

CHAPTER ONE

THE ACCIDENTAL EXPERIMENT

FOR TENS OF THOUSANDS OF YEARS, we and our ancestors have treated the earth as a laboratory in which we have tinkered with the forces of nature. From taming fire and harnessing wind to developing antibiotics, the results have often advanced civilization. Yet for the past two centuries, we have been conducting what could be the most momentous and dangerous of all experiments: warming the globe.

We started the experiment without meaning to, and, until recently, we did not even know it was under way. Now it may be out of control, threatening to ruin our planet as a home for us and countless other creatures.

Avoiding that fate is a test of our humanity. We flatter ourselves with the anthropological designation *Homo sapiens*. The phrase is often translated simply as “man who knows.” We have now, belatedly, met that definition: those of us alive today are the first generation to know that we live in the Age of Global Warming. We may also be the last generation to have any chance of doing something about it. Our forebears had the excuse of

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ignorance. Our descendants will have the excuse of helplessness. We have no excuse.

But the Latin participle *sapiens* means more than just possessing knowledge; it connotes wisdom, common sense, and competence. By that standard, we have a long way to go—and not much time. It is as though we were watching a video on fast forward. There is still some mystery about what is happening and plenty of suspense about how it will turn out. But we cannot just wait and see. We must respond, and our response, too, must be on fast forward.

Climate change is a test of our scientific and entrepreneurial ingenuity. The necessary restructuring of our industries and economy will be possible only if our leaders demonstrate determination, skill, and courage in their policies for their own nations and in cooperation with one another. So climate change is a test of politics as the art of the possible in the face of what we must hope is only a *nearly* impossible problem.

Climate change is also a test of our ethics, the values that underlie our politics. The potential catastrophe the planet faces obliges us to rethink our rights and duties as citizens. More fundamentally, we need to rethink our obligations as members of a sometimes shortsighted, sometimes sapient, potentially endangered species—and to act accordingly.

A PLANETARY FEVER

During the Industrial Revolution, starting in the late eighteenth century, manual labor and draft-animal farming gave way to the manufacture of goods by machines that ran on energy generated from burning coal. About a hundred years later, in 1897 Mark Twain thought it a witty truism to observe that “everybody talks about the weather, but nobody does anything about it.”¹ Yet

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factories in Europe and North America, including in Twain's adopted home state of Connecticut, were emitting carbon dioxide and other gases in quantities that would shift the balance between the absorption and reflection of solar energy in a way that would risk overheating the planet.

Shortly after Twain died in 1910, temperatures started to creep upward. At first, the warming effects of carbon dioxide were too small to be identified as a trend. Then, around 1970, scientists began to close ranks around the suspicion that something new and worrisome was happening. In 1988 the World Meteorological Organization and the United Nations Environment Program established the Intergovernmental Panel on Climate Change (IPCC). Based on input from more than a thousand of the world's leading meteorologists, geologists, oceanographers, and physicists, the panel concluded that in the course of the twentieth century, the average temperature of the earth's surface had increased 1.3° Fahrenheit from the average in the nineteenth century.

That may not sound like a lot, given the day-to-day fluctuations in weather, not to mention season to season or even year to year. In the winter of 2009–10, for example, three snowstorms dumped a total of four and a half feet of snow on Washington, D.C. The U.S. government shut down for four days; Maryland, Virginia, and Delaware declared a state of emergency; and Senator James Inhofe of Oklahoma mocked the idea of global warming by building an igloo near the U.S. Capitol. In fact, the blizzards—which President Obama called “Snowmageddon”—neither proved nor disproved the reality of climate change. Neither did Katrina, the Category 3 hurricane that devastated New Orleans in 2005.

The reason for alarm is in the pattern that scientists have discerned over time. A century ago, the numbers of record hot days and record cold days were about the same, whereas in the past

decade, there have been about twice as many record highs, and the frequency and severity of storms have increased. And while there have been spikes at both the hot and cold ends of the spectrum, the net effect has been a rise in the average surface temperature of the planet.²

Warming since the nineteenth century has initiated the melting of the polar ice caps and the rapid retreat of major glaciers, such as those in the Rockies and the Andes. That phenomenon has begun to deprive the earth of the dual cooling function that ice performs by chilling its surroundings and forming a reflective shield that bounces heat rays back into space.

A few degrees' increase in global average temperature can have a significant impact. Twenty thousand years ago—when it was about 9°F colder than it is today—the ice covering present-day Canada and much of the northern United States was more than a mile thick.³ As the earth gradually warmed over the following millennia, the combination of temperate climate and stable sea levels was conducive to the enrichment of soil and the growth of fish populations along the coasts. These conditions—a result of natural global warming—opened a new chapter in human history: the Neolithic Revolution, about 10,000 years ago, when nomadic hunter-gatherers settled down on the eastern coast of the Mediterranean and formed stationary communities.

The IPCC has concluded that what is happening now—a sudden and rapid change in weather patterns—is *not* natural; rather, it is largely anthropogenic, a consequence of human activity. The panel also believes that the effects of rising temperatures to date are a likely prelude to more menacing developments in the decades to come.

So far the IPCC has issued four multivolume reports. The last came out in 2007.⁴ Each assessment represents an updated

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consensus, and each update has been more alarming than its predecessor about how fast the planet seems to be warming and more certain about human activity being the cause.

AS TEMPERATURES RISE, the danger is analogous to a fever in the human body. We feel healthy at 98.6°F, not so good at 99.5°, and lousy at 101°; if we get up to 105° or so we are likely to be taken to the hospital. So where, on a thermometer that registers the earth's temperature, should there be a marker indicating that a fever is not just uncomfortable and unhealthy but life-threatening? As they contemplate this question, scientists have settled on 3.6°F above average temperatures about a century ago, before they began to rise as a result of the Industrial Revolution. Since the global average has already risen 1.3°F, that means we have only 2.3°F to go before we hit 3.6°F.⁵

That now-canonical figure—3.6°—sounds suspiciously precise, especially in Fahrenheit. It suggests that we can predict within a tenth of a degree when the situation might become catastrophic. On the Celsius or (centigrade) scale, which most of the world uses, the equivalent of 3.6°F is 2°C, which sounds less like a tipping point and more like a focal point on the spectrum of global warming as the disruptive effects grow in frequency, multiplicity, severity, and unpredictability.⁶

The hydrological factor in climate change is another example of questions that are still under debate. Two-thirds of the earth's surface is water. Warming causes evaporation, and vapor traps heat in the atmosphere, which adds to warming. But vapor also adds to cloud cover, which has two effects: it too traps heat at the earth's surface, but it also reflects heat from the sun back into space, which partially offsets warming. Scientists are not yet sure about the net effect, although their tentative judgment is that

increased cloud cover probably raises temperatures. By contrast, there is little doubt that the accelerated melting of ice caps and glaciers tends to swell rivers and raise sea levels.

As experts combine what they know with what they suspect may happen, they can imagine Biblical-scale floods, droughts, and famines: Manhattan and much of Florida under water; breadbaskets turned into wastelands; a major change in the Gulf Stream that could bring Siberian winters to what is now temperate Europe; the buckling of Arctic permafrost that could release tens of billions of tons of methane, a greenhouse gas that is twenty times more powerful in its heat-trapping effect than carbon dioxide.⁷

These and other “perturbations”—the term scientists use for disturbances that result from changes in climate—would constitute not just an environmental and humanitarian disaster but a geopolitical one, particularly if they interact in ways that are mutually exacerbating. Defense and intelligence agencies of the U.S. government are concerned about global warming becoming a cause of political instability soon enough in the future to make it a factor in U.S. strategic planning today.⁸

BECAUSE THE PROBLEM OF CLIMATE CHANGE is almost certainly anthropogenic, the solution, insofar as there is one, must be the same: a change in human activity that counteracts—or, as we have learned to put the goal more modestly, mitigates—the consequences of our two-hundred-year accidental experiment.

Scientists and economists believe the world can stay below the 3.6°F/2°C threshold at a reasonable cost. That calculation takes into account the cost if we do *not* act and if the consequences of global warming are as severe as science indicates they might be. Precisely because there is uncertainty about where on

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the temperature scale the danger zone is, we should try to stay as much below the 3.6°F threshold as possible.

Moreover, we need to start reductions *now* in order to slow temperature rise later. Even if we could throw a switch and shut down all emissions, gases that are already in the atmosphere will continue to trap heat for some time to come. Once emitted into the atmosphere, a molecule of carbon dioxide, or CO₂, lingers for decades. So gases emitted today are added to ones that have been around for fifty years or more.

The current concentration of CO₂ in the atmosphere is about 385 parts per million (ppm), and growing by 2 ppm each year. The IPCC believes that if that level rises and stays above 400 ppm over the next several decades, the consequent increased warming could push global temperatures past 3.6°F by mid-century.⁹

So 400 ppm is—like 3.6°F—another dangerous ceiling, and it is one we are already close to hitting. Yet the production and consumption of energy from fossil fuels at current rates puts us on a course that may well boost CO₂ concentrations to nearly 1,000 ppm by 2050—more than double the level we must avoid.*

IF WE CONTINUE WITH BUSINESS AS USUAL, the globe could keep warming for millennia. Even if the human species is biologically resilient enough to survive for centuries, the human enterprise may well be hard to maintain in anything like its current form.

*This book refers primarily to CO₂ since it is the most prevalent anthropogenic greenhouse gas. There are five others. Nitrous oxide and methane are natural gases that, like CO₂, have been emitted into the atmosphere because of human activity. Sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons are synthetic, in that they do not occur in nature and are in the atmosphere because of industrial emissions. In addition, black carbon or soot (a particulate, not a gas) contributes significantly to the greenhouse effect.

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Granted, that is the worst case. Granted, too, it is debatable. Scientists, like everyone else, can only guess about the future. The dangers the IPCC is warning of may be exaggerated, or—best case—they may not come to pass.

But we cannot count on the scientists overestimating the problem; it is just as likely they are underestimating it. In the past, the IPCC's reports were often criticized for equivocating or erring on the side of caution. Recently they have been attacked from the other direction after some reports were found to contain substantive errors and citations of work that had not been peer reviewed. Yet despite these controversies, most independent evaluations of the IPCC's two decades of work—including separate assessments by over fifty national science academies—have endorsed the panel's findings about the cause, nature, pace, and possible consequences of the climate change.

In any event, we do not want to sit back and wait for the future's verdict on whether the panel is alarmist or too sanguine. Nor can we wait for the science to be even more convincing before we take action. While the contributors to the IPCC and other researchers continue to refine their analysis and forecasts, governments should put in place policies that will keep CO₂ concentrations from reaching the barely safe limit of 400 ppm by 2050.

Today, humanity is cumulatively emitting, on a yearly basis, around 30 gigatons of CO₂. A gigaton is a billion tons. Thirty gigatons is about the weight of 8,000 Empire State Buildings, which, if stacked one on top of another, would reach almost 2,000 miles into space.

To keep CO₂ concentrations below 400 ppm and thereby keep temperature rise below 3.6°, we should use the next four decades to cut the current output of 30 gigatons a year approximately

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in half. So that is another target for mitigation: a staged process that would bring the global annual output down to 15 gigatons a year by 2050.

To reach that goal, we have to build a new worldwide system for generating and using energy. We have to begin quickly in order to achieve the bulk of the necessary cuts between 2020 and 2035 so that there is some hope that, by 2050, emissions will have come down to 15 gigatons, concentrations will have stabilized below the 400 ppm level, and temperature rise will have flattened out before hitting the 3.6°F mark.

At the heart of this mammoth undertaking is a transition from a high-carbon to a low-carbon global economy—that is, one that is powered as much as possible by forms of energy that do not burn fossil fuels and therefore do not pump CO₂ into the atmosphere.

THE TRANSACTION

The design of a mitigation strategy combines complicated science with elementary economics. The world relies on carbon-based fuels—principally coal, oil, and natural gas—because they are relatively cheap. But the price of fossil fuels does not begin to cover the costs incurred in damage to the environment. Hence, mitigating global warming requires a high price on carbon so that citizens, public utilities, companies, institutions of all kinds, and entire countries have an incentive to shift to alternative sources of energy on a vast scale and within a relatively short amount of time.

Richard Gephardt—an American politician who has grappled with the issue in government and the private sector—has said that changing how the planet generates and consumes energy will be “the single most difficult political transaction in the history of mankind.”¹⁰

The United States must be part of that transaction. Of the dozen or so countries that have put most of the greenhouse gases into the air, the United States is far and away at the top of the list. With only about 5 percent of the world's population, it is responsible for about 17 percent of total accumulation of those gases in the atmosphere and for about 20 percent of the world's annual greenhouse gas emissions. (Of those 30 gigatons of CO₂ that will be emitted this year, just under 6 gigatons are from the United States.)

That dubious distinction—combined with the nation's unmatched power in the world economy and in the various institutions and arrangements that make up the international system—makes Americans more responsible than anyone else both for causing the problem and for leading the search for a solution.

BARACK OBAMA TAKES that responsibility personally. He has often said that his presidency coincides with what may be a now-or-never moment because the peril is growing and the opportunity to avert it is shrinking.

Obama and members of his administration often speak of being at an inflection point.¹¹ That phrase is a mathematical term adapted to organizational theory. Business executives use it to describe how a new technology or a new source of competition forces a company or a sector to adjust and innovate. Andy Grove, the long-time CEO of Intel Corporation and a guru of corporate strategy, has defined an inflection point as an event that changes the way people think and act.¹²

We should be so lucky—and so smart—as to be at an inflection point. So far, we have begun to think more realistically, but we are still a long way from taking sufficient action.

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FOR NEARLY TWENTY YEARS, the nations of the world have been engaged, under the auspices of the United Nations, in a permanent floating negotiation on a global deal to reduce greenhouse gas emissions. That process nearly collapsed at the Copenhagen conference in December 2009. The chaos Obama found on arrival and the barebones agreement he was able to get before departing convinced him and many others that they would have to lower expectations for the next such meeting, which took place in Cancun, Mexico, in late November and early December 2010.

Copenhagen highlighted the danger of investing too much hope and political will in the cumbersome UN-led pursuit of a legally binding global treaty—a process that has been on slow forward and that Copenhagen did little to accelerate. Instead, the United States, the European Union, China, and India should form the core of an expanding circle of countries that develop their energy policies and regulate their emissions in an increasingly coordinated fashion.

AS THE PAPERBACK EDITION OF THIS BOOK WENT TO PRESS IN JUNE 2011, another cold winter in much of the United States had given way to the first signs of spring. Just weeks after the last traces of snow left over from the blizzards had melted, there were reminders that local weather can be deceptive about what is happening to global climate. In Washington, many species of birds were migrating north sooner than they had in past decades; the cherry trees along the Tidal Basin were blooming earlier than a few decades before.¹³

The political atmosphere in the nation's capital turned increasingly inhospitable to meaningful action on the issue of climate change. With power divided between Democrats and Republicans, it appeared even less likely that Congress would find a path forward.

It had taken the support of eight Republicans for Democrats to pass, by the narrowest of margins, a climate and energy bill in the House during the summer of 2009. In the fall of that year, counterpart legislation got nowhere in the Senate. During the long, harsh, rancorous winter of 2009–10, the chances for climate legislation seemed bleak. Then, in the spring that followed, there was a fleeting glimmer of hope. Senator Lindsey Graham, a Republican from South Carolina, worked with John Kerry, a Democrat from Massachusetts, and Joseph Lieberman, an independent from Connecticut, in crafting a bill that would put a price on CO₂. However, that effort fell victim to escalating partisanship in advance of the midterm elections in November 2010. The resulting Republican victories increased the strength in Congress of opposition to effective climate legislation. Many newly elected members shared Senator Inhofe's skepticism about whether global warming was real. As a consequence, what should have already been a national priority in 2011 was likely to remain on hold at least until after the 2012 presidential election.

The longer the delay in U.S.-led international action, the more serious the problem of climate change would become, the more drastic the measures that would be required to do something about it, and the greater the risk of irreversible damage to the ecosphere.

That threat is almost, but not quite, without precedent. As Americans debate whether—and better yet, *how*—to take action on climate change before it is too late, they would do well to recall the only other time that humanity has confronted a comparable peril and met the challenge of keeping it in check.