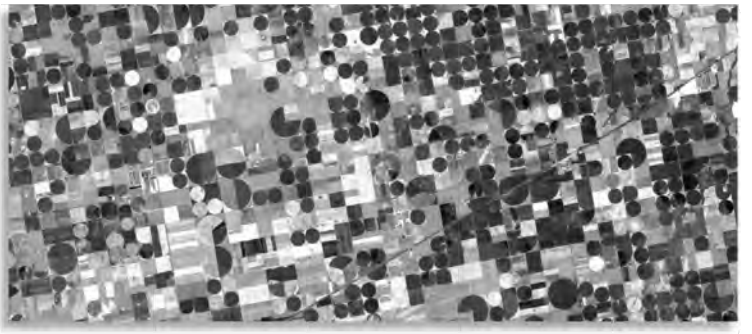
Spraying in this way has all of the delicacy of a fire hose.



The cookie-cutter crop circles in southwestern Kansas that result from using well water dispensed by a pivoting platform. The highway at right provides a sense of scale.

6

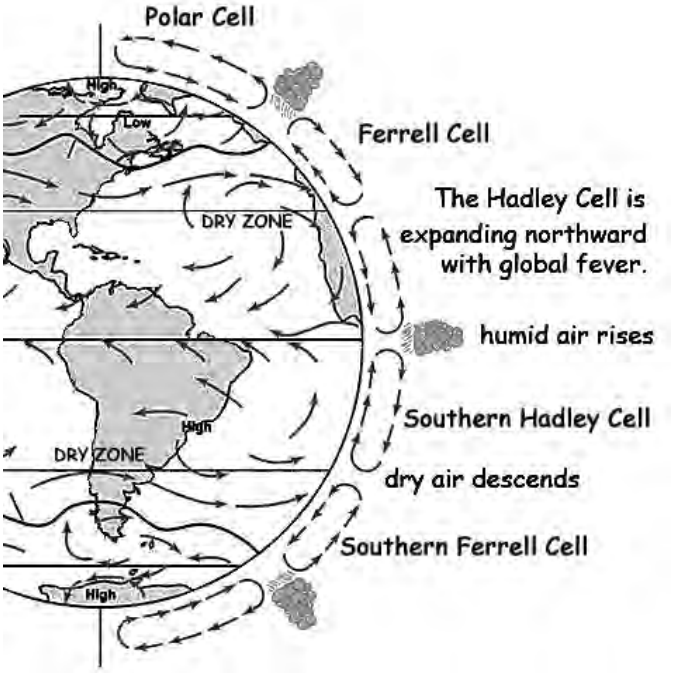
Why Deserts Expand

> [T]he high Sierra meadows would likely die in the summer droughts. I love those high meadows, and the thought that I might be part of the last generation to see them, that the beautiful high Sierra might become like the blasted wastelands of Nevada, filled me with rage and grief.
>
> —writer Kim Stanley Robinson, 2005 essay

Back before the 1998 El Niño fires in Borneo and the Amazon Basin, I assumed that a forest fire in a rain forest was improbable. Another early misconception was to think that because more equatorial evaporation will occur in global fever, more rain will fall and therefore—my mistake—the deserts should bloom.

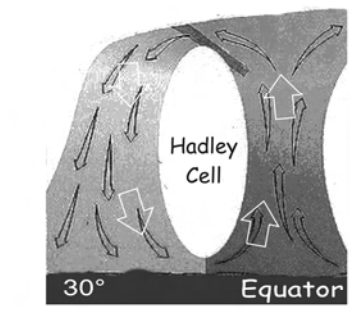
Common sense failed me on both. In general, the big computer simulations of the physics show that the wet areas will become wetter, the dry areas will receive even less rainfall, and the deserts will expand into some heavily populated areas such as the Mediterranean, Cape Town, Perth, and southern California.

It takes some knowledge of the ups and downs of air to appreciate the reasons for this counterintuitive result. Some deserts are merely in a rain shadow of a mountain range—say, eastern Oregon—or just too far from an ocean—say, in western China or Mongolia—that there isn't much left for them. The world's major deserts, however, are mostly located between 20° and 35° from the equator for a different reason.

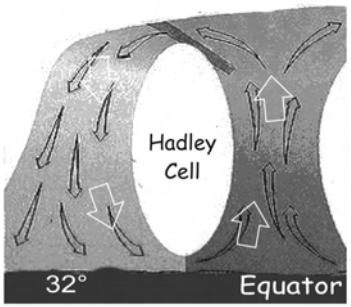


What goes up in all those thunderstorms in the tropics must come down somewhere. And, having lost most of the moisture on the way up, the air tends to come down very dry.

As the Hadley Cell expands with global fever, so do the deserts.



What goes up must come down somewhere. In the case of the warm, humid air that rises from the equatorial regions, it comes down dry about 30° from the equator, then turns back to make another loop. This is called the Hadley Cell after a London barrister, George Hadley, who in 1735 figured out the physics of how the return loop creates the trade winds.



Dry deserts humid tropics

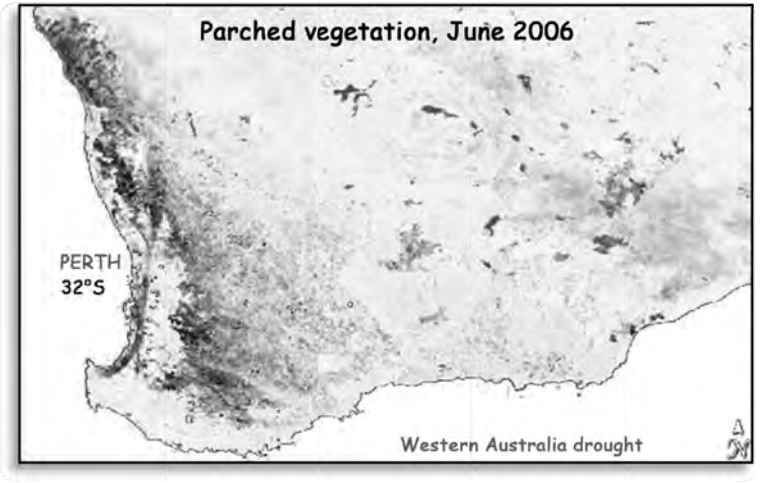
But now the Hadley Cell seems to be getting wider as a result of our global fever and its complications. That's pushing the dry zone farther away from the equator.

This is called the Hadley Cell circulation and it's why we have the Sahara and Arabian deserts. In North America, we see the Sonoran desert at the same latitudes. (But why isn't Florida a desert? It's because that peninsula has the Gulf Stream on three sides to override the general tendency.)

There's another Hadley Cell to the south, resulting in the deserts in the Kalahari, Patagonia, and Australia. (There's also the Ferrell Cell between 30° and 60° and the

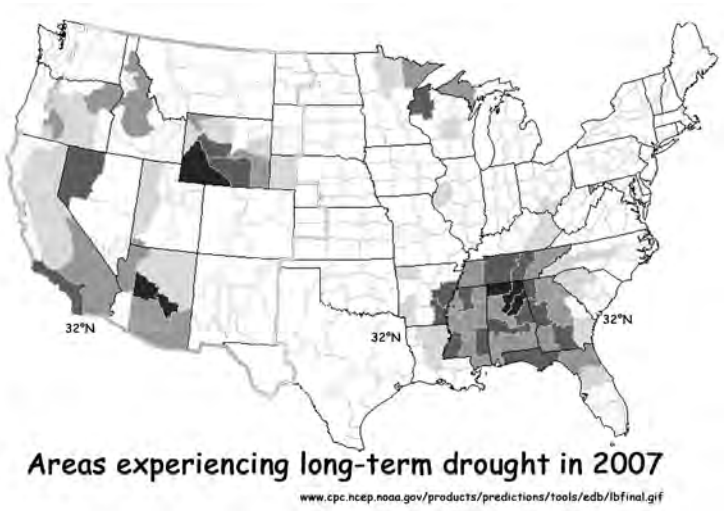
Polar Cell between 60° and the pole. The descending air at the poles makes them dry as well.)

The current global fever has the deserts on the march to higher latitudes. That's because the tropic's Hadley Cell is widening, changing where the air comes back down. Such climate creep spells big trouble for southern Europe and all around the Mediterranean Sea. The rain in Spain is mainly gone astray. Conditions as dry as the Dust Bowl will become the average climate in the American Southwest, probably before midcentury.



Australia is already having major problems with drought and encroaching desert. Perth had its average rainfall drop by 10 to 20 percent starting in 1976, resulting in stream flows being cut in half. Since 1997, the stream flows are down to a third of the 1911–74 average. In 2005, Perth's water experts rated the yearly chances of

catastrophic failure—no water coming out of the faucet—at one in five.

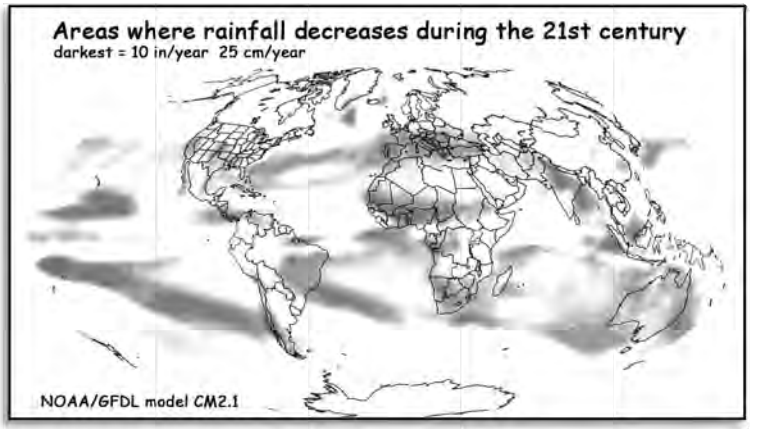


It's been a similar problem in Cape Town which presently, like Perth, just barely catches the westerly winds that mark the end of the dry latitudes. The food and water supplies of such major cities as San Diego at 32° from the equator, Los Angeles at 34°, Cairo at 30°, Tel Aviv at 32°, Cape Town at 34°, Perth at 32°, and Sydney at 34° are particularly vulnerable to global fever.

Furthermore, the high places such as the Andes will warm more than average, killing off the glaciers and much of the water supply for cities such as Quito.

Both irrigation and drinking water will become a problem in areas that rely on snowpack to store water for summer use. With overheating, the same precipitation will fall as rain, running off immediately. Even Seattle and San

Francisco will have problems from this, but southern California has had a serious water shortage for decades. Yet they keep building new houses in the desert without providing new sources of water—say, desalination plants run by carbon-free power. Perth just built a desalination plant to supply 15 percent of the city's water needs that is powered by a wind farm.



In the U.S., western and southern states get less rain. More serious decreases are seen in Central America, the mouth of the Amazon River, much of Brazil, all of southern Europe, the entire Sahel, southern Africa, northern India, Borneo, and most of Australia.

Besides making drought permanent in some areas during the coming decades, the Earth's fever is going to create deluges in other areas. Three straight days of heavy rain will become a more common event in areas that still have rain.

Recent evaporation helps to seed the next rainfall, as I mentioned earlier. That is going to be a big problem in the

Amazon as climate changes. Today, the flat bottom of the clouds (where the dew point is) isn't very high off the ground.

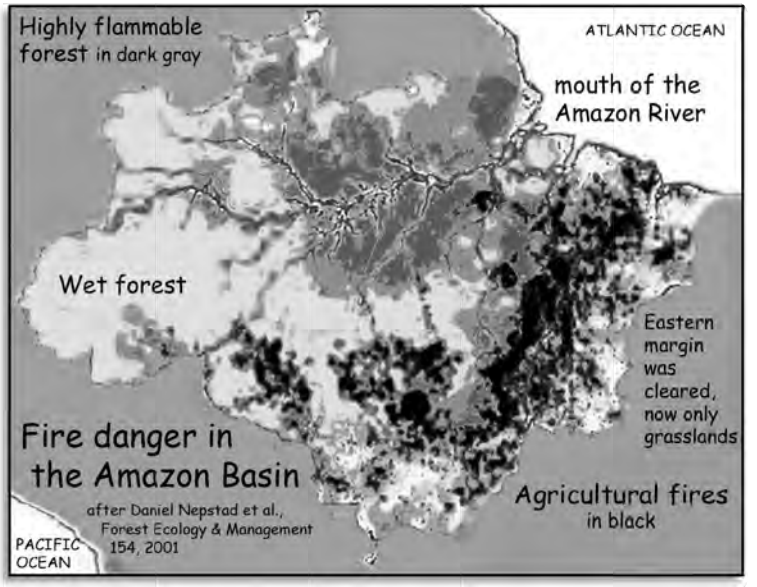
But with greenhouse warming, that flat bottom will move up higher in the sky, not mixing well with the recent evaporation. The clouds will continue westward until they run into the Andes. The rain they drop there will flow down the Amazon River as it does now, but the lush vegetation on the riverbanks will be gone—likely burned off during the onset of drought. It also means that many species of plants and animals will go extinct.

Morning clouds above the Amazon River in Peru.

It is estimated that burning off the Amazon and Asian rain forests will release the equivalent of twenty years of our usual carbon emissions—and that lacking their annual

removal of CO_2 from the air, global overheating from other sources will increase by 50 percent.

We don't get big trees back very soon after a big fire, as the plant succession cycle has to build up to them starting with grasses and weeds, progressing to brush and trees. The vegetation reboots, but slowly—not recapturing much of the carbon that escaped into the air from combustion and decomposition until a century later. That could be too late.



In the case of the Amazon Basin, it's even worse. Because of those peculiarities of the Amazon's water cycle, the climate models say that plant succession won't get past grass and brush. In the area on the southeastern rim of the

Amazon basin, already subjected to slash-and-burn forest clearing for a few years of marginal agriculture, the now-abandoned land has returned to savannah. The rain forest isn't coming back there.

Some "renewables" simply cannot be renewed within the relevant time frame. But this is a case of no new trees, period.

We must shockproof our food supply and our economy, and do this well in advance of encountering another regional or world-wide drought. To enjoy the long term, you have to survive the short term, over and over.

Too much focus on gradual trends, important as they can be in the long run, sets you up to be blindsided by the abrupt recurrence of a problem that you should have prepared for. Any notion of sustainability now needs to include surviving the flips.

Many people are still stuck in the outmoded balance-of-nature or ramping-up metaphors, not comprehending the true challenge of climate change. *Climate takes leaps and so we cannot merely back up if we overextend ourselves.* There are just too many aspects that are irreversible, such as the Amazon not re-growing its rain forest—or regaining its extinct species.

[The] amounts of carbon that may be going to the atmosphere following Amazon droughts are probably big enough to accelerate global warming. Currently trends suggest that a big chunk of the Amazon forest will probably be displaced by fire-prone scrub vegetation; global warming will probably exacerbate this trend.

—Amazon ecologist Daniel Nepstad, 2007

Our complex society relies on our being able to plant crops and build cities, knowing that the rains will come and the cities will not be flooded by incoming tides. When that certainty fails, as when Hurricane Katrina hit New Orleans [in 2005], even the most sophisticated society is brought to its knees.

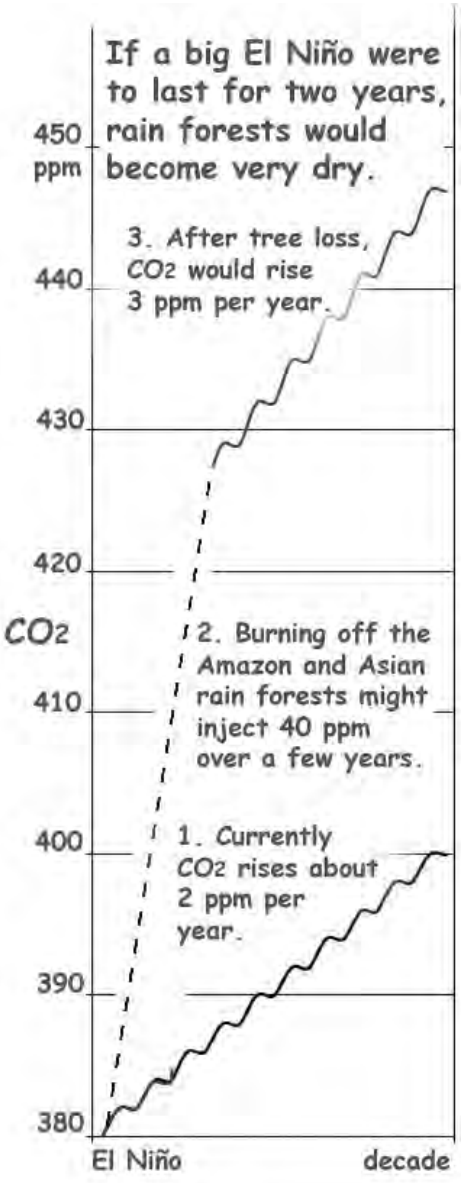
But there is a growing fear among scientists that, thanks to man-made climate change, we are about to return to a world of climatic turbulence, where tipping points are constantly crossed.

—science writer Fred Pearce, 2006

Fossil fuels helped us to fight wars of a horror never contemplated before, but they also reduced the need for war. For the first time in human history - indeed for the first time in biological history - there was a surplus of available energy. We could survive without having to fight someone for the resources we needed. Our freedoms, our comforts, our prosperity are all the products of fossil carbon, whose combustion creates the gas carbon dioxide, which is primarily responsible for global warming.

Ours are the most fortunate generations that have ever lived. Ours might also be the most fortunate generations that ever will. We inhabit the brief historical interlude between ecological constraint and ecological catastrophe.

—commentator George Monbiot, 2006



William H. Calvin, GLOBAL FEVER (University of Chicago Press, 2008)

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How to Treat Climate Change

WILLIAM H. CALVIN

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