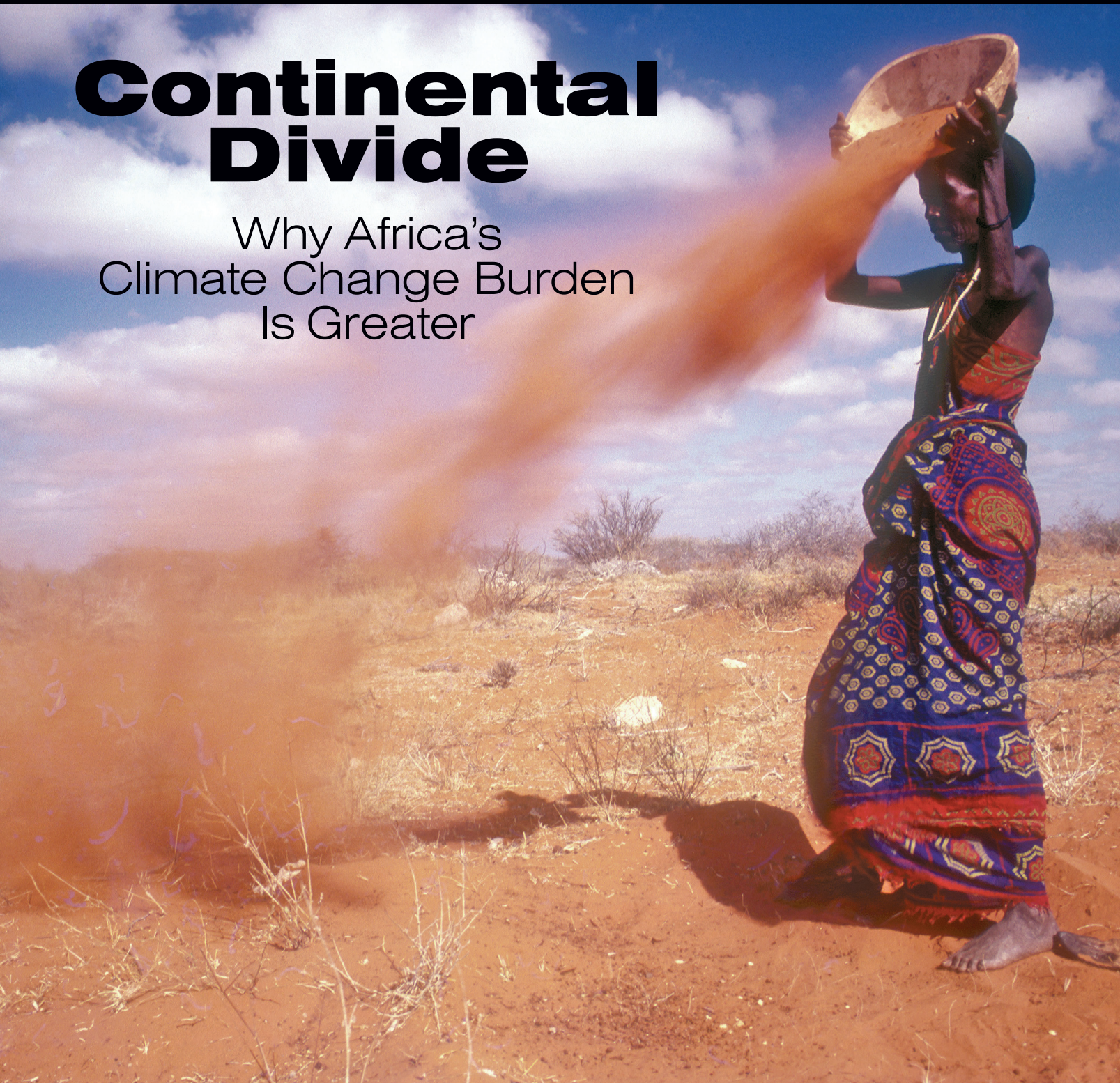


Continental Divide

Why Africa's
Climate Change Burden
Is Greater





Hamish Wilson/Panos Pictures

Africa can easily be said to contribute the least of any continent to global warming. Each year Africa produces an average of just over 1 metric ton of the greenhouse gas carbon dioxide per person, according to the U.S. Department of Energy's *International Energy Annual 2002*. The most industrialized African countries, such as South Africa, generate 8.44 metric tons per person, and the least developed countries, such as Mali, generate less than a tenth of a metric ton per person. By comparison, each American generates almost 16 metric tons per year. That adds up to the United States alone generating 5.7 billion metric tons of carbon dioxide per year (about 23% of the world total, making it the leading producer), while Africa as a whole contributes only 918.49 million metric tons (less than 4%). It is a cruel irony that, in many experts' opinion, the people living on the continent that has contributed the least to global warming are in line to be the hardest hit by the resulting climate changes.

"The critical challenge in terms of climate change in Africa is the way that multiple stressors—such as the spread of HIV/AIDS, the effects of economic globalization, the privatization of resources, and conflict—converge with climate change," says Siri Eriksen, a senior research fellow in sociology and human geography at the University of Oslo. "It is where several stressors reinforce each other that societies become vulnerable, and impacts of climate change can be particularly severe." She cites the example of the 2002 drought-triggered famine in southern Africa, which affected millions due

Winds of change. A Somalian girl searches for edible seeds among the dust. Increasing droughts are one of the most devastating effects of climate change.

partly to populations' coping capacity being weakened by HIV/AIDS.

"Climate change could undo even the little progress most African countries have achieved so far in terms of development," says Anthony Nyong, a professor of environmental science at the University of Jos in Nigeria. With climate change has come an increase in health problems such as malaria, meningitis, and dengue fever, he says. This means that the few resources these poor countries have that would have been channeled into essential projects to further economic development must instead be put toward health crisis after health crisis, providing emergency care for the people.

Models of Change

Africa may already be feeling the effects of global warming, says Isaac Held, a senior research scientist at the National Oceanic and Atmospheric Administration (NOAA) Geophysical Fluid Dynamics Laboratory, and more marked effects are likely to come, according to models developed by climate scientists around the world. Projected effects of global warming on precipitation throughout the world can be summarized in a single sentence, according to Held: areas that already get a lot of rainfall—such as the equatorial and subpolar rain belts—will get more, and areas that get little—such as the subtropical dry zones—will get less.

Climate models suggest that subtropical Africa south of the equator will follow this trend, and a plausible case can be made that global warming has already reduced rainfall in that region. In a paper published in the September 2004 issue of the *International Journal of Climatology*, NOAA scientist Pingping Xie and colleagues wrote, "Large decreasing rainfall trends were widespread in the Sahel from the late 1950s

to the late 1980s; thereafter, Sahel rainfall has recovered somewhat through 2003, even though the drought conditions have not ended in the region.” The study also found that major multiyear oscillations have appeared to occur more frequently and to be more extreme since the late 1980s.

About 300,000 people died in a prolonged drought in the Sahel during the 1970s. Until recently the scientific community attributed that drought to the severe loss of vegetation accompanying such factors as overgrazing and overpopulation; according to this model, the reduction in vegetation meant greater reflectivity of the Earth’s surface and less moisture being returned to the atmosphere, with a net drying effect. But now, Held says, “we think of that drought as having been driven by changes in the ocean temperatures.”

New climate models posit that precipitation changes are occurring because of alterations in the temperature gradient between the Southern and Northern hemispheres. “When the [ocean] waters are warmer in the Northern Hemisphere, rains are attracted farther north, and when they are warmer in the Southern Hemisphere, it doesn’t get as far north,” Held explains.

But it is a subject of debate, he says, whether the changes in temperature gradient that caused the Sahel drought were due to natural variability of the oceans or were partly the result of man-made changes in the composition of the atmosphere. There is as yet no consensus among climate modelers on the most likely future trend of Sahel rainfall, he emphasizes.

Still, climatologists agree that warming is happening. In *Climate Change 2001: Impacts, Adaptation and Vulnerability*, the Intergovernmental Panel on Climate Change Working Group II reported, “The historical climate record for Africa shows warming of approximately 0.7°C [1.3°F] over most of the continent during the twentieth century; a decrease in rainfall over large portions of the Sahel . . . and an increase in rainfall in east central Africa.”

Accompanying the Sahel droughts has been an increase in dust storms, although whether these storms are a result of the droughts or a cause has been a subject of controversy. Research published in the 22 May 2001 issue of the *Proceedings of the National Academy of Sciences*, for example, presents an analysis that demonstrated that the particles in Sahel dust storms weren’t able to absorb much water. As a result, they did not form cloud condensation nuclei, as is usually expected in such dust particles, and so they suppressed rainfall and exacerbated the droughts. In addition to effects on weather, dust motes averaging less than

2.5 micrometers in diameter are in the range of particles that research shows may have serious health consequences. Such dust can carry with it a variety of hitchhikers including bacteria, fungi, and chemical pollutants, all of which may adversely affect health.

Food Stock Failure

On any continent crop failure means trouble, but in Africa it’s a catastrophe. About 40% of the gross national product of African countries flows from agriculture, and about 70% of African workers are employed in agriculture, most of them on small plots of land. “Africa is full of poor people who are very highly dependent on climate-related issues for their livelihoods,” says Bob Scholes, an ecologist at the Council for Scientific and Industrial Research in Pretoria, South Africa. “They are subsistence farmers in often very marginal environments.” African governments are frequently chaotic, ineffective, unstable, and corrupt, adding to the people’s precarious existence.

Land ownership changes, less restrictive trade policies, commercialization of the agricultural sector, and increasing impoverishment, along with population growth, have pushed people into farming in dry areas, such as savanna, that not long ago were open to cattle and wildlife grazing, says Jennifer Olson, regional coordinator for land use with the LUCID (Land Use, Change, Impacts, and Dynamics) project at the International Livestock Research Institute in Kenya and a geography professor at Michigan State University. Faced with shrinking open grasslands, once solely pastoral people are settling down and planting crops of their own to supplement their livestock. New farmers tend to be poor, Olson says, and their farms, set in these dry areas, are usually small and thus especially vulnerable to droughts, floods, and other weather hazards associated with climate change.

“Rainfall is the biggest variable for crop and animal production here,” Olson says. “Everything goes up and down depending on how the rainy seasons are going, so climate change is going to have a huge impact with the expansion of the number of people doing cropping in the more marginal areas. These tend to be the people on the edge of doing well anyway because there’s not enough rainfall for them to be productive.”

According to Robert Mendelsohn, a professor at the Yale School of Forestry and Environmental Studies, small farmers in Africa are especially vulnerable to changes in precipitation. Only a small number use irrigation or fertilizer of any kind. Larger growers, such as the commercial farms of parts of East Africa, are better able to cope with weather extremes, but they are in the minority.

People who depend on livestock will be just as hard-hit as pastures go brown, Mendelsohn says. But in this case smaller spreads fare better than large ones. Big operations are usually committed to herds of cattle, which demand plentiful water and easy-to-reach areas in which to graze. When water is scarce, large pastoralists are forced to move their herds southward to relatively wetter areas that are usually occupied by sedentary farmers, thus precipitating intergroup conflicts. However, people who have just a few animals can switch to goats and sheep, animals that tend to be more inventive when it comes to finding food and water.

Ecosystem Changes

With changes in land use and climate, some areas in East Africa have become drier, Olson says, and water sources are becoming intermittent or disappearing. Streams that used to run year-round are now seasonal. The expansion of agriculture into savannas also blocks migration routes for large animals such as zebras, wildebeest, and elephants, she says.

As a result of climate-related ecosystem changes, some wild sources of food are also becoming harder to find, says Catherine O’Reilly, an assistant professor of environmental science at Vassar College. The fish stock in the deep Rift Valley lakes of East Africa, for example, are decreasing as average air temperatures rise. These lakes—a chain of fresh and brackish bodies including lakes Malawi, Tanganyika, and Victoria—contain greater biodiversity than any other of the world’s freshwater systems, she says. That diversity depends on algae that are supplied when surface waters mix with nutrient-rich deep waters.

“With climate change,” O’Reilly explains, “there is less of this mixing, because the [temperature-mediated] density difference between the surface waters and the deep waters has gotten greater, and so it takes more energy to mix deep water up to the surface.” Less algae means less food for the entire food web, and the result, she says, is big decreases in fish catches in all of these lakes.

O’Reilly and colleagues reported in the 14 August 2003 issue of *Nature* that climate change had contributed to a 30% decline in Lake Tanganyika fish stocks over the past 80 years. Such declines can be disastrous for the villages in the region, where the average income is less than US\$250 per year, and where the people depend on the fish from these lakes for all of their protein.

When this important food source fades, every aspect of the regional environment is affected. As fish yields go down, increased demands are put upon the land as some

fishermen switch to arable farming, O'Reilly says. This in turn leads to more intensified farming, and thus more deforestation, increased erosion, and degradation of the shoreline. Degradation of the shoreline destroys in-shore habitat and spawning grounds for many fish species, further impacting the fish population. "You get a positive feedback loop started," she says, "whereby a small decrease in productivity in the lakes can cycle through all these factors and impact [yet] another aspect of the fish life-history cycle."

When food sources dry up, Africans also turn to wild game. This can put pressure on already endangered species and potentially expose diners to the diseases these exotic animals carry. A report published in the 12 November 2004 issue of *Science* showed that declining fish stocks in Ghana—down by at least 50% since 1970—corresponded with a demand for "bushmeat" that led to a 76% decline in the numbers of 41 species of mammals, including buffalo, antelope, jackals, monkeys, and elephants.

Insects—and with them the diseases they harbor—have also been affected by new climatic conditions, says Jonathan Patz, a physician and associate professor of environmental studies and population health sciences at the University of Wisconsin–Madison. As Africa has warmed, he says, vectorborne diseases—those in which a pathogen is carried from one host to another by pests such as mosquitoes—have increased their range. Malaria, for example, has moved into higher African latitudes as highlands have warmed enough for mosquitoes to breed. (However, other experts, such as Marlies Craig, a malaria researcher at the South African Medical Research Council in Durban, believe that factors besides increasing temperatures, such as increased resistance to drugs, are the cause of this vector spread.) Further, as malaria makes its way into higher latitudes, it reaches people who didn't develop malaria immunity as children. The result is an increase in adult mortality.

Although some areas may become more suitable for some diseases, others may become less so, Patz adds—disease vectors don't universally seek warmer temperatures. Rather, each has optimum conditions in which it thrives. In North America, for example, Patz says the warmer, wetter temperatures that foster some mosquito growth tend to worsen conditions for the tick that carries Lyme disease. Similarly, research by a team from the Institut Français de Recherche Scientifique pour le Développement en Coopération in Senegal, published in the March 1996 issue of the *American Journal of Tropical Medicine and Hygiene*, indicated that tickborne borreliosis extended its range out of the Sahel and into West

Africa most likely because of the Sahel drought of the 1970s.

Wages of War

When the apocalyptic horsemen of famine and pestilence appear, war can't be far behind. Decreasing pastoral lands, decreasing available tillable land, decreasing wild game, and decreasing available water all add up to more strife, Scholes says. "Subtropical dry, arid areas are going to be a huge source of conflict over the next half-century because we still have very, very high population growth rates in those areas, very low economic growth rates, and deteriorating environment," he says.

"Basically," he adds, "not only are the spillover effects environmental, in terms of dust storms and soil erosion and so forth, but there is also massive spillover of people moving out of [more stressed areas] into better resourced areas." In relatively developed countries such as Nigeria and South Africa, 30% or more of the population consists of illegal immigrants.

Farmers, pastoralists, and the new agro-pastoralists are already competing for water and suitable agricultural and grazing land, Olson says; regional warming and drying can only be expected to worsen the situation. On occasion, she says, the conflicts that result from this competition can turn violent, although most are settled peacefully.

But according to Eriksen, extended periods of increased violent raiding in parts of East Africa have led to loss of livestock and land, and have driven people into a state of destitution that makes them extremely vulnerable to drought events. "Although many conflicts are politically instigated and driven by underlying economic inequities in resource access, rather than climate change as such, increasing drought stress can exacerbate conflict and violence," she says.

Strategies for Coping

As a reaction to so much bad news, in July 2005 the G8 countries—Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States—approved a pledge to forgive about US\$40 billion of debt owed by 18 nations, including 14 African countries. These forgiven debts represent about one-sixth of the total owed by African nations to the G8 nations and international lenders. According to Nyong, relief from these debts will allow these African governments to spend more on local issues related to climate change. The G8 leaders also committed to double annual African aid from US\$25 billion to US\$50 billion.

But debt relief isn't an instant cure. "We really have to spend some time exploring the implications of [debt relief] for rural

economies and urban economies," says David Campbell, a geography professor at Michigan State University who has studied East African communities for more than 25 years. It's also important, he says, to determine what investment should be made with financial aid to maintain the resilience of societies, both urban and rural, in the face of potential increased climatic variability.

Industrialized nations bear another responsibility, Nyong says: "Just as Africa is trying to adapt to these adverse impacts of climate change, the developed countries, particularly the G8 countries, should put in place a mechanism to which they are committed to substantially reducing their greenhouse gas emissions. [With Nigeria] having signed the Kyoto protocol, we want to see definite plans articulated to achieving the targets set by the protocol."

Mendelsohn lays out the bottom line: "As the net income of this land deteriorates, it's not going to be able to sustain the number of bodies that are on it anymore. So the question is, where will these bodies go?" One long-term answer is to try to increase industrialization in Africa to give people other alternatives, to move away from climate-sensitive livelihoods and industries toward those that are not climate-sensitive—ecotourism has been suggested as one possible replacement for farm income.

In the meantime, Campbell says, "It's important that the G8 outcome be committed over the long term to maintaining [financial aid] policies." This financial aid, he says, will be vital to the lives of Africa's poor, who represent an ever increasing segment of African society. And climate change is likely to accelerate such societal stratification, he says. People who have at least some wealth will be better able to switch to different crops, buy a different kind of livestock, or combine growing and herding. "Herders who had taken on farming appeared to be less vulnerable to drought than the people who had maintained themselves in terms of subsisting almost entirely on herding," Campbell says. "So that diversification showed itself to be successful in terms of allowing them to cope with prolonged drought." However, those Africans who don't have sufficient wealth to buffer the effects of increasing climatic variability will plunge deeper into poverty.

But as much as financial aid is needed, Nyong says, the reality is that no amount of money is going to stop climate change from affecting Africa in profound and unpredictable ways. Africa wasn't able to prevent the buildup of greenhouse gases, he says; "What we are left to do now is to adapt to the buildup."

Scott Fields