America, and the Caribbean. The next step is to get the Coalition's proposal through UNFCCC red tape. Conrad has spent months on the road getting countries that have ratified the UNFCCC to agree even to enter the dialogue. His hard work and diplomatic skills have paid off: now, all 189 parties are on board to negotiate.

"It'll be difficult," Conrad admits. "But considering the benefits for climate, biodiversity, and rural poverty, we have no option but to succeed."

Glaciers on the Rocks

As the Earth heats up, even glaciers are no longer moving at a glacial pace. A glacier such as the Helheim in Greenland moves approximately 7.5 miles a year, twice as fast as it did five years ago. Scientists have also discovered that melting glaciers are

generating earthquakes. When ice at the top of a glacier melts, the water seeps down to the base and acts as a lubricant between the glacier and the rock it sits on, causing an extreme shift that can register as high as a magnitude 5 earthquake. “It provides evidence that ice sheets can respond much faster to climate than we thought they could,” says Meredith Nettles, a seismologist and postdoctoral research scientist at the Lamont-Doherty Earth Observatory. “People thought that the main way climate change would affect glaciers was through melting. But what we see now is there’s actually a much more dynamic response.”

Nettles coauthored a paper in a recent issue of Science documenting a doubling of glacial earthquakes from five years ago and six times as many since 1993. She and her colleague Göran Ekström, professor of earth and environmental sciences, along with Victor Tsai, a geophysics graduate student at Harvard, concentrated their research on Greenland, where some glaciers are half a mile thick and four miles across. If one could see a glacier during an earthquake, it wouldn’t appear to have the violent shaking we associate with regular earthquakes, but it could shift approximately ten meters in the 30-second event — dramatic movement in glacial terms.

Another crucial role that glaciers play in climate change involves a feedback loop. Bright ice sheets reflect nearly all of the sun’s rays that hit them, bouncing heat back out of the atmosphere. Once ice dissolves into the ocean, however, the dark water absorbs the majority of the heat. Consequently, local water and air temperatures rise, more ice melts, and the cycle continues.

Ice sheets take many thousands of years to form, but while scientists previously thought it would take centuries for them to disintegrate, the feedback loop has made them reevaluate their projections. “Those calculations were based on the water melting from the top,” says Ekström. “But now there’s a possibility that the ice will slide off.” If the ice sheets of Antarctica and Greenland melted, the resulting water could raise the world’s sea level some 70 meters.

“The speed of changes we’re seeing is worrying,” says Nettles. “Climate change isn’t something we can think about as a problem for our children. It’s our problem.”

Grass on a Hot Tin Roof

“I refuse to be pessimistic about global warming,” says Cynthia Rosenzweig. “It presents challenges and opportunities.” One of the challenges the earnest and cheerful research scientist has taken on is the urban heat island of New York City.

Five years ago, Rosenzweig, the leader of the Climate Impacts Group at Goddard Institute for Space Studies, headed a major study on global warming’s effects on New York City. Climate Change and a Global City was funded in part by the Earth Institute and commissioned by the U.S. Global Change Research Program, an interagency government program that studies the effects of climate change on society. The report assessed data from 31 counties in the New York metropolitan area. Climate models project that by 2020, thermometers will register up to 3.5 degrees Fahrenheit higher than the average temperature for the period from 1961 to 1990. Energy loads will increase by up to 12 percent, and rainfall will rise by up to 9 percent.

One of Rosenzweig’s research areas is “eco-roofs,” or green rooftops, which is an approach that could help solve multiple environmental problems detailed in the study. She is working with the Urban Design Lab, an interdisciplinary center within the Earth Institute, to install what will virtually be a wall-to-wall meadow on the rooftop of the Future Leaders Institute, a public school on 122nd Street. It will be the first large-scale green rooftop on a public school in the city. Roofs are outfitted with a synthetic growing medium, which looks like soil but isn’t as heavy, and in which plants such as sedum, a hardy succulent, can thrive. Green rooftops are already in place in Europe, Asia, and a number of U.S. cities, including Seattle, Portland, and Chicago. The Gap’s headquarters in San Bruno, Calif., has one, as does a Ford plant in Dearborn, Mich.

In the summer, New York City is about 7 degrees hotter than the suburbs because of such factors as heat-absorbing concrete and asphalt, fewer trees, more cars, and higher energy use. A lesser-known effect comes from skyscrapers. Tall buildings prevent energy from escaping and instead radiate heat back to the sidewalks and streets. Cities also have feedback loops similar to other areas of the climate system. Air conditioners are cranked up, emitting more heat, increasing energy use, necessitating use of more fossil fuels, and in turn exacerbating global warming.

Whether a building is tall or short, all roofs contribute to the heat. A standard dark roof in New York City can reach up to 160 degrees on a hot July day, but a green rooftop could decrease that temperature by 60 degrees. An added benefit is that

eco-roofs retain water, reducing storm runoff that floods New York City's overloaded sewage systems. The Future Leaders Institute, a K–8 school, is a shallow three-story building with an 80,000-square-foot roof surface that spans nearly half a city block; the large area makes it a prime testing ground for Rosenzweig's roof, which will serve multiple purposes. She's working out the logistics with the school to use the project as research terrain for scientists and a living classroom for students. "We're starting to reach out to the community," says Stuart Gaffin '78CC, '81GSAS, an associate research scientist in Columbia's Center for Climate Systems Research who works with Rosenzweig. They hope to have the rooftop in place by next spring.

It's just one school, but Rosenzweig says that by working locally communities can effect change globally. "Climate change is the transformative issue of our time," she says. "It's the issue by which we are enabling our planetary survival."

Future in the Balance

Back in his Upper Broadway office, even James Hansen sees reason for optimism. "The truth is," he says, "it's possible to solve the problem, and the solutions have immediate economic advantages. For example, a 30 percent improvement in fuel efficiency for cars and light trucks would result in a per-year savings of $150 billion in fuel costs." Indeed, one of Hansen's major criticisms of the government is that, despite his warnings, it hasn't made research and development in fuel efficiency a higher priority. And, he points out, "that is only a first step toward stabilizing atmospheric composition and slowing climate change."

If government has been failing, institutions like Columbia have been stepping up, as the work of Hansen and others makes clear. In the 1980s, Wallace Broecker, a sort of elder statesman of climate scientists at the Lamont-Doherty Earth Observatory, developed a groundbreaking theory of a "great conveyor belt" of ocean currents that play a critical role in regulating the Earth's climate. Klaus Lackner, Ewing-Worzel Professor of Geophysics, is working on ways to remove carbon from the atmosphere (see Columbia magazine's piece in the Spring 2006 issue). And last year, Columbia instituted a master's program in climate and society, led by Mark Cane, G. Unger Vetlesen Professor of Earth and Climate Sciences. "Our researchers are tracing historical climates, modeling future scenarios, helping communities especially vulnerable to climate, and working with industry and policymakers to inform their

thinking,” says Jeffrey Sachs, director of the Earth Institute. “And very importantly, Columbia has instituted pathbreaking educational programs to train the next generation of leaders on climate.”

“There seems to be a significant push for universities to do something about global warming,” says Andrew Revkin ’82JRN, a New York Times science reporter who has covered climate change since 1988. “And Columbia is a cornerstone.”

Columbians in the HOT Seat

Columbia’s scientists study climate change across a broad range of disciplines. Here, a small sampling of institutes and individuals contributing to the global warming issue.

Robert Chen is interim director of the Center for International Earth Science Information Network, which collects data to understand the relationship between people and the environment.

Edward Cook heads the Tree-Ring Lab, which uses historical tree ring records to study anthropogenic impacts on forest growth.

Peter DeMenocal ’92GSAS, associate professor of earth and environmental sciences, takes marine sediments to reconstruct changes in ocean circulation and terrestrial climate.

Dana Fisher, assistant sociology professor, researches U.S. climate change policy. Her recent work analyzed environmentally related voting records of coal-extracting states.

Steven Goldstein ’76CC, ’86GSAS, earth and environmental sciences professor, studies coral reefs to determine how sea level has changed in the past.

John Mutter ’82GSAS, deputy director of the Earth Institute and professor of earth and environmental sciences, studies the effects of natural disasters on the poor.

Stephanie Pfirman, Hirschorn Professor and chair of the environmental science department at Barnard, researches the effects of Arctic sea ice movement on climate.

Stephen Zebiak is director general of the International Research Institute for Climate and Society, which helps societies establish climate risk management approaches in health, agriculture, and other vital sectors.

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