

## Roundtable: The Anthropocene in British History

*Chris Otter (moderator), with Alison Bashford, John L. Brooke, Fredrik Albritton Jonsson, Jason M. Kelly*

**Abstract** The following exchange was the result of ongoing informal conversations among the contributors, who are all, in different ways, interested in the emergent concept of the Anthropocene and the challenges it posed, and the opportunities it provided, for historians working on Britain and the world. The conversation began at the end of 2015 and continued for about a year.

### INTRODUCTION

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In an article published in the *New Statesman* in January 2017, Martin Lawrence paints a disturbing, dystopian picture of 2020s Britain. Brexit has undermined economic growth and investment has collapsed. Robots and artificial intelligence are threatening to push the country into a posthuman age. Finally, he notes, we are “transitioning into the Anthropocene”<sup>1</sup>: species extinction is accelerating, resources are being depleted, and the planet is continuing to warm. The immediate future is, he implies, basically rather terrifying.

This transition into the Anthropocene is unquestionably the deepest and most profound event in recent history. While the term is only a couple of decades old, it has become hard to imagine conceptualizing the impact of human beings on the earth—the collision of human history and planetary geology—without it. But how should scholars working on British culture and history respond to the conceptual challenges of the Anthropocene? How are we supposed to combine two scales of analysis—the geological and the historical? To get our bearings, we assembled ourselves as a roundtable of scholars with significant interest in these debates. Chris Otter, the moderator, is associate professor of British history at Ohio State University. Alison Bashford is research professor of history, University of New South Wales. John Brooke is humanities distinguished professor at Ohio State University. Fredrik Albritton Jonsson is associate professor of British history and the history of science at the University of Chicago. Jason M. Kelly is director of the IUPUI Arts and Humanities Institute and associate professor of British history at Indiana University–Purdue University at Indianapolis.

First some background for those unfamiliar with the basic terrain of these debates: The term *Anthropocene* was coined by Eugene Stoermer in the early 1980s, but it fully entered the scientific community following the forceful adoption of the concept by

<sup>1</sup> Martin Lawrence, “Robots, Brexit and the Anthropocene—Welcome to 2020s Britain,” *The Staggers* (blog), *New Statesman*, 4 January 2017, <https://www.newstatesman.com/politics/staggers/2017/01/robots-brexit-and-anthropocene-welcome-2020s-britain>.

Dutch atmospheric chemist Paul Crutzen in 2000.<sup>2</sup> The Anthropocene, according to Stoermer and Crutzen, is a new geological *epoch*. It follows the Holocene, an approximately 12,000-year epoch with relatively stable climate within which complex human societies developed. The transition from the Holocene to the Anthropocene is, unlike any previous geological transition, caused by the deliberate acts of sentient creatures: “This is not just an environmental crisis, but a geological revolution of human origin.”<sup>3</sup> The concept of the Anthropocene, then, essentially argues that the history of human societies cannot be separate from the histories of climate, the life of nonhuman species, and the earth’s biogeochemical cycles. History and geology have become interwoven, which is a major conceptual challenge to the humanities.

There are, however, several competing versions of *when* this transition took place. Three basic camps have emerged so far. Some scholars, such as William Ruddiman, argue for a “long” or “deep” Anthropocene with origins in the Paleolithic or even further back in the Pleistocene (the epoch before the Holocene).<sup>4</sup> This “deep” Anthropocene is sometimes referred to as the Paleoanthropocene.<sup>5</sup> Others postulate an “early modern” Anthropocene emerging as a result the ecological disruptions of the Columbian Exchange.<sup>6</sup> However, there is most support, at least in scientific communities, for the idea that the Anthropocene really gets underway in the industrial age and particularly after 1945. This post-1945 Anthropocene is often called “the Great Acceleration,” a period in which “every indicator of human activity underwent a sharp increase in rate.”<sup>7</sup> This Great Acceleration is characterized by a swathe of phenomena including the explosion of novel pollutants from plastics to synthetic nitrogen, the emergence of megacities, and the steadily increasing concentrations of atmospheric greenhouse gases, which have pushed the planet beyond its Holocene climatic norms. For geologists, there are many potential stratigraphical signatures, or “Golden Spikes,” which are possible candidates as definitive markers of the Holocene-Anthropocene transition, including anthropogenic soils, technofossils, hybrid plants, and lead concentrations. However, there is widespread geological agreement that “the most dramatic isochronous contamination signature” is the “global-scale spread of artificial radionuclides” evident from 1945.<sup>8</sup>

This talk of Golden Spikes, technofossils, deranged biogeochemical cycles, and Holocene norms might seem well removed from the everyday concerns of scholars

<sup>2</sup> Will Steffen et al., “The Anthropocene: Conceptual and Historical Perspectives,” *Philosophical Transactions of the Royal Society A* 369, no. 1938 (April 2011): 842–67, at 843; Paul J. Crutzen and Eugene F. Stoermer, “The ‘Anthropocene,’” *IGBP Newsletter*, no. 41 (May 2000): 17–18.

<sup>3</sup> Christophe Bonneuil and Jean-Baptiste Fressoz, *The Shock of the Anthropocene: The Earth, History and Us* (London, 2016), xi.

<sup>4</sup> William Ruddiman, *Plows, Plagues, and Petroleum: How Humans Took Control of Climate* (Princeton, 2005).

<sup>5</sup> Stephen F. Foley et al., “The Palaeoanthropocene—The Beginnings of Anthropogenic Environmental Change,” *Anthropocene*, no. 3 (January 2013): 83–88.

<sup>6</sup> Simon Lewis and Mark Maslin, “Defining the Anthropocene,” *Nature*, no. 519 (12 March 2015): 171–80; John L. Brooke and Chris Otter, “Concluding Remarks: The Organic Anthropocene,” in “Humans and the Environment,” special issue, *Eighteenth-Century Studies* 49, no. 2 (Winter 2016): 281–302.

<sup>7</sup> Steffen et al., “Anthropocene,” 849.

<sup>8</sup> Colin N. Waters et al., “A Stratigraphical Basis for the Anthropocene?,” in *A Stratigraphical Basis for the Anthropocene*, ed. Colin N. Waters et al. (London, 2014), 1–22, at 15.

working on, say, Renaissance literature or Victorian politics. But the concept of the Anthropocene has spilled out from the pages of geological journals into other fields, including history and literature. The path-breaking work of Dipesh Chakrabarty is central here. Chakrabarty argued that the Anthropocene forced humanities scholars to confront the reality of the human species as a geological agent.<sup>9</sup> This assertion generated critique from scholars like Jason Moore and Andreas Malm, who argue, in rather differing ways, that such a proposition ignores the specific role of European capitalists, rather than the whole human species, in creating the extractive, globalized, mineral economies that forced the planet over the threshold of the Anthropocene—or as Moore would have it, the Capitalocene.<sup>10</sup> Other scholars, such as Jean-Baptiste Fressoz and Christophe Bonneuil and Amitav Ghosh, have produced more multi-causal accounts of the Anthropocene's emergence, including an important emphasis on empire.<sup>11</sup> In his excellent recent summary of the Anthropocene debates, Jeremy Davies has wisely emphasized a protracted “end-Holocene” event running from the Columbian Exchange to today, within which humanity slowly but fatefully pushed the planet out of its comfortable Holocene envelope into something far more turbulent and unpredictable.<sup>12</sup>

There is, then, an emergent historiography of the Anthropocene. Although some might argue the term has become gratuitously polysemous, the opposite is arguably the case: literatures are often at their most provocative, dynamic, and exciting when concepts are pliable and molten. The urgency and stakes of these debates makes them essential reading for all scholars, irrespective of discipline. The Anthropocene is clearly important to think *with*. Moreover, beneath the conceptual jousting, there are real and profoundly alarming phenomena here—climate change and biodiversity loss, for example—about which there is no serious disagreement at all. Additionally, there can also be no serious disagreement that these phenomena were products of human activity, mediated through capitalism, imperial expansion, fossil fuels, and mechanization. These processes are, of course, the stuff of historians—and not least British historians—and also novelists, poets, and artists. Indeed, numerous scholars have explicitly connected the emergence of the Anthropocene to British capitalist and industrial development. This is certainly Andreas Malm's argument in *Fossil Capital*. In *The Shock of the Anthropocene*, Bonneuil and Fressoz even argue that “from the standpoint of climate, the Anthropocene should rather be called an ‘Anglo-cene.’”<sup>13</sup> Dipesh Chakrabarty, meanwhile, reminds us that the most cherished of anglophone political ideals, freedom, “stands on an ever-expanding base of fossil fuel use.”<sup>14</sup>

The concept of the Anthropocene has thus catalyzed tremendous cross-disciplinary debate and stimulated vibrant and challenging scholarship. But should all modern

<sup>9</sup> Dipesh Chakrabarty, “The Climate of History: Four Theses,” *Critical Inquiry* 35 no. 2 (Winter 2009): 197–222.

<sup>10</sup> Jason W. Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (London, 2015); Andreas Malm, *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming* (London, 2016).

<sup>11</sup> Bonneuil and Fressoz, *Shock of the Anthropocene*; Amitav Ghosh, *The Great Derangement: Climate Change and the Unthinkable* (Chicago, 2016).

<sup>12</sup> Jeremy Davies, *The Birth of the Anthropocene* (Oakland, 2016), 95.

<sup>13</sup> Bonneuil and Fressoz, *Shock of the Anthropocene*, 116.

<sup>14</sup> Chakrabarty, “The Climate of History,” 208.

British historians care about coal? Rather like earlier waves of scholarship on, say, class, race, gender, culture, and empire, the various dimensions of the Anthropocene debate concern all historians and are something we should all be aware of, even if our scholarly focus lies elsewhere. History—and British history specifically—has been inseparable from multiple forms of subject-creation and oppression and profoundly complicit in them. British history has also been deeply implicated in the dramatic reconfiguration of the environment. Both these processes—one human and one non-human—inform the turbulent, troubled present.

What follows is a conversation in which four scholars introduce readers to the various ways in which the Anthropocene concept has influenced their thoughts and scholarship. It shows how attempting to think geologically and historically, in a British context, can lead one in very interesting and innovative directions. These are not the last words on the subject but very much thoughts about work in progress.

First, however, I must address two concepts that are of particular importance. The first concept is that of *scale*. As Chakrabarty notes, any historical understanding of the Anthropocene has to combine human and planetary time in a single, multi-scalar framework. Historians have perhaps tended to be more comfortable with the micro-historical than the *longue durée* and with the local rather than the global, while the modern novel, as Ghosh reminds us, operates at very human time scales. It is easier to feel, conceptualize, and narrate the immediate, spectacular violence of war or genocide than the glacial, silent violence wrought by carbon emissions.<sup>15</sup> Confronting the Anthropocene does not mean abandoning microhistory and the intimacy of modern novels, but it does involve an appreciation of scaling effects. Simply put, large-scale phenomena are not linearly scaled.<sup>16</sup> As the scale of an entity increases, novel, unpredictable, and emergent phenomena appear. The Victorian hearth, the symbol of intimacy, is nonlinearly connected to the amount of carbon dioxide in the atmosphere and the quantity of particulate matter in human lungs. In the Anthropocene, historians need epistemologies, cultural frameworks, and imaginative strategies and policies that allow us to shift back and forth between different scales of analysis. As Deborah Coen has shown, scaling also has a long and complex history: all cultures, at different historical times, have had specific ways of mediating between the smaller and the larger, the close and the distant.<sup>17</sup> Scholars of Britain routinely scale back and forth between geopolitical units (nation and empire, for example). The Anthropocene invites us to complement such practices with new types of scaling techniques, particularly ones extending across long periods of time and linking technologies (steam engines, cars) to vast nonhuman entities (ecologies, climate). These emergent scalar challenges are epistemological and ethical challenges of the Anthropocene.

The second concept is that of *the agency of nonhumans*. The idea of nonhuman agency has been popular in science studies for many years.<sup>18</sup> Indeed, it has become so commonplace as to appear unremarkable. But the stakes for historians

<sup>15</sup> Rob Nixon, *Slow Violence and the Environmentalism of the Poor* (Cambridge, MA, 2011).

<sup>16</sup> Geoffrey West, *Scale: The Universal Laws of Life and Death in Organisms, Cities and Companies* (London, 2017).

<sup>17</sup> Deborah Coen, "Big Is a Thing of the Past: Climate Change and Methodology in the History of Ideas," *Journal of the History of Ideas* 77, no. 2 (April 2016): 305–21.

<sup>18</sup> Bruno Latour, *Reassembling the Social: An Introduction to Actor-Network Theory* (Oxford, 2005).

are important. Climate, animals, machines, and cities cannot now be regarded as simply the passive backdrop of history, if indeed they ever truly were. They are also actors, even if they lack the intentionality and reflexivity that has made humans such profoundly effective geoengineers. History is now about the interactions not simply of humans with other humans but also humans with the entire earth system, revealing “devious chains of cause and effect.”<sup>19</sup> The widespread reintroduction of nonhuman agency, or capacity, into British history and culture involves a changed perspective. It is commonplace to hear that the concept of the Anthropocene really adds nothing to history, since we knew coal and industrialization were important. But as Ghosh notes, acknowledging the teeming diversity of agents and their myriad interactions makes history *uncanny*: the same history becomes vitally different.<sup>20</sup> It is at once biological, technological, and *geological*, no longer ontologically insulated from wider earth processes. In the Anthropocene, historians can no longer deny that our “nonhuman interlocutors” are here to stay as active parts of our narratives.<sup>21</sup>

## COMMENT

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Even if the Anthropocene as a geological fact is under dispute, the Anthropocene as a scholarly object of inquiry is definitely not. After a decade of proliferating conferences and monographs, its status is confirmed not least by its own journals: *Anthropocene*, commencing in 2013, and the *Anthropocene Review*, from 2014. Neither of these, I note, are currently particularly engaged with historians, still less historians of Britain, yet there have been earlier and other scholarly conversations in which historical methods and claims have featured. It is certainly the case that first climate change, and then the Anthropocene, generated excited and sometimes excitable historical debate. Historians were perhaps the first to bring the idea of an Anthropocene from geology to the humanities and social sciences. Libby Robin and John McNeill did so separately but simultaneously in 2007, through the shared intermediary of Australia-based chemist Will Steffen.<sup>22</sup> Early in the scholarly era of the Anthropocene, it was both natural and surely unsurprising that scientists turned to environmental historians, many of whom had long been involved in interdisciplinary conversations and scholarship, not least in variants of historical ecology. Geologists and historians, after all, share time as both an object of inquiry and as a method of analysis.

It may be useful, then, to begin my comment on the question of time and periodization, for this has been one of the key elements of Anthropocene conversation among and for historians. Periodization exercised Anthropocene talk from the beginning. “How long have we been in the Anthropocene era?” asked Crutzen and Steffen

<sup>19</sup> Davies, *The Birth of the Anthropocene*, 8.

<sup>20</sup> Ghosh, *Great Derangement*, 30.

<sup>21</sup> *Ibid.*, 31.

<sup>22</sup> Libby Robin and Will Steffen, “History for the Anthropocene,” *History Compass* 5, no. 5 (July 2007): 1694–1719; Will Steffen, Paul J. Crutzen, John R. McNeill, “The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?,” *Ambio* 36, no. 8 (December 2007): 614–21.

in 2003.<sup>23</sup> Multiple answers have been offered, now a fairly familiar set of claims, and the weight of argument (most of it not built from historians' evidence) seems to be settling at a great acceleration from the 1950s.<sup>24</sup> Yet it matters greatly for British history and historians of modern Britain that there was early and sustained argument for the late eighteenth-century take-off of industrialization as signaling a new era for humankind and for the planet. And even if scientists tend toward the 1950s onward as the starting point, this is an era of capitalist and technological growth inconceivable without the history of industrialization.

Given the inclination of geologists and chemists to date the Anthropocene relatively recently, it has long puzzled me that for historians the Anthropocene has been twinned with a flurry of scholarship on the deep human past.<sup>25</sup> For our discipline, the Anthropocene has opened—and is retrospectively cast as opening—a new and exciting temporal scale in history writing. In other words, and curiously, the same phenomenon has manifested as geologists' interest in (shallow) historical time and historians' interest in (deep) geological time.

On one view, conceiving of and analyzing the past in terms of both geological and historical time is an old enterprise. It engaged all kinds of thinkers in early nineteenth-century “age of the Earth” debates, for example, familiar to historians of modern Britain and historians of science alike. These debates yielded versions of latter-day universal histories that routinely linked the organic and inorganic world to human civilizations in one broad sweep (and indeed sometimes beyond to a supernatural world, as the idiosyncratic H. G. Wells and Julian Huxley did in their *Science of Life*).<sup>26</sup> Long-standing consideration of Indigenous histories was another version of deep time that well and truly preexisted Anthropocene discussion. What puzzles me, however, is that this reauthorizing of deep time for historians via the Anthropocene fails to engage with its very recent periodization. Surely scientists' interest in recent history is more to the Anthropocene point, no matter how exciting and interesting the rediscovery of “deep time” by historians is in other respects. Whether the consensus is late eighteenth-century industrialization or 1950s acceleration, it is modern history under discussion, not human or geological deep time. As I have argued before, the Anthropocene *is* modern history.<sup>27</sup> Indeed, given industrialization, it is modern *British* history and historiography, before it is—or was—anything else, as Fredrik Jonsson suggests.<sup>28</sup> It is certainly time to take stock of what the

<sup>23</sup> Paul J. Crutzen and Will Steffen, “How Long Have We Been in the Anthropocene Era?” *Climatic Change* 61, no. 3 (December 2003): 251–57.

<sup>24</sup> Will Steffen et al., “The Trajectory of the Anthropocene: The Great Acceleration,” *Anthropocene Review* 2, no. 1 (April 2015): 81–98; John R. McNeill and Peter Engelke, “Into the Anthropocene: People and Their Planet,” in *Global Interdependence: The World after 1945*, ed. Akira Iriye, (Cambridge, MA, 2014), 365–533.

<sup>25</sup> Ann McGrath and Mary Anne Jeb, ed., *Long History, Deep Time: Deepening Histories of Place* (Canberra, 2015); John R. McNeill, “The First Hundred Thousand Years,” in *Turning Points of Environmental History*, ed. Frank Uekotter (Pittsburgh, 2010): 13–28. And from a geologist, Jan Zalasiewicz, *The Planet in a Pebble: A Journey into Earth's Deep History* (Oxford, 2012).

<sup>26</sup> H. G. Wells, Julian S. Huxley, and G. P. Wells, *The Science of Life* (New York, 1934).

<sup>27</sup> Alison Bashford, “The Anthropocene is Modern History: Reflections on Climate and Australian Deep Time,” *Australian Historical Studies* 44, no. 3 (September 2013): 341–49.

<sup>28</sup> Fredrik Albritton Jonsson, “The Industrial Revolution in the Anthropocene,” *Journal of Modern History* 84, no. 3 (September 2012): 679–96.

Anthropocene means for modern British history, and to enter strongly into the curiously “geological” debate over what British-led industrialization has meant for the Anthropocene.

I offer two issues. The first concerns the intellectual genealogy of current conversations. The second concerns key thematics in British history and historiography, which I believe are important to foreground in this forum.

There are many declarations in our own Anthropocene discussion, as well as those of others, about the need to think about nature, culture, the planet, and scale, as if we have not done so previously. Benefits obviously accrue when claiming the novelty of scholarly discourse, yet historians needed neither the term Anthropocene nor even the phenomenon of climate change to consider human/nature by scale. And in fixing on an apparently new conversation between historians and geologists, “Anthropocene” historians often forget a third, linking discipline: geography. Humans, history, earth, and Earth have been core business for geographers for a hundred years. And, importantly for us, historical geography and geographical history have long put forward models for the stratigraphical comprehension of geological and human history. We are hardly the first to consider humans and landscapes in multi-scalar ways. And while we do not “like” environmental determinism for obvious reasons, there is nonetheless a connected twentieth-century intellectual history that links our scholarly ambitions with theirs. If an old geopolitical writer like Carl Schmitt can be resurrected as a twenty-first-century theorist (and we’re all supposed to hold our nose with regard to his politics and sometimes quite mundane geopolitics), why should not we also see what might be gleaned from, say, Ellen Churchill Semple’s “anthropogeography” and her considerations of the human-environment-planet nexus? There is an interesting bio/geo holism in this tradition of thought that can move with some conceptual ease between temporal and spatial scales. At the very least, we might press on with the question I posed at a Harvard meeting in 2009: What is at stake in the apparent late twentieth-century reversal from the neo-Hippocratic question—“How did climate make us?”—to our current driving question—“How did we make the climate?”<sup>29</sup>

To Chris Otter’s preceding discussion, I add population growth as part of the great acceleration, whether from a late eighteenth-century or post-1945 starting point. Population growth did, of course, have an important British starting point. This is one of the key reasons why the Anthropocene is (or was) British history. We might even say the Anthropocene started in Britain for this reason. Population growth is the other side of industrialization—far more politically difficult to enter into the conversation than coal. Yet early recognition of population growth prompted strong debate on energy, its use, and its conversion. The history of alternative energy lies in expert debate on population growth, including very early discussion of solar energy. All the ecologists, demographers, and geographers who recognized population growth as a problem did so by scaling out from households, to towns, to nations and, with relative ease, to a planetary imaginary. For three main reasons, I remain convinced that population debate over the long twentieth century was the direct

<sup>29</sup> Alison Bashford and Sarah W. Tracy, “Introduction: Modern Airs, Waters, and Places,” in “Modern Airs, Waters, and Places,” special issue, ed. Alison Bashford and Sarah W. Tracy, *Bulletin of the History of Medicine* 86, no. 4 (Winter 2012): 495–541, at 495–96.

and significant antecedent to planetary climate-change debate: first, because of the shared catastrophic register; second, because ecological holism was initially developed in that context; and third, because population debate folded the “bio” and “geo” domains together, in a way that the Anthropocene recapitulates.<sup>30</sup>

If there is a particular British history to population growth, not unrelated is the modern history of intercontinental land clearance to feed that growing population. Although it seems obvious, and has been touched on above, it is important to state that the British history of imperial expansion is critical to the environmental history of the Anthropocene. In many ways there needs to be a radical conflation of two great historiographical traditions of Britain and the British world: For one, the economic history of industrialization, population, and energy changes, and on the other, the history of settler colonialism, land use, and global land clearance. The long-standing work of Tony Wrigley and the Cambridge population group has been instrumental in linking economic and environmental history but is radically insufficient for Anthropocene analytic purposes unless the geography in question expands beyond the United Kingdom, just as British people themselves did. For another, while settler colonial histories gave rise to early ecological histories (Libby Robin’s work again is key), comprehension of “environment” and resource use has unfolded in large part without the benefit of rigorous economic history analysis. Further, it is often through settler colonial historiography that Indigenous peoples’ cosmologies and economies of resource, ocean, and land use, as well as sometimes radically different periodizations and scales of time, are communicated.

## COMMENT

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Professor Bashford puts the problem of the Anthropocene before us. Historians are just beginning to come to terms with the new reality that historical and geological time have suddenly collided. Geology is a distant domain for historians working in the past few centuries, or even the past few millennia. With some justification, we have comfortably assumed that, setting aside the occasional earthquake, the earth is a stable platform for our narratives in historical time. Geological time simply has not seemed to bear on the human-scale stories we tell.

But the geologists are knocking at our door, telling us that humanity has altered that seemingly stable earth system, that we now inhabit a new geological chronology, and they are on the verge of settling on a very historical date for its clear and certain beginning. In 2016 the Subcommittee of Quaternary Stratigraphy of the International Commission on Stratigraphy considered a proposal from its Anthropocene Working Group to formally adopt the Anthropocene as a geological “epoch.” It would begin with a “Global Boundary Stratotype Section and Point,” a “GSSP,” known as a “Golden Spike”—a hard, chemically defined transition in the hard rock that can be located in global stratigraphy far into the future. The entire period since the end of the Pleistocene Ice Ages is called the Holocene. If all reports are correct, the beginning of the Anthropocene will be officially set at 1945, at

<sup>30</sup> Alison Bashford, *Global Population: History, Geopolitics and Life on Earth* (New York, 2014).

opening of what is called in environmental history “the Great Acceleration,” indicated by the radiocarbon markers of nuclear weapons and a host of other enduring markers, such as aluminum, concrete, plastics, artificial nitrogen, black carbon, and most importantly, a rising volume of carbon dioxide in the atmosphere.<sup>31</sup> The last, of course, is the one that seems to matter the most: rising atmospheric carbon dioxide (CO<sub>2</sub>) caused by fossil-fuel emissions is the most important of the human-produced greenhouse gases that are warming the surface of the earth and clearly launching dramatic shifts in global climate. Humanity, once simply an inhabitant of the earth, is now an agent in its planetary structure.

Perhaps the geologists have stolen a march on the historians, suddenly entering our domain and laying claim to a date and, beyond that, an interpretation. As Bashford notes in her introduction, Paul Crutzen’s original Anthropocene proposal set its beginning firmly at a key moment in British history: in 1784, with Watt’s invention of the double-condensing steam engine. The Anthropocene Working Group moves this opening date forward 160 years and puts it on a global stage. Realistically, the scale and pace of human impacts since 1945 have been so vast and so sudden that there is solid ground for saying the obvious: we have within our lifetimes profoundly altered the very structure of the planetary ecosystem. The geologists may well have political purpose in their very recent date; one of the virtues of a short time frame for the Anthropocene is that we can visualize remedial action in real time: the success of the Montreal protocols to restrict chlorofluorocarbons (CFCs) and gradually restore the ozone layer are a case in point.<sup>32</sup>

But we need to distinguish between cause and effect. The new official Anthropocene date of 1945 marks a moment when the planetary environmental effects of a history of economic, geopolitical, and intellectual transformation began to be overwhelming manifest. Historians and archaeologists whose intellectual project goes beyond the past half century are deeply invested in the problem of causes. Environmental historians and archaeologists have been wrestling with the dating of the Anthropocene for decades. Since the publication of William Thomas’s *Man’s Role in Changing the Face of the Earth* in 1956, picking up where George Perkins Marsh and William Stanley Jevons left off in the 1860s, the central problem in environmental history has been to describe the impact of humanity on nature.<sup>33</sup> Despite the looming certainty of the “Great Acceleration” geological datum, there has been and will continue to be a vigorous debate over when to start the Anthropocene. Archaeologists have argued for a series of deep-time markers: human control of fire at least 1.8 million years ago, the extinction of the Pleistocene megafauna about 14,000 years ago, the combination of hardened soil surfaces and anthropogenic soils created around the world by the rise of Neolithic farming, and the

<sup>31</sup> Colin N. Waters et al., “The Anthropocene Is Functionally and Stratigraphically Distinct from the Holocene,” *Science* 351, no. 6269 (8 January 2016): 137–47.

<sup>32</sup> M. P. Chipperfield et. al., “Quantifying the Ozone and Ultraviolet Benefits Already Achieved by the Montreal Protocol,” *Nature Communications* 6 (26 May 2015): article number 7233, doi:10.1038/ncomms8233; Guus Velders, “The Importance of the Montreal Protocol,” *Proceedings of the National Academy of Sciences* 104, no. 12 (March 2007): 4814–19.

<sup>33</sup> George Perkins Marsh, *Man and Nature; or, Physical Geography as Modified by Human Action* (New York, 1864); William Stanley Jevons, *The Coal Question: An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal-Mines* (London, 1865); William L. Thomas, Jr., *Man’s Role in Changing the Face of the Earth* (Chicago, 1956).

permanently altered bio-spaces more broadly being termed “anthromes.”<sup>34</sup> Others caution that there is a much deeper story to tell about the evolutionary and biological history of humanity.<sup>35</sup> And if in 2000 Paul Crutzen and Eugene Stoermer pegged the beginning of the Anthropocene at 1784, they were challenged in 2003 by William Ruddiman, who started a decade of debate by arguing that wisps of CO<sub>2</sub> and methane emitted by early farmers, really the expansion of farming with the rise of the state five thousand years ago, slowly began to offset the curve of an inevitable Holocene cooling.<sup>36</sup>

One resolution has been to suggest the distinction between an essentially modern Anthropocene and a “Paleoanthropocene” reaching back into the deep past.<sup>37</sup> But the weight of key recent historical work has been to focus on the origins of that modernity: the vitally important early modern transition between roughly 1500 and 1910, in which the geopolitics of population growth, capitalism, and state formation drove a reconfiguration of the global flows of resources and energy. Archaeologists and paleoclimatologists will debate the Paleoanthropocene; many historians are already carefully examining the early modern Anthropocene transition and, in re-examining classic historical questions of the building of extractive and settler empires, the origins of industrialization, and the scientific revolution.<sup>38</sup>

Jeremy Davies has usefully suggested that we think of this broader historian’s framework as a longer “end of Holocene event” reaching back to the destabilizing of the medieval world and the launching of European voyages of “discovery” and expropriation. In this spirit, Chris Otter and I have proposed the distinction between an organic Anthropocene and a mineral Anthropocene in the great early modern transition.<sup>39</sup> Shaped by extractive empire and industrialization, both involve escaping the energy constraints of limited geography and the annual solar-photosynthetic cycle that E. A. Wrigley and Kenneth Pomeranz have put at the center of their accounts of the early modern transition: the appropriation of

<sup>34</sup> Andrew Glikson, “Fire and Human Evolution: The Deep-Time Blueprints of the Anthropocene,” *Anthropocene*, no. 3 (November 2013): 89–92; Christopher E. Doughty, Adam Wolf, and Christopher B. Field, “Biophysical Feedbacks between the Pleistocene Megafauna Extinction and Climate: The First Human-Induced Global Warming?,” *Geophysical Research Letters* 37 (2010); Erle C. Ellis, “Anthropogenic Transformation of the Terrestrial Biosphere,” *Philosophical Transactions of the Royal Society A* 369, no. 1938 (31 January 2011): 1010–35.

<sup>35</sup> Bruce D. Smith and Melinda A. Zeder, “The Onset of the Anthropocene,” *Anthropocene*, no. 4 (December 2013): 8–13; Michael R. Gillings and Ian T. Paulsen, “Microbiology of the Anthropocene,” *Anthropocene*, no. 5 (March 2014): 1–8.

<sup>36</sup> Crutzen and Stoermer, “The ‘Anthropocene’”; William Ruddiman, “The Anthropogenic Greenhouse Era Began Thousands of Years Ago,” *Climatic Change* 61, no. 3 (December 2003): 261–93

<sup>37</sup> Foley et al., “The Palaeoanthropocene,” 83–88.

<sup>38</sup> E. A. Wrigley, *Energy and the English Industrial Revolution* (Cambridge, 2010); Chakrabarty, “The Climate of History, 197–222; Dipesh Chakrabarty, “Climate and Capital: On Conjoined Histories,” *Critical Inquiry* 41 no. 1 (Autumn 2014): 1–23; Fredrik Albritton Jonsson, *Enlightenment’s Frontier: The Scottish Highlands and the Origins of Environmentalism* (New Haven, 2013); Bashford, *Global Population*; Sven Beckert, *Empire of Cotton: A Global History* (New York, 2014); John L. Brooke, *Climate Change and the Course of Global History: A Rough Journey* (New York, 2014), 413–518; Moore, *Capitalism in the Web of Life*; Malm, *Fossil Capital*.

<sup>39</sup> Davies, *The Birth of the Anthropocene*, 5, 90–102, 162–97, 200–8; Brooke and Otter, “Concluding Remarks: The Organic Anthropocene.”

geographically and temporally distant energy sources for the benefit of a given nation.<sup>40</sup>

What bears emphasis here is the timing of their greenhouse-gas impacts on the earth system: until a century ago, organic sources of greenhouse gas emissions far outstripped mineral sources. In the past few years, atmospheric CO<sub>2</sub> has exceeded 400 parts per million (ppm), compared to a Holocene norm of roughly 280 ppm; such is the most dramatic measure of the Anthropocene. During the Little Ice Age, this figure dipped to roughly 275 ppm but had recovered by 1800; around 1850, it began to rise beyond the Holocene norm, hitting 300 ppm around 1910. But industrial emissions shared the stage in this first rise in atmospheric CO<sub>2</sub>; industrial emissions were negligible in a global accounting until the 1870s relative to organic emissions from land clearance, burning, and plowing. While expansion in China accounts for a large proportion of these organic land-use emissions, colonial agriculture in the Americas, and particularly North America, drove emissions sharply from the late seventeenth century. As of 1860, industrial emissions are estimated at 91 teragrams (million metric tons), 45 of which were from British coal use, while global land-use global emissions are estimated at 569 teragrams, half of which came from the surging agricultural expansions across the wheat and cotton frontiers of the American West, growing products destined for British markets. North American land-use emissions probably exceeded British industrial emissions by the early eighteenth century.<sup>41</sup> So if the mineral Anthropocene “is modern British history,” as Bashford suggests in her contribution, a quantitatively far more significant organic Anthropocene is a wider early modern British history, encompassing the wider Atlantic world and specifically North America.

## COMMENT

*Fredrik Albritton Jonsson*, University of Chicago

It is well worth reminding ourselves that the concept of the Anthropocene has carried two basic meanings from the beginning, the first focused on carbon dioxide and climate change, and a second broader view concerned with the general biophysical context of economic development. We find that dual orientation already in Paul Crutzen’s short piece from 2002, “The Geology of Mankind.” On the one hand, the essay suggests a symbolic origin for the Anthropocene in one of the landmark events of the Industrial Revolution—the 1784 patent for the double-condensing steam engine by James Watt. On the other hand, Crutzen also draws attention to a critical threshold of ecological threats in the twentieth century—overfishing the seas, depleting biodiversity, and polluting the earth system with excess nitrogen from industrial agriculture. This second broader definition resonates with the ongoing efforts to find a formal stratigraphic definition of the Anthropocene epoch in geology. The Working Group on the Anthropocene led by Jan Zalasiewicz is searching for signs of

<sup>40</sup> Wrigley, *Energy and the English Industrial Revolution*, 9–25, 193–96, 205–10, 239–50; Kenneth Pomranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton, 2000), 264–97.

<sup>41</sup> For details and full citations, see Brooke and Otter, “Concluding Remarks: The Organic Anthropocene.”

change that are at the same time durable over geological time and so widespread that we can speak of a truly planetary impact.<sup>42</sup>

Evidence of massive human interference with the earth system becomes especially abundant after 1945. This era saw unprecedented economic growth rates among rich countries. Unsurprisingly, the Great Acceleration also witnessed biogeochemical change on a planetary scale. Bulldozers, deep mines, and dams reshaped the basic features of the land in numerous places. Others hallmark of the postwar economy, plastics and electronics, are leaving behind a clear stratigraphic signal in the form of new kinds of durable waste. Microplastics in particular have become “an abundant trace fossil within marine sediments since the 1950s.” Meanwhile, synthetic fertilizers have increased the level of nitrogen and phosphorus in circulation, doubling the level of reactive nitrogen in the planet’s surface and causing eutrophication and algae blooms in the oceans. Atmospheric nuclear weapon testing has spread anthropogenic radioactive isotopes throughout the earth system.<sup>43</sup>

As John observes, this stress on postwar developments sidelines the problem of origins. Anthropogenic carbon dioxide, although present globally in the polar ice cores, is deemed insufficiently representative because the “cause of the signature reflects industrialization in only a small part of the Earth.” The Working Group on the Anthropocene seems to be moving away from the question about historical origins toward an emphasis on planetary impacts. What matters here is the threshold when industrial economies began to trigger global and long-lasting environmental effects. Yet it is worth pointing out here that the new interpretation remains committed to the same kind of chronometric and historical precision that Crutzen promoted with his original date of 1784. Rather than picking an abstract milestone like 2000, the Working Group seems intent on finding a specific decade or year within the twentieth century that marks the rupture. Current candidates for the start of the Anthropocene include 1945, 1950, and 1964.<sup>44</sup>

Chronometric signals embodied in microplastics and isotopes in fact serve as ersatz fossils. Geologists in the distant future may one day date our era using the evidence of the sixth great mass extinction on the planet. This would be in keeping with the geological classification of other stratigraphic boundaries, like the Permian-Triassic event 252 million years ago, when 90 percent of marine species became extinct. But the scholars in the Working Group understandably prefer not to wait for mass extinction and fossil formation before they decide on the formal validation of the new epoch. After all, such an extinction event might well include our own species. By the time we have good fossil evidence of extinction, there might be no geologists left to collect it.

Where does this leave us? If the Working Group is now moving toward a postwar chronology, does this not in fact marginalize the history of the British Industrial Revolution and British Empire? It might be useful to think of the process of stratigraphic validation not as a moment of closure and consensus but rather as a fruitful turning point when the stakes of rival interpretations begin to crystallize and become plain to see. I very much agree with professors Brooke and Bashford that it is far too early to

<sup>42</sup> Paul J. Crutzen, “Geology of Mankind,” *Nature* 415, no. 6867 (3 January 2002): 23; Colin N. Waters et al., “A Stratigraphical Basis for the Anthropocene?”

<sup>43</sup> Waters et al., “A Stratigraphical Basis for the Anthropocene,” 13–15, at 13).

<sup>44</sup> *Ibid.*, 9, 15.

abandon our search for the historical origins of climate change. We need to learn a lot more about the long-term growth of greenhouse gas emissions and energy consumption. As a matter of fact, energy history is now coming into its own as a new field, combining a robust economic and quantitative account with a growing understanding of labor, politics, and culture. This development is in turn generating new friction and rifts. Some scholars have begun to construct an alternative conceptual framework centered on histories of labor and ecology under the banner of the Capitalocene.<sup>45</sup>

We are also very much in need of historical reflection when it comes to the key concepts and norms employed in the discourse on the Anthropocene. Earth system science provides a foundation for much of the work. Yet it is far from obvious how we as historians should engage with the natural sciences. Many of us are committed to sociological and constructivist approaches. How do we reconcile those positions with the perspective of earth system science? Historians of science Christophe Bonneuil and Jean-Baptiste Fressoz have recently suggested that we need to articulate a critical response to earth system science. They resist the notion that the present moment of climate change presents an unprecedented rupture in political and social consciousness when humans for the first time have become aware of themselves as a geological force that puts the planet in danger. Instead, they want to uncover a longer history of “environmental reflexivity” that stretches back to the Enlightenment.<sup>46</sup>

This ambition to situate Anthropocene norms in a broader historical context could be extended in a number of directions. For a long time, we have recognized that environmental change confronts us with political challenges on a planetary scale. Deborah Coen brilliantly reminds us that scaling is a social activity with a complex history. How did people in the past learn to scale between the local and the global or geological time and the present? To take just one example, Martin Rudwick and others have shown how the discovery of deep time stimulated a rich scientific and popular culture in nineteenth-century Britain. We can only grasp the meaning of the Anthropocene if we understand how the notion of the Holocene emerged as a geological and climatological norm in Victorian geology. Another central problem of the Anthropocene concerns the science of prediction and forecasts. Here again, we will find strong British connections. It is possible to uncover a rich history of the future in the Victorian debates about the stationary state and the duration of the British coal supply. Paul Warde, Libby Robin, and Sverker Sörlin trace the history of forecasting back to seminal figures like T. R. Malthus and William Stanley Jevons. Anxieties about resource exhaustion developed in tandem with cornucopian expectations of endless growth. The politics of natural limits is as old as the Enlightenment.<sup>47</sup>

<sup>45</sup> See, for example, Timothy Mitchell, *Carbon Democracy* (London, 2007); Astrid Kander, Paolo Malanima, and Paul Warde, *Power to the People* (Princeton, 2014); Malm, *Fossil Capital*; Jason W. Moore, *Anthropocene or Capitalocene: Nature, History and the Crisis of Capitalism* (Oakland, 2016).

<sup>46</sup> Frank Oldfield and Will Steffen, “Anthropogenic Climate Change and the Nature of Earth System Science,” *Anthropocene Review* 1, no. 1 (April 2014): 70–75; Bonneuil and Fressoz, *The Shock of the Anthropocene*.

<sup>47</sup> Coen, “Big Is a Thing of the Past”; Libby Robin, Sverker Sörlin, and Paul Warde, *The Future of Nature* (New Haven, 2013); Fredrik Albritton Jonsson, “The Origins of Cornucopianism: A Preliminary Genealogy,” *Critical Historical Studies* 1, no. 1 (Spring 2014): 151–68.

## COMMENT

Jason M. Kelly, Indiana University-Purdue University, Indianapolis

It is a strange moment. Debates taking place in the pages of *Nature* are spilling into the world of the social sciences and humanities. The discussions of the Subcommittee on Quaternary Stratigraphy—a group within the International Commission on Stratigraphy, itself an organization within the International Union of Geological Sciences—are increasingly relevant to a growing number of scholars whose previous scholarship has seemed distant from debates over Global Boundary Stratotype Sections and Points, carbon cycles, and microplastics. The reason for this, as professors Bashford, Brooke, and Jonsson have already suggested, is because the stakes of defining the Anthropocene have implications far beyond discussions within the field of geology. For historians, these stakes are both conceptual and methodological.

On the one hand, the Anthropocene is a historically constituted construct, with a provenance that dates back to the eighteenth century or further. At the heart of the construct are two ideas. The first is that humans have become a geological force. At its simplest, this idea means that humanity has created a distinct stratum in the planet's crust that indicates telltale signs of human activity across the planet. The notion that humanity might act as a geological force was contemporaneous with the development of the notion of deep time. In the last years of his life, the president of the Royal Society, Humphry Davy, for example, imagined that humans had created a new sedimentary layer in the earth:

Were the surface of the earth now to be carried down into the depths of the ocean, or were some great revolution of the waters to cover the existing land, and it was again to be elevated by fire, covered with consolidated depositions of sand or mud, how entirely different would it be in character from any of the secondary strata; its great features would undoubtedly be works of man, hewn stones and statues of bronze and marble, and tools of iron, and human remains would be more common than those of animals on the greatest part of the surface. The columns of Pæstum, or of Agrigentum or the immense iron and granite bridges of the Thames, would offer a striking contrast to the bones of the crocodiles or sauri in the older rocks, or even to those of the mammoth or elephas primogenius in the diluvial strata. And, whoever dwells upon this subject must be convinced, that the present order of things and the comparatively recent existence of man, as the master of the globe, is as certain as the destruction of a former and different order and the extinction of a number of living forms which have now no types in being; and which have left their remains wonderful monuments of the revolutions of nature.<sup>48</sup>

In recent decades this idea has expanded somewhat to suggest that humans have left an imprint upon—or even radically altered—the planet's biogeophysical systems. This increasing realization has been the cumulative effect of concerns about human-induced extinctions, the destruction of old-growth forests, the birth of the nuclear age, the unintended consequences of insecticides such as DDT (dichlorodiphenyltrichloroethane), and the discovery of the ozone hole and of global

<sup>48</sup> Humphry Davy, *Consolations in Travel, or the Last Days of a Philosopher* (London, 1830), 146–47.

warming, which have increasingly served as symbols of humanity's potential to transform the planet.

The second idea central to the Anthropocene construct is closely related to the notion of humanity as a geological force. It is the idea that biogeophysical systems and sociocultural systems are inextricably entangled. In other words, humanity's sociocultural structures and practices operate in a feedback loop with environmental systems such as water and nitrogen cycles. The implication of this is that humans aren't simply actors responding to their environments: they are actors *within* the environment and can reshape what were once supposed to be stable systems. The idea that earth systems and human systems are entwined has been central to the environmental imagination since at least the 1950s. The most prominent early names associated with this notion are Rachel Carson, Lynn Margulis, and James Lovelock. However, as Jacob Hamblin has recently argued, the growth of Cold War science and investigations into environmental warfare were important in changing scientific attitudes overall.<sup>49</sup> After the 1970s, debates in evolutionary biology and psychology about theories related to sociobiology, niche construction, and gene-culture coevolution helped to put even more emphasis on the importance of understanding the relationship of sociocultural and biophysical systems—most recently exemplified in the work of Colin Renfrew and Lambros Malafouris on Material Engagement Theory.<sup>50</sup> Since the 1950s, a concurrent move has been taking place in the humanities. The growth of environmental sociology and the environmental humanities has led to important insights into how societies and individuals act as agents in transforming their environments, shaping and reshaping cultural frameworks to justify or respond to environmental change. The work of scholars such as Bruno Latour and Donna Haraway (and more recently, individuals such as Manuel DeLanda and Jane Bennett) have led to wide-scale criticisms of the dualistic separation of humans and nature, exemplified in a variety of approaches associated with posthumanism, new materialism, and Actor-Network Theory. In effect, some key frameworks for understanding the environment in the sciences, social sciences, and humanities were converging at the moment when Paul Crutzen began popularizing the term in the early 2000s, which may explain some of its potency in attracting scholars from across the disciplines.

<sup>49</sup> Jacob Hamblin, *Arming Mother Nature: The Birth of Catastrophic Environmentalism* (Oxford, 2013).

<sup>50</sup> Patrick Roberts, "We Have Never Been Behaviourally Modern: The Implications of Material Engagement Theory and Metaplasticity for Understanding the Late Pleistocene Record of Human Behaviour," in "The Material Dimensions of Cognition: Reconsidering the Nature and Emergence of the Human Mind," ed. Antonis Iliopoulos, Duilio Garofoli, special issue, *Quaternary International* 405, Part A (June 2016): 8–20; Lambros Malafouris and Colin Renfrew, eds., *The Cognitive Life of Things: Recasting the Boundaries of the Mind* (Cambridge, 2010); Elizabeth DeMarrais, Chris Gosden, and Colin Renfrew, eds., *Rethinking Materiality: The Engagement of Mind with the Material World* (Cambridge, 2004); Lambros Malafouris, "Beads for a Plastic Mind: The 'Blind Man's Stick' (BMS) Hypothesis and the Active Nature of Material Culture," *Cambridge Archaeological Journal* 18, no. 3 (2008): 401–14; Malafouris, "Neuroarchaeology: Exploring the Links between Neural and Cultural Plasticity," *Progress in Brain Research* 178, no. 1 (January 2009): 253–61; Malafouris, "Metaplasticity and the Human Becoming: Principles of Neuroarchaeology," *Journal of Anthropological Sciences*, no. 88 (2010): 49–72; Malafouris, "The Brain-Artifact Interface (BAI): A Challenge for Archaeology and Cultural Neuroscience," *Social Cognitive and Affective Neuroscience* 5, nos. 2–3 (June 2010): 264–73; Malafouris, *How Things Shape the Mind: A Theory of Material Engagement* (Cambridge, MA, 2013).

From a methodological standpoint, the Anthropocene poses a key problem for historians. As it is used across the disciplines, the Anthropocene is a device for narrating history. This is exemplified in the debates over dating its point of origin. Scholars have offered a number of alternatives: 10,000 YA, 1610, 1785, and 1945 have all been put forward as potential dates.<sup>51</sup> Each has its own evidentiary strengths: extinctions, domestications, erosion, CO<sub>2</sub> ppm, radioactivity. The problem, it seems to me, is that much of the discussion around a date for the Anthropocene has responded to the methodological assumptions of geology, which necessitate identifying anthropogenic biophysical markers. Thus, the 2016 proposal by the Anthropocene Working Group of the Subcommission on Quaternary Stratigraphy to date the Anthropocene to the post-1945 era was largely determined by the need to identify a historical moment when these markers were present across the planet at a scale worthy of identifying a new geological epoch. The date they chose describes the effects of anthropogenic environmental process—not the processes themselves. Consequently, the sociocultural conditions and practices that made the Anthropocene possible must be, by definition, tangential to the geochronological break.

In defining the Age of the Anthropocene—an epoch defined by the activities of humans—our disciplinary frameworks fall short. A study of earth systems that examines only the effects of human action misses a fundamental variable—humanity. In a very important sense, prioritizing biophysical markers leaves the “Anthropos” out of the Anthropocene. If we work with the date that the Anthropocene Working Group identified—1945—it becomes quite clear that the relevant biophysical markers are the product of complex, centuries-long sociocultural processes: capitalism, industrialization, imperialism (and it must be made clear that the Anthropocene Working Group recognizes this).

As a device for narrating history, the Anthropocene has the potential to reshape scientific understanding, political policies, and even popular knowledge about humanity’s relationship to its environment. If historians and scholars in allied disciplines engage in this debate, they have the potential to affect our understanding of the Anthropocene (and humanity’s relationship to its environment more generally) in some fundamental ways. Most importantly, I think, we can emphasize a historical narrative in which studying complex, long-term sociocultural processes is essential to understanding biophysical change. The result might be more nuanced frameworks for environmental policy, grounded in the research of social scientists and humanists. Allying with scientists in research on the Anthropocene, we might challenge disciplinary conventions and limits, ultimately leading to new interdisciplinary research on the entanglements between sociocultural and biophysical systems.

<sup>51</sup> Simon L. Lewis and Mark A. Maslin, “Defining the Anthropocene,” *Nature* 519, no. 7542 (12 March 2015): 171–80; Jan Zalasiewicz, “Epochs: Disputed Start Dates for Anthropocene,” *Nature* 520, no. 7548 (April 23, 2015): 436.

## RESPONSE

*Fredrik Albritton Jonsson*

Outside economic and environmental history, energy remains mostly absent as an analytical category and empirical subject. Dipesh Chakrabarty is surely right to suggest a link between modern society and energy use, yet how do we turn this deep insight into a productive conceptual framework for historians? So far, the significance of energy consumption has surfaced most clearly in a long-term and large-scale perspective. A strong causal connection between rising income and energy use seems evident when we compare rich and developing countries in the present, or the development of economies from the early modern time to the present. But we still know very little about how energy use has shaped social and political structures across time, from households and social classes to states and empires. One pioneering project of this sort now under way is a comparative study led by Frank Trentmann, which aims to investigate national energy regimes in twentieth-century Britain, East Germany, Canada, and Japan.<sup>52</sup>

We will also want to rethink the analytical apparatus of economic history and social theory in light of these questions. Paul Warde and his colleagues Paolo Malanima and Astrid Kander observe that energy has long been excluded from the production function in standard models of growth accounting. Have we in fact fundamentally underestimated the place of energy in the making of modern economies? Andreas Malm in turn suggests that fossil fuel and carbon dioxide emissions must be introduced into the M-C-M formula (money-commodities-money) of Marxist analysis. In gender theory, we need more work to understand how energy use has reshaped household and family structure, following the neglected lead of Ruth Cowan's classic work on household appliances.<sup>53</sup>

It is tempting to seek analytical clarity here by deriving a specific economic or social interpretation from the material properties of fossil fuels. Yet energy forms tend to include overlapping uses and multiple properties. For example, we will get quite different narratives about the importance of coal use depending on which of its many attributes we choose to stress, including energy density, portability, labor saving, land saving, or the physical conditions of extraction. Another kind of reductionist fallacy arises from a temptation to exaggerate the importance of one kind of energy form over others at a given moment ("the age of oil").

Modern ideologies have arguably gained much of their credence from the cheap energy fueling economic and technological development, as Chakrabarty suggests. But we should be careful not to assume too neat a coincidence of political thought and popular culture with its energy base. To what degree can we speak of a history of liberty before fossil fuels? We also need to recognize that political and cultural interest in energy consumption has been uneven and intermittent rather than steady and uniform. Sometimes confidence in the force of industrialization may

<sup>52</sup> Chakrabarty, "The Climate of History," 208; Frank Trentmann, "Material Cultures of Energy," <http://www.bbk.ac.uk/mce/>; strangely, William Cronon left out coal in his path-breaking environmental history, *Nature's Metropolis: Chicago and the Great West* (New York, 1991).

<sup>53</sup> Kander, Malanima, and Warde, *Power to the People*; Malm, *Fossil Capital*; Ruth Schwartz Cowan, *More Work for Mother: The Ironies of Household Technology from the Open Hearth to the Microwave* (New York, 1984).

have tempted thinkers away from considering its material substrate. (Marx had relatively little to say about coal.) Debates about the significance of coal to the economy appear to have reached a high mark during the 1860s and 1870s when fears of coal exhaustion haunted leading Victorian figures. Perhaps we should think of fossil fuel culture as an oscillation between cornucopian amnesia and moments of panic?

## RESPONSE

*John Brooke*

As this conversation unfolded, encouraged by comments by professors Bashford and Jonsson on liberty, energy, and growth accounting, my thoughts turned to the problem of slavery. (Well, I am also writing a book on culture, politics, and the American Civil War crisis.) One of the central realities of the early modern age of the “Organic Anthropocene” was that productive new lands required hard manual labor, and at the center of this imperial equation stands the problem of slavery. In her opening, Professor Bashford points to the wider Malthusian paradox of modernity: we have replaced the energy constraints, civil boundaries, and moderate environmental impacts of the organic regime for the energy bounty, civil liberties, and accelerating environmental damage of the mineral regime. What then of liberty and energy? We know that electricity is liberating, creating profoundly new understandings of personal space and time. And fossil-fueled economic growth has underwritten the social contract of an ever-expanding economic pie that has helped democracy work. But the relationship was much more direct in the nineteenth-century American circuit of empire and republic forged in the First British Empire.

John McNeill, Naomi Klein, and Jean-Francois Mouhot have argued that we need to consider the relationship between slavery and fossil-fueled machinery. Both slaves and machines burn energy to produce work output that an “owner” does not have to exert: both slave societies and industrial societies live off externalized energies.<sup>54</sup> As Malm notes in *Fossil Capital*, Benjamin Disraeli, writing as a novelist in 1844, called steam-powered machinery “a supernatural slave.” Machinery multiplied the energy brought to bear without the moral and political dangers of labor coercion, Malm observes: “A machine is a slave that neither brings nor bears degradation: it is a being endowed with the greatest degree of energy and acting under the greatest degree of excitement, yet free at the same time from all passion and emotion.”<sup>55</sup> As Jason Moore reminds us, early modern merchant capitalism centered on the “cheap energy” of slavery; modern industrial capitalism revolved around the cheaper energy of fossil fuels.<sup>56</sup> In the popular culture of American abolitionism of

<sup>54</sup> John McNeill, *Something New under the Sun: An Environmental History of the Twentieth-Century World* (New York, 2000), 11–12, 15; Naomi Klein *This Changes Everything: Capitalism vs. The Climate* (New York, 2014), 415–17, 450, 455–57, 462–63; Jean-François Mouhot, “Past Connections and Present Similarities in Slave Ownership and Fossil Fuel Usage,” *Climatic Change* 105, no. 1–2 (March 2011), 329–55; for a dissenting view, see Klas Rönnbäck, “Slave Ownership and Fossil Fuel Usage: A Commentary,” *Climatic Change* 122, no. 1 (January 2014): 1–9.

<sup>55</sup> Malm, *Fossil Capital*, 201–2.

<sup>56</sup> Moore, *Capitalism in the Web of Life*.

the 1840s and 1850s, steam became the metaphoric vehicle of freedom on the Underground Railroad, popularized in the Hutchinson Family Singers' 1845 song "Get off the Track (for Emancipation)."<sup>57</sup> Mouhot and Klein remind us of the forgotten "simultaneous rise of the steam engine and the abolitionist movement"—as steam-powered machinery developed, people began to see the possibilities of the end of slavery, in a broad and diffuse transition similar to that proposed by Thomas Haskell in his account of how spreading awareness of the connections between slave producer and free consumer in the eighteenth-century empire forged a culture of humanitarianism and eventually abolitionism.<sup>58</sup>

Can we estimate the relationship between the energy output of human labor and that of steam power? In 1832, John Quincy Adams, about to emerge as the central force in American political anti-slavery, made one such attempt, telling his colleagues in Congress that as of 1815 "the multiplication of physical power by the agency of machinery" in British manufacturing had reached the point "that the mechanical inventions then in use in Great Britain were estimated as equivalent to the manual labor of two hundred million people."<sup>59</sup> For what it's worth, commonly available data allow us to test Adams's numbers, estimating the coal/steam-manual labor relationship for the United Kingdom and the United States during the organic-mineral economy transition. We know the units of heat (British thermal units, or BTUs) produced by coal burning, and we can estimate the BTUs available for manual labor output based on assumptions about caloric content of diets and the age and gender structure of the labor force. It appears that Adams's source was very close for 1815 and virtually spot on for 1820: British coal burned for industrial purposes annually produced 284 trillion BTUs in 1815; 200 million working men fed a typical American diet (3,300 calories daily) might have 382 trillion BTUs available for labor; 200 million men fed a typical British diet (2,800 calories) might have 324 trillion BTUs available. British coal produced 350 trillion BTUs in 1820. And what of slaves? A general if somewhat controversial consensus is that since slaves were salable property, their diets were larger on average than free whites in the United Kingdom or the antebellum North.<sup>60</sup> If we reduce the 4,000 calories cited in the literature to a

<sup>57</sup> Eric Foner, *Gateway to Freedom: The Hidden History of the Underground Railroad* (New York, 2015).

<sup>58</sup> Mouhot, "Past Connections and Present Similarities," 331; Thomas Haskell, "Capitalism and the Origins of the Humanitarian Sensibility," in two parts, published originally in the *American Historical Review* 90, no. 2 (April 1985): 339–62 and vol. 90, no. 3 (June 1985): 547–66, and republished in *The Antislavery Debate: Capitalism and Abolitionism as a Problem in Historical Interpretation*, ed. Thomas Bender (Berkeley, 1992), 107–60.

<sup>59</sup> Adams, Report on Manufacturing, 23 May 1832, *Gale & Seaton's Register*, House Journal, 22nd Congress, 1st Session, Appendix, 83. I am obliged to Mouhot, "Past Connections and Present Similarities," 335.

<sup>60</sup> Richard Sutch, "The Care and Feeding of Slaves," in Paul A. David et al., *Reckoning with Slavery: A Critical Study of the Quantitative History of American Negro Slavery* (New York 1976), 231–301, at 265–68; Carole Shammas, *The Pre-Industrial Consumer in England and America* (Oxford, 1990), 134–48; David Grigg, "The Nutritional Transition in Western Europe," *Journal of Historical Geography* 21, no. 3 (July 1995): 247–61; Gregory Clark, Michael Huberman, and Peter H. Lindert, "A British Food Puzzle, 1770–1850," *Economic History Review* 48, no. 2 (May 1995): 215–37; Roderick Floud et al., *The Changing Body: Health, Nutrition, and Human Development in the Western World since 1700* (Cambridge, 2011), 41–131; Michael R. Haines, Lee A. Craig, and Thomas Weiss, "The Short and the Dead: Nutrition, Mortality, and the 'Antebellum Puzzle' in the United States," *Journal of Economic History* 63, no. 2 (June 2003), 382–413; Haines, Craig, and Weiss, "Did African Americans Experience the 'Antebellum Puzzle'?"

more realistic average of 3,500, 200 million slaves would produce an astounding 400 trillion labor BTUs per year (see tables 1 and 2).

An analysis of real populations suggests a few basic, perhaps obvious points about energy in the early modern era. First, the slaves in the West Indies were so few in number that their labor output in BTUs was dwarfed by the value of the sugar crop that they produced and that Eric Williams long ago argued might have financed the British Industrial Revolution.<sup>61</sup> Second, the British economy, including estimates of the working population for England, Wales, Scotland, and Ireland, was certainly coal dependent from an early date. Coal consumption—first for domestic heating—rose from the early sixteenth century; by roughly the 1730s, industrial coal BTUs were twice those of manual labor, thirty-three times higher by 1815, and one hundred times higher by the mid-1850s. Third, the economy of the antebellum American North—where most of the coal was burned—was much less coal dependent, hitting the 33 to 1 ratio in 1850, and the 100 to 1 ratio sometime in the 1870s or 1880s.<sup>62</sup> Finally, we have the circumstances of the enslaved nineteenth-century African-Americans, subjected to a stunningly violent system of accelerating, profit-making production in the cotton fields of the Deep South gulf states.<sup>63</sup> Right from its earliest origins, as of 1800, coal was far more energy-dense than enslaved human labor in the American economy, but the ratio of coal labor to slave labor was only a somewhat hypothetical 13 to 1 in 1832, when Adams spoke in Congress of the labor of coal. The ratio of coal to slave labor, perhaps something on the order of more than 100 to one, became overwhelmingly obvious in the 1850s on the eve of the Civil War and was becoming part of the public discourse.

Sometime in 1860, Thomas Ewbank delivered a lecture titled “Inorganic Forces Ordained to Supersede Human Slavery” to the American Ethnological Association in New York. Anticipating the fossil-fueled mechanization of agriculture to come in the next century, he argued that abolitionists should promote “the application of inanimate forces to the raising and reaping of staple products in tropical and semi-tropical regions”<sup>64</sup>; mechanical energy would break the grip on labor and liberty. That October, just before Lincoln’s election and the crisis of the Union, William Lloyd Garrison’s *Liberator*, the flagship American abolitionist publication, took great offense at such an equation of slavery and steam power. The *Liberator* asserted that “human rights are not to be determined by the quantity of steam that can be generated, or by coal that can be excavated for mechanical uses.”<sup>65</sup> But it is all too possible that others more calculating drew the same conclusions as did Ewbank in years

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Evidence from the United States Colored Troops during the Civil War,” *Economics and Human Biology* 9, no. 1 (January 2011): 45–55; Wrigley, *Energy and the English Industrial Revolution*, 15–16.

<sup>61</sup> Eric Williams, *Slavery and Capitalism* (Chapel Hill, 1944); see the commentary by William A. Green, “Race and Slavery: Considerations on the Williams Thesis,” in *British Capitalism and Caribbean Slavery: The Legacy of Eric Williams*, ed. Barbara Lewis Solow and Stanley L. Engerman (New York, 2004), 25–50.

<sup>62</sup> This does not include the very significant role of horses in the antebellum northern economy. Here see Paul Johnson’s excellent discussion in “Northern Horse: American Eclipse as a Representative New Yorker,” *Journal of the Early Republic* 33, no. 4 (Winter 2013): 701–26.

<sup>63</sup> Edward E. Baptist, *The Half Has Never Been Told: Slavery and the Making of American Capitalism* (New York, 2014), 131–44, 261–65, 363–65.

<sup>64</sup> Thomas Ewbank, *Inorganic Forces Ordained to Supersede Human Slavery* (New York, 1860), 30.

<sup>65</sup> *Liberator*, 5 October 1860.

**Table 1—United Kingdom and the British West Indies: Energy from Industrial Coal and Manual Labor**

	All coal not exported: Britain (in US short 1000 tons)	Estimated BTUs in trillions from all coal (Britain, not exported)	Coal used in industry (estimated)	Estimated BTUs in trillions from industrial coal	Total popu- lation of the United Kingdom (England, Wales, Scotland, Ireland)	Estimated BTUs in trillions from UK manual labor	All coal/ UK manual labor BTU ratio	Industrial Coal/ UK Manual Labor BTU Ratio	Total British West Indies slave popu- lation	Estimated BTUs in trillions from West Indies slave manual labor	
<b>1500</b>					4,550,000	2.1					
<b>1520</b>	110	3			4,970,000	2.2	1.3				
<b>1550</b>	220	6			5,600,000	2.5	2.3				
<b>1600</b>	1,200	31			7,700,000	3.5	9.0				
<b>1650</b>	2,182	57			9,800,000	4.4	12.8				
<b>1700</b>	3,164	82	158	4.1	9,450,000	4.3	19.3	1.0			
<b>1750</b>	5,698	148	855	22.2	10,675,000	4.8	30.7	4.6	<b>1774</b>	342,605	0.29
<b>1775</b>	9,655	251	2,414	62.8	12,075,000	5.5	46.0	11.5	<b>1787</b>	394,120	0.33
<b>1800</b>	16,414	427	5,909	153.6	15,067,500	6.8	62.7	22.6			
<b>1810</b>	21,665	563	8,666	225.3	17,870,000	8.1	69.8	27.9	<b>1807</b>	776,105	0.66
<b>1815</b>	24,269	631	10,921	284.0	19,210,000	8.7	72.7	32.7			
<b>1820</b>	27,280	709	13,504	351.1	20,680,000	9.3	75.9	37.6			
<b>1830</b>	33,047	859	17,845	464.0	23,800,000	10.8	79.9	43.2	<b>1834</b>	664,970	0.56
<b>1840</b>	45,162	1,174	28,904	751.5	26,490,000	12.0	98.1	62.8			
<b>1850</b>	65,278	1,697	45,695	1188.1	27,550,000	12.4	136.4	95.5			
<b>1860</b>	88,972	2,313	67,619	1758.1	28,770,000	13.0	178.0	135.3			
<b>1870</b>	114,232	2,970	91,386	2376.0	31,260,000	14.1	210.3	168.3			
<b>1880</b>	144,166	3,748	115,333	2998.6	34,620,000	15.6	239.7	191.7			

<b>1890</b>	171,693	4,464	137,354	3571.2	37,480,000	16.9	263.7	210.9
<b>1900</b>	202,993	5,278	166,454	4327.8	41,160,000	18.6	283.9	232.8

**Note:** All coal, not exported: Britain (converted from metric to short tons): Joseph U. Nef, *The Rise of the British Coal Industry* (London, 1932), 1:20; John Hatcher, *The History of the British Coal Industry, Vol. I, Before 1700: Towards the Age of Coal* (Oxford, 1993), 68; Michael W. Flinn, *History of the British Coal Industry, vol. 2, 1700–1830: The Industrial Revolution* (Oxford, 1984), 26; B. R. Mitchell, *International Historical Statistics: Europe, 1750–1993*, 4th ed. (New York, 1998), 426, 428, 431.

Estimated trillion BTU of energy from coal: from Susan B. Carter et al., eds., *Historical Statistics of the United States: Millennial Edition Online* (Cambridge University Press), table Db1653 (.026 trillion/1000 short tons);

industrial coal = estimated from B. R. Mitchell, *British Historical Statistics* (Cambridge, 1988), 258, and extrapolated from 1700 to 1815;

UK population from *International Historical Statistics*, table A2; [extrapolated 1500–1800, assuming England and Wales = 57% of British Isles population].

Work output in trillion BTUs: calculated as follows, from the 1861 Census:

laboring men = 80% of all males 15–64, consuming 2800 kcalories daily

laboring women = 25% of women aged 15–64, consuming 2300 kcalories daily

total kcalories converted to BTUs with the Google unit converter

1861 estimate applied to other populations, 1500–1900

West Indies slave populations: Selwyn H.H. Carrington, *The Sugar Industry and the Abolition of the Slave Trade, 1775–1810* (Gainesville: University Press of Florida, 2002), table 3.3, p. 73; B.W. Higman, *Slave Populations of the British Caribbean, 1807–1834* (Barbados: The Press, University of the West Indies, 1995), table 4.1, p. 74.

**Table 2—US Industrial Coal BTUs and Manual Labor BTUs for Free States and Slaves, 1800–1860**

Year	Total US coal production (in US short 1000 tons)	Estimated trillion BTU of energy from US coal	Total population, free states	US free states: Work output in trillion BTUs	Coal/free state labor BTU Ratio	US slave population	US slaves: Work output in trillion BTUs*	Coal/slave labor BTU ratio
1800	108	3	2,632,707	1.26	2.23	893,041	0.76	3.70
1810	178	5	3,800,000	1.82	2.55	1,191,364	1.01	4.57
1820	334	9	5,700,000	2.72	3.19	1,538,038	1.31	6.64
1830	881	23	7,012,399	3.35	6.84	2,009,050	1.71	13.42
1840	2,474	64	9,728,959	4.65	13.84	2,487,455	2.11	30.43
1850	8,356	217	13,440,999	6.42	33.83	3,204,313	2.72	79.78
1860	20,041	521	18,368,808	8.78	59.37	3,953,760	3.36	155.08

**Note:** Total coal production in 1000 short tons: *United States Historical Statistics*, tables Db60, Db67

Estimated trillion BTU of energy from coal: from *United State Historical Statistics*, table Db1653

US free states work output in trillion BTUs calculated as follows, from the 1860 Census:

working men: 80% of all men aged 15–59, consuming 3300 kcalories daily, 40% available for labor

working women: 10% of all women age 15–59, consuming 2700 kcalories daily, 30% available for labor

total kcalories converted to BTUs with the Google unit converter

1860 estimate of labors BTUs applied to 1800–1850 populations

US slaves work output in trillion BTUs calculated as follows from the 1860 census:

\*Calculated assuming that all slaves aged 15–54 in 1860 received 3500 calories daily, 40% output to labor for men, 30% output to labor for women;

total kcalories converted to BTUs with the Google unit converter;

1860 estimate applied to 1800–1850 populations

following: human slavery was an impediment to progress, and progress meant the fossil-fueled mineral economy. The decades following the Civil War would see the great transition from the organic to the mineral Anthropocene in the United States, following and far exceeding Britain's early lead. It is perhaps a great irony that the transnational, trans-racial abolitionist movement in which Garrison played a formative role is a formative model for the modern environmental movement, as it confronts the challenge of the modern Anthropocene.<sup>66</sup>

## RESPONSE

*Jason M. Kelly*

Professor Otter poses the question, “Should all modern British historians care about coal?” Our response so far has been in the affirmative. After all, changing energy regimes have been fundamental to the making of the modern world. And those in Britain were integrally linked to slavery, capitalism, industrialization, and imperialism. As such, the history of energy—whether organic or mineral—pervades nearly every facet of modern British history. With this in mind, new historiographical approaches to the history of energy and its byproducts, most notably CO<sub>2</sub>, have been welcome contributions to our histories. To focus on energy regimes, however, does not account for the full scope of what we mean when we discuss the Anthropocene. Global climate change and the Anthropocene are not the same thing.

The notion of the Anthropocene refers both to a concept (or, more accurately, a series of concepts) and a lived reality. As a concept, the Anthropocene refers to large-scale anthropogenic processes that have transformed a variety of interrelated earth systems through feedback loops. These interactions have emergent properties that can, in turn, reset the baseline of the planet's biogeophysical systems. Scientists have been particularly keen on identifying global markers of these changes—and the carbon cycle has been one of the most prominent. There are, however, a host of other systems and markers to which historians may turn their attention. A number of these have been noted above, but a fuller discussion of them might help us to reflect on the relationship that the Anthropocene might play in historiographies of Britain. I want to offer a brief example by looking at synthetic fertilizers during the twentieth century.

The introduction of synthetic chemical fertilizers into agriculture in the nineteenth century dramatically altered the water-food-energy nexus. While the extraction and fixing of elements such as phosphorous and nitrogen require significant energy inputs, the creation of synthetic fertilizers has had implications far beyond energy use. The Haber-Bosch process, for example, has allowed the mass production of nitrates so central to modern agriculture (and modern warfare). Without it, the global twentieth-century population boom would have looked very different. According to one estimate, “the number of humans supported per hectare of arable land has increased from 1.9 to 4.3 persons between 1908 and 2008,” primarily

<sup>66</sup> Klein, *This Changes Everything*, 262–64.

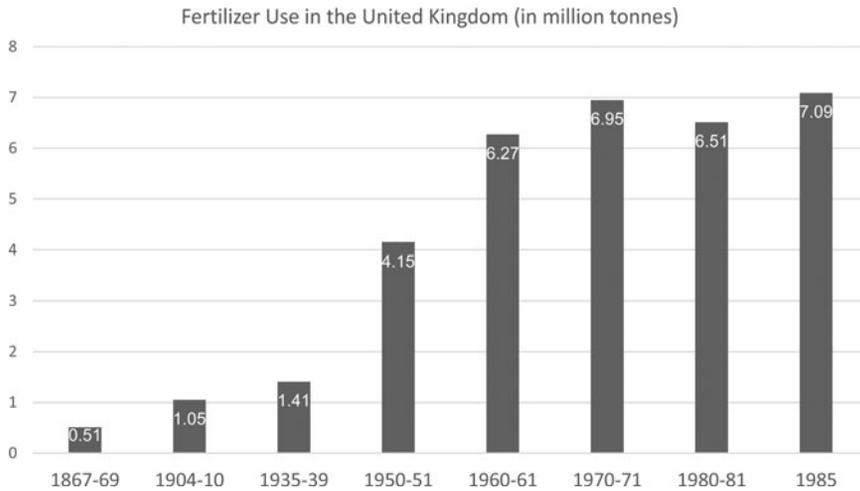


Figure 1—Data from Paul Brassley, *Output and Technical Change in Twentieth-Century British Agriculture*, *Agricultural History Review* 48, no. 1 (2000): 60–84.

because of the Haber-Bosch process.<sup>67</sup> In the United Kingdom, increased fertilizer use after World War II allowed farmers to both increase production and turn to purchased feedstuffs for their animals.<sup>68</sup>

Increased production not only transformed the calories that could be consumed (Paul Warde estimates that the average daily per capita consumption in Britain increased from a low of 2,000 Kcal in 1900 to 3,100 Kcal by 1956) but also altered what was consumed.<sup>69</sup> As rationing came to an end, meat consumption climbed, continuing the pattern that had begun in the nineteenth century.<sup>70</sup> This trend reflects a more general global phenomenon that has taken place since 1950, with implications not only for human health but for ecosystems transformed through land clearance.<sup>71</sup>

Synthetic fertilizers were also important for the spread of new “improved” crops, introduced around the world as part of the so-called Green Revolution beginning in the 1960s. Though more study remains to be done, the larger-scale political and economic consequences of this process are well known, as are its effects on family and labor structures. Less recognized have been its implications for human health and disease. The increased cultivation of maize, for example, has been responsible for

<sup>67</sup> Jan Willem Erisman et al., “How a Century of Ammonia Synthesis Changed the World,” *Nature Geoscience* 1, no. 10 (October 2008): 636–39.

<sup>68</sup> Paul Brassley, “Output and Technical Change in Twentieth-Century British Agriculture,” *Agricultural History Review* 48, no. 1 (2000): 60–84, at 72, <http://www.bahs.org.uk/AGHR/AGHR48.pdf>.

<sup>69</sup> Paul Warde, *Energy Consumption in England and Wales, 1560–2000* (Naples, 2007), 32.

<sup>70</sup> Vincent J. Knapp, “The Democratization of Meat and Protein in Late Eighteenth- and Nineteenth-Century Europe,” *Historian* 59, no. 3 (March 1997): 541–51.

<sup>71</sup> For data, see Food and Agriculture Organization of the United Nations Statistics Division, <http://faostat3.fao.org>.

the spread of mosquito-borne illnesses such as malaria.<sup>72</sup> Much research is certainly still to be done on imperial and postcolonial histories looking at the intersections of ecology, agriculture, economics, and disease.

The increased use of nitrogen has done more than simply affect food output and population. Much of it leaches into the environment, affecting both the atmosphere and hydrosphere. Nitric oxide (NO) and nitrogen dioxide (NO<sub>2</sub>) create smog and contribute to acid rain, while N<sub>2</sub>O not only destroys ozone but stays in the stratosphere for approximately 114 years as a greenhouse gas, trapping 300 times more heat than does CO<sub>2</sub>.<sup>73</sup> This effect can be devastating for water environments. Nitrogen and phosphorous are primary contributors to eutrophication, the process in which water is inundated with nutrients, causing algal blooms and hypoxia, killing off aquatic animals in both freshwater and marine environments. In northern Europe, these “dead zones” reveal the close links between agriculture and fisheries—as well as the importance of studying the integrated histories of technology, society, environment, and governance.<sup>74</sup> No doubt Brexit will necessitate new histories of shifting cultural attitudes toward regulation and environmentalism in Britain. In relation to the discussion above, the future of the European Union’s Common Agricultural Policy and its Nitrates Directive (part of the Water Framework Directive) is unclear.

While the history of nitrogen and phosphorous cycles are only two elements of a series of global environmental shifts that fall under the rubric of the Anthropocene, there are other environmental systems that British and British imperial historians might productively integrate into our current historiographical discussions. For example, how might histories of weirs and dams or of wells and irrigation generate more nuanced understandings of both the conceptual and lived experiences of the Anthropocene?<sup>75</sup> Analyses of energy, the carbon cycle, and global warming are absolutely essential to Anthropocenic histories, fitting quite well into our current British historiographies of capitalism, empire, industrialization, and modernization. And, a focus on modern energy regimes is sure to put British history at the center of the Anthropocene’s origin story. However, does the larger Anthropocene story—say, of land clearances, pollution, chemical signatures, ocean acidification, extinctions, erosion, disease, species migration, salinization, and arheism—decenter British history from the narrative? In fact, in considering the Anthropocene, is the nation even an appropriate primary unit of analysis? For that matter, to what extent have Anthropocenic processes played roles in constructing nations and nationalism?

<sup>72</sup> James McCann, *Maize and Grace: Africa’s Encounter with a New World Crop, 1500–2000* (Boston, 2005), 174–96; James McCann, *The Historical Ecology of Malaria in Ethiopia: Deposing the Spirits* (Athens, OH, 2016).

<sup>73</sup> Environmental Protection Agency, “Overview of Greenhouse Gasses: Nitrous Oxide Emissions,” <https://www.epa.gov/ghgemissions/overview-greenhouse-gases#nitrous-oxide>, accessed 21 August 2016.

<sup>74</sup> Mindy Selman et al., “Eutrophication and Hypoxia in Coastal Areas: A Global Assessment of the State of Knowledge,” in “Water Quality: Eutrophication and Hypoxia,” WRI Policy Note, no. 1 (March 2008): 1–6, at 3. For an updated list of hypoxic sites around the world, see Robert Diaz, “Dead Zones,” Virginia Institute of Marine Science, [http://www.vims.edu/research/topics/dead\\_zones/](http://www.vims.edu/research/topics/dead_zones/).

<sup>75</sup> Matt Edgeworth, “Rivers as Material Infrastructure: A Legacy from the Past to the Future,” in *Water and Power in Past Societies*, ed. Emily Holt (Albany, 2018), 243–57.

## CONCLUDING REMARKS

*Chris Otter*

This conversation has included many pathways and threads, reflecting the dynamic and intriguing state of current literature on the Anthropocene. There are, however, some common themes and ideas here, and I conclude by summarizing five of them.

1. Dating the Anthropocene has been a point of contention since the term was coined. Jan Zalasiewicz's working group is likely to date the Anthropocene to 1945, when nuclear fallout can be detected globally in geological strata. The Anthropocene and the Great Acceleration are thus coemergent and coterminous. Historians, however, while agreeing on the geological logic of such a periodization, might want to use the concept of the Anthropocene rather differently and perhaps more flexibly (as many scholars use the term "modernity"). Since the various processes composing the Anthropocene unfurled at uneven rates and scales, historians might wish to abandon firm, precise periodization and speak more loosely of multiple transitional phases, tipping points, thresholds, and so on. Moreover, the conflation of the Anthropocene with the Great Acceleration draws our attention away from deep, long-term transitions and processes like the advent of agriculture, the Columbian Exchange, and the Industrial Revolution. In other words, the alignment of geological and historical time will perhaps never be total, and there is nothing particularly wrong with this. After all, they are different disciplines with different methodologies and objectives.

2. Professor Kelly reminds us that Anthropocene is about more than climate change and fossil fuels. It is also about the derangement of wider earth systems (nitrogen, phosphorus), reduced biodiversity, ocean acidification, land-use change, and pollution. In other words, this is not simply about chemical agents like carbon dioxide, nitrogen, phosphorus, water, sulphur dioxide, particulate matter, and lead (the list could go on). It also involves biological agents (animals, insects, bacteria) and technological agents (machines, cities, networks). The Anthropocene, as its moniker suggests, also involves humans and their ideas, metaphors, discourses, art and literature. As Professor Jonsson notes, numerous writers and thinkers were recording the human impact on the environment in the eighteenth and early nineteenth centuries. It is an event in the history of thought as well as in the history of earth systems. In fact, there are few phenomena that cannot be rethought in the light of the Anthropocene.

3. What are the methodological challenges posed by the Anthropocene? Some trepidation has been expressed among historians that the traditional tools of our trade—close reading, primary documents, archival research—will suddenly become redundant. Perhaps there is some justification for these concerns. After all, mathematical, statistical, and scientific competency are demonstrably necessary if one is producing climate history, for example. But historians are not being asked to become scientists: even climate history still requires the more traditional tools and skills of the historian, as Professor Brooke's magisterial work shows.<sup>76</sup> So we might more accurately say that the Anthropocene challenges historians to broaden and diversify their tools, as the *Annales* school suggested decades ago. Moreover,

<sup>76</sup> Brooke, *Climate Change and the Course of Global History*.

as Professor Kelly argues, the Anthropocene also invites us to reflect methodologically on the power, force, and agency of nonhuman entities—animals, carbon dioxide, nitrogen. Absorbing them into our histories requires engagement with a heterogeneous body of literature that takes the material world seriously, from Braudel to Cronon to Latour.<sup>77</sup> The methodological implications are significant: the world cannot be approached as pure representation, and historical transformation cannot be reduced to discursive shift, change, or rupture. Extinction rates map fateful transformations of living, breathing populations, wiped out often without our having been conscious of their existence.

Yet many observers and writers from eighteenth-century political economists and Romantics onward were alive to the manifold, complex ramifications of industrialization. It is precisely by ignoring this plexus of representations that the mistaken idea of the blithe, insouciant drift into the Anthropocene became popular. This idea in turn has political consequences: the Anthropocene is not simply a discovery of scientists who will now save us by managing a “good Anthropocene” of harmoniously aligned anthromes. Discursive analysis, literary theory, and microhistory also have a demonstrable role to play in our historical comprehension of the Anthropocene, something palpable in the rise of environmental humanities. In short, the Anthropocene invites a multiplicity of methodological approaches and does not close down some avenues of inquiry at the expense of others. Perhaps this methodological ferment could promise to rejuvenate British studies.

4. As Professor Bashford observes, historians addressing ecological transition have to think in terms of space as well as time. The Anthropocene is a four-dimensional phenomenon, composed of multiple unfurling material processes each with their own space-time. The derangement of the nitrogen cycle and rising carbon emissions are slow, diffuse, and large scale, even global: local food movements and the rise of environmentalism and green politics are faster, with smaller ambits. Studying the Anthropocene, then, is *not* an automatically *longue durée* practice: big, deep, or macro approaches are not de rigueur. Professors Brooke and Jonsson have suggested as much in their comments: the study of the localized spread of steam power or the way that domestic consumption and gender were interwoven with ecological change is vital. Such studies allow us to interweave human choice and technological change, everyday life, and the incremental accumulation of greenhouse gases in the atmosphere. We see an attempt to do this, via an unabashedly Marxist framework, in Malm’s *Fossil Capital*. Such histories suggest how historians might shuttle between scales, explaining how small-scale phenomena (like a factory adopting a steam engine) generated large-scale phenomena (particulate emissions, acid rain, climate change) via multiple, recursive, aleatory acts.<sup>78</sup>

5. The Anthropocene is the latest in a very long line of challenges to the idea of the nation as a basic unit of spatial analysis, and it does so in distinct scalar ways. Environmental problems, from climate change to mass extinction to resource depletion, simply do not fit within the framework of nations or national history. Their scope and scale are much larger and increasingly planetary. Moreover, the particular

<sup>77</sup> Fernand Braudel, *The Mediterranean and the Mediterranean World in the Age of Philip II*, trans. Siân Reynolds (Berkeley, 1995); Cronon, *Nature’s Metropolis*; Bruno Latour, *We Have Never Been Modern*, trans. Catherine Porter (Cambridge, MA, 1993).

<sup>78</sup> Coen, “Big Is a Thing of the Past.”

spatiotemporalities of Anthropocene phenomena are often better analyzed through the concept of the network. The steam economy, for example, was a network linking English coalfields and mills with American cotton plantations. The great nineteenth-century guano rush connected businessmen from Liverpool and London with cormorants, coolie labor, and progressive English farmers. These networks were characterized by mobility, dynamism, and circulation: they were distinctly non-national.

The nation has long since ceased to be the only or even primary spatial modality for historians. Is the Anthropocene the final nail in the coffin? This position is surely premature. The emergence of global and *longue durée* modes of historical analysis invites multi-scalar, not purely planetary, histories. The nation remains one key scale among many, and one key to comprehending the expanding ecological scale of human activity. Britain's legal system, social norms, political structures, culture, and geological resources surely provide clues to how relatively small groups of humans "scaled up" their capacity to manipulate, mobilize, and control significant swathes of the earth's surface and the people and resources located on it. This process, it is now abundantly clear, has had fateful human *and* geological effects. Viewed thus, one might argue that the Anthropocene has significantly widened the scope of our field.