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The History of Human-Caused Global Heating

> Whether one chooses to ignore, suppress, deny or agonize over the knowledge of what is happening, it is there, in the air, heavier by the year. And yet the descendants of the Lancashire manufacturers, whose dominion now spans the globe, are taking decisions on a daily basis to invest in new oil wells, new coal-fired power plants, new airports, new highways, new liquefied natural gas facilities, new machines to replace human workers, so that emissions are not only continuing to grow but doing so at a higher speed.
>
> Andreas Malm, *Fossil Capital*

In 1988, the prominent climate scientist James Hansen, director of NASA's Goddard Institute for Space Studies, testified before the US Congress that human emissions of greenhouse gases were heating our planet to dangerous levels. His warning, however, was ignored. Since his testimony, more than 50 percent of all greenhouse gases in human history have been emitted, and almost every biosphere and earth system indicator is blinking red.[1] Time is now running out to keep global heating from reaching levels that would be catastrophic for millions of species and for organized human existence as we know it.

Our current fossil fuel economy and industrial-scale agricultural practices are releasing vast amounts of carbon dioxide (CO_2) and methane (CH_4) into the atmosphere. These gases are called greenhouse gases because they lead to global heat accumulation via the accelerated **greenhouse gas effect**, as shown in Figure 1.1. The resulting global heat accumulation is equivalent to the addition of about four Hiroshima bombs of energy every second of every minute of every hour of every day, day in and day out, for decades.[2] This has already led to about 1.1°C (2°F) of heating since preindustrial times, which has resulted in a roughly 400 percent increase in such extreme weather events as hurricanes, floods, droughts, and heat waves since just the 1970s.[3] According

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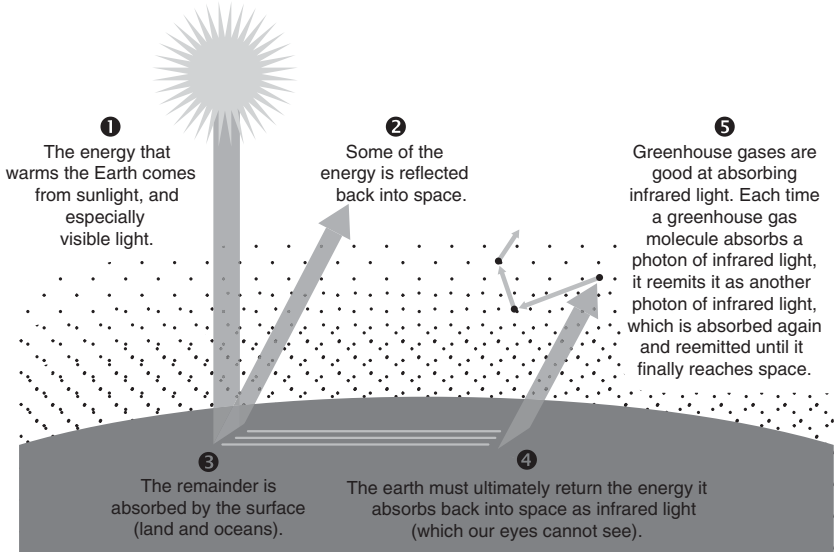
Figure 1.1

The greenhouse gas effect

Greenhouse gases slow the escape of infrared light into space. This traps heat in the lower atmosphere, making it, and the surface, warmer than it would otherwise be. The best analogy is a blanket. You stay warm when wrapped by a blanket because it slows the escape of your body heat.



to the IPCC, which represents the international consensus among climate scientists and is backed by the world's governments, if our greenhouse gas emissions continue on our current high-emissions pathway, we are likely to experience a rise of 2.4°C (4.3°F) by some time between 2040 and 2060, and even reducing that to a medium-emissions pathway would lead to a 2.0°C (3.8°F) increase by then.[4] In the meantime, every fraction of a degree of increase in global heating will unleash dramatically worse consequences around the globe.[5]

What must be done to avert the worst of those consequences? In 2018 the IPCC declared that to have a good chance of limiting global heating to a target of 1.5°C (2.7°F) above preindustrial levels, by 2030 we would have to cut 2010 levels of greenhouse gas emissions by 45 percent.[6] Put in terms of our remaining **carbon budget**, to have even a 50 percent chance of keeping heating to 1.5°C, we can afford to emit only about 300 gigatons (Gt, or billion tons) more of CO_2.[7] Yet, counting up all the existing and currently pledged

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fossil fuel infrastructure and business-as-usual activities around the world indicates that we are already committed to producing 840 gigatons of CO_2. (See Box 1.1 for an explanation of the units of measurement used in this book.) It is clear that, even accounting for the temporary dip of emissions induced by the Covid-19 pandemic, we are rushing well past that target toward an increase of 2°C, which as noted above could occur in a sustained fashion in the 2040 to 2060 time frame according to the IPCC.[8]

To better understand our current predicament and why we failed to heed the warnings of the scientific consensus regarding global heating, this chapter

Box 1.1 Units and measurements

Different temperature scales: 1° Celsius of global heating = 1.8° Fahrenheit, so a 2°C increase is 2 × 1.8 = 3.6°F.

Converting temperature: To convert a temperature in Celsius to Fahrenheit, take the temperature in Celsius, multiple by 1.8 and then add 32. For example, 29°C = (32 + 1.8 × 29) = 84.2°F.

How to weigh the gas that comes out of the chimney: Every carbon atom burned will produce one CO_2 molecule. An oxygen atom weighs 1⅓ times that of a carbon atom, so a CO_2 molecule weighs 2 × 1⅓ + 1 = 3⅓ times as much as a carbon atom. Power stations record how much coal they burn each year and determine the carbon content of the coal (which typically ranges from 60 percent to over 80 percent, depending upon where it is mined). So if a power station burns one million tons of coal that is 70 percent carbon, it uses 700,000 tons of carbon that produces around 2.5 million tons of CO_2.

Weights: One metric ton is 1,000 kilograms. A kilogram is 2.2 pounds; 1,000 metric tons is a kiloton; and one billion metric tons is a gigaton (Gt).

Energy: The standard unit is one joule – the amount of energy that acts on an object when one Newton moves one meter or the amount of energy dissipated as heat when one amp passes through a resistance of one ohm for one second.

Power: One watt is one joule per second. It reflects the rate at which work is done or energy is transferred. One horsepower is 745.7 watts. A kilowatt (Kw) is 1,000 watts. A medium-size car can produce about 40 Kw running at typical constant speed. A megawatt (MW) is one million watts or 1,000 Kw. This is enough to power about 400 to 900 US homes.[9] A megawatt hour (MWh) is one MW of electricity used continuously for one hour.

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offers an historical examination of how global heating arose, how much we have already had and can anticipate, and the international attempts to deal with it.

The Industrial Revolution's Huge Increase in Fossil Fuel Use

As Timothy Mitchell points out in *Carbon Democracy*, before the Industrial Revolution, people used mostly renewable sources of energy, such as water or animal power and wood that "captured" energy from the Sun.[10] The renewable forms of energy that powered such activities as heating, farming, and milling in preindustrial life were weakly concentrated (not energy dense like fossil fuels) and required people to live mostly in relatively dispersed settlements near rivers, pastures, and woodland. The timescale of such energy production was also slow, depending on the life span of animals and the time it took to replenish forests via photosynthesis. But around 1800, European countries, and Britain in particular, began to replace these organic supplies with highly concentrated stores of buried solar energy, such as coal and oil – fossil fuels that were produced by the compression of the decomposed biomass of dead marine organisms from about 150 to 300 million years ago. To understand just how concentrated these fossil fuels are, consider that one liter (about a quarter of a US gallon) of gasoline used today required about 25 metric tons (about 55,000 pounds) of material from ancient marine life.

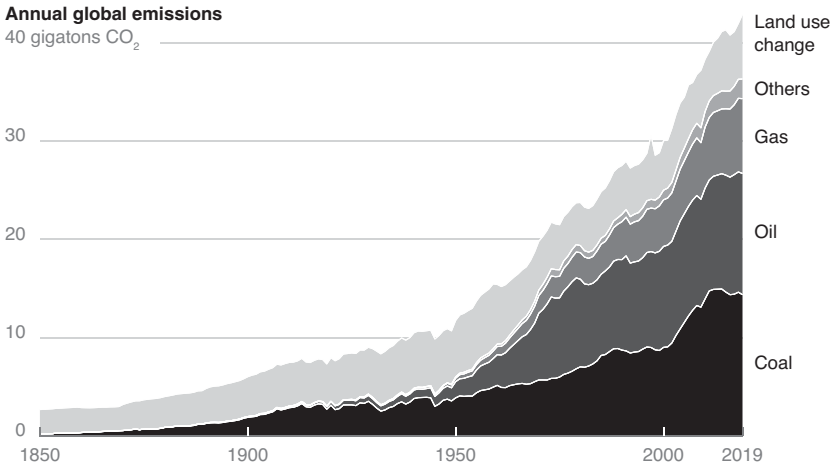
Once humans discovered a way to "free" energy from the limits of the muscles of living animals and the replenishment of woodlands, their use of such energy began to grow at an exponential rate. The amount of energy produced by this change was stupendous. The amount of coal energy put to work in Britain grew from 170,000 horsepower in 1800 to 2.2 million in 1870, 10.5 million in 1907, and 100 million by 1977. Before Britain's coal reserves were mostly exhausted about twenty years ago, they released as much raw energy as the total amount of oil provided so far by Saudi oil production.

As Mitchell explains, the enormous increase in energy made possible by this use of fossil fuels in European countries accelerated the development not only of industrial capitalism but of colonialism. First, European countries had a growing need for territory that could provide the raw materials, such as cotton and sugar, to which this enormous fossil energy could now be applied through manufacturing and production processes. Second, as more European workers became engaged in industrial production, they could no longer grow food, and thus industrializing nations needed additional territory and populations to supply their workforces with consumables. But given that faraway agrarian peoples understandably preferred to use their land and labor to provide for

Figure 1.2

Annual global emissions of carbon dioxide are rising

Fossil fuel use and carbon production have increased enormously since the nineteenth century. With them, atmospheric concentrations of carbon dioxide and temperature have also gone up.



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their own needs, European colonial powers devised ways to control the land and farming practices of those distant populations, such as dispossessing Indigenous populations and importing slave labor to acquire sugar and cotton from the Americas.

Thus, while coal provided concentrated energy for rapid industrialization, colonization provided the raw materials and markets for the work to be done and the goods necessary to feed the industrial workers. Since the nineteenth century, the use of fossil fuels has continued to increase enormously – not only of coal but, following World War II, of oil and then methane (so-called natural gas) (Figure 1.2). As we will see in Chapter 2, this increase in the use of fossil fuels closely parallels the increases in atmospheric CO_2 concentrations.

The Discovery of the Greenhouse Effect

Meanwhile, scientists in the late nineteenth century first began to make the links between the use of fossil fuels, increases in CO_2 concentrations in the atmosphere, and global heating. The initial step in this new understanding is

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typically credited to the Irish scientist John Tyndall, who demonstrated in 1859 that gases such as CO_2 and water vapor can absorb heat. (While Tyndall is generally credited with this discovery, it was in fact made three years earlier by an American amateur scientist named Eunice Foote, whose findings were largely overlooked at the time, probably due at least in part to her gender and lack of professional credentials.)[11] In 1896, the Swedish scientist Svante Arrhenius took Tyndall's findings a step further, arguing that fossil fuel burning, by adding CO_2 to the atmosphere, would raise the planet's average temperature, a phenomenon Arrhenius referred to with a Swedish term that translates as "hotbed" or "hothouse," a precursor to our term *greenhouse effect*.[12] At the time, however, few took Arrhenius' argument seriously, as they thought that changes in human activity would affect vast climate cycles only over the timescale of tens of thousands of years.

Little further progress in climate science took place until the Cold War, which led to a sharp increase in science funding for research on the weather and oceans, motivated largely by military concerns. During this period, Charles Keeling of the Scripps Institution of Oceanography in La Jolla took painstaking measurements of CO_2 from the top of the Mauna Loa mountain in Hawaii that showed that CO_2 levels were rising year by year. In the next few decades, scientists devised simple mathematical models to describe the climate and found creative ways to retrieve information about past temperatures by studying ancient pollens and fossil shells. At the time, climate scientists' calculations suggested that average temperatures were likely to rise a few degrees in the next century, a likelihood that at the time seemed too far off to inspire policy recommendations. Yet, while a few degrees may not sound like much, such an increase corresponds to enormous impacts on climate. As we will see in Chapter 2, even the less than 1°C of heating that has occurred since the 1980s corresponds to a 400 percent increase in the number of extreme weather events since then.

The inattention to climate began to change in the 1960s, however, as well-publicized ecological disasters and the publication of popular books such as Rachel Carson's *Silent Spring* created greater attention to the environment in Western societies. The huge post-World War II economic growth and increase in industrialization brought with it increased environmental disruption and risk and a growing recognition that environmental problems can also produce human health problems. Together, greater concern over such health effects among members of the well-off middle class and the context of general support for social change and social movements led to the rise of a "green politics" in European countries, as left-wing political parties began to champion environmental concerns.[13] In the USA, this new consciousness led to the bipartisan

passage of extensive legislation, such as the Clean Air Act of 1970 and the Water Pollution Control Amendment of 1972, even under the conservative administration of President Richard Nixon. This growing public awareness of the harm that human activity was doing to the planet created a wider backdrop for climate science's growing focus on fossil fuel emissions. As research activity further accelerated with the use, by scientists, of international fleets of ocean-going ships and orbiting satellites, these scientists and policy makers in the USA and elsewhere began to warn that climate change was not merely a distant concern but was taking place already.

As investigative reporter Nathaniel Rich points out in "Losing Earth: The Decade We Almost Stopped Climate Change," by 1979 scientists had accumulated nearly all the knowledge that was needed to understand global heating.[14] That year a report published by a research team led by Jule Charney, a major figure in meteorology, titled *Carbon Dioxide and Climate: A Scientific Assessment*, distilled much that was known about ocean, sun, sea, air, and fossil fuels and attempted to estimate something they called **climate sensitivity**, or how sensitive the climate is to increases in CO_2. Although the researchers noted that the thermal inertia of the ocean would lead to a lag on the order of decades between the release of CO_2 and the resulting temperature rise, they calculated that atmospheric CO_2 concentrations would double their preindustrial levels sometime in the first half of the twenty-first century and predicted that, as a result, the average global surface temperature would increase by 3°C (with 95 percent confidence that it would occur between 1.5 and 4.5°C). This estimated 3°C rise in temperature was particularly striking, as the last time the world had been that warm was about twenty million years ago, when trees grew in Antarctica and sea levels were eighty feet higher, as will be shown in Chapter 2. As the report made clear, human beings had altered the Earth's atmosphere through their massive burning of fossil fuels, a problem that could be reduced to a simple axiom: the more CO_2 in the atmosphere, the warmer the planet.

The Thwarted Opportunity to Act in the 1980s and 1990s

As Rich and others have pointed out, at the start of the 1980s, with the main scientific question settled beyond debate, attention shifted from the diagnosis of the problem to its predicted consequences and the need to act. In 1980, US President Jimmy Carter signed the Energy Security Act, which directed the National Academy of Sciences to undertake a comprehensive study to analyze the social and economic effects of a warming planet. Even the major oil company Exxon, anticipating that legislation to restrict hydrocarbons might

be passed following Charney's report, created its own dedicated CO_2 research program to understand how much its activities had contributed to the problem. Indeed, the company had been studying the CO_2 problem for decades, as had the American Petroleum Institute, the oil industry's largest trade association. In anticipation of the results of the National Academy of Sciences study, Exxon began to spend substantially on global warming research, including funding outside scientists. In 1982, Edward David, Jr., the president of Exxon's research division, boasted that the company would create new global energy systems to save the planet. Indeed, the CO_2 issue was now receiving major attention not only from scientists and policy makers but from the energy sector of the economy, which also began to make heavy investments in nuclear and solar power.

When the eventual National Academy of Sciences report, titled *Changing Climate*, appeared in 1983 during President Reagan's administration, it echoed the report of Charney's group in calling for immediate action to solve this pressing existential problem. Yet, that was not the way the report was represented by the chairman of the committee, William Nierenberg, a presidential advisor and director of the Scripps Institution of Oceanography in La Jolla, California. At press interviews following the report's release, Nierenberg denied there was an urgent need for action, advised the public not to be frightened by the most "extreme negative speculations," and argued that it was better to wait and see what would happen because American ingenuity would save the day. Those who knew Nierenberg were not surprised by his remarks. A devout believer in American exceptionalism and one of a group of scientists who had helped win World War II and created the booming aerospace and computer industries, he was a free market ideologue who was hugely optimistic about the saving grace of market forces and deeply pessimistic about the value of government regulation. As Rich explains, despite the evidence and conclusions of the actual report, Nierenberg's remarks, which were probably 1/500th of the length of the report, received 500 times the press coverage. This was reflected on the front page of the *New York Times*, whose headline announcing the release of the report read "Haste on Global Warming Trend is Opposed."

Historians Naomi Oreskes and Eric Conway have identified this statement as the beginning of what they call the climate change debate. As their classic book *The Merchants of Doubt* notes, "Nierenberg didn't deny the legitimacy of climate science. He simply ignored it in favor of the claims made by economists: that treating symptoms rather than causes would be less expensive, that new technology would solve the problems that might appear so long as government did not interfere, and that if technology couldn't solve all the

problems, we could just migrate."[15] Yet not even all economists shared that perspective; by the late 1960s, some had begun to realize that free market economics focused on the growth of consumption was destructive to the ecosystems upon which we all depend. But Nierenberg had not put any of those economists on his panel. Instead, Nierenberg's one-sided view gave the White House the scientific cover it needed to largely ignore the impending climate crisis: a report that presented a unified view rather than the differences of opinion between social and physical scientists and which insisted that no immediate action was needed. Nierenberg, who still has buildings named after him at the Scripps Institution of Oceanography at University of California San Diego, went on to work in right-wing think tanks, where he continued to create doubt about climate change.

The effectiveness of Nierenberg's ploy was reflected in a shift in Exxon's position, which soon cited the *Changing Climate* report as evidence that "the general consensus is that society has sufficient time to technologically adapt to a CO_2 greenhouse effect" and reverted to being mainly a supplier of hydrocarbon fuels. The American Petroleum Institute also canceled its CO_2 research programs. This shift not only marked a new commitment to fostering climate change denial among powerful elites and institutions but represented a missed critical turning point at a time when a shift to non-fossil fuel energy might have been much easier to manage.

Meanwhile, as Rich points out, a new problem related to the atmosphere emerged, that of the so-called "hole in the ozone layer." In fact, there was no layer and no hole: ozone, which shields us from ultraviolet radiation, is present throughout the atmosphere, and the supposed hole was merely a descriptive metaphor for how the amount of ozone in Antarctic had begun to decline dramatically for about two months per year. Still, the reductions in ozone were real, allowing more ultraviolet radiation to reach Earth's surface and increasing the likely incidence of skin cancer in humans. This reduction of ozone was traceable to the human-made chloroflourocarbons used in refrigerators and aerosol cans, which, when released into the atmosphere, devoured ozone and also functioned as potent greenhouse gases (much more so than CO_2). Yet the huge public concern over this issue came not from people's concern about atmospheric warming but their worry about getting skin cancer. The public outcry was such as to produce alarm in dozens of American businesses that had the word "refrigeration" in their name, which formed an alliance to hound members of Congress, the Environmental Protection Agency, and President Reagan to resist pressures to outlaw these common refrigerants. But in this case, the business interests failed; every relevant government agency and every member of the US

Senate urged the president to endorse a United Nations treaty calling for such action.

And thus in 1987, four years after the *Changing Climate* report, the USA and more than three dozen other nations signed a treaty that limited the use of chloroflourocarbons. Obviously, banning chloroflourocarbons had very minor consequences for everyday life in comparison to those of getting off fossil fuels, which is likely to be incredibly difficult for just about everyone, especially industry and governments that rely on them for cheap energy to fuel economic growth. But as Rich points out, the metaphor of the ozone hole had also moved the public because it allowed people to "see" the problem in a visceral way: "Instead of summoning a glass building that sheltered plants from chilly weather ('Everything seems to flourish in there'), the hole evoked a violent rending of the firmament, inviting deathly radiation. Americans felt that their lives were in danger." As a result, "[a]n abstract, atmospheric problem had been reduced to the size of the human imagination. It had been made just small enough, and just large enough, to break through."

Inspired by the success of the international treaty on ozone, in March 1988, forty-two senators, nearly half Republicans, now demanded that President Reagan also call for an international treaty on climate change. Reagan agreed and signed a pledge with Gorbachev of Russia to cooperate.

The following year of 1988 was one of the hottest and driest in US history. Two million acres in Alaska were incinerated in wildfires, and some streets in New York melted. For the first time in its history, Harvard University was closed because of the heat. Forty percent of the nation's counties were affected, and many people began to wonder if global warming was not so far off after all. That recognition was reinforced by a hearing of the US Senate Committee on Energy and Natural Resources at which the previously mentioned James Hansen was the star of the show. Testifying about new research that showed a current warming of 0.5°C relative to the 1950–80 average, he reported that NASA had determined that the probability that this warming could be explained by natural events, rather than human causes, was only 1 percent. Hansen's dramatic testimony brought unprecedented public attention to the issue of the warming climate, with the front page of the *New York Times* reporting his declaration that "global warming has reached a level such that we can ascribe with a high degree of confidence a cause and effect relationship between the greenhouse effect and observed warming."[16]

As Rich recounts, by the end of that summer, global warming had become a major theme of the presidential campaign. While the Democratic candidate Michael Dukakis proposed tax incentives to encourage domestic oil production, it was the Republican George H. W. Bush who declared, "I am an

environmentalist" and that "those who think we are powerless to do anything about the greenhouse effect are forgetting about the White House effect." By the end of the year, thirty-two climate bills had been introduced in Congress, co-sponsored by Democrats and Republicans. Meanwhile, the German Parliament created a special commission on climate change, and Canada and Norway called for a binding international treaty on the atmosphere. Even the archconservative Margaret Thatcher, who had been trained in chemistry at Oxford, declared that "the health of the economy and the health of our environment are totally dependent on each other." For its part, the United Nations endorsed the joint establishment of the IPCC by the World Metereological Organization and the United Nations Environmental Program and charged it with making a series of policy recommendations for grappling with the problem. To this day the IPCC remains the most widely recognized and respected international organization on climate, as its reports reflect the consensus of hundreds of scientists and are signed by the representatives of nearly 200 governments around the world.

The newly elected President Bush's supposed commitment to addressing global warming and growing public concern over the issue made it look like actual action on global warming might be possible. In 1989, a bipartisan group of twenty-four senators requested that Bush cut emissions in the USA even before the IPCC's working group offered its own recommendations. Yet, as Rich explains this momentum was soon stopped by Bush's chief of staff, John Sununu, who was ideologically opposed to any limitations on emissions, which to him implied imposing limitations on the economy. At a 1989 international meeting to promote policy action on climate change in the Dutch town of Noordwijk, Sununu's appointed delegate torpedoed a framework for a global treaty. With the acquiescence of Britain, Japan, and the Soviet Union, the conference abandoned any commitment to freeze emissions. Thus, what had appeared to be a decade of progress in understanding and facing the climate crisis had come to a dead end. Once again, and anticipating much of the situation today, climate action had crashed into the wall of a free market ideology that would not countenance government intervention and concerns about the primacy of economic growth.

The United Nations Framework for International Climate Policy from the 1990s to the Present

Even as efforts to take global heating seriously stalled in the USA, since the 1990s the United Nations has promoted numerous international attempts to reduce emissions. As recounted by Brian Tokar in his book Toward Climate

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Justice, in 1990, the IPCC released its first assessment of the science on climate change, which declared that the amount of heating was consistent with the rise predicted by the climate models discussed above but acknowledged that its magnitude was consistent with normal short-term variability (Table 1.1 provides a brief history of IPCC assessments).[17] Even though this conclusion was much weaker than that made by NASA as reflected in Hansen's testimony, it was nonetheless enough to lead many world leaders to believe that action had to be taken and to send delegates to the UN-sponsored Earth Summit in Rio in 1992. This summit culminated in a treaty known as the United Nations Framework Convention on Climate Change (UNFCCC), whose stated objective is to "stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Within a few years, 192 countries had become signatory parties.

To ensure that the principle of justice would be honored in ensuing climate change agreements, this framework enshrined the important concept of **common but differentiated responsibilities**. This notion acknowledges that individual countries have different capabilities for combating climate change, recognizing that, for instance, rich countries would be able to cut emissions sooner with less dire consequences for their populace than less developed countries. It also encompasses moral considerations regarding equity and historical responsibility, such as acknowledging that raising billions of poor people in developing countries out of poverty will require the use of energy and that making energy more expensive could thus work at cross-purposes with improvements in their well-being. It also recognizes that, regardless of current levels of energy use, the vast majority of the CO_2 in the atmosphere has already been put there by rich and industrialized countries. As shown in Figure 1.3, the historical per capita emissions in the USA are more than 300 tons of carbon, or eight times that of China and hundreds of times more than African countries. Given this history, rich countries clearly must bear much greater responsibility for dealing with the emissions problem.

But as important as the UNFCCC framework may have been for encouraging international cooperation in mitigating the greenhouse effect and global heating, it included no enforcement mechanisms. Instead, it set nonbinding limits on greenhouse gas emissions for individual rich countries that were intended to reduce emissions to 1990 levels by 2000 and stipulated how subsequent international treaties (called "protocols" or "agreements") might be negotiated to specify further action. By the mid-1990s, it became clear that no country would meet the nonbinding emissions reduction targets set by the UNFCCC and that real action would require a treaty with mandatory reductions.

Table 1.1. *Key UN summits and reports*

a) Major accord or report	b) Year	c) Major findings
IPCC Assessment 1	1990	"The size of the [observed] warming is broadly consistent with predictions of climate models, but it is also of the same magnitude as natural climate variability"
Rio Earth Summit	1992	The concept of "common and differentiated responsibilities"
IPCC Assessment 2	1996	"The balance of evidence suggests a *discernable* human influence on the climate"
IPCC Assessment 3	2001	"There is new and stronger evidence that most of the warming observed over the last 50 years is *likely* attributable to human activities"
IPCC Assessment 4	2007	"Most of the observed increase in globally averaged temperatures since the mid-twentieth century is *very likely* due to the observed increase in anthropogenic greenhouse gas emissions"
IPCC Assessment 5	2014	"It is *extremely likely* that human influence has been the dominant cause of the observed warming since the mid-20th century"
Paris Climate Accord	2015	Emissions should be reduced as soon as possible to keep the increase in global average temperature to well below 2°C above preindustrial levels and to pursue efforts to limit the increase to 1.5°C, which will substantially reduce the risks and impacts of climate change
Special Report on Global Warming of 1.5°C	2018	Limiting warming below or close to 1.5°C will require reducing emissions from 2010 levels by around 45% by 2030
IPCC Assessment 6, Working Group 1	2021	"It is *unequivocal* that human influence has warmed the atmosphere, ocean and land"
IPCC Assessment 6, Working Groups 2 and 3	2022	"If global warming transiently exceeds 1.5°C in the coming decades … some impacts will cause release of additional greenhouse gases (medium confidence) and some will be irreversible, even if global warming is reduced (high confidence)" "The continued installation of unabated fossil fuel infrastructure will 'lock in' GHG [greenhouse gas] emissions" (high confidence)

Note: Some quotes drawn from https://insideclimatenews.org/content/growing-certainty-ipcc-climate-models-and-assessments.

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In 1997, a new international treaty, the Kyoto Protocol, was signed by 192 countries with the intention of creating a schedule of binding targets for reducing emissions and a process for reaching those targets (Figure 1.4). The primary responsibility for such cuts fell on the rich countries, with the rest accepting common but differentiated responsibilities. But as so often happens, the devil was in the details, and the USA was soon objecting to mandatory cuts. At that point, then President Bill Clinton sent US Vice President Al Gore to Kyoto. Gore was credited with turning the situation around by giving rich countries and corporations an out by suggesting that the USA would sign on to the Kyoto Protocol under two conditions: that mandated emissions reductions would be limited to half of those that were proposed, and that cuts could be implemented through carbon trading. Carbon trading relied on the two approaches of **cap-and-trade** and the **Clean Development Mechanism (CDM) (carbon offsets**), both of which turned out to be deeply problematic (see Box 1.2). Cap-and-trade ostensibly tried to cap the emissions of corporations by allowing them to trade in pollution credits, while the CDM allowed industrialized countries to invest in emissions reduction projects in the developing world and count them toward their own targets. (Such market approaches to the climate crisis are considered in more detail in Chapter 8.)

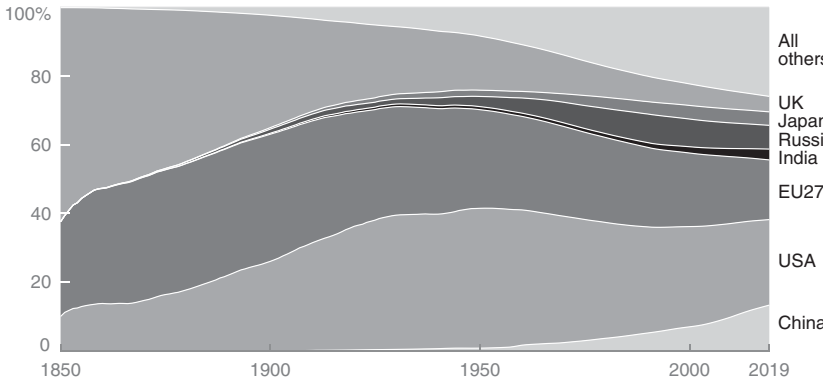
As further recounted by Tokar, the ambitions ambitions of the Kyoto Protocol were further undermined when, in 2001, the administration of George W. Bush withdrew the USA from the agreement on the grounds that it would harm the US economy. Meanwhile, some other industrialized countries continued with the legally binding protocol, whose commitment period was specified as 2008–12. Although the thirty-six countries that continued to participate in the protocols did reduce emissions, the required reductions were only 5 percent less than 1990 levels, a paltry amount, and were abetted by slowdowns created by the financial crisis of 2007–8.[18] In addition, the countries that made the greatest reductions were those of the former Eastern bloc, whose emissions had plummeted even before the deal was signed because of the dissolution of the Soviet Union. Furthermore, ten countries achieved their targets only by using carbon credits (not genuine emissions cuts), and some of the reductions were likely due to a shift of manufacturing to China. Lastly, the accounting did not include fast-rising emissions from aviation and shipping (such as for moving all those products whose emissions were generated in China). Meanwhile, global emissions increased by 32 percent from 1990 to 2010. Thus, the Kyoto Protocol can only be considered a very qualified success, and even though the USA never ratified it, the rest of the world has continued to live with its effects – a cumbersome and corporate-friendly carbon-trading system that manifestly failed to reduce emissions overall.

Figure 1.3

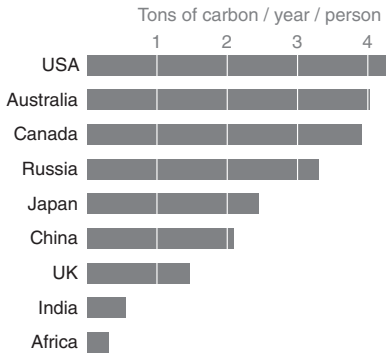
Countries of the Global North have contributed vastly more emissions over time

The UN concept of **common and differentiated responsibilities** refers to the dramatically different historical contributions of countries. For example, in (A) the UK contributed more than 60 percent of global emissions at the time of the Industrial Revolution, but that has declined dramatically, so that in 2019 the UK's emissions are much less than China (B). However, if one takes the cumulative emissions from the UK over history, and divides them by the current population, the per capita contribution of the UK is the second highest in the world (C).

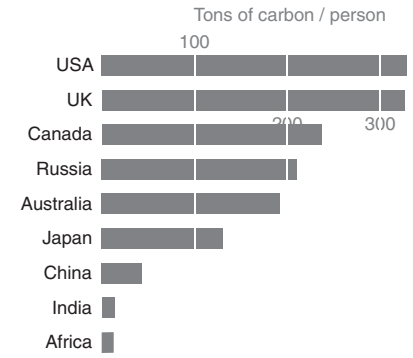
(A) Shares of worldwide historical CO_2 of emissions



(B) 2019 per capita emissions



(C) 1751–2016 per capita cumulative emissions



(A) Adapted from the Global Carbon Project | CC BY 4.0
(B) and (C) Adapted from 1751–2015:T.A. Boden, G. Marland, and R.J. Andres. 2017. Global, Regional, and National Fossil-Fuel CO2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi 10.3334/CDIAC/00001_V2017. April 2017 and 2016-2019: BP Statistical Review of World Energy June 2020.

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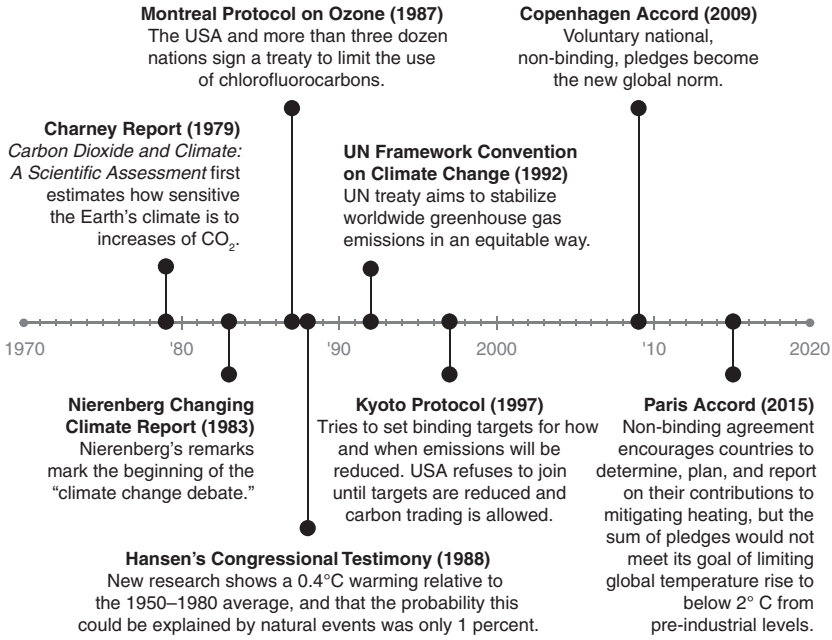
Figure 1.4

Timeline of US climate reports and international negotiations and how these culminated in a deeply inadequate and non-binding framework on emissions reductions

Although the science is overwhelming and many agreements have been made over the years to limit greenhouse gases, in the end, non-binding agreements have prevailed. And these are inadequate to reach the goal of staying below 2˚C.



In 2009, as Barack Obama took office in the USA, climate activists and policy makers looked forward to the upcoming Copenhagen summit, which was intended to negotiate a post-Kyoto protocol. As Tokar also explains in his book *Toward Climate Justice*, outside of this UN-led process and its corporate-dominated interests, a broader climate justice movement had also been building among activists in Europe and North America and Indigenous and small farming communities worldwide.[19] This movement represented the voices of the communities most affected by the climate changes already underway and they challenged what they saw as the corporate-friendly false solutions of carbon trading and offsets, "clean coal," new nuclear plants, and industrial-scale bioenergy (see Box 1.3 for one of those voices from the Global South).

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Box 1.2 Market mechanisms for emissions reduction under the Kyoto Protocol

When US Vice President Al Gore addressed the UN conference in Kyoto in 1997, he stipulated that the USA would sign the agreement if the emissions reductions were implemented under a market-based trading of rights to pollute that became known as cap-and-trade.

Under this scheme, governments set a ceiling on the maximum allowable CO_2 – the cap – for a given industry. Then, for every ton of CO_2 that a polluter reduces under this cap, it is awarded one permit to pollute that can be bought, sold, and banked. Over time, governments were supposed to ratchet down these caps, on the assumption that this would gradually make fossil fuels uncompetitive with renewable sources of energy. While many economists claim this scheme induces companies to implement the most cost-effective mechanisms to reduce emissions as soon as possible, experience has showed that cap-and-trade was often subject to fraud and manipulation. Many industries complained that the cap acted like a tax and that they were made uncompetitive by it. For example, in Europe in 2005, where the world's first mandatory trading market was established, giant utilities and smokestack industries beseeched governments for exemptions, many of which were granted.[20] In Germany, electricity companies ended up being allocated 3 percent more permits than they needed – a windfall worth about $374 billion. As governments caved in, emissions soared and the profits went to the polluters and traders. Other forms of cap-and-trade, such as that currently operating in California, might be more effective, but some critics consider even that form and indeed the overall approach to have been a failure and a distraction from what should have happened instead: genuine emissions cuts.[21]

Another market approach developed under the Kyoto Protocol was the CDM, which allows rich countries to achieve some of their emissions reductions by buying certified emissions reductions units (i.e., carbon offsets) from emissions reduction projects in developing countries. The projects were subject to approval by a monitoring board to determine that the emissions reductions were both "real" and "additional." Additionality is key to this approach, as it means that the project in the developing country would not have happened unless the rich country had paid. Yet a detailed 2016 analysis of the CDM showed that only 2 percent of the projects up until that point had a high chance of being additional, and by the Madrid 2019 climate summit the CDM market had crashed.[22] More

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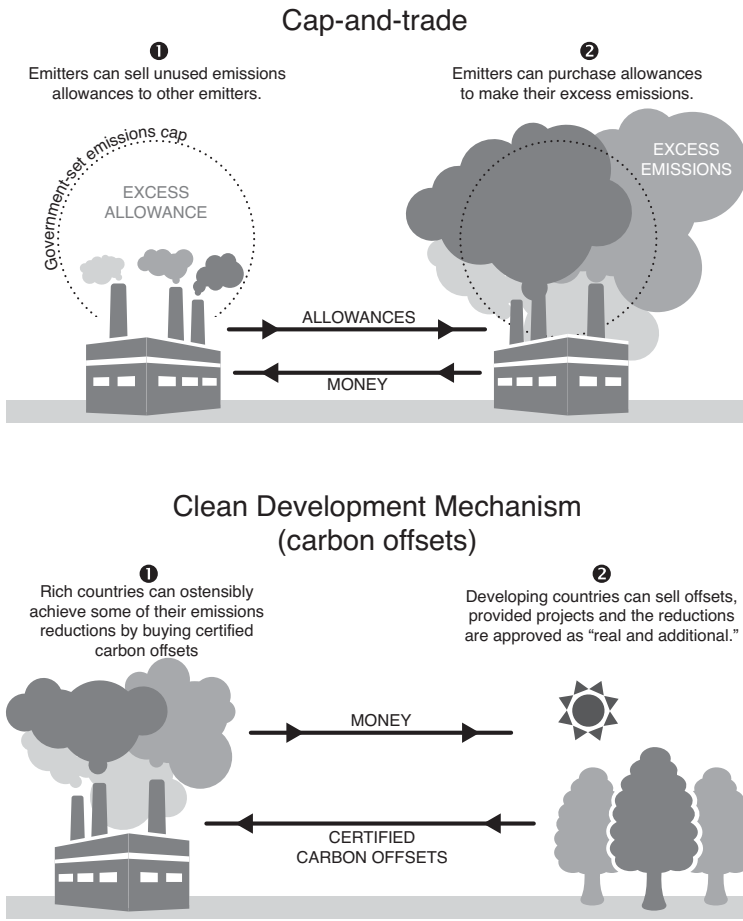

generally, however, carbon offsetting has continued to grow as Google, Apple, and other institutions such as the University of California rely on it. (A more detailed critique of offsets is presented in Chapter 8, the fundamental problem being that those who purchase carbon offsets aren't changing their planet-heating behavior.[23])

That November, North American activists held a continent-wide day of action, during which protestors in the state of South Carolina blocked the shipment of a generator for a new coal plant and in Canada blockaded the office of the finance minister. When the Copenhagen summit on climate change opened in

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December, a hundred thousand protestors took to the streets with the cry of "System Change, Not Climate Change" and called for fossil fuels to stay in the ground, for Indigenous people's rights to be respected, and for reparations for ecological damage to be paid by rich countries.

During the summit, a memo put together by Denmark, the USA, and the UK was leaked to Lumumba Di'Aping, the lead negotiator for participants from the **Global South**, a term that refers broadly to the mostly low-income and often politically marginalized regions of Latin America, Asia, Africa, and Oceania that are also sometimes referred to as the Third World or Periphery to denote regions outside of Europe, North America, Japan, Australia, and New Zealand. In the UN negotiations, Di'Aping specifically represented the Group of 77 countries plus China. According to the memo, summit participants were planning to make a deal that would require developing countries to sign an agreement that gave more power to the rich, sideline the UN's role, and set a new global heating target of 2°C. Di'Aping, who had been named after the Congolese independence leader Patrice Lumumba, loudly and bravely declared that the Global South was being asked to sign a "suicide pact" (Figure 1.5).[24] Referring to the IPCC's own evidence, he explained that a 2°C rise globally actually meant a 3.5°C (6.3°F) rise for much of Africa, which he called "certain death for Africa" and a type of "climate fascism" imposed on Africa by polluters in exchange for promised fast-track funding – a carrot dangled to break the solidarity of the Group of 77 plus China. Declaring that "I would rather die with my dignity than sign a deal that will channel my people into a furnace," Di'Aping asked, "[w]hat is Obama going to tell his daughters? That their [Kenyan] relatives' lives are not worth anything? It is unfortunate that after 500+ years of interaction with the West, we are still considered 'disposables'." Indeed, the most recent IPCC report at the time had predicted that heating in parts of Africa was expected to be much more than the global average (a result that also appears in the IPCC 2021 report and in the future scenarios provided in its 2021 interactive atlas).[25]

The final Copenhagen Accord gave little comfort to the people Di'Aping represented; it agreed that global temperatures should not rise more than 2°C above preindustrial levels; that deep cuts in emissions were necessary to meet that goal; that the rich industrialized countries would set their own targets for emissions in 2020; that the world's developing countries would take steps to mitigate their emissions without having specific targets; and that flexibility should again be incorporated into climate-related policies. As Tokar explains, In the end, a handful of countries, including Bolivia, Cuba, Peru, and Venezuela, objected to the formal adoption of the accord, so that the assembled countries agreed to merely "take note" of it rather than to adopt it (and since it

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Figure 1.5

"I would rather die with my dignity than sign a deal that will channel my people into a furnace"

At the Copenhagen 2009 climate summit, a memo that was being drafted by a small group from the US and richer countries was leaked to **Lumumba Di-Aping**, the lead negotiator for the Global South. He frankly pointed out that a target of 2 degrees Celsius would condemn Africa to much more heating than the gobal average. Estimates from the AR5 report of the IPCC show that under the high scenario of emissions (RCP 8.5) parts of Africa may have more than 3 degrees Celsius (5.4F) heating by mid-century compared to the 1986–2005 mean. (For definitions of AR5 and RCP8.5 please see Chapter 2.)

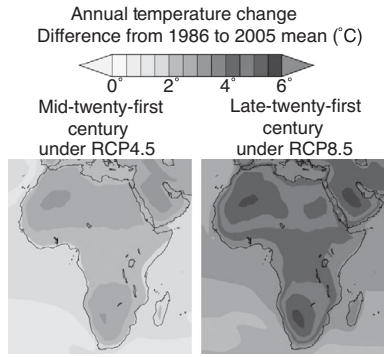

Photo courtesy of Yale University. Data reproduced from the IPCC AR5 report. Figure 22.1 (Top panel, right) from Niang, I. et al., 2014: Africa. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199–1265.

was a political framework and not a legal one the distinction was perhaps unimportant).

The overall outcome represented a triumph for the new agenda of the USA, which was to replace a comprehensive international treaty with a patchwork of informal, individual country commitments. Notably, the European Union, which had once called for a strong worldwide agreement to reduce greenhouse gases, now fell in line with the US strategy. The legacy of the Copenhagen Accord was to establish the notion of voluntary and nonbinding national pledges as the new global norm, which still stands today and represents a failure for emissions reductions.

Even with this evisceration of binding climate action at the international level, a new problem now emerged in many rich countries: a conservative

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backlash against such action and cooperation. In the USA, before about 2009 a number of prominent Republicans had openly accepted the reality of climate change and supported mitigation policies, but that all changed after the Tea Party came to prominence and the Citizens United ruling of the Supreme Court allowed the use of "dark money," such as from fossil fuel interests, to influence elections.[26] After 2009, for example, John McCain, Newt Gingrich, and Mitt Romney all adopted a skeptical position regarding climate change, and other Republicans felt they had to do the same or risk losing their positions. Similarly, in 2011 the conservative government of Stephen Harper in Canada withdrew from the Kyoto Protocol, at least in part because enacting emissions reductions would reduce the value of Canada's immense tar sands, and in 2013 the conservative government in Australia began rolling back its emissions reduction commitments.

The next major international accord on climate policy was the Paris Accord in late 2015, which had the long-term goal of keeping the increase in global temperature to "well below 2°C" above preindustrial levels. Eventually, 189 UNFCCC members, including the USA, became party to this agreement, under which each country agreed to determine, plan, and report on the contributions it makes toward mitigating global heating, although once again it included no binding enforcement mechanism. Although the Paris Accord was much heralded in the press, James Hansen called it a "fraud," describing it as "no action, just promises."[27] Within a few years, it was clear that none of the major industrialized nations were implementing the policies they had agreed to, and research pointed out that even if they had, the sum of the pledges would not be enough to keep the global temperature rise to the 1.5°C target.[28] Shortly after taking office in 2016, President Donald Trump withdrew the USA from the accord.

The next notable event in the development of the IPCC framework was its 2018 publication of a "Special Report on Global Warming of 1.5°C," a consensus document ratified by IPCC member governments that included more than 6,000 scientific references, analyses by ninety-one authors and editors from forty countries, and the input of thousands of scientists. The key finding of this report was that limiting global heating to 1.5°C (2.7°F) would require "deep emissions reductions" and "rapid, far-reaching and unprecedented changes in all aspects of society." [29] It concluded that to meet that target, by 2030 we would have to cut 2010 levels of greenhouse gas emissions by 45 percent. Much of the report was taken up by a comparison of the consequences of increases of 1.5° and of 2° on the biosphere, showing that

there are quite dramatic differences between the two targets in terms of extreme weather, rising sea levels, diminishing Arctic sea ice, loss of ecosystems, and more (for example, at 2°C, 99 percent of coral reefs would be destroyed vs. 70 to 90 percent at 1.5°C). Later in 2018, the USA's own Fourth National Climate Assessment was released quietly by the Trump administration, predicting that by the end of the century climate change damage to the USA would cost hundreds of billions of dollars per year.[30]

Notwithstanding these declarations, however, governments continued to take steps to massively exploit fossil fuels. For example, in mid-2021, the Biden administration was on course to approve as much oil and gas drilling on public lands as the Trump and George W. Bush administrations, and Germany was completing the Nord Stream 2 gas pipeline from Russia that would double the methane supply from Russia.[31] This was despite the fact that at about the same time, the IPCC released its sixth assessment (Working Group 1: Science), now finally declaring that "it is unequivocal that human influence has warmed the atmosphere, ocean and land."[32]

Box 1.3 Interview with Dipti Bhatnagar

Dipti Bhatnagar is the co-coordinator of the climate justice and energy program of Friends of the Earth International, based at Justiça Ambiental/Friends of the Earth Mozambique. Originally from Kolkata, India, Dipti has fought destructive dams in India and has worked on immigrant rights and safe drinking water for farmworker communities of color in California and on climate and energy issues in Mozambique. She lives in Maputo, Mozambique.

AA: How do you feel about the climate crisis?

DB: I feel it very deeply. I feel the suffering that people are going through and that the planet is going through. This is Mother Earth that's sustaining us. It's really horrific the way that our dominant system, our economic system, is treating her. We need to be active, we need to do our part to protect the planet. And we need more people to feel it deeply and not be switched off and not sit with a sense of normalcy that a billion shellfish got roasted in their shells [in the Pacific Northwest heat wave of June 2021], not sit with a sense of normalcy about these wildfires that are ripping through the Amazon, Australia, and California.

AA: You've been an activist for twenty years. What is it about your psychological makeup and your formation that put you ahead of so many people?

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DB: I grew up a normal, middle-class child playing on the streets in Kolkata. My father was in the first generation of independent India, so he saw his role as contributing to building the country. I learned to have a sense of context, to think about history, about what got us to this point, the promise of our freedom struggles. And that has been really important in my life. And then I heard Arundhati Roy [the legendary Indian author and environmental activist] speak at my college in Delhi in 1999. She spoke of what she saw in the Narmada Valley [a dam project that would displace half a million people]. That was the changing point for me. And so I went there to the Narmada Valley with my sister and became a part of the people's movement. And the respect that I have for peoples' movements and local communities and Indigenous peoples and the struggles on the ground, it comes from there. I think this is really important for students to learn as well. While we're in college, we learn how to build knowledge and to have a deep analysis, but at the same time we need to appreciate those whose knowledge isn't typically accepted or understood. I think it's critical that young people are placed in situations where they are face to face with realities that are different from their own.

AA: I want to ask you about Mozambique. It was devastated by Cyclone Idai in 2019. Do the local people understand that it was likely climate change-related and that it will escalate?

DB: Yes, Cyclone Idai was supercharged by climate change, made much more likely and intense. And there was another cyclone that year, Kenneth, and Cyclone Eloise this year. In the urban areas of Mozambique, people have heard of climate change. The government talks about it. Mozambique is one of the most vulnerable countries in the world to the ravages of climate change. Now, rural people may not use that terminology. But rural people do keenly understand and describe the changes occurring in their environment, that something is wrong, that what's happening to their fields, what's happening to their rainfall patterns, is different. Life is becoming harder. It's becoming drier. And when the rain comes, it's much heavier. There are also sea-level rise issues along the coast of this country. At the same time, Mozambicans are dealing with an onslaught of multiple interrelated crises and injustices. We have to put the climate crisis in context with all those other crises that they are facing. For example, 70 percent do not have access to electricity. People are struggling to survive. At the same time, our government is pushing coal and gas extraction, they are pushing mega-projects that are grabbing land.

AA: I want to ask about the historical responsibility for emissions. Some of the elites here don't accept it they say that India and China are emitting more than us now.

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DB: First of all, historical responsibility is very real, and just because those individual elites and their governments don't recognize it doesn't mean it's not true. It's based on science. Much of the carbon dioxide that these countries emitted in building their societies is still in the atmosphere and affecting us all. They created this crisis. The concept of historical responsibility is also enshrined in the UN (Rio) Convention of 1992 [common but differentiated responsibilities]. Of course, actors in the Global North have tried very hard to get away from it. At Copenhagen, President Obama introduced the bottom-up approach, which normally sounds great because it feels like it's decentralized and building power from the bottom up, but in this case it's completely wrong because each country now offers their nationally determined contributions, how much carbon emissions reductions they feel like doing, which is not based on climate science, not based on justice, and none of it is binding. What we needed was a top-down architecture that was going to mandate emissions reductions, based on climate science and based on justice – so that would determine how much each country needs to reduce.

AA: What problems do you see in the way the Global North is responding?

DB: The rich countries continue to fund fossil fuel infrastructure in their countries and abroad while the ink is still drying on their emergency climate declarations. These are the countries that have been polluting since the Industrial Revolution and are most responsible for the climate change we are experiencing today. What's stopping them from acting? It's all about so-called "economic feasibility." They want to be seen to curb emissions while maintaining infinite growth on a finite planet. It's not going to work. This explains why they are pouring money into and pushing the rhetoric of dodgy schemes such as offsetting and carbon markets; towards inefficient and dangerous energy technologies such as mega-hydro, nuclear and bioenergy; and towards developing high-risk, unproven technofixes such as geoengineering and carbon capture and storage. In the climate justice movement we call these "false solutions" – because it poses as an alleged solution but is designed to secure profit for the corporate elite and keep unjust business as usual going, so it is not a solution at all.

AA: What would real solutions look like to you?

DB: Of course we need to quickly and justly transform our energy systems away from fossil fuels, towards renewable energy. But we also need to serve the hundreds of millions who don't even have electricity, most of whom live on this continent. We need to

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underpin this energy transition with just principles. How is the transition going to be done? On whose lands are the solar panels going to be set up? Where are the minerals and other materials going to come from? Friends of the Earth is working on this. It's not just any renewable energy that will be just. It's not about large solar farms in Morocco that export energy to Europe, that's not the transition we need. Ownership matters as well. Is the energy owned by a private corporation or is it in community hands? We're calling for socially owned renewable energy systems. It could be at the building level, at the village, at the city level, wherever, but the people who use the electric power must govern it and make decisions about it. Land use is also a huge factor. The corporate agribusiness model is a huge driver of climate change, also deforestation. We're calling for better, more sustainable ways to grow and distribute our food. We're calling for support for peasant agroecology. And we're demanding land rights and forest rights for the communities who have always taken care of those resources. And that's one of the big problems with the false solutions. False solutions of offsetting, carbon trading, net zero is coming to grab those lands, those forests, those resources because it wants that land, that lake, that forest to sequester carbon so that the Global North countries and the corporations can keep on polluting. And that's why the land rights are so important for local communities.

Conclusion

As this chapter has shown, anthropogenic global heating began in earnest with the burning of coal in the 1800s and has increased exponentially ever since. The basic greenhouse effect was explained as early as 1896, and the scientific evidence supporting it and the reality of global heating was well established by the time of the Charney report in 1979. Although the 1980s and 1990s offered reasons to be hopeful that the USA and international community would take action to confront the need to actively reduce emissions levels, conservative movements and free market economics seem to have so undermined such efforts as to leave them toothless and insufficient. As noted, even if all countries were to meet their nonbinding commitments under the Paris Accord of 2015, it will not be enough to limit heating to 2°C, which according to one estimate will require emissions cuts of about 5 percent per year from 2022 onward.[33] Even though doing so is possible, as evidenced by a reduction

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of about 6.4 percent globally and 13 percent in the USA during the Covid-19 pandemic in 2020, the economic rebound in 2021 put global CO_2 emissions on course to actually increase by 5 percent, reversing most of that decline, and governments such as those of the USA, Canada, and Germany, far from squelching new fossil fuel extraction and development, were increasing their fossil fuel investments and approving more licenses to extract such energy sources.[34] Overall, therefore, apart from temporary dips in emissions after the 2008/9 financial crisis and the Covid-19 pandemic in 2020, the total quantity of greenhouse gases emitted per year has continued its inexorable rise, notwithstanding all the billions invested in research, the nonbinding treaties, and the carbon trading.