the Federal University of Minas Gerais, Brazil, and Tatyiana Karafet of the University of Arizona, Tucson—say that they have identified a set of chromosome markers that looks like the ancestor of the New World Y in two small Siberian ethnic groups: the Kets from the Yenissey River Basin and the Altaians from the Altai Mountains. And in Y chromosomes from populations in other parts of Asia and Europe, they have found clues that the ancestral Y's own precursor originated in central Asia, then in ancient migrations spread eastward into Siberia and as far west as England.

Other genetic evidence has also hinted at a central Asian population that spread both east and west (*Science*, 24 April 1998, p. 520). Says Andrew Bergen, one of the researchers: "In essence, the ancestral founding Y chromosome found its way to America, and also supplied Europe."

–DIEGO HURTADO DE MENDOZA AND RICARDO BRAGINSKI

Hurtado and Braginski are science writers in Buenos Aires, Argentina.

CLIMATE ANTHROPOLOGY

Taking Global Warming to The People

Thanks to ever-finer tools for calculating the costs of climate change, scientists are making a case to deal with global warming now

Cruising down northern Vietnam's Red River on a research boat 2 years ago, Mick Kelly started to get a queasy feeling. It wasn't seasickness that troubled him—it was the sight of a feeble earthen dike meant to protect people south of Ha Long City if a storm-whipped South China Sea were to push the river over its banks. Kelly, an atmospheric scientist at the University of East Anglia, United Kingdom, knew that the risk of a calamity is likely to grow: Computer models suggest the South China Sea could creep tens of centimeters higher over the next century and spawn more frequent and violent storms. Hadn't local officials considered building a better barricade, Kelly asked his Vietnamese colleagues? Their answer: Politicians had indeed debated the project but splurged for new roads instead.

When the 2000 scientists on the United Nations Intergovernmental Panel on Climate Change issued their landmark report 4 years ago spelling out the risks of global warming, they cited possible shifts in vegetation and storm patterns. Now, researchers such as Kelly are focusing on the human dimension of those changes. They have launched dozens of projects to assess how various segments of society—farmers, forestry managers, and politicians, for example—are bracing for future climate events. And even as negotiations drag on over implementing the climate change treaty signed so far by 76 nations, scientists are stepping up efforts to help communities devise ways to cope with, and even benefit from, global warming. In Vietnam, says Kelly, "it's the human dimension that will determine just how much an area remains at risk from sea-level rise, not the physics."

Although forecasts of regional effects of global warming are still far from precise, last year's vicious El Niño events have helped focus attention on the kinds of local devastation that might be in store. Also highlighting the need for contingency planning is a report released last month by the nonprofit Pew Center on Global Climate Change, which forecasts a bleak future for the U.S. heartland. If global warming shifts agricultural patterns, the report states, some farming communities could become "ghost towns as people seek economic opportunity elsewhere."

As a sign of the emergence of what some call "climate anthropology," the National Oceanic and Atmospheric Administration (NOAA) and several other U.S. agencies are placing an increasing emphasis on projects with a human dimension, which are expected to total $85 million next year. "We're finding that the effects of climate look totally different when you add people to the equation," says Michael Hall, director of NOAA's Office of Global Programs. "A physicist who forecasts that La Niña will cause heavy rains in Indonesia might stop right there." But if you factor in land-use practices—for example, planting an extra rice crop in the winter season because of the increased rain, or catastrophic floods in a region denuded by clear-cutting—"you begin to get a fuller view of climate's good and bad sides," Hall says.

Warning light. Recent disasters—such as this March 1998 blaze in northern Brazil, blamed on an El Niño–driven drought—could offer a field guide to coping with global warming.

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A developing field. Scientists are hoping to ground such socioeconomic forecasts in lessons drawn from present-day calamities. Working last year in Ceará, a semi-arid state in northeast Brazil, anthropologist Timothy Finan of the University of Arizona in Tucson and his colleagues interviewed some 500 farm families struggling through a year-long El Niño–related drought that scorched the region's corn and bean fields. Finan's team found that most farmers had failed to comprehend—or had not even seen—the jargon-laden drought forecasts issued by the government, so they did not stockpile food. The researchers also observed that the government had distributed food and water only when household shortages threatened mass starvation.

"If global warming scenarios are right, they've got to learn how to live in a drought environment," says Finan, whose group has advised the Ceará government to plan ahead by creating nonfarming jobs, drilling wells for isolated farmers, and desalinating groundwater for drinking. With funding from the World Bank, Ceará's government is taking steps toward implementing some of these recommendations. "In a sense, our job is to get people to plan, to think ahead," Finan says. "And that's happening right now."

While one Brazilian state is moving to minimize the toll of future droughts, Vietnam's social and economic trends are only exacerbating its vulnerability to flooding. Shore-hugging Vietnamese towns have for centuries relied on dikes and mangrove wetlands for protection from typhoons. Since 1994, Kelly and East Anglia economist Neil Adger have queried 250 farmers and government officials about the upkeep of this storm shield. The duo has documented an alarming trend: People increasingly are clearing coastal mangroves for shrimp farms and croplands.

Officials realize the danger of losing mangroves, Kelly says, but they feel pressure to boost the economy. In response, Kelly, Adger, and Nguyen Hoang Tri of the Vietnam National University in Hanoi have analyzed the costs and benefits of conserving mangroves.

They found that in providing honey, shrimp, fish, and crabs, as well as a defense against storm surges, mangroves are well worth keeping. "Mangroves are a win-win solution for ecology and economics," says Kelly, who has shared his findings with local officials.

For many developing countries, scaring up the resources to do such analyses is tough. "Climate change is a very different reality in the developing world, much lower on the list of concerns," says Max Campos, an advisor to Costa Rica's National Climate Change Program. Researchers such as Campos—who has studied the possible effects of climate change on Costa Rican crops and water supply—rely on a trickle of money from the U.S. Country Studies Program, which has spent $40 million over 5 years to help countries assess and prepare for climate change.

In Gambia, for example, program funds have allowed water resource manager Bubu Jallow to assemble aerial photos, topographic maps, and land-use data to estimate global warming's impact on Banjul, the capital. Although seas swelling more than a meter, on average, could submerge the coastal city, Jallow found that smaller rises threaten Banjul's water quality and beach property. His research is meant to undergird Gambia's coastal management plan, which is likely to include sea walls to block the rising tide and lines of palm and mangrove trees to stabilize eroding beaches. "There's little expertise in Africa to develop or apply global warming research," says Jallow, "and it's difficult to get the funds from national governments. So the Country Studies program is critical."

Politicians aren't the only people whom researchers must win over in making a case for what life may be like in a warming world. Since 1996, Carlo Jaeger, a sociologist who splits his time at the Darmstadt University of Technology in Germany and the Swiss Federal Institute for Environmental Science and Technology in Duebendorf, has overseen some 300 focus groups in seven European regions. The rap sessions included select groups—venture capitalists and tourist business owners, for instance—or ordinary folks plucked randomly from phone books. Jaeger has found that people of all stripes are surprised at the scientific uncertainty over the magnitude of global warming and the havoc it might wreak. It's essential, he concludes, that scientists explain better how to cope with a changing world.

Calculating the costs. In the United States, some companies seem to be getting the message. Twenty-two firms, including DuPont, Boeing, and Shell, work with the Pew Center to find ways to lessen and adapt to warming. The center's new report, "Agriculture and Global Climate Change," suggests that although global warming overall will do little harm to the U.S. food supply, certain regions and crops may be in for a big change. Warmer temperatures in North America might nurture crops in northern states but parch southern crops. Wheat yields could drop by 20% and corn by 30%. Soybean production could plummet 40%—or rise 15%, depending on soil and air conditions. Some landscapes could get a new reputation: California's Napa Valley, for example, may no longer be wine country.

Some companies are already positioning themselves to reap global warming's harvest. In 1997, plant biologists at Pioneer Hi-Bred International Inc. in Des Moines, Iowa, began collaborating with a team led by Cynthia Rosenzweig of Columbia University and NASA's Goddard Institute for Space Studies to model how temperature and rainfall changes could alter crop yields and water supplies worldwide. Pioneer Hi-Bred and its partner companies plan to use data from the ongoing project to reevaluate existing markets and tap new ones over the next 30 years. "This research finally has become real, with companies using it to decide where they will strategically place their investments," Rosenzweig says. "This isn't just an academic model—it's a tool for economic development."

Calamity rain? Future storm surges, perhaps fueled by global warming, could take out these rice paddies in Vietnam's Red River Delta; inset shows one of the fragile earthen dikes meant to protect the delta.

Scientists hope that communities, too, can make better use of improved climate models. They're now trying to craft Integrated Assessment Models—analyses that estimate global warming costs—that are more realistic, says Hadi Dowlatabadi, director of the Center for the Integrated Study of the Human Dimensions of Global Change, at Carnegie Mellon University in Pittsburgh. In the past, for example, scientists have estimated the economic toll of rising seas by calculating the value of shorefront property lost to encroaching water. But that's too simple, says Dowlatabadi, who predicts that shore homeowners won't just pick up and move because the tide creeps a bit higher each year. (His forecasts, rosier than most, assume that low-lying coastal cities could, for instance, build sea walls to protect property.) Dowlatabadi's models focus instead on the costs that homeowners, insurance companies, and local governments would bear following hurricanes and other damaging storms—events that could increase in frequency with warming. This approach, he argues, better depicts global warming costs and gives coastal communities real-life data they can use to plan shoreline development and disaster strategy.

Researchers also have to do a better job of modeling how people might adapt to warming, says Robert Mendelsohn, an economist at Yale University. In a new book, *The Impact of Climate Change on the United States Economy* (Cambridge University Press, 1999), Mendelsohn suggests that warming may boost the U.S. economy as farmers and orchard owners, for example, switch to vegetables and fruits that flourish in warmer weather. He predicts that by 2060, U.S. agriculture—thanks to warmer temperatures and more rainfall—could come out as much as $41 billion a year ahead. That is a far cry from the billions of dollars that most economists predict agriculture will lose to warming every year. Mendelsohn does say that some sectors—such as energy—may suffer, and that his models do not address important quality-of-life issues, such as sweltering heat in the south and disease-carrying mosquitoes invading the north.

Such questions linger, but climate anthropologists appear to be making strides at relating global warming models to everyday lives. Michael MacCracken, head of the U.S. Global Change Research Program's National Assessment, which coordinates studies on the potential regional effects of climate change, recalls a recent meeting with homeowners and officials in New York. At first, city dwellers asked why they should care if the midwestern economy were to slump during global warming. But they soon realized that many of New York's goods—cars, food, and even elevator equipment—are imported from the Midwest. "This is a human ecosystem we're talking about," in which environmental and economic forces are intertwined, MacCracken says. "People are beginning to understand that." **–KATHRYN S. BROWN**

Kathryn S. Brown is a science writer in Columbia, MO.

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