An Invitation to Environmental Sociology

Sixth Edition

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CHAPTER

1 Environmental Problems and Society

"PASS THE HOMINY, *please.*"

It was a lovely brunch with fruit salad, homemade coffee cake, a great pan of scrambled eggs, bread, butter, jam, coffee, tea—and hominy grits. Mike's friends Dan and Sarah had invited him, his wife, and their son over that morning to meet some friends of theirs. The grown-ups sat around the dining room table, and the kids (four in all) careened from their own table in the kitchen to the pile of toys in the living room, and often into each other. Each family had contributed something to the feast before them. It was all good food, but for some reason the hominy grits (which Mike had never had before) were the most popular.

There was a pleasant mix of personalities, and the adults soon got into one of those excited chats that leads from one topic to another as unfamiliar people seek to get to know each other a bit better. Eventually, the inevitable question came Mike's way: "So, what do you do?"

"I'm an environmental sociologist."

"Environmental sociology. That's interesting. I've never heard of it. What does sociology have to do with the environment?"

It's a question all four of us—Ike, Laura, Loka, and Mike—sometimes get. But Mike, the oldest of us, used to get it a lot, as in this breakfast conversation from many years ago. Today, we sense a change in general attitudes. Environmental problems are everywhere, and people know that our species has much to do with them. Most people we meet have still never heard of the field, but more and more of them immediately get the basic idea behind it: society and environment interrelate.

And more and more, the people we meet recognize that this interrelation has to confront some significant problems—perhaps the most fundamental problems facing the future of life, human and otherwise. They readily understand that environmental problems are not only problems of technology and industry, of ecology and biology, of pollution control and pollution prevention. Environmental problems are also social problems. Environmental problems are problems *for* society—problems that threaten our existing patterns of social organization and social thought. Environmental problems are as well problems *of* society—problems that challenge us to change those patterns of organization and thought. Increasingly, those we meet appreciate that it is people who create environmental problems, and it is people who must resolve them.

That recognition is good news. But we—every one of us—sure have a lot to do. And we'll need the insights of every discipline, from the biophysical sciences, to the social sciences, to the humanities. There is an environmental dimension to all knowledge. This book aims to bring the sociological imagination to this necessarily pan-disciplinary conversation.

The phrase "sociological imagination" comes from the great twentieth-century sociologist C. Wright Mills. He famously defined it as the ability to "grasp history and biography and the relations between the two within society" in order to understand our lives "as minute points of the intersections of biography and history within society."[1] His point was that life is lived in context. You can't do just anything you might want to do. And what you might want to do is likewise shaped by context to begin with. Our social life is a mighty factor in that context. Our decisions are not merely our own.

But there is another mighty factor in that context. We should add at the end of each of those famous phrases "and ecology." Gaining the ability to grasp history and biography and the relations between the two within society and ecology—to learn to understand our lives as minute points of the intersections of biography and history within society and ecology—is what we might call the *environmental sociological imagination.*[2] Our decisions about how to lead our lives, and our hopes about how we might live otherwise, are embedded in the constraints and possibilities of both our social and ecological contexts.

To live contextually (and there is no other way to live) is also to live relationally. Action requires interaction. To get along you have to get along. You may be on your own, but still you're not alone, neither socially nor environmentally. The environmental sociological imagination, with its contextual and therefore relational way of thinking about the world, suggests the following definition of environmental sociology itself. *Environmental sociology is the study of community in the largest possible sense, the community of all.* People, other animals, land, water, air—all of these are closely interconnected. They interact and interrelate. Together they form a kind of togetherness. As in any community, there are also conflicts in the midst of the interconnections, interactions, and interrelations. Environmental sociology studies the community of all with an eye to understanding the origins of, and proposing solutions to, these all-too-real social and biophysical conflicts.

But who are environmental sociologists? They are participants in a wide-ranging conversation among scholars from many social science disciplines who share a passion for studying community in the largest possible sense. Some might call themselves "political ecologists" or "social ecologists" or "human ecologists" or "ecological economists." Or they might prefer to think of themselves as "environmental geographers" or "environmental anthropologists" or "environmental economists" or "environmental psychologists."[3] It is not the disciplinary label that is important but the passion to study this largest of communities, with its many conflicts. Increasingly, academic conferences focus on an issue like climate change, sustainable consumption, sustainable agriculture, or environmental justice and not on a specific discipline's take on it. The research papers that come out of these conferences similarly cite scholars from across this wide spectrum. We all have our starting points, of course, our distinctive voices and angles of vision to bring to the conversation, which is great. That is how, and why, one learns from others. But it is the goals that matter, not the disciplines—the aims, not the names. In this book, we discuss contributions from scholars with all these many different departments on their business cards. These many voices and angles of vision help widen our imagination for a better tomorrow as we better understand today.

This wideness of imagination is particularly important as we deal with the heavy matters of inequality, which are at the center of gravity of environmental sociology. Not only are the effects of environmental problems distributed unequally across the human and nonhuman community, but inequality is deeply involved in causing those problems in the first place. Inequality is both a product and a producer of climate change, pollution, overconsumption, resource depletion, habitat loss, risky technology, and rapid population growth. Inequality also influences how we understand what our environmental problems are. And most fundamentally, it can influence how we envision nature itself, for inequality shapes our experiences, and our experiences shape all our knowledge.

This returns us to the question of community. Inequality cannot be understood apart from the justice of the communities in which it takes place. Ecology is often described as the study of natural communities. Sociology is often described as the study of human communities. Environmental sociology is the study of both together, the *social ecology* of the single commons of the Earth we humans share, sometimes grudgingly, with others—other people, other forms of life, and the rocks and water and oil and air that support all life.[3] Environmental sociology is the study of this, the biggest community of all.

Joining the Dialogue

The biggest community of all—clearly, the topic of environmental sociology—is vast. Not even a book the length of this one can cover all of it, at least not in any detail. In the pages to come, we will take up the main conversations about the state of relations within this vast community. We won't take up all the side conversations, but we will invite the reader into a good many of them to trace how the larger debates play out in particular neighborhoods of discussion and investigation. We do so in the three main parts of the book:

The Material: How health, consumption, the economy, science, technology, development, and population shape our environmental conditions

The Ideal: How culture, ideology, symbols, moral values, and social relations influence the way we think about and act toward the environment

The Practical: How we can bring about a just ecological society through governance, mobilization, and the politics of our everyday lives

Of course, it is not possible to fully separate these three topics. The deep union of the material, the ideal, and the practical is one of the most important insights that environmental sociology has to offer. The parts of this book represent only a sequence of emphases, not rigid conceptual boundaries. A number of themes running throughout the book help unite the parts:

- The central importance of inequality and questions of justice in environmental problems
- The dialogic—or interactive and unfinished—character of causality in environmental sociology
- The interplay of material and ideal factors with each other, constituting the practical conditions of lived experience
- The value of understanding these social and ecological dynamics as matters of community
- The important influence of political institutions and commitments on our environmental practices
- The many, many, many possibilities—and demonstrated successes—for resolving conflicts and achieving justice in the biggest community of all

The overarching goal of this biggest community, it seems to us authors, is to help all as we help each one. How? Recognizing our ties opens the door to forging them, giving us the imaginative fodder for a more just tomorrow. It's a tall charge but one that has to start somewhere. And why not start here, with this invitation to environmental sociology?

We hope you find our invitation welcoming and open to all as we seek to engage with you as one. Our capacity to be inviting, though, is undoubtedly informed and sometimes limited by what we four as authors have come to know and not know in our lives. We certainly do not know everything about you or about the topics at hand. We make a few assumptions that are best for us to be up front about. Although we welcome a wider readership, we assume that most who turn the pages of this book do so in the United States and Canada as part of college courses. That means our readers tend to be better off financially than others domestically and internationally—but not always. College students and others are a diverse lot. We assume that our readers bring diverse perspectives and experiences across differences of race, nationality, class, ability, gender, sexuality, and many other dimensions. As we try to engage with the biggest community of all through the environmental sociological imagination, we may not imagine quite enough. Or we may imagine too much. In any event, stay with us and even reach out to us, as we try to write—and rewrite with every new edition—the most inclusive text we can to work toward a more just and ecological tomorrow.

The Ecology of Dialogue

Engaging with the social ecology of the biggest community of all asks us to step back and consider how the ideals we try to put into practice are shaped, and sometimes even compromised, by our material positions. By approaching environmental sociology in this way, we bridge a long-standing debate among scholars about the relationship between environment and society—and indeed about all of life—a debate between more *materialist* and *idealist* views about our practices of living. Materialists argue that environmental problems cannot be understood apart from the material threats posed by the way we have organized our societies, including the organization of ecologic relations. They believe that we can ill afford to ignore the material truth of organizational problems and their ecologic consequences. Idealists do not necessarily disagree, but they emphasize the influence of social life on how we conceptualize those problems or the lack of those problems. Idealists focus on the ideological origins of environmental problems—including their very definition *as* problems (or as nonproblems). A materialist might say, for example, that climate change is a dangerous consequence of how we currently organize the economic side of social life. An idealist might say that to recognize the danger—or even the existence—of climate change, we must wear the appropriate conceptual and ideological eyeglasses, which we gain through our social relations.

Although this debate sometimes gets quite abstract, it has important consequences. Materialists argue that the practical thing to do is to solve the social organizational issues behind environmental problems, like the way land use laws and current technologies encourage the overuse of cars. Idealists argue that the first step must be to understand our environmental ideologies, with all their insights and oversights, and their social connections and disconnections, lest our solutions lead to still other conflicts.[4]

Note that we mean "materialist" here in the philosophical sense of emphasizing the material conditions of life, not in the sense of material acquisitiveness. And we similarly mean "idealist" in the philosophical sense of emphasizing the role of ideas, not in the sense of what is the best or highest. But in practice (and despite the polarization that sometimes arises in academic debates), no scholar uses only one or the other perspective. Following a materialist position inevitably leads you to consider the ideas by which we understand material reality, sometimes to our regret. Similarly, following an idealist position long enough leads you to recognize that the world resists what we say about it and that our ideas are shaped by this resistance. Each helps constitute the other.

To understand the mutually constitutive relationship between the material and the ideal, and its practical consequences, let's turn to an ancient fable from India. A group of blind people encounters an elephant for the first time. One grabs the elephant's tail and says, "An elephant is like a snake!" Another grabs a leg and says, "An elephant is like a tree!" A third grabs an ear and says, "An elephant is like a big leaf!" To the materialist, the fable shows how misinformed all three blind people are, for a sighted person can plainly see how the "snake," "tree," and "big leaf" connect together into what an elephant really is. To the idealist, the fable says that we all have our ideological blindnesses and there is no fully sighted person who can see the whole elephant—that we are all wildly grasping at the elusive truth of the world.

The approach we take to this ancient debate is that the material and the ideal dimensions of the environment depend upon and interact with each other and together constitute the practical conditions of our social ecology.

What we believe depends on what we see and feel, and what we see and feel depends on what we believe—and therefore do. It is not a matter of either/or; rather, it is a matter of both together. Each helps constitute and reconstitute the other in a process that will never, we must hope, finish. We term this mutual and unfinalizable interrelationship *ecological dialogue*.[5] Throughout the book, we consider the constant conversation between the material and ideal dimensions of this never-ending dialogue of life and how our environmental practices emerge from it.

Ecological dialogue is also a way to conceptualize power—to conceptualize the environmental relations that shape our scope for action: our ability to do, to think, to be. These relations of power include both the organizational factors of materiality and the knowledge factors of our ideas, which in turn, shape each other. By using the word *dialogue*, we don't mean that everything in this interrelationship is happy and respectful, smooth and trouble free, or even that it always should be. Dialogue is not a state we reach when we have overcome power; it only happens *because of* power—the power to engage another's response and the power another grants by responding. There is often conflict involved, which is one of the main ways that the material and the ideal continually reshape each other and express themselves in our practices of living.

And conflict is not necessarily a bad thing. Sometimes it is exactly what is needed to get us to pay attention. Neither is power all kicking and yelling. There is much cooperative and complementary action in the dialogue of ecology, much conviviality that we relish and that constantly changes us. We experience power in cooperative and complementary action, too. Nor is power necessarily a bad thing. (Imagine for a moment having no power at all in your life and what an awful circumstance that would be.) It's a matter of who has power, what power does and how and why, and the legitimacy of power's balances and imbalances. These are moral questions that we need to continually ask and re-ask.

Maybe a diagram will help. Have a look at Figure 1.1, a kind of environmental sociological reinterpretation of the *Taijitu*, the ancient Chinese yin–yang icon. The *Taijitu* suggests that the world is constituted through the interaction of yin and yang, which together create a unity between notions of Earth and Heaven—between the material and the ideal. Often the *Taijitu* is interpreted to mean that yin and yang are opposites, but the black dot in the white side and the white dot in the black side are supposed to indicate that each is the seed of the other. Also, the *Taijitu* indicates the interactiveness of yin and yang through curved inter-nesting of the two sides instead of a straight line dividing yin and yang into oppositional hemispheres. It's one of history's great images.

But from the perspective of ecological dialogue, the *Taijitu* represents the world as overly unified, static, and finished. Figure 1.1 suggests the changing, unfinished, and sometimes conflictual character of the world through showing the material and the ideal as two partial moon faces in practical dialogue with each other. Together, the moons of the "material" and the "ideal," which tuck together in a basket weave at their edges, making a circle and a kind of ecological holism. That holism is always unfinished, though, and thus never fully whole, which the diagram represents through the open space between the partial moons. But the open space is not empty. Rather, it is an active space of interchange, interaction, and interrelation through the "practical"—the ideas and materialisms we put into joint practice. Some of that practice may be conflictual, and some may be cooperative and complementary. Through it, the ideal and material shape each other and change each other, shaping and changing the practical at the same time. To further represent this mutual constitution of the material and the ideal, through the relations of the practical, Figure 1.1 takes the seed imagery of the *Taijitu* and converts it to eyes, one of the central organs of communication, with a black eye on the white side and a white eye on the black side. Plus, the imagery of the moon faces is meant to suggest the motion of light and shadow across the ever-unfinished holism, like phases of a moon, as white becomes black and black becomes white over time.

The open pocket of space between the partial moons can be especially meaningful. Environmental issues are often a real downer. But we will continually emphasize in this book that positive and practical environmental change is possible through the engagement of the material with the ideal. We know this is true because people have so marvelously often achieved it already. People have done it by coming to see themselves as part of ecological dialogue, that is, as part of the creative community of the Earth and all its inhabitants, ever working out our ever-changing samenesses and differences, connections and disconnections, in the practical art of social ecology.[6] The biggest community of all is thus the biggest dialogue of all.

Figure 1.1 Ecological Dialogue

Source: Matt Robinson & Michael M. Bell

The Dialogue of Environmental Justice

But what stands in the way of ecological dialogue? The common breakdown of our dialogue with each other and the Earth is a symptom of a broader disease: the untying of life from its potential to thrive in community. Thankfully, that problem has a positive corollary because we can retie what we have untied or make new ties as we think about a transformative framework for the future. This is what we authors understand as *environmental justice*—the flourishing of mutual aid through communal ties within and across social ecology. Environmental justice is not only a question of fairness for humans and nonhumans alike. Even the equal distribution of a harm (what we sometimes call fair) doesn't capture the transformative need for justice beckoned by ecological dialogue. There's nothing fair about the equal distribution of a harm when that harm could be prevented in the first place. Neither is environmental justice just a question of equality. After all, not all inequality is unfair. Everyone differs and thus has different needs, wants, and gifts to share. That is part of the beauty of the world.

Transformative justice calls for identifying and changing gaps in mutual aid. Such gaps (and possibilities for making ties anew) manifest themselves within three intersecting axes of environmental justice: *across time*, *across social space*, and *across species*. Environmental justice across time concerns what are often called issues of "sustainability." Environmental justice across social space is often simply called "environmental justice" to designate disproportional burdens carried by particular social groups, commonly abbreviated as "EJ." Environmental justice across species raises questions about the rights and sustenance of the nonhuman, which humans understand through ideas of "ecological beauty" and what we cherish and what we do not. In earlier editions of this book, we referred to these intersecting three dimensions as sustainability, environmental justice in the purely human sense, and ecological beauty, as is commonly done in environmental discussions. We introduce here new language, for we have come to conclude that, analytically, all three are aspects of what should be seen as the central moral and practical challenge of social ecology: what we will term the *one justice* of environmental justice.[7] It's justice of all in all, for the biggest community of all.

Environmental Justice Across Time

How long can we keep doing what we're doing? Is it sustainable—that is, can we continue doing what we're doing without compromising the needs of the future, both for humans and nonhumans? Are we aiding future generations or taking from them?

"You say you love your children above all else, and yet you are stealing their future in front of their very eyes," said then-fifteen-year-old Swedish activist and Nobel Peace Prize nominee Greta Thunberg, speaking at the UN Climate Summit in Poland in December 2018. Thunberg's call to action poses the essential question of environmental justice across time.

The list of threats to environmental sustainability is long indeed.[8] Yet it's difficult to wrap our minds around such threats because we struggle to process complex and uncertain challenges of the future. Scientists call this temporal myopia *contempocentrism*.[9] We are generally good at planning for the immediate future: next meal, next week, next quarter profits. But when the needs and consequences of our actions are further away, taking action is not exactly our strong suit.

Tying into the future thus requires us to take a *precautionary* approach to ecological relations—to watch for environmental "yellow lights" about what may be coming down the ecological pike and to hit the breaks to avert worst-case scenarios when the lights are clearly red. The precautionary principle calls for us to think about what's ahead as we think about what we face now while remaining mindful that questions of time are also questions of social space and species. We sure have a lot to think about: issues of climate change, energy, smog, land, water, food, disease, and more.

Global Climate Change

How much longer can we keep doing what we're doing to our climate?

Some say don't worry, and some even say it's a hoax. But it's not a hoax. Given the controversy in some quarters, we'll take up the scientific evidence about climate change in detail. Yet in the minds of the overwhelming majority of scientists—the same people who helped provide us the modern comforts we routinely enjoy—the debate is over. The global climate is warming, mostly due to human actions. The continuing scientific controversy concerns what we should do about it.

Scientists are not alone in this judgment. A majority of people in most countries agree that climate change is happening. Even in the United States, where climate change skepticism is unusually high, a majority of people agree that the effects of climate change are here now or will begin within a few years, according to eighteen straight years of Gallup polls, from 2001 to 2018.[10] After all, there is plenty of evidence you don't need statistical software to appreciate. Broiling hot summers. Drought alerts. Floods. Rising sea levels. Record hurricanes. Melting glaciers. Decreased snow cover. Open-water fishing at the North Pole. Palm trees and peaches where they never grew before. Diseases and insects our grandparents' generation never had to contend with in our own regions. Or even hardly any insects at all. People notice such things in their own lives, and that makes a difference.

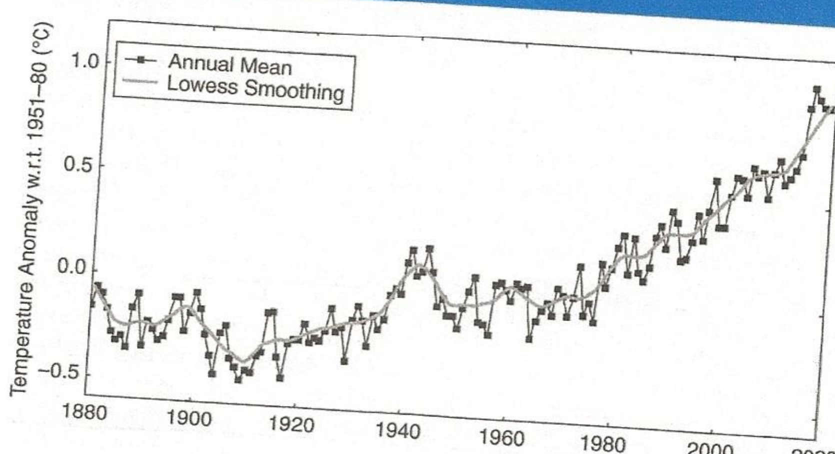
And here it is in numbers: When averages are calculated for the entire globe, the ten warmest years on record (through 2019) have all occurred since 1997. The five warmest years are the last five years.[11] The warmest ever was 2017.[12] The second warmest was 2019.[13] The third warmest was 2018[14] (see Figure 1.2). And it is a sure bet that by the time this edition is in print, or shortly afterward, those years will be topped. At least that has been the case with every previous edition of this book because the overall trend is continuously upward. The 1970s were hotter than the 1960s, the 1980s were hotter than the 1970s, the 1990s were still hotter, the 2000s were hotter yet, and the 2010s were even hotter than that.[15] Wow.

Long-term weather records also show that there was a grain of truth to an earlier generation's fireside stories about having to walk to school through 3 feet of chilling snow, barefoot and uphill both ways. The eighteenth- and nineteenth-century images of the whole town out for a skating party, or of Hans Brinker and his silver skates on the frozen canals of the Netherlands, are more than merely romantic. It really was colder back then. Winters were longer, blizzards were stronger, and glaciers used to come down farther out of the mountains. The year 1997 was the last time Dutch canals froze enough to hold the "Tour of Eleven Towns," once an annual skating event with thousands of participants.[16] There are reports that Long Island Sound, the body of salt water between Long Island and the Connecticut coast, used to freeze over some winters, and people would drive fifteen miles across the ice with a team and wagon. That kind of freeze hasn't happened in 150 years.[17]

It's not heating up everywhere, however, although it is in most places. And the changes going on entail a lot more than warming. Different places are experiencing a wide range of climatic disruptions, which is why scientists have historically preferred to call the issue "global climate change" rather than the more popular phrase "global warming." Plus, some areas may not experience much warming in one particular year. But overall, the heat is on, globally.

We are already feeling the effects of what many scientists call not just global climate change but the "climate emergency."[18] Our best knowledge comes from the Intergovernmental Panel on Climate Change (IPCC), a group of hundreds of scientists from around the world that periodically summarizes what we know.[19] It documents that already climatic zones have shifted, rainfall patterns have changed, weather conditions have become more variable, and sea level is rising—and more, much more. Some of these changes—like how cool it gets in an average evening—are relatively subtle. But if climate

Figure 1.2 A Warming World: Global Surface Temperatures, 1880 to 2019



Source: NASA (2020).

change trends continue, the IPCC says that by 2100 we will see major environmental changes that will drastically compromise the lives of billions.

Why is it happening? You'd have to be living in a cave not to have heard by now that scientists place the blame most squarely on carbon dioxide emissions from fossil fuel use. The excess carbon dioxide in turn leads to an increased "greenhouse effect" through the ability of carbon dioxide to trap heat that would otherwise radiate out into space. The greenhouse effect is not a new discovery. Scientists figured out 150 years ago that the Earth would be a cold and barren place without it. But too much of a good thing is, well, too much of a good thing.

However, extra carbon dioxide accounts for only about 58 percent of human-induced climate "forcing," as climatologists say.[20] Other greenhouse gases like methane, nitrous oxide, chlorofluorocarbons (CFCs), and ozone, as well as the soot or "black carbon" released by the myriad combustion processes of human activity, together account for the rest.[21] Methane is the most important of these, amounting to about half of the other forcings. But note this: most forcings other than carbon dioxide also come about through the burning of carbon-based fuels, directly or indirectly. Here's where a lot of the controversy comes, of course. The great engine of modern life is currently utterly dependent on carbon-based fuels.

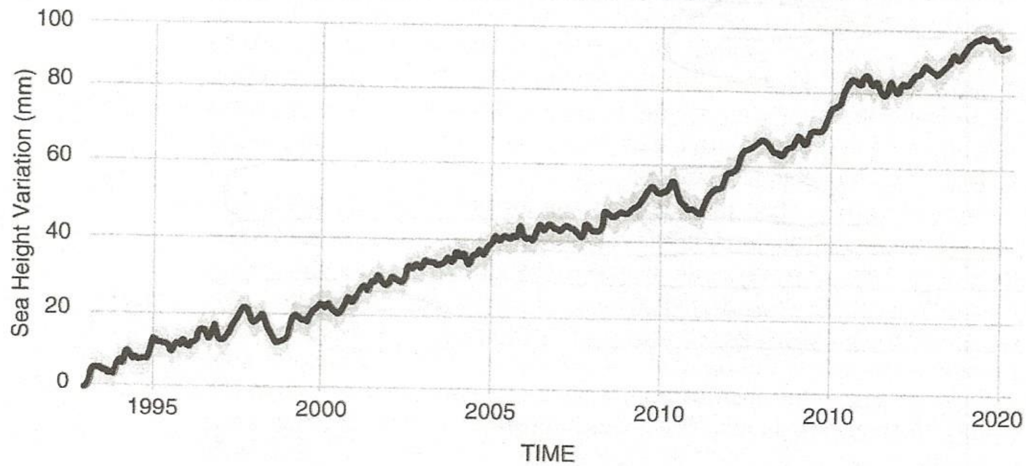
20%

The good news, as we'll discuss in the next section, is that our current dependence on fossil fuels is largely unnecessary. There are workable alternatives. But we'd better implement them really soon—like now. Our situation is pretty scary if we don't.

Take sea-level rise. As the global climate warms, glaciers and the ice caps melt, and ocean water heats up and expands. Sea level has already risen significantly (see Figure 1.3), increasing the danger of flooding during storm surges. Plus, the IPCC projects that the average level will go up another 0.44 to 0.74 meters (1.4 to 2.4 feet) by the beginning of the twenty-second century.[22] That may not seem like all that much unless you happen to live in a place like New Orleans, Amsterdam, or the low-lying Pacific Island nations of Tuvalu and Kiribati. Some 3.7 million people in the United States live on land less than a meter (3.3 feet) above the high tide line.[23] Moreover, a recent study by the U.S. National Aeronautics and Space Administration (NASA) found that it was "physically plausible" that sea-level rise by 2100 could top 8 feet.[24] The average elevation of Tuvalu is only 6.6 feet—an entire nation basically washed away. Globally, a 2019 study found that 187 million people would be displaced.[25]

Or consider the ecological disruptions climate change will bring. A particularly unnerving one is ocean acidification. Until recently, even scientists didn't consider this effect much. But it turns out that oceans absorb a third of our carbon dioxide emissions—22 million tons a day.[26] That lessens the greenhouse effect of excess carbon dioxide, which is helpful. Yet it also changes the chemistry of ocean water, leaving it more acidic, which makes it harder for shelled organisms to grow. To pull dissolved calcium carbonate out of ocean water—calcium carbonate being the basic building block of shells—organisms have to lower the acidity at the specific spots where their shells are growing. A more acidic ocean leaves such creatures struggling to

Figure 1.3 Oceans on the Rise: Global Mean Sea Level, 1993–2019, Based on Satellite Data



Source: NASA (2020).

do so. If we don't take any additional steps to control our emissions, by 2100 easily half of corals, echinoderms, and mollusks would be affected.[27] It is even plausible that oceans will become so acidic that shellfish cannot make shells.[28] Think of the massive species extinction that would result. It would also mean that coral reefs will no longer grow.[29] Not only would that be a tragedy in its own right; it might even undermine the calcium carbonate platforms that hold up coral islands, causing them to collapse into the sea with the next big storm.

And consider these other ecological impacts. Increased risk of extinction for up to 30 percent of species.[30] Gradual replacement of tropical forests with savanna in eastern Amazonia.[31] More disease, as our warmer weather creates conditions more hospitable to mosquitoes, ticks, rodents, bacteria, and viruses.[32] More variable weather, probably much more variable. More storms. More floods. More wildfires.[33] More drinking-water shortages and heat waves. More drought stress.[34] More competition among human uses for surface waters until little is left, like Lake Urmia, once Iran's largest lake and the sixth-largest saltwater lake in the world. Now, it's 90 percent dried up due to drought, water wells, and irrigation—a graveyard for rusting cruise ships.[35]

If you live in the western and southwestern United States or Australia, these last issues—wildfires, drought stress, and competition for the water that remains—are no longer abstract and far away. The wildfires and brushfires have perhaps the most direct impact: highways closed, mandatory evacuations, warnings not to go outside because of smoke inhalation. Social space is violently reshaped as whole neighborhoods are consumed by fire, like the more than 1,600 homes burned in August of 2018 in the Carr Fire in California's Shasta and Trinity Counties or the Camp Fire in November of 2018 in Butte County of California, which destroyed more than 18,000 structures and caused 85 fatalities.[36] Scientists estimate that at least 800 million animals were affected in the Australian state of New South Wales, where more than 12 million acres burned.[37] No one will ever know precisely how many suffered.

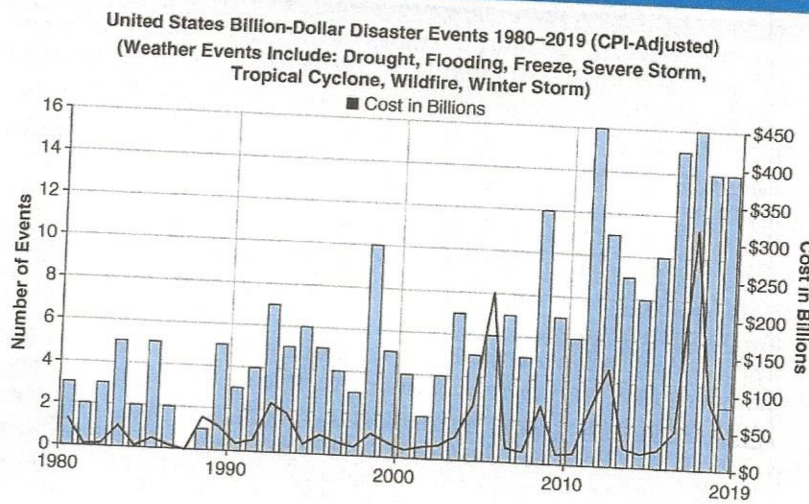
Meanwhile, the Great Lakes and St. Lawrence River drainage basin is, as of 2019, at record high water levels, with widespread shoreline flooding due to record rainfalls. Climate change is like that—much less water in some regions, much more in some others.

If we don't turn things around, the consequences for agriculture will be complex but pretty scary overall. Some farming areas are already stricken with drier conditions. Others are submerged under 100-year floods. But many of these newly wetter regions around the world do not have the same quality of soil as, say, Iowa. To add to the complexity, carbon dioxide can stimulate growth in some crop plants; one study found a 17 percent yield boost in soybeans.[38] However, this stimulation does not always result in actual increased crop yields because of other limiting factors, such as low rainfall, poor soil conditions, and the existence of other pollutants in the air.[39] Taking these pluses and minuses together, the IPCC finds an overall minus for agriculture.

And we're not just talking about projections anymore. We are already seeing an increase in scorching heat waves, devastating storms, and epic floods. Among other things, these events cost money, lots of it. In the United States alone, the National Oceanic and Atmospheric Association (NOAA) found that in 2017 alone there were sixteen climate change–related extreme weather events that each caused more than $1 billion in damages (see Figure 1.4). After adjusting for inflation, every year since 2003 has seen at least five weather-related disasters that topped $1 billion in damages. In the 1980s, most years saw three or less, and no year saw more than five.[40] In 2017, Hurricane Harvey hit Texas and Louisiana, causing $130 billion in damages in just one storm.

Plus the world is melting, literally. About 10 percent of the surface of the Earth is permanently covered by snow and ice. Seasonal fluctuations can bring the coverage up to about a third of the Earth's surface. But that coverage is wasting away. Here are a few alarming facts. When the U.S. Park Service established Glacier National Park in 1910, the park hosted some 150 glaciers. As of 2015, it was down to about twenty-six, and most of those have shrunk drastically.[41] Sea ice in the Arctic is thinning, and its area is down about a third in the last thirty years.[42] The decline in area is especially worrying because less white surface cover on the Earth means less solar energy is reflected back out to space, heating the planet even more. Now there are even frequent sizable stretches of open water at the Arctic ice cap during the summer.[43]

Figure 1.4 Billion-Dollar U.S. Weather Disasters 1980–2019



Source: NOAA (2020).

Then there are implications for infectious disease. Warmer world weather tends to encourage the spread of pathogens, their hosts, and their ability to be transmitted to humans. (Typically, microbes thrive with heat.) The World Health Organization (WHO) has found that climate change increases malaria, dengue, diarrhea, Lyme disease, tick-borne encephalitis, and food-borne pathogens such as salmonella.[44] As we write, scientists are still working to understand if climate change has had any role in the spread of COVID-19. But this much we already know for sure: In areas where a population's disease resistance is already weakened by malnutrition and other health challenges, any increases in infectious disease are particularly problematic. In the face of factors like these, WHO expects climate change to cause an additional 250,000 deaths worldwide per year between 2030 and 2050.[45]

Meanwhile, greenhouse gas emissions continue to rise. Annual mean carbon dioxide, as measured at Hawaii's Mauna Loa Observatory as of 2019, is up to 4011.4 parts per million in the atmosphere and first crossed over the line to the low 400s during seasonal fluctuations in 2013 and 2014.[46] In the mid-eighteenth century, the number was about 277 parts per million, according to data from ice cores drilled in Antarctica.[47] But growth still hasn't leveled out, despite the initial efforts of many nations around the world. Recently, the concentration has been going up about 2 parts per million per year as we continue to force the climate and push our luck.[48]

You could think of human-induced climate forcings as acting like extra blankets on a warm night, gradually stifling the planet. We say "on a warm night" because solar radiation is also on the rise, adding a climate forcing about a tenth as strong as human-induced forcings.[49] Taking all the forcings together—and there are indeed a few working in the direction of cooling, such as increased reflectivity back into outer space from increased cloudiness—the IPCC estimates that by 2100 average temperatures will likely exceed 1.5 to 2 degrees Celsius over where they were in the late nineteenth century, depending on the scenario and model.[50] These are enormous increases when you consider that an average drop of 6 degrees Celsius caused the ice ages, covering much of the northern latitudes with a mile-thick sheet of ice.[51]

Think about it the next hot summer evening as you ponder whether you should crank the air-conditioner up another notch, causing your local utility to burn just that much more carbon-based fuel and to release that much more smog and soot to generate the necessary electricity.[52] More cooling for you will mean more heating for all of us.

Energy

And how long can we keep doing what we're doing with regard to our energy sources? Not any longer at all. The trouble is we want more energy than we have—or at least more than we can easily get. The issues of this mismatch confront the world already. Rising costs. Pollution of land, air, and water. Declining stocks of some sources. Competition for space to produce energy. Tense international politics and even, say some, war. And, of course, our increasing climate emergency.

What to do? When you don't have enough of something, there are two basic ways to go: Get more or use less. Or maybe do both. There is a caveat, too, especially with regard to energy: Make sure that any way you go is clean, safe, and just. Given our record with energy recently, we'll have to inspect our options with care.

First, let's review where we get energy from now, as of 2017 (see Figure 1.5). About 32 percent of the world's energy supply comes from oil, the most of any source. Coal, peat, and oil shale are next at a combined 27.1 percent, followed by natural gas at 22.2 percent. Add all that together, and we're up to 81.3 percent of our energy coming from fossil carbon. That's a lot of fossil carbon. And then add in what the International Energy Agency (the keeper of these statistics) calls biofuels and waste—firewood, ethanol, and other such fuels, plus whatever else people can get to burn, like municipal solid waste and animal dung—at 9.5 percent. That's a lot of total carbon. Combined, we're up to a 90.8 percent carbon energy economy.[53]

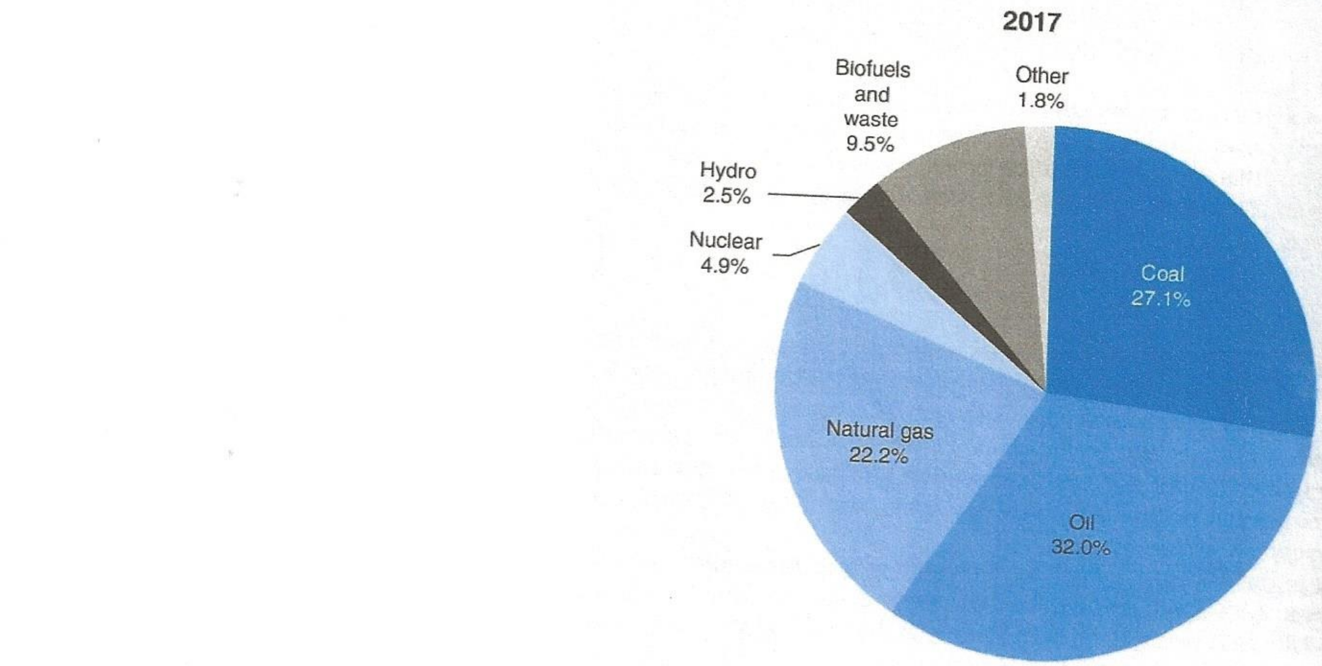
The rest? Some 4.9 percent of the world's total energy is from nuclear, and 2.5 percent from hydropower. The rest is so quantitatively insignificant that the International Energy Agency lumps it all into a single "other" category of 1.8 percent: mostly wind, solar, and geothermal.

Can we get more? There are a lot of unknowns of geology and technology here. And can we do it without wrecking the planet? A lot of money and jobs hang on this question, so clear and straight answers are hard to come by.

Fossil Fuels

Much attention has been given to the contention that we have now reached a "peak oil" state, fulfilling M. King Hubbert's prediction in the 1950s that we would soon see terminal decline in oil and gas production, albeit a few

Figure 1.5 Share of Total World Primary Energy Supply by Type of Fuel in 2017



Source: Based on IEA data from Key World Energy Statistics © OECD/IEA 2019, IEA Publishing; modified by Sage Publications. License: www.iea.org/t&c.

decades later than Hubbert thought. There is some truth to the idea. Yes, we still have substantial reserves of oil and gas in the world and some regions that have not been fully prospected. But the big and easy petroleum fields appear to have been pretty much all found.

So now companies are reverting to more difficult, dirty, and dangerous sources. Consider the huge Gulf of Mexico spill in the spring and summer of 2010 from the explosion of the Deepwater Horizon drilling platform. The Deepwater Horizon well was part of a push into deeper waters, further offshore, where water pressure is higher and infrastructure is chancier. There may be a lot of oil out there, but it's harder to get—which is why companies hadn't pumped it earlier.

Similarly, Canada and Venezuela boast huge reserves of what used to be known as *tar sands* but recently have come to have the more polite name *oil sands*. *Tar sands* is more accurate to describe the form these deposits take in the ground: thick, rigid, and sticky, in need of vast investments in digging equipment for surface mining and heating equipment for pumping it out through steam injection, which makes the tar flow. The resulting landscape is not pretty. Getting the tar to flow takes a monumental amount of fresh water, which ends up in toxic waste pools. Great pyramids of sulfur extracted from the tar rise above the land. Dust clouds swirl from the mining operations. Hundreds of square miles of forest and peatland lay decimated. Plus it takes a lot of energy to cook the oil out of the tar, reducing efficiency and increasing climate impact.[54]

Another new method of oil and gas production is "fracking," or hydraulic fracturing. Drillers stimulate the flow of oil and gas by injecting at high pressure a soup of water and chemicals mixed with fine-grained sand deep into the bedrock. The high-pressure soup opens up a network of micro-fractures in the rock, and the sand holds those micro-fractures open after drillers stop pumping in the chemicals. Huge gains in the production of oil and gas often result. Instead of finding new oil and gas fields, fracking allows companies to squeeze a lot more out of the ones they know about already. But it's expensive, so the production gains have to be high. And it's messy, very messy. The chemicals get into water wells. The gases too—to the point where some residents in fracking areas can literally light their water faucets like they were Bunsen burners.[55] In fact, the gases can seep out everywhere, polluting the air and contributing to climate change. The high pressure not only fractures the rock but also sometimes induces earthquakes—small ones generally but sometimes large enough to damage buildings. A lot of the drill water comes back up to the surface after the injecting is done, and these wastewaters can pick up radiation underground—in addition to their toxic mixture of drilling chemicals—and that wastewater is often poorly handled. And the special "frack sand" entails extensive surface mining, radically reshaping local landscapes, broadcasting fine dust particles into the air, and using vast quantities of water to wash and sort the grains. In sum, fracking bumps oil and gas production yet also poses major challenges to environmental justice—not just across time but also across social space and species. As the environmental sociologist Colin Jerolmack puts it, community itself gets fracked.[56]

> but not necessarily at fracking site

How about coal, the next biggest of our current energy sources? There is still a lot of it in the ground, to be sure. But coal is infamously dirty. In addition to climate change, burning it contributes to smog, acid rain, particulates, and most of the rest of our carbon woes. Plus, coal has some special zingers of its own. Take the continued despoliation of land from coal mining. Take the billions of gallons of hot water discharged from coal-fired power plants into surrounding lakes and rivers. Take the hundreds of thousands of tons of highly toxic ash and sludge from smokestack scrubbers that a typical coal-fired power plant produces each year. Take the airborne mercury deposition from coal-fired power plants that has led to health guidelines on how many wild-caught fish from lakes in the U.S. Midwest one can safely eat. Or take the continued loss of miners' lives, like the twenty-nine coal miners who died in the Upper Big Branch Mine disaster on April 5, 2010, in Raleigh County, West Virginia, or the 104 miners who died in a coal mine explosion on November 21, 2009, in China's Heilongjiang Province.

Wisconsin has cleaner coal than W. VA.

Consequently, despite these new methods and sources, the portion of the world's energy supplied by fossil fuels has declined from about 94.1 percent in 1973 to the 81.3 percent registered in 2017.[57] The stuff is simply getting harder to extract from the Earth, and the damage done along the way is continually rising.

Non-Fossil Energy Sources

Yet there is some reason to cheer here. In a world that often seems to agree on little, politicians from across the political spectrum now often speak of the need to transition to non–fossil fuel energy sources. There are a few notable exceptions, unfortunately. But several countries have made remarkable progress, demonstrating the possibility of a world that has kicked its fossil carbon addiction.

Nuclear energy enthuses many as a solution to the carbon economy, and it is rapidly growing. Nuclear now comprises 4.9 percent of the world's energy sources, as we noted earlier, up from 1.3 percent in 1973. But nuclear energy also worries many. For sometimes the grandest of technological marvels fail, and their decoupling from the social and ecological lifeforms around them comes into full specter. The 2011 Fukushima Daiichi reactor meltdowns in Japan were only the latest in a long and scary history of nuclear accidents. The Chernobyl and Three Mile Island accidents were terrible too—especially Chernobyl, which killed several thousand as a direct result of the explosion and is expected in time to cause at least another 4,000 deaths (some say tens of thousands more) due to radiation exposure.[58] The worry is not just the potential for accidents and plant malfunctions from earthquakes, tsunamis, tornados, hurricanes, engineering problems, and operator errors. There are also issues of terrorism, nuclear proliferation and warfare, and the challenge of safely storing the waste for 100,000 years, with dangerous interactions for all three dimensions of environmental justice.

Nonetheless, others contend that these risks are better than floods, droughts, heat waves, strip mining, air pollution, oil spills, coal mine accidents, and the rest of the carbon economy mess. Whether or not the risks of nuclear are worth it, of this we can be sure. The situation can't be good if the choices are so bad.

Or are they so bad? Renewables increasingly demonstrate that they are a realistic option, showing the potential to power our economy with the Sun, the wind, the water, the tide, the heat of the Earth, and the living power of biofuels. Some countries, such as Germany and Costa Rica, have made huge progress. As of 2018, Germany was getting 37.8 percent of its electricity from renewables and 16.7 percent of its total energy, thanks to policies like "feed-in tariffs" that require utilities to buy from renewable sources.[59] The country's aims are even grander: 45 percent renewable energy by 2030.[60] In Germany now, it is utterly routine to see a house with photovoltaic solar panels on the roof. Costa Rica is arguably the world leader. In 2016, Costa Rica generated 98.1 percent of its electricity from renewables—about 80 percent from hydropower but also from geothermal, photovoltaics, and wind power.[61]

Wind power has also been growing rapidly and has huge potential for further increases. In percentage terms, Denmark is tops in wind production. As of 2017, wind energy provided Denmark consumers with 43.4 percent of their electric energy.[62] The world adds about 50 gigawatts of new wind power capacity every year. That's a lot—about the same generating capacity as fifty nuclear reactors. In absolute terms, China produces the most energy from wind, churning out 35.7 percent of the world's installed capacity, and is working hard to have a whole lot more (as well as to have a whole lot more nuclear, it must be said). The United States is next, with 16.3 percent of the world's installed wind capacity.[63] Offshore wind power is now only a small part of total wind-generating capacity—just 4 percent as of 2018.[64] But its potential contribution is vast. According to a study by the International Energy Agency, offshore wind energy from floating turbines could by 2040 generate eleven times more than the world's total electricity demand. To repeat: not just meet that demand but meet it eleven times over.[65]

The winds of change are blowing.

Imagine this way of living. Heat and cool our houses with heat pumps run through the soil. Light them with wind and photovoltaic roofing tiles, and power our transportation that way, too. Concentrate sunlight with some well-placed mirrors, or split hydrogen from water with the sun, or set up axial turbines to catch the tide, greening the energy of our schools, offices, hospitals, and factories. It can all be done, and it is being done. Moreover, many non-nuclear alternatives—especially wind—are now cheaper to install per megawatt than fossil fuel or nuclear generation, once subsidies are discounted.[66] And they are much cheaper once one takes into account the high cost of the environmental and health damage caused by fossil fuels and the risks of nuclear.

But renewable energy sources have their costs and consequences, too—arguably considerably lower and fewer than with oil and gas, coal, and nuclear energy—but costs and consequences nonetheless with implications for justice across the generations for humans and nonhumans alike. Bright light radiating from turbines and their turning noise can alter the daily lives of those who live in proximity to wind power production sites. Hydropower dams up the flow of ecology with the flow of water and displaces people from their lands and homes. Biofuels also consume space, competing with land for food and habitat, as well as needing to be combusted to yield energy, contributing to the ills of the carbon economy we look to them to help resolve. Photovoltaics, heat pumps, and tidal turbines also aren't without their environmental impacts, from the mining needed for batteries and copper tubing to the wider array of power lines required to feed more spread-out energy sources into a nation's electrical grid.

Using Less

So maybe "get more" isn't the best approach to solving our energy needs. Maybe "use less" is the better emphasis. How about not just a little conservation and efficiency but a whole lot of it? That hasn't been tried much either, after all. And using less almost certainly means abusing less. This seems right to us and to essentially all environmental thinkers. There is huge agreement here.

Of course, you shouldn't necessarily rush out and ditch the gas-guzzling SUV you bought three years ago to spring for a Prius or a Tesla instead. Tossing out the not-very-old for something that is more efficient can introduce significant inefficiencies of waste, like the embedded energy and environmental damage in the manufacture of any car, even a Prius. You'd probably do more good by driving the gas-guzzler less, and slower, and by buying a bike. This points to one of the great challenges of conservation: the slow transition time caused by the investments we have already made.

The good news is that when you invest in something more efficient, its advantages continue on through the years. That's hard to give up: Something efficient should last longer, and we'll want to keep it longer, if it is truly efficient—a point that we will come back to at the end of this chapter.

There are two other huge challenges for energy conservation: Some interests profit through waste, and our appetite for energy goes up with many of the ways we put population and aspiration into practice. But these challenges are not as inevitable as we might fear in our darker moments. There is a lot of money to be made and jobs to be had in selling conservation, as businesses around the world are starting to recognize. And there is plenty of money and lots of jobs in replacing our current energy sources with more benign ones like renewables. (Even with a vast decrease in energy use, we will still need some energy generation.) As of 2018, the renewable energy sector in Germany employed some 338,000 people.[67] And the form and consequences of our population and aspiration, and even of our aspiration for population, depend upon how we constitute our lives as social and ecological beings.

We can do better, much better.

Threats to Land and Water

There's a well-known saying about land: They aren't making any more of it. The same is true of water. And we're not using any less of either, each year. Indeed, in a way, there is less of both land and water for us to use as the expansion of industry, agriculture, and development erodes and pollutes what we have, reducing the world's capacity to sustain life.

Consider soil erosion in the United States. Soil erodes from U.S. farmland at least ten times faster than it can be replaced by ecological processes.[68] Despite decades of work in reducing soil erosion, largely in response to the lessons of the Dust Bowl, it still takes a bushel of soil erosion to grow a bushel of corn.[69] The Conservation Reserve Program, implemented by the U.S. Congress in 1985, led to some initial significant improvements by offering farmers contracts to take the most erodible land out of production. Many farmers also switched to less erosive cropping practices. Consequently, soil erosion dropped 31 percent from 1982 to 2007.[70] But since then, there has been no overall improvement.[71]

Elsewhere, the situation is equally grim. Soil erosion exceeds replacement rates on a third of the world's agricultural land.[72] And all those wildfires brought about by climate change aren't helping anything, leaving massive spaces of land without vegetation to help hold the soil in place. Overgrazing associated with poor pasture management isn't helping either. Worldwide, almost a quarter—23 percent—of cropland, pastureland, forests, and woodlands have become degraded.[73] The United Nations (UN) estimates that the decline in soil fertility costs about $40 billion globally every year, excluding costs of fertilizer and loss of biodiversity.[74]

Soil erosion is only one of many serious threats to farmland. Much of the twentieth century's gain in crop production was due to irrigation. But irrigation can also salinize soils. Because most irrigation occurs in parched regions, the abundant sunlight of dry climates evaporates much of the water away, leaving salts behind. Irrigation can also waterlog poorly drained soils. This, in turn, can lead to salinization as waterlogged soils bake in the sun. Thus, over-irrigation can turn soils both swampy and salty at the same time.

Irrigation of cropland, combined with the growing thirst of cities, is leading to an even more fundamental problem: a lack of fresh water. Some 4 billion people around the world experience severe water scarcity—when demand for fresh water is double or more than the supply—for at least a month every year. Some 500 million experience severe water scarcity all the time.[75] A new vogue term is "day zero," first coined when Cape Town, South Africa, projected that the city would simply run out of water on April 16, 2018, if drastic action wasn't taken to cut water use. Fortunately, government and city residents responded with strong conservation efforts until plentiful rains finally arrived in June, and the worst outcomes were avoided. Chennai, India, wasn't so fortunate. This city of 7 million people, capital of the Indian state of Tamil Nadu, hit "day zero" on June 19, 2019. The city's four reservoirs simply ran out of water. The monsoons failed three years in a row, and a scorching heat wave began in May 2019 baking dry what little water was left.

Even in countries not classified as facing severe water stress, the situation is increasingly dire. Take the United States and Mexico. By the time it reaches the ocean in the Gulf of California, the Colorado is probably the world's most famous "non-river," for not a running drop remains after the farms and cities of the United States and Mexico have drunk their fill. Similar situations afflict the planet elsewhere. Like the Murray River in Australia, which is nearly dry by the time it reaches the sea due to diversion for irrigation[76]—or the Aral Sea in central Asia, once the world's fourth-largest lake. Diversion for irrigation reduced the Aral's surface area to 10 percent of its original size.[77] The former area of the rest of the Aral has a new name, now: the Aralkum Desert. Really—look it up.

Surface water isn't the only issue. Groundwater is also being rapidly depleted. Around the world, extraction of groundwater for cities and farms is exceeding replenishment rates. In the dry Great Plains of the United States, farmers pump the famous Ogallala Aquifer eight times faster than it recharges from precipitation, endangering a fifth of the corn, wheat, cotton, and cattle production in the United States.[78] Nearly 10 percent of the Ogallala's water reserves have already been pumped out, and the taps have had to be turned off in many places.[79] It took thousands of years for the environment to fill the Ogallala, and we are rapidly draining it. In the North China Plain, a major grain-producing area, water tables have been dropping at the rate of 3 to 5 feet each year due to overdraw for irrigation.[80] In some regions, the lowering of water tables is causing major land subsidence. Downtown Mexico City has dropped nearly 25 feet.[81] Venice has dropped 10 centimeters because of pumping the freshwater aquifer beneath it—which may not sound like a lot, but for a city at the water line, that is an alarming figure.[82] With rising sea levels and continued groundwater extraction, researchers expect that Venice could sink another 3.2 inches in the next twenty years. Already, St. Marks Square commonly floods—three times in one particularly bad week in November of 2019.[83]

Much of the fresh water that remains is badly polluted. Some years ago, in 1992, Donella Meadows, Dennis Meadows, and Jorgen Randers calculated that "the amount of water made unusable by pollution is almost as great as the amount actually used by the human economy."[84] They also noted then that we are close to using, or making unusable, all the easily accessible fresh water—fresh water that is close to where people live (as opposed to rivers in the Arctic, say) and that can be stored in rivers, lakes, and aquifers (as opposed to the huge amounts of fresh water lost to the sea during seasonal floods, which cannot be easily stored).[85] The situation around the world today remains dire. The remaining margin for growth in freshwater use is disturbingly narrow.

Cleaning up water pollution is one way to increase that vital margin, and industrial water pollution has diminished in many areas. We have also made progress in controlling agricultural water pollution. But we still have a long way to go. From 1950 to 2001, farmers across the world upped their use of commercial fertilizers eightfold and their use of pesticides thirty-two-fold.[86] Worldwide consumption of fertilizer is now around 200 million tons per year, and after a bit of a lull because of the development of stronger chemicals, the pounds of pesticide applied are rising once again.[87] Many countries in the Global South are continuing a "green revolution" approach to food production, using all available agricultural chemistry. And in wealthy nations, use has increased with the widespread planting of herbicide-tolerant genetically modified organism (GMO) crops like "Roundup Ready" corn and soybeans—that is, crops with a gene spliced in that lets farmers increase their use of Roundup, a popular herbicide, without hurting the crop. The resulting runoff continues to threaten the safety of many drinking water supplies. As Chapter 2 discusses in detail, many pesticides are quite hazardous for human health. Excess nitrogen fertilizer in the water is, too. We all need something to eat and something to drink, but some of our efforts at maintaining food production put us in the untenable position of trading food to eat for water to drink.

Summary

Or are we trading them both away? In addition to the threats to agricultural production caused by soil erosion, salinization, waterlogging, and water shortages, we are losing considerable amounts of productive farmland to the expansion of roads and suburbs, particularly in the wealthiest nations. Cities need food; thus, the sensible place to build a city is in the midst of productive agricultural land. And that is just what people have done for centuries. But the advent of the automobile made possible (although not inevitable) the sprawling forms of low-density development so characteristic of the modern city. The result is that cities now gobble up not only food but also the best land for growing it. The problem is worst in the United States, which has both a large proportion of the world's best agricultural land and some of the world's most land-consuming patterns of development. The United States loses about 1.5 million acres of farmland every year to development or about 30 million acres every twenty years.[88] That's an area larger than the entire state of Pennsylvania. Typically, this is high-quality farmland, adjacent to metropolitan areas, and thus in the places where it is most needed: close to where people live.

We're not running out of food. Hunger mainly has other causes, which we'll explore later in this book, especially Chapter 6 and a little bit later in