

## Inventing Pollution

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# Preface

IT'S EASY TO assume that environmental problems are entirely recent in origin, but that's far from the case. Although many of the hazards that threaten human health and the natural world—such as nuclear wastes, synthetic pesticides, and petrochemicals—are quintessentially modern, other types of pollution have a much longer history. This book explores humanity's long and complicated interaction with coal, the energy source that fueled the Industrial Revolution and the main factor driving climate change. As people in the world's first industrial nation experienced, came to understand, and tried to solve the myriad problems that accompanied their Faustian bargain with this fossil fuel, they created environmental pressure groups, launched scientific efforts to measure and study emissions, enacted pollution regulations, and sought ways to reduce and mitigate the unintended consequences of technological change. In short, they invented the idea of environmental pollution.

The ancients were well aware of the flammable properties of the dark sedimentary rock known as coal, but they viewed it largely as a curiosity. For centuries, its use remained extremely limited, both quantitatively and geographically. To generate heat, people throughout most of the world found it far easier to use wood as a fuel. Britain, however, was an early exception. Starting in the thirteenth century, population growth and deforestation caused shortages of firewood, and Londoners began to adopt coal as their principal source of heat.<sup>1</sup> New uses for coal

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1. Peter Brimblecombe, *The Big Smoke: A History of Air Pollution in London since Medieval Times* (London: Methuen, 1987); William M. Cavert, *Smoke of London: Energy and Environment in the Early Modern City* (Cambridge: Cambridge University Press, 2017).

emerged in the late eighteenth century, following improvements to the steam engine by the Scottish inventor James Watt. For the first time in history, industry and transportation could be powered not by muscles, wind, and flowing water, but by machines that converted the heat of combustion into mechanical energy.

Coal generated great wealth for industrialists and provided employment for millions of people in mines, factories, and the transport sector. A miracle substance in many respects, it also brought enormous problems, many of which were immediately apparent. At first, the extraction of coal involved nothing more elaborate than breaking it free from surrounding rock in veins that emerged on the earth's surface. Over time, miners followed coal deposits deeper and deeper underground, a development aided by the steam engine, which was used to pump groundwater out of mines to prevent them from flooding.<sup>2</sup> Deep mines were extremely dangerous places to work. As coal mining became a major industry in Britain and other countries during the nineteenth century, thousands died each year in explosions and other accidents, and occupational exposure to coal dust caused debilitating and often fatal harm to many of those fortunate enough to have avoided violent death underground.<sup>3</sup>

Mining disasters and the risks of black lung haunted miners and their families for generations, but these dangers affected a relatively small percentage of the populace. A far more significant hazard than coal mining, in terms of the numbers it affected, was coal combustion. Wherever people burned coal, they filled the air with both visible and invisible pollutants. Scientific identification of the constituents of coal smoke emerged slowly, and medical understanding of their effects took even longer. Today we know that coal emissions include fine particles of soot and ash, as well as carbon dioxide, sulphur, a host of highly toxic

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2. Rolf Peter Sieferle and Michael P. Osmann, *The Subterranean Forest: Energy Systems and the Industrial Revolution* (Winwick, UK: White Horse Press, 2010).

3. Barbara Freese, *Coal: A Human History* (Cambridge, Mass.: Perseus, 2003); Thomas G. Andrews, *Killing for Coal: America's Deadliest Labor War* (Cambridge, Mass.: Harvard University Press, 2008).



Figure 0.1. Global carbon emissions from fossil fuels, 1900–2014. Source: T. A. Boden, G. Marland, and R. J. Andres (2017), *Global, Regional, and National Fossil-Fuel CO<sub>2</sub> Emissions*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn. doi 10.3334/CDIAC/o0001\_V2017.

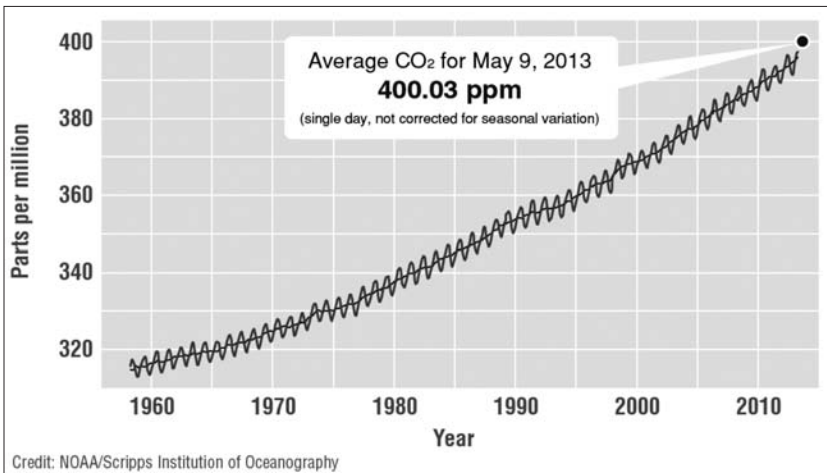


Figure 0.2. Atmospheric carbon dioxide, 1958–2013. Credit: NOAA/Scripps Institution of Oceanography. Source: NASA, *Global Climate Change: Vital Signs of the Planet*, accessed 17 Sept. 2017, [https://climate.nasa.gov/system/image\\_uploads/main/graph-co2-1200x720.png](https://climate.nasa.gov/system/image_uploads/main/graph-co2-1200x720.png).

organic compounds, and poisonous metals such as arsenic and mercury. Exposure to coal smoke increases the risk of heart disease, stroke, respiratory diseases, and cancer.<sup>4</sup>

The last deep coal mine in Britain ceased operation in 2015, and the remaining surface mines produce even less today than what British miners extracted in 1800.<sup>5</sup> Long a major exporter of coal, Britain now relies on imports for the modest amount of coal that it continues to burn. The air of London and other large cities is now far clearer than it was throughout much of the nineteenth and twentieth centuries. Yet significant threats to air quality remain in Britain, now caused mainly by the millions of diesel and gasoline vehicles that crowd the country's cities. Air pollution in London often exceeds regulatory limits, and the government recently announced that air pollution causes between 40,000 and 50,000 early deaths in the United Kingdom every year.<sup>6</sup>

At the same time that coal production has declined drastically in Britain, it has expanded sharply in other countries. Worldwide coal production has more than doubled in recent decades, rising from approximately 3,000 million tons in 1973 to 7,700 million tons in 2015.<sup>7</sup> Rapidly expanding fossil fuel consumption, combined with weak and poorly enforced environmental protections in many countries, recently led the World Health Organization to declare air pollution “the world’s largest single environmental health risk.” Across the globe, the WHO

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4. M. Zhou et al., “The Associations between Ambient Air Pollution and Adult Respiratory Mortality in 32 Major Chinese Cities, 2006–2010,” *Environmental Research* 137 (2015): 278–86; S. Buchanan, E. Burt, and P. Orris, “Beyond Black Lung: Scientific Evidence of Health Effects from Coal Use in Electricity Generation,” *Journal of Public Health Policy* 35 (2014): 266–77.

5. Department for Business, Energy & Industrial Strategy, “Digest of UK Energy Statistics (DUKES),” *UK National Statistics*, last updated 27 July 2017, <https://www.gov.uk/government/statistics/solid-fuels-and-derived-gases-chapter-2-digest-of-united-kingdom-energy-statistics-dukes>.

6. “MPs: UK Air Pollution Is a ‘Public Health Emergency,’” *Guardian*, 26 Apr. 2016, <https://www.theguardian.com/environment/2016/apr/27/uk-air-pollution-public-health-emergency-crisis-diesel-cars>.

7. “Key World Energy Statistics,” *International Energy Agency*, accessed 15 Sept. 2017, <http://www.iea.org/publications/freepublications/publication/KeyWorld2016.pdf>.

estimates that air pollution killed seven million people in 2012 alone.<sup>8</sup> The problem is greatest in countries that are following the pattern that Britain and the world's other wealthiest nations pioneered in the nineteenth century: rapid industrial development, combined with weak or nonexistent environmental protections.

Today, the entire world faces the grave threat of human-induced climate change, caused mainly by the billions of tons of carbon dioxide we have poured into the atmosphere through the burning of coal and other fossil fuels since the start of the Industrial Revolution. For more than half a century, scientists have conducted precise measurements of the constituents of the earth's atmosphere, which have revealed a clear and disturbing trend: each year, the concentration of carbon dioxide is higher than the previous year. Most of the increase in carbon dioxide comes from coal and oil. All fossil fuels contain carbon, but some have more of this element than others. Natural gas and liquid fuels derived from petroleum contain much more hydrogen than does coal, so their combustion emits less carbon dioxide than does an equivalent quantity of coal. The type of coal that yields the most carbon dioxide in relation to its energy content is anthracite, paradoxically praised by smoke-abatement advocates because it produces less visible smoke than other solid fossil fuels, such as bituminous coal or lignite. Anthracite produces nearly twice as much carbon dioxide as natural gas in generating the same amount of heat.<sup>9</sup>

As hard as they tried, the early environmentalists who rallied behind the cause of smoke abatement succeeded neither technologically nor politically in ridding the air of pollution. Yet they did not strive in vain. In many ways, they faced a hurdle similar to the one we now face with climate change: convincing those in positions of economic and political power of the seriousness of the problem. In December 2015, representatives of 195 nations unanimously approved the Paris Climate Accord, which for the first time committed each signatory country to

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8. "7 Million Premature Deaths Annually Linked to Air Pollution," *World Health Organization*, news release, 25 Mar. 2014, <http://www.who.int/mediacentre/news/releases/2014/air-pollution/en/>.

9. "How Much Carbon Dioxide Is Produced When Different Fuels Are Burned?," *U.S. Energy Information Administration*, last reviewed 8 June 2017, <https://www.eia.gov/tools/faqs/faq.php?id=73&t=11>.

reduce its emissions of greenhouse gases. Crucially, the agreement included rich and poor nations alike, and it gained the support of the two countries that produce the greatest amount of carbon dioxide, China and the United States.<sup>10</sup> The latter have been far slower than many countries to acknowledge the dangers of climate change and their own roles in contributing to it, but in recent years both countries have begun to make important strides through investments in renewable energy, efficiency, and efforts to reduce greenhouse emissions from fossil fuel use. In 2007, the US Supreme Court ruled that the Environmental Protection Agency possessed the authority to limit carbon dioxide from vehicles, and seven years later it asserted that the EPA could regulate emissions from new and updated power plants and factories.<sup>11</sup> This development is yet another chapter in the long and continually unfolding story that began in Britain two centuries ago when a constellation of farsighted individuals first invented the concept of environmental pollution. In light of Donald Trump's hostility toward international cooperation in general and the Paris agreement in particular, grave doubts exist about whether the US and other nations will sustain the commitments they have made to address carbon pollution—and whether these will be sufficient to avert catastrophic climate change.

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10. Coral Davenport, "Nations Approve Landmark Climate Accord in Paris," *New York Times*, 12 Dec. 2015.

11. "Justices Rule against Bush Administration on Emissions," *New York Times*, 2 Apr. 2007; "Justices Uphold Emission Limits on Big Industry," *New York Times*, 24 June 2014.