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Anthropocenes

A Fractured Picture

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"There was no such thing as the Scientific Revolution, and this is a book about it" (Shapin 1996, 1). So began Stephen Shapin's *The Scientific Revolution,* a work, concise and smart, that embodied an approach to the history of science termed "the social construction of science." Shapin argued that if we are going to talk about a "scientific revolution," then we need to see it not simply as a historical event, but as a product of trends in twentieth-century historical writing. Following a pattern laid down as early as the eighteenth century, much twentieth-century writing conceptualized the Scientific Revolution as the linear unfolding of reason—a process in which discovery built on discovery, inevitably ushering in the modern world. The Scientific Revolution, in this story, completely transformed the intellectual landscape and allowed people to imagine natural phenomena in fundamentally new ways. However, as Shapin countered, if there was a Scientific Revolution, it was not a single moment but a set of processes that took place over hundreds of years and unfolded unevenly across different fields of study. The changes in understanding and practices that did take place were initially limited to a relatively small group in society, and these people needed to legitimate their claims within dominant intellectual and social frameworks. In fact, what they could claim as knowledge was hotly contested both within their various scientific communities and beyond. The Scientific Revolution was a powerful way for thinking about changes in early modern science, but it was neither so linear, complete, nor isolated from sociocultural concerns as moderns had been tempted to imagine.

What Shapin was arguing was hardly iconoclastic when he wrote in 1996.[1] In fact, his book was the product of decades of research that overturned triumphalist accounts of the history of science (Feyerabend 1975; Bloor 1976; Latour and

Woolgar 1986; Shapin and Schaffer 1986; Haraway 1988; Latour 1988; Daston and Galison 1992; Shapin 1995; Cetina 1999; Daston and Galison 2010). This scholarship suggested that science was neither internally rational and objective nor removed from its historical context. Science was a sociocultural practice like any other. At its most general level, this approach to the history of science—sometimes referred to as scientific constructivism—asks the question, how does something become deemed "true" or "false" in science?[2] How are decisions made, problems constructed, experiments formulated, solutions articulated? Shapin and his scientific constructivist colleagues argue that no scientific knowledge exists in a vacuum; the questions scientists ask, the methods they use, the claims they make are in fact social constructions. Consequently, science is a social practice always mediated by culture, social structures, economics, politics, and religion, which shape its production and consumption in the laboratory and beyond. Importantly, their analyses are not necessarily focused on the validity of truth claims but rather on the forces that drive the search for truths, determine interpretations, or influence reception.

Shapin's and his colleagues' critique of triumphalist accounts of the Scientific Revolution is a useful framework for thinking about the so-called Age of the Anthropocene. As with "the Scientific Revolution," a term first used in the early twentieth century, "the Anthropocene" is a neologism, used widely only since the early twenty-first century (Crutzen and Stoermer 2000; Meybeck 2001; Steffen et al. 2004; Syvitski et al. 2005; Costanza, Graumlich, and Steffen 2007; Robin and Steffen 2007; Zalasiewicz et al. 2008; Chakrabarty 2009; Rockström et al. 2009; Armesto et al. 2010; Davis 2011; Steffen, Persson, et al. 2011; Zalasiewicz et al. 2011; Dibley 2012; Crutzen and Steffen 2016). The origins of both concepts can be traced back two hundred years before their wide use—to the Enlightenment in the case of the Scientific Revolution and to the middle of the nineteenth century in the case of the Anthropocene. As new concepts they had imaginative force, reflecting changes in contemporary attitudes about the past as well as a sense that the present was experiencing a revolution. It is not a coincidence that the term "Scientific Revolution" was adopted widely at a moment when relativity, quantum physics, logical positivism, and even psychiatry suggested major leaps forward in knowledge about the universe and human cognition. Likewise, it is not a coincidence that "Anthropocene" entered the popular lexicon at a crucial moment in our understanding of earth systems science, neurobiology, exoplanets, and wide-scale threats to the planet's ecosystems.

This essay examines the origins of the concept of the Anthropocene by comparing and contrasting nineteenth- and twenty-first-century attitudes to irreversible anthropogenic impacts on the earth. Doing so helps elucidate how our understandings of anthropogenic environmental transformation have been (and remain) entangled with the historical legacy of our social, political, and cultural worlds. It suggests that contemporary discussions of the Anthropocene have close

historical connections to nineteenth-century thought, which was not value neutral and which often served the interests of European and American imperial powers. Because of this, this essay suggests that there is no such thing as a singular Anthropocene—like the Scientific Revolution, the category is embedded in wider sociocultural frameworks—and that it would be productive for scientists, humanists, policy makers, and others to engage with it in more nuanced ways. Fracturing the Anthropocene into Anthropocene*s* helps combat a tendency to oversimplify complex, historically emergent biophysical and sociocultural entanglements. In sum, there is no such thing as the Anthropocene—at least as we typically discuss it—and this is an essay about it.

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In Europe, humanity's relationship with the earth changed dramatically in the nineteenth century. In just a few decades, a planet that had long seemed young became millions, then billions of years old. Its face, once etched and cracked by a single great flood, was now marked by eons of watery flows, fiery magmatic expulsions, and layers upon layers of briny sediments. Fossils, from microscopic plankton to gargantuan reptiles, indicated worlds that had come and gone. The biosphere, once imagined to be constant and unchanging, was in fact a world of constant flux. Plants and animals—even human beings—were no longer the fixed creations of an omnipotent and beneficent heavenly creator. Every creature was subject to change, development—even extinction—as internal mutations and ever-morphing environments altered the balance between resources and reproduction. The Renaissance's Great Chain of Being, which suggested an orderly and hierarchical relationship between the divine and the earthly, was broken. For increasing numbers of people, the new cosmology made a supreme being seem unnecessary and irrelevant.

Grappling with the work of people such as Hutton, Cuvier, Lyell, Wallace, and Darwin—with concepts of deep time, a planet with many geological ages, and a constantly changing natural world—necessitated that scientists and philosophers alike shed many of the last trappings of medieval Aristotelianism, Platonism, and Renaissance notions of providence and order. It forced them to resituate humankind in the grand order of natural processes. If Copernicanism had decentered earth's place in the universe, the revolutions of the early nineteenth century removed humans from the center of earth's history. In fact, the notion of deep time suggested that humans were relatively tangential to the course of natural history. Only a belief in the invisible hand of providence—of a deity that controlled the seemingly random processes of evolution—could promise a master plan in which the existence of humans was more than mere chance.

Even as contemporaries began to grapple with these facts, integrating them into their scientific models, philosophical categories, and historical narratives, many began to notice that humans seemed to be quickening the pace of environmental

change. Taking the long view of the history of civilization, Humphry Davy argued in 1830 that humanity had initiated its own geological age.

> 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. (Davy 1830, 146–47)

Writing in 1848, the president of the Ashmolean Society, Hugh Edwin Strickland, observed that humans were becoming prime movers in the extinction of species.

> It appears, indeed, highly probably that Death is a law of Nature in the Species as well as in the Individual; but this internal tendency to extinction is in both cases liable to be anticipated by violent or accidental causes. Numerous external agents have affected the distribution of organic life at various periods, and one of these has operated exclusively during the existing epoch, viz. the agency of Man, an influence peculiar in its effects, and which is made known to us by testimony as well as by inference. (Strickland 1848, iii)

The planet's deep history was entering a new phase. The human population was booming. The consumption of resources was increasing. With this came a concomitant effect on natural systems.

In the 1830s, Charles Lyell, the geologist so influential on Charles Darwin, described the destructive tendencies of humankind in the second volume of *Principles of Geology* (1832). Human migrations, he argued, were responsible for introducing foreign species that devastated local ecologies. One hundred fifty years before Alfred Crosby, he described a version of the "Columbian Exchange" in which Old World horses, cattle, and hogs upended and displaced American species (Crosby 1973). Lyell questioned the ultimate benefits of draining fens and clearing forests. Dubious about anthropocentric models of progress, he mused, "It admits of reasonable doubt whether, upon the whole, we fertilize or impoverish the lands which we occupy"(Lyell 1832, 2:146–47). In sum, he argued, "Man is, in truth, continually striving to diminish the natural diversity in the *stations* of animals and plants in every country, and to reduce them all to a small number fitted

for species of economical use. He may succeed perfectly in attaining his object, even though the vegetation be comparatively meagre, and the total amount of animal life be greatly lessened" (147–48; original emphasis).

Critics would soon term the man whom Lyell had in mind *homo oeconomicus,* a pejorative neologism used to connote a modern person ruled by rationality, markets, and selfish individualism. *Homo oeconomicus* could be found perusing his mills in Manchester or planning new mineshafts for his holdings in Durham. Economic man saw copses, meadows, and fens as wastes waiting to be turned into productive cropland or factory floors.[3] He saw European imperialism as—if not good—a necessary evil that would benefit both the conqueror and the conquered. Imperial commerce, industrialization, and urbanization would bring wealth to the metropole while imposing European religion, morals, and education on inferior peoples. Reshaping global ecologies, imperialism would improve foreign lands along European models by intensively extracting natural resources and cultivating cash crops. The governor-general in India, Charles John Canning, 1st Earl Canning, reflected this attitude when he stated in December 1858:

> As regards the sale of waste lands [in Awadh], there can be no question of the substantial benefits, both to India and to England, which must follow the establishment of settlers who will introduce profitable and judicious cultivation into districts hitherto unclaimed. His Excellency in Council looks for the best results to the people of India, wherever in such districts European settlers may find a climate in which they can live and occupy themselves without detriment to their health, and whence they may direct such improvements as European capital, skill, and enterprise can effect in the agriculture, communications, and commerce of the surrounding country. He confidently expects that harmony of interests between permanent European settlers and half civilized tribes by whom most of these waste districts or the country adjoining them are thinly peopled will conduce to the material and moral improvement of large classes of the Queen's Indian subjects. (*Papers Relating to Land Tenures and Revenue Settlement in Oude* 1865, 251–52)

Through conquest, expropriation, settlement, commerce, and technology, *homo oeconomicus* attempted to bend the planet and its peoples to the desires and ideologies of the European and American bourgeoisie and their empires.

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There was little doubt in the mind of learned contemporaries that even though the planet had been constantly in flux over the course of its history, something unprecedented was taking place: humans seemed to be having an increasingly outsized (and devastating) impact on their environments. Some voiced concerns about humanity's attempts to control natural processes. In *Frankenstein* (1818), for example, the consequences were tragic. In pretending to be like a god and attempting to master nature, Victor Frankenstein finds himself mutant nature's slave, his monster declaring, "You are my creator, but I am your master;—obey!" By the end

of the novel, Frankenstein, psychologically broken, finally admits, "Man . . . how ignorant art thou in thy pride of wisdom!" It was a moral fable that resonated with many contemporaries and set a precedent for subsequent works, most famously *The Island of Dr. Moreau* (1896).

The adulteration of nature might open a Pandora's box of uncontrollable hybrids and monsters—a world of unintended consequences for humanity's hubris. Of course, these were intuitions and conjectures. There was no way that contemporaries could have known the extent to which they were transforming the planet. However, there were indications. A small but growing number of prominent examples, such as the dodo of Mauritius or the bison herds of North America, suggested that humans could wipe entire species from the face of the earth. Human industries, sewer systems, and habitation could dramatically transform water systems as well. Industrial waterways had become so polluted that by 1867 the water from the River Dee (Afon Dyfrdwy) near Chester was "so poisoned that, mixed with five hundred times its quantity of wholesome water, it was so deadly that no fish could live in it" ("The Salmon Fisheries Conference [Horticultural Gardens, South Kensington, 7th June 1867]" 1867, 155). By clear-cutting forests, contemporaries recognized that they could change the climate, though, to be clear, this was not always considered problematic. As Andrew Ure reported in 1831, "The improvement that is continually taking place in the climate of America, proves, that the power of man extends to phenomena, which, from the magnitude and variety of their causes, seemed entirely beyond his controul"(Ure 1831, 335).

In a sense, concern (or pride) over science's and technology's ability to manipulate nature—that is, recognizing that human-induced environmental changes could be permanent and measurable—was an antidote to the metaphysical displacement of humanity from the center of natural history. Emphasizing human agency in effecting environmental change and its responsibility for mitigating negative consequences helped reassert humanity's place in the natural world. It is not surprising, therefore, that the conservation movements of the nineteenth century reasserted (in secular terms) one of the major precepts of Christian theology: humankind's dominion over the earth.

Those alarmed about irreversible environmental change included George Perkins Marsh, who was, with people such as Frederick Law Olmsted, among the early and vocal advocates for conservation and the creation of nature preserves. In 1864, Marsh wrote *Man and Nature,* one of the period's most perceptive and influential warnings about anthropogenic environmental change: "The earth is fast becoming an unfit home for its noblest inhabitant, and another era of equal human crime and human improvidence, and of like duration with that through which traces of that crime and improvidence extend, would reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the depravation, barbarism, and perhaps even the extinction of the species"(Marsh 1864, 44). The conservation movement that he helped spur

in the United States eventually resulted in a system of national parks, forests, and animal preserves.

The early conservation movement was, however, a product of its place and time. While criticizing the worst abuses of *homo oeconomicus,* conservationists were tied nevertheless to the structures of capital and empire. In fact, much of the impetus for conservation came from those who didn't want to waste natural resources, seeing them as economic and imperial tools—*national* resources that required state management and protection. In India, for example, Alexander Gibson, Dietrich Brandis, John McClelland, and Hugh Cleghorn called for the establishment of a forest service in response to deforestation caused by logging for an expanding railroad system and the navy (Das 2005; Beinart and Hughes 2007; Grove 1996). The railways, like so much colonial infrastructure, existed primarily for the extraction of Indian resources, which, as with the case of cotton, could also be both environmentally and economically devastating to the colony. However, in most publications of the period, it was not the machine of empire but rather the indigenous peoples and rapacious, immoral merchants who were blamed for the damage. One representative report stated that "the natives" used teak "without afterthought for the future," fabricating wooden dishes "chopped out of the heart of a tree that would make the mainmast of a man-of-war, and the rest . . . left to rot" ("The Forests of Pegu" 1856, 253). His solution was to follow the advice of Cleghorn and McClelland and found a forest department.

Major state legislation came with the India Forest Acts of 1865 and 1878, which set aside forests for conservation, bringing an end to the most egregious practices of clear cutting. However, there was a more insidious side to these pieces of legislation. They established guidelines for the expropriation and seizure of land considered unused, unclaimed, or waste. And, mirroring the enclosure acts that had deprived Britons of their commons over the previous centuries, the colonial authorities immediately began seizing tens of thousands of square miles (Beinart and Hughes 2007, 117–18). By 1900, approximately 85,000 square miles of forests had been taken by the government—nearly the size of the province of Bengal (Gadgil and Guha 1993, 134).

In Africa, where Europeans had wreaked havoc for hundreds of years—murdering, pillaging, destabilizing governments, destroying infrastructure, and enslaving millions to feed their economies—they now arrived with advanced weapons, intent on extracting the continent's biological and mineral wealth. The arrival of more and more Europeans shifted the relationship between humans and the local fauna. Animals that had been hunted at more moderate levels were pushed to extinction as European markets demanded exotic furs and ivory. Imperialists transformed economies, and in large swaths of Africa they created first a boom, then a bust, in animal commodities.

Wildlife preserves served the interests of empire, protecting valuable commercial resources while providing elites with continued access to big game hunting. By

the 1850s, the commercialization of African hunting led colonial administrators to establish preserves in the Knysna and Tsitsikamma forests, primarily to protect elephants (McCormick 1991, 9). By the 1890s, nearly all big game in British Africa fell under some form of administrative protection. A series of game laws adopted in the various colonies promised fines and jail time for those who hunted without permission. Nevertheless, governors still sold licenses to tourists who wished to hunt. One tourist guide from 1893 offered helpful hints to these hunter-tourists. In the (unlikely) event of being attacked by a lion, one should shoot it between the eyes or, failing that, in the shoulder, which would break its bones and prevent a "deadly spring." African elephants could not be shot between the eyes like Indian elephants, and hippopotami were to be shot beneath the eye and ear (*Brown's South Africa* 1893, 78–80).

Since big game exports could bring the colonies little revenue (by the 1890s, ivory exports had plummeted) hunting licenses provided a means for the state to squeeze just a bit more from its natural resources. And for European and American elites, this offered the thrill of an exotic hunt, which they could recount to their peers at private clubs in Paris, New York, Berlin, and London or in adventure narratives that were all the rage at the height of empire. When Theodore Roosevelt wrote *African Game Trails* about a hunt he took in 1909, he highlighted the dangers of the expedition: "During the last few decades, in Africa, hundreds of white hunters, and thousands of native hunters, have been killed or wounded by lions, buffaloes, elephants, and rhinos. All are dangerous game: each species has to its grewsome [*sic*] credit a long list of mighty hunters slain or disabled"(Roosevelt 1910, 72). At the end of the volume, he proudly listed his and his brother's kills in a table: 9 lions for Teddy, 8 for Kermit; 8 elephants for Teddy, 3 for Kermit. Together, they killed 512 animals (Roosevelt 1910, 532).

Unsurprisingly, the colonial administrators' efforts to control land and animals fell unevenly along class and racial lines (MacKenzie 1997, 201–60; Steinhart 2006). Some critics blamed the decimation of African species on indigenous groups—often with an explicit sense of moral and cultural superiority. François Coillard, for example, argued that it was "native hunters themselves who, totally destitute of conscience in this respect, are hastening the extermination of certain species"(Coillard 1897, 638; see also MacKenzie 1997, 233). The game regulations, which limited hunting over the last half of the nineteenth century, increasingly restricted traditional African hunting techniques in favor of guns, considered to be more humane (MacKenzie 1997, 209). Beginning in 1891 in Natal, for example, it was illegal not only to use "nets, springes, gins, traps, snares, or sticks" to catch animals and birds but also to own them with the intent to hunt (House of Commons 1906, 14). Firearms, however, were also regulated by colonial administrations, which sought to keep them out of the hands of African subjects. So, even as imperial governments argued for the use of guns in hunting, it also prohibited gun ownership for "any person of the native tribes of this Colony."[4] In other

colonies, the government and various civic preservation societies used the cause of conservation to decide which groups should have the right to hunt. As John MacKenzie has noted, in Kenya, the Ndorobo would be encouraged to abandon hunting in favor of herding, but the Kamba, who were not reliant on hunting to subsist, would be banned from the activity (MacKenzie 1997, 215).

In effect, conservation legislation increasingly limited equal use of land and natural resources in favor of the European colonists. Walling off preserves from hunters without licenses was a nineteenth-century parallel to the aristocracy's claims to private hunting grounds in early modern Europe. And, as with the eighteenth-century Black Acts, which were used to control England's rural populace, imperialists in places such as the Cape Colony created legislation to wall off property over which they claimed control.

The close relationship between conservation, imperialism, and race is just one example of how easily environmental discourses and practices can become entangled with sociocultural, political, and economic fields. This observation aligns with what scientific constructivists argue: the history of science cannot be disentangled from broader cultural forces. This observation does not make the practice of conservation any less valid but it does reveal its potential to serve interests and ideologies beyond its stated objectives.

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It is clear that by the early nineteenth century, what we might call an "anthropocenic consciousness" was emerging among the European and American scientific community. What I mean by this is that some people were beginning to recognize that humans were making potentially permanent changes to the earth and that this could be corroborated by empirical evidence. Developing this new understanding of humanity's relationship to the planet also necessitated policy changes in order to mitigate humanity's most devastating environmental effects. These adaptations, often favoring the interests of elites in Europe and America, included changes in forest practices, hunting, sewage infrastructure, and even consumption patterns.

Over the course of the next 150 years, the development of an anthropocenic consciousness was an uneven and protracted process. Despite the fact that early nineteenth-century writers articulated many of the basic concepts that scholars typically associate with the Anthropocene—despite evocative concepts such as a "silent spring" or "Gaia" in the twentieth century—it has been only in the first decade of the twenty-first century that scientists have coined a term that seems to have resonated with both the academic and general publics (Carson [1962] 2002; Lovelock 1974, 1983, 2000; Margulis 2008; Steffen, Grinevald, et al. 2011). There are now academic journals devoted to the Anthropocene, and new books on the topic are appearing at a rapid rate. Scholarly forums debate the definition of the term and the way that it might affect their disciplines. Academic discussions about "the Anthropocene" are beginning to spill over into popular culture, making the covers

of *The Economist* and *National Geographic* and being reviewed in articles in the *New Yorker* and *The Guardian*.

With a conceptual lineage that goes back two hundred years, the Anthropocene brings with it a host of scientific, philosophical, and cultural accretions. This fact is never part of the popular discussion and is rarely examined in academic literature, except for the obligatory nod to Will Steffen, Jacques Grinevald, Paul Crutzen, and William McNeill's essay, "The Anthropocene: Conceptual and Historical Perspectives" (2011).[5] It is, however, implicit in some of the more nuanced scholarship. Take, for example, the Subcommission on Quaternary Stratigraphy's Working Group on the Anthropocene, chaired by Jan Zalasiewicz. Its task since 2009 has been to decide whether we can associate the Anthropocene with an identifiable and global "geological signal." If there were a "geological signal," then the International Union of Geological Sciences might vote to designate the Anthropocene a new geological age—symbolized by placing "golden spikes" (also known as a Global Boundary Stratotype Sections and Points) at representative points in the earth's stratigraphy. This working group has often been cited as key for asserting an "official" age of the Anthropocene, which, in August 2016, they put at 1945. In its mission documents, however, the working group notes the limits of its task: "the currently informal term 'Anthropocene' has already proven to be very useful to the global change research community and thus will continue to be used, but it remains to be determined whether formalisation within the Geological Time Scale would make it more useful or broaden its usefulness to other scientific communities, such as the geological community" (Subcommission on Quaternary Stratigraphy, International Commission on Stratigraphy 2015). In other words, its task is determined by the standards of the discipline of geology and that other research communities have used and will continue to use the term in different contexts. Implicitly, it recognizes that there is no single Anthropocene but rather multiple Anthropocenes that serve different but potentially complementary functions.

Thinking about the Anthropocene as a cluster of mutually complementary approaches recognizes the historically complicated origins of the idea and opens up the possibility of rich multidisciplinary dialogues that have the potential to reshape research and policy agendas. Likewise, it makes it easier to acknowledge the fact that while anthropocenic indicators—climate change, ocean level rise, water pollution, cultural awareness of environmental change, and more—may be globally measurable phenomena, they are not experienced equally around the planet. Further, this approach is more in line with actual usage in that the Anthropocene is a concept that serves a variety of sometimes incommensurable agendas and perspectives.

For example, an approach to the Anthropocene that focuses on geological indicators might find that while there were increased anthropogenic effects since the eighteenth century, a marked sedimentary divergence occurs only in the middle of the twentieth century, with the introduction of radioactive isotopes created by

nuclear fallout—a nuclear Anthropocene. Moving away from geological indicators to mediums such as ice cores, tree rings, and coral and to other isotopic signatures such as $\delta^{13}C$ or $\delta^{15}N$, we might find Anthropocenes manifesting at different rates, times, and places (Dean, Leng, and Mackay 2014). Likewise, changes in biodiversity and a so-called Sixth Extinction might indicate still other standards and moments for the onset of the Anthropocene (Braje and Erlandson 2013). In fact, depending on one's preferred data point, the Holocene-Anthropocene boundary might be as long ago as ten thousand years or as recently as fifty years (Steffen et al. 2005; Steffen, Crutzen, and McNeill 2007; Steffen, Grinevald, et al. 2011; Ellis, Fuller, et al. 2013; Ellis, Kaplan, et al. 2013; Ruddiman 2013).

No matter what the data, however, most studies assume that the Anthropocene is a measurable biophysical phenomenon, usually ignoring the fact that neither the choice of key data points nor the concept of an Anthropocene is value neutral. The Anthropocene nearly always serves as a metanarrative of modernity—a narrative in which energy- and resource-intensive industrialization and capitalism have been accompanied by population booms, increased flows of goods and peoples, the central role of nation-states, and demands for improvements in quality of life. It is a story in which humans have exploited the environment at unprecedented and ever-expanding rates, soon finding that their local actions have consequences on global scales (Kelly 2014). The Anthropocene becomes a category for critique—a way to define excess, limits, thresholds, and boundaries (Meadows et al. 1972; Chakrabarty 2009; Rockström et al. 2009; Dibley 2012). In effect, it becomes a standard by which to measure human action and hold societies accountable for their actions—an ethical framework. And, as scholars of environmental ethics, environmental justice, and ecocriticism suggest, this standard is often dominated by Eurocentric assumptions and interests (Egan 2002; Mosley 2006; Timmons Roberts 2007; Sze and London 2008; Ottinger and Cohen 2011).

Given the historical context in which anthropocenic consciousness emerged, it is not surprising that "the Anthropocene" is a term used in both descriptive and prescriptive senses. From its origins, the term "Anthropocene" was meant to convey an objective description of the world as well as to suggest a moral imperative to respond to the state of this world in appropriat e ways. In David Hume's sense, the Anthropocene serves dual functions as an "is" and an "ought." Take for example what might be considered the founding document of twenty-first-century research on the Anthropocene, Paul Crutzen and Stoermer's article "Anthropocene" in the International Geosphere-Biosphere Programme newsletter in 2000. After describing the conditions of anthropogenic change since the Industrial Revolution, they conclude:

> Mankind will remain a major geological force for many millennia, maybe millions of years, to come. To develop a world-wide accepted strategy leading to sustainability of ecosystems against human induced stresses will be one of the great future tasks of mankind, requiring intensive research efforts and wise application of the knowledge thus acquired in the noösphere, better known as knowledge or information society.

> An exciting, but also difficult and daunting task lies ahead of the global research and engineering community to guide mankind towards global, sustainable, environmental management. (Crutzen and Stoermer 2000, 18)

In this short summary, Crutzen and Stoermer set the scientific agenda for research on the Anthropocene: to serve the needs of society by being embedded in the process of making public knowledge, guiding policy decisions, and advocating for proper environmental management policies. According to them, the task of the global research and engineering community is not simply descriptive, and it is certainly not value neutral. Deciding what ought to be done to solve a looming crisis for humanity is a fundamentally moral position that necessitates defining responsibilities and obligations as well as distinguishing between "good" and "bad" behaviors and responses.

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Recognizing that the concept of the Anthropocene is already laden with a multiplicity of meanings, I would like to conclude by summarizing several ways that scholars might engage more productively with the concept across disciplines. These observations emerge out of the discussions of the RoA Working Group, which met in Indianapolis in January 2014.

First, given that human-induced environmental change continues to transform the planet in both predictable and unpredictable ways and given that researchers would like to create a framework for responding to these changes, it is not enough to simply understand biophysical environmental processes. It is necessary that researchers also understand the sociocultural processes that drive human-induced environmental change. This is necessary because things such as cultural beliefs can limit responses to ecological crises and therefore contribute to environmental feedback loops. Only through an understanding of the ways in which religious, economic, cultural, ideological, and political processes function—integrating them into our analyses of environmental processes and embedding them in our policies—are we likely to produce robust responses to the environmental challenges we face. This requires multidisciplinary teams of researchers, policy makers, and community stakeholders articulating agendas together and collaborating in the analysis of the human-environment interface.

Pursuing a multidisciplinary research agenda that integrates scientists, social scientists, humanists, artists, policy makers, and community stakeholders requires recognizing that "the Anthropocene" is a fluid signifier. The term encompasses a bundle of emerging concepts that reflect discipline-specific cultures, methodologies, and epistemologies. In other words, the Anthropocene is not a single thing, entity, or ideal; it is a category onto which different groups map multiple, and sometimes conflicting, ways of knowing and/or describing the world. Because of the many different ways that researchers approach these Anthropocenes—defining

problems, asking questions, devising methods, and even articulating truth claims or uncertainties—collaborative work necessarily generates tensions among multidisciplinary participants. This can be incredibly productive when the project design focuses on articulating these tensions—from the very beginnings of the project discussing how different approaches frame or define boundaries differently.[6] Doing so reminds researchers that their disciplinary perspectives are subjective, historically situated, socially constructed models. It encourages participants to recognize that they tell only part of a larger story and that multidisciplinary cooperation may ultimately be the most effective way for all groups to achieve their ends.

Second, the Anthropocene is not simply an intellectual category for describing the environment. It is also a lived phenomenon that humans experience on a variety of scales. This simple fact can often get lost in discussions of CO_2 emissions and extinctions, or even in the critical analysis of the Anthropocene as an epistemological category. The emergent processes—the entanglement of environmental and sociocultural processes and structures—that characterize the Anthropocene have very real consequences for people's day-to-day lives. These consequences are experienced unevenly and therefore function quite differently in different contexts. Take, for example, the destruction of freshwater environments. The scale at which freshwater environments are threatened in the United States is surprising. Drought, overconsumption, industrial waste, agricultural runoff, and more mean that the state of over 40 percent of American waterways threatens aquatic life (U.S. Environmental Protection Agency 2015). In places such as the Great Lakes, the threat to aquatic life is near 100 percent (U.S. Environmental Protection Agency 2015). Nevertheless, these numbers do not take into account the United States' total threat to freshwater systems around the world. This is because from its position of safety, power, and wealth, the United States exports much of its pollution overseas. American consumption patterns and the international supply chain mean that much production for American markets is done in places such as Asia, where manufacturers pollute surface waters and drain aquifers. In fact, over 20 percent of the water footprint of the United States is beyond its shores (Mekonnen and Hoekstra 2011; Water Footprint Calculator 2015). The apparel industry alone accounts for significant water pollution in Asia, and dyeing textiles for American and European "fast fashion" has been particularly devastating (Brigden et al. 2012; Institute of Public and Environmental Affairs et al. 2012). Americans are free to consume without the worry of immediate consequences while pollution in foreign rivers is decimating species and increasing the incidence of death and disease.

The uneven experience of the Anthropocene is a product of its late eighteenth- and early nineteenth-century origins.[7] Even as Europeans and Americans were harvesting coal to replace the energy once provided by timber, water, and animals, they were also using their militaries to expand control over trading routes, territory, and natural resources. They extracted labor and materials while disrupting

foreign political and economic systems. They imposed restrictions on trade and forced open markets to drive a sequence of industrial revolutions over the course of two hundred years. And, in so doing, they exploited, undermined, and underdeveloped foreign economies. As they absorbed the world's raw materials and processed them through coal-driven systems of manufacture, they caused their own economies to diverge from those in Asia, Africa, and Latin America (figs. 1.1, 1.2).

Economists and historians have discussed this "Great Divergence" in primarily economic terms, but there was an environmental side to the Great Divergence as well. European and American imperial capitalism did significant damage to the planet's ecosystems through CO_2 emissions, clear cutting, and industrial waste, and the consequences were experienced (and continue to be experienced) unevenly. By the last quarter of the twentieth century, the environmental movement forced reforms in Europe and the United States. This helped push some of the most costly environmental practices overseas, where poor and underdeveloped nations struggled to close the economic gap. Thus the Anthropocene is also a story of the unequal distribution of resources and environmental costs, amplified by political and economic structures and legacies. Consequently, any large-scale environmental solutions requires scientists to work with social scientists, humanists, policy makers, and local communities to both understand and design responses that address asymmetric power structures and the uneven consequences of global environmental change.[8] This move toward an environmental justice agenda is under way, but it requires environmental researchers to integrate into their work a deep analysis and critique of the structures of global capitalism as it relates to the human-environment nexus. Key topics include the following:

- the commodification of environmental resources (e.g., water) and knowledge (e.g., genomes or "improved seeds")
- the privatization of environmental commons (e.g., the Cochabamba Water War)
- the growth in the power, influence, and networks of nonstate actors, particularly through multinational corporations and the system of monopoly-finance capital
- the construction of poverty induced and sustained by systems of finance, trade, development, and technology
- planetary boundaries, cultural knowledge, and social practices at the local level
- displacement from intended and unintended human-induced environmental change (e.g., sea level rise, construction of dams)
- the distribution of environmental resources, risks, and responsibilities

Third, as a prescriptive category, the Anthropocene necessitates that research teams intentionally integrate questions from philosophical ethics and critical theory into their projects. After all, the ultimate purpose of nearly all anthropocenic research is to create standards for responsible policies and behaviors—effectively,

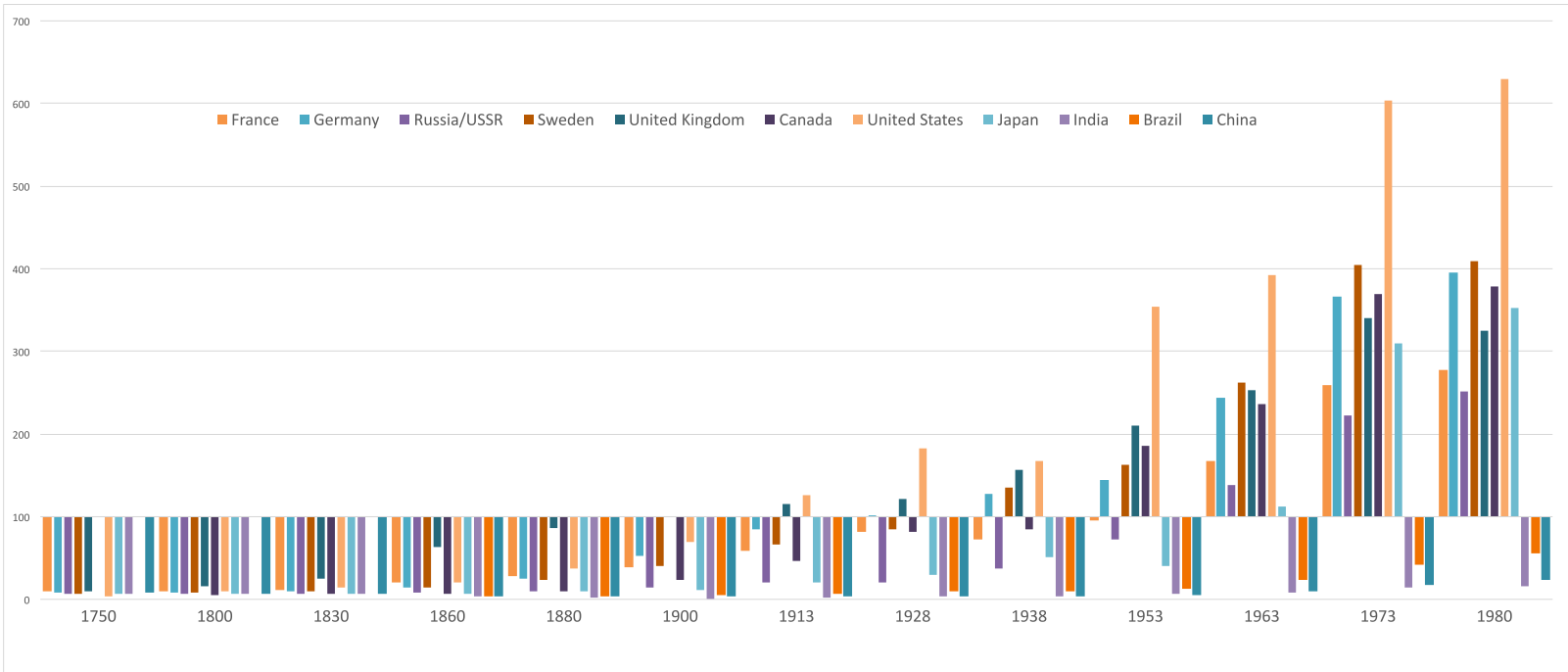

FIGURE 1.1. Per capita levels of industrialization (U.K. in 1900 = 100) derived from Bairoch 1982.

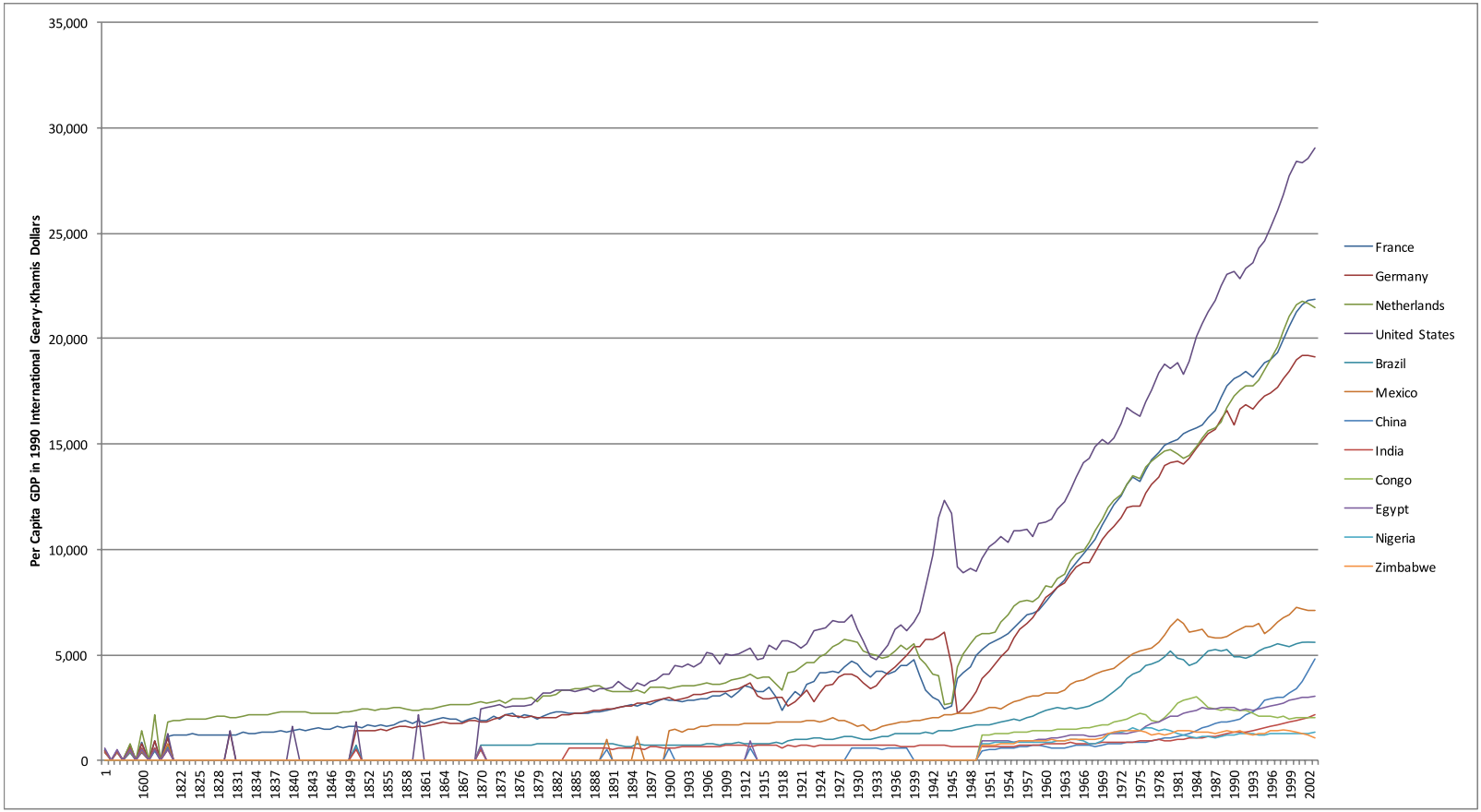

FIGURE 1.2. Per capita GDP based on Angus Madison's Historical Statistics for the World Economy: 1–2003 C.E., http://www.ggdc.net/.

guidelines for acting in the world, also known as normative ethics. And, since no moral code is objective and no ethical framework exists outside of historically situated sociocultural frameworks, the participation of specialists in morality, religion, history, art, and behavioral psychology is essential to the success of any project that seeks to most effectively address environmental problems—especially if the solution requires people to reimagine their cultural norms or transform their social practices.[9] Critical theory, on the other hand, is important in that its mission is to examine assumptions, discursive frameworks, and epistemologies that create or reproduce inequality. Critical theory provides ways for thinking about the role that research and policy agendas unintentionally play in perpetuating inequalities. And it points to new directions for addressing issues such as environmental justice.

The three observations outlined above have a common thread: multidisciplinarity. They suggest that research on the Anthropocene could better attain its ultimate goals—both descriptive and prescriptive—by building broader-based research and policy teams that integrate people from multiple (and sometimes epistemologically divergent) fields. When collaborative research projects are designed in such a way that participants can learn from one another, with the intent that only through pooling their specialties will they all be successful, the outcomes will be more fruitful. To do this, however, takes a sustained and intentional effort to integrate experts from across the disciplines. This is the ultimate goal of the RoA project—to provide an infrastructure and a set of standards for undertaking multidisciplinary research on the Anthropocene.

This essay began by arguing that there is no such thing as the Anthropocene and that this is an essay about it. What I want to suggest is that the Anthropocene (and what I term "anthropocenic consciousness") is not something that can simply be quantified, described, or measured. It is an emerging biophysical state as well as an emerging intellectual category. It is a thing both manifested in the physical world and manifested in our imaginations. As such, it is a fractured thing, or things—Anthropocenes. This realization can be very useful for researchers and can help us create more nuanced research and policy. Embracing this open-endedness can help us gain a clearer understanding of our assumptions, lead to more integrated cross-disciplinary engagement, and create better solutions to the greatest challenges facing humanity in the coming century.

NOTES

1. However, it should also be noted that Shapin published his book at the height of the "science wars" of the 1990s that pitted scientific realists (those who subscribe to a set of philosophical positions that claim science can reveal natural truth) against scientific constructivists. See Gross and Levitt 1994; Sokal and Bricmont 1999; Hacking 2000; Labinger and Collins 2001; Brown 2004.

2. For a summary of scientific constructivism and its historiography, see Golinski 2005.

3. See, e.g., Mill 1878, 324–25.

4. "All guns, or pistols, or gunpowder, found in the Colony in the possession of any person of

the native tribes of this Colony, or of any person of the native tribes of the countries adjacent thereto, without the written permission of the Governor as aforesaid, shall be seized and forfeited, whether the said gun or pistol be marked and registered or not; and the party in whose possession, as aforesaid, any such gun, or pistol, or gunpowder, may be found, shall be liable to a penalty not exceeding fifty pounds, or at the discretion of the Resident Magistrate to imprisonment for any term not exceeding two years" (Cadiz and Lyon 1891, 250).

5. See also Visconti 2014.

6. Projects that have done this effectively have recognized the benefits to their research outcomes (e.g., Dewulf et al. 2007; Mattor et al. 2013). Where project directors, participants, and institutions have integrated a dialogue about the ways that their respective disciplines frame discourse and create disciplinary boundaries, they have become more aware of their biases and thus more invested in the transdisciplinary process. From the beginning, these projects encourage "participatory modeling," an approach with analogues in other formats (e.g., "shared authority" in the field of public history) that allows participants to frame the problems and questions associated with the research. See Mollinga 2010.

7. The following paragraphs summarize the major outlines of a debate that continues to dominate discussions of modern world history. See Frank 1998; Landes 1999; Wong 2000; Vries 2001; Moore 2003; Duchesne 2004; Landes 2006; Allen 2009; Vries 2010; Parthasarathi 2011; Wallerstein 2011a, 2011b, 2011c, 2011d; Jonsson 2012.

8. While there is a prevalent subset of environmental research in the social sciences and the humanities that deals with environmental justice—and specifically environmental justice related to imperial and postimperial contexts—there remains a substantial disconnect between these discussions and more general discussions about the Anthropocene.

9. For an astute analysis of the problem of conflating biological description and normative ethics, see Thomas 2014.