ENVIRONMENT

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Science is at the center of many contemporary efforts to grapple with environmental problems. Indeed, without science, many such problems might never have come to light at all — even if one can in many cases also say, with as much justice, that without science such problems would never have arisen in the first place. It was scientific research that revealed the harmful effects of radioactive substances on bodies and ecosystems in the mid-twentieth century, and it was also scientific research that made it possible, in combination with other technological, economic, and political factors, to produce and disseminate such substances on a massive scale.[1] Modern science thus sits at the nexus of environmental concern and environmental harm.

It should be no surprise that, as both the concerns and the harms have grown over recent several decades, historians of science have increasingly turned their attention to the environmental sciences. What may be more surprising is that the category of the environmental sciences itself is of recent vintage. Among scientists, it first came into wide use in the 1960s. Among historians of science, it is only since the 1990s that the multidisciplinary category of the environmental sciences has been seen as worthy of study in its own right, as opposed to the history of individual sciences such as botany, geology, ecology, or meteorology. At the same time, it is clear that the sciences now recognized as environmental have long, complex histories predating the emergence of the category, and that there are many other ways of knowing that have, over the course of human history, produced what would now be called environmental knowledge.

The sections below describe ways that historians of science have grappled with the tension between the recent emergence of the category of the environmental sciences and these longer histories. The first focuses on the emergence of the category itself, describing how environmental and national security concerns in the United States in the early years of the Cold War drove investment in sciences seen as critical to understanding both environmental problems and the environments of future wars. The second focuses on the history of a concept foundational to the environmental sciences — namely, "environment," which

1 Lindee, *Suffering Made Real*; Campos, *Radium and the Secret of Life*; Masco, *The Nuclear Borderlands*; Brown, *Plutopia*; Higuchi, *Political Fallout*.

became the object of a diverse range of scientific specializations in the nineteenth century, not all of which were incorporated into the contemporary category of the environmental sciences. The third section describes some of the ways that historians have used the concepts of environment and the environmental sciences to explore resonances and connections that go beyond these histories.

THE COLD WAR CATEGORY OF THE ENVIRONMENTAL SCIENCES

While scattered references to "environmental science" or "the environmental sciences" can be found in the printed record before the 1960s, it was only in that decade that the term became central to an effort — not just terminological, but also conceptual and institutional — to gather a wide range of scientific disciplines under a single umbrella.[2]

In 1959, Lloyd Berkner, one of the architects of the just-completed International Geophysical Year, published an article in *Science* arguing for the creation of a US Department of Science and Technology, whose work would mostly focus on environmental subjects such as oceanography, meteorology, climate and atmospheric science, hydrology, and fish and wildlife.[3] While that vision never became a reality, it did lead to the creation of the Environmental Science Services Administration in 1965 — the first US governmental agency to include the words "environment" or "environmental" in its title, and the predecessor of the National Oceanic and Atmospheric Administration, which was established in 1970.[4] In subsequent years, the "environmental sciences," as a category, increasingly served as a useful shorthand and organizing principle, both within the US government and beyond it.

These developments owed a great deal to the emerging environmental movement of the time — not so much the more radical and countercultural side of the movement on display during the Earth Day demonstrations and teach-ins of 1970, but rather various forms of technocratic management that drew on scientific expertise to address the negative environmental externalities of the economic boom of the post-World War II decades.[5] It was during this period that ecologists such as Eugene Odum and H.T. Odum, for example, promoted their science as offering highly generalizable tools for the expert management of

2 The Google Ngram Viewer (https://books.google.com/ngrams/) shows an exponential increase in the frequency of the phrase "environmental sciences" in English-language books in the 1960s.

3 Berkner, "Government Sponsorship of Scientific Research"; Wolfle, "Government Organization of Science." On the history of the IGY, see Needell, *Science, Cold War, and the American State*; Launius, Fleming, and DeVorkin, *Globalizing Polar Science*; Belanger, *Deep Freeze*.

4 White and Hollomon, "Environmental Science Services Administration."

5 Rome, *The Genius of Earth Day*.

flows of energy and materials.[6] In this context, the environmental sciences were the epistemological counterpart to what the political scientist Lynton Caldwell, who helped draft the US National Environmental Policy Act of 1969, described as "integrated" and "comprehensive" approaches to public policy.[7]

But such environmentalist concerns were not the only, nor in many cases the most important, factor leading to the emergence of the environmental sciences as a multidisciplinary category during this period. Just as important were Cold War national security concerns, which drove shifts in the practices and subjects of research in the individual environmental sciences while also shaping the meaning and scope of the overarching category.

US military planners in the early Cold War years were preoccupied with the prospect of fighting a global war across the environments of land, sea, air, and outer space, as well as with the possibilities for offensive and defensive forms of environmental warfare.[8] These concerns were reflected in funding priorities that reshaped the practice of science in the United States at a time when the military was one of the largest sponsors of basic research. As Jacob Darwin Hamblin has argued, "the collaboration between scientists and the military as they imagined and planned to fight a third world war" was critical to the emergence of the interdisciplinary environmental sciences during this period.[9] Military funding had profound impacts on fields such as oceanography, geology, meteorology, ecology, and climate science, each of which was seen as having direct relevance to national security.[10]

The Cold War also affected the environmental sciences in ways less directly connected to immediate military needs and resources. Just as historians of the Cold War have shown how the United States pursued its national security objectives through a variety of non-military means — food aid, technical assistance, the civilian space program, cultural programs, and so forth — so have historians of the environmental sciences shown how environmental expertise became a central component of US international development and diplomacy in fields such as agronomy, soil science, ecology, geology, and hydrology. The science of plant

6 Taylor, "Technocratic Optimism, H. T. Odum, and the Partial Transformation of Ecological Metaphor after World War II."

7 Caldwell, "Environment."

8 Hamblin, *Arming Mother Nature*. See also Masco, "Bad Weather."

9 Hamblin, *Arming Mother Nature*, 246.

10 Mukerji, *A Fragile Power*; Doel, "Constituting the Postwar Earth Sciences"; Oreskes, "A Context of Motivation"; Oreskes, *Science on a Mission*; Oreskes and Krige, *Science and Technology in the Global Cold War*; Turchetti and Roberts, *The Surveillance Imperative*.

breeding, for example, received extensive material support during the Cold War because of its supposed relevance to preventing Communist inroads in the Third World.[11]

The consequences of military patronage for the environmental sciences and the broader geopolitical context of the Cold War can be roughly divided into three categories. The first concerns the model of interdisciplinarity and the range of disciplines that were incorporated into the environmental sciences. The idea that one needed to assemble expertise from across a range of disciplines, each with its specialized methods and subjects, in order to effectively address real-world problems was one of the basic tenets of military-supported science in the Cold War era — a tenet that challenged both the idea of disciplinary self-sufficiency and the idea of generalist expertise. It was almost always military and government research sponsors who demanded interdisciplinarity from the scientists they supported, not the other way around.[12] Those sponsors had definite understandings of which disciplines were relevant to the environments they cared about, and which were not. The physical environmental sciences — oceanography, seismology, atmospheric science, and so forth — received especially generous military support during this period.[13]

The second category of consequences concerns the instruments and infrastructures of research. Navy ships and submersibles gave oceanographers unprecedented views of the depths and helped tip the balance in favor of the theory of plate tectonics, while underwater sensors designed to listen for Soviet submarines flooded marine biologists with acoustic data that revealed, among other things, the sophisticated communicative capacities of cetaceans.[14] Seismologists were recruited to help build sensor networks sensitive enough to detect Soviet underground nuclear tests, which also provided an unprecedented view of the planet's shifting crust.[15] Ecologists mapped ecosystems using radioisotopes provided by the Atomic Energy Commission (AEC) or, in some cases, the radioactive residues of nuclear weapons tests, and tracked animals using radiotags developed with AEC grants.[16] Atmospheric scientists took advantage of high-flying military aircraft and spy satellites to map the upper reaches of the atmosphere and survey the Earth's surface from a distance, while also modeling the global climate using digital computers that had initially been

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11 Cullather, *The Hungry World*.

12 Fred Turner has described, in another context, the US military's embrace of interdisciplinarity during this period; Turner, *From Counterculture to Cyberculture*.

13 Doel, "Constituting the Postwar Earth Sciences," 2003.

14 Oreskes, Science on a Mission; Oreskes, *The Rejection of Continental Drift*. On the US navy's interest in marine biology and bioacoustics, see Mitman, *Reel Nature*; Burnett, *The Sounding of the Whale*; Colby, *Orca*.

15 Barth, "The Politics of Seismology."

16 Benson, *Wired Wilderness*; Bocking, *Ecologists and Environmental Politics*; Martin, "Proving Grounds"; DeLoughrey, "The Myth of Isolates."

developed to aid in the design of nuclear weapons.[17] The list of examples could be continued.[18]

Finally, military sponsorship helped make quantitative data and systems theories central to the environmental sciences. Norbert Wiener's cybernetics, Claude Shannon's information theory, the systems analysis of the RAND Corporation, and the general system theory of biologist Ludwig von Bertalanffy were all endorsed by military research sponsors as ways of working across disciplinary borders.[19] At the same time, the quantitative and deductive methods of physics became a model for research across a variety of disciplines in the environmental sciences.[20] Within ecology, for example, the AEC, warden of the US nuclear arsenal, sponsored the development of methods for quantitatively studying circuits of feedback and control between living beings and their surroundings, thereby facilitating the ascendance of ecosystem ecology over other subfields.[21] This military-sponsored adoption of systems thinking across a range of disciplines within the environmental sciences gave weight to the metaphor of Spaceship Earth in the 1960s and prepared the way for the development of the concept of the Earth system and Earth System Science in the 1980s.[22]

17 Edwards, *A Vast Machine*; Harper, *Weather by the Numbers*; Conway, *Atmospheric Science at NASA*; Fleming, *Inventing Atmospheric Science*.

18 See, e.g., Herzberg, Kehrt, and Torma, *Ice and Snow in the Cold War*; Rand, "Falling Cosmos"; Munns, *Engineering the Environment*.

19 Heyck, *Age of System*; Kline, *The Cybernetics Moment*.

20 Doel, "Constituting the Postwar Earth Sciences."

21 Hagen, *An Entangled Bank*; Coleman, *Big Ecology*; Kwa, "Radiation Ecology, Systems Ecology and the Management of the Environment."

22 Höhler, *Spaceship Earth in the Environmental Age*; Anker, "The Ecological Colonization of Space"; Kwa, "Local Ecologies and Global Science"; Steffen et al., "The Emergence and Evolution of Earth System Science."

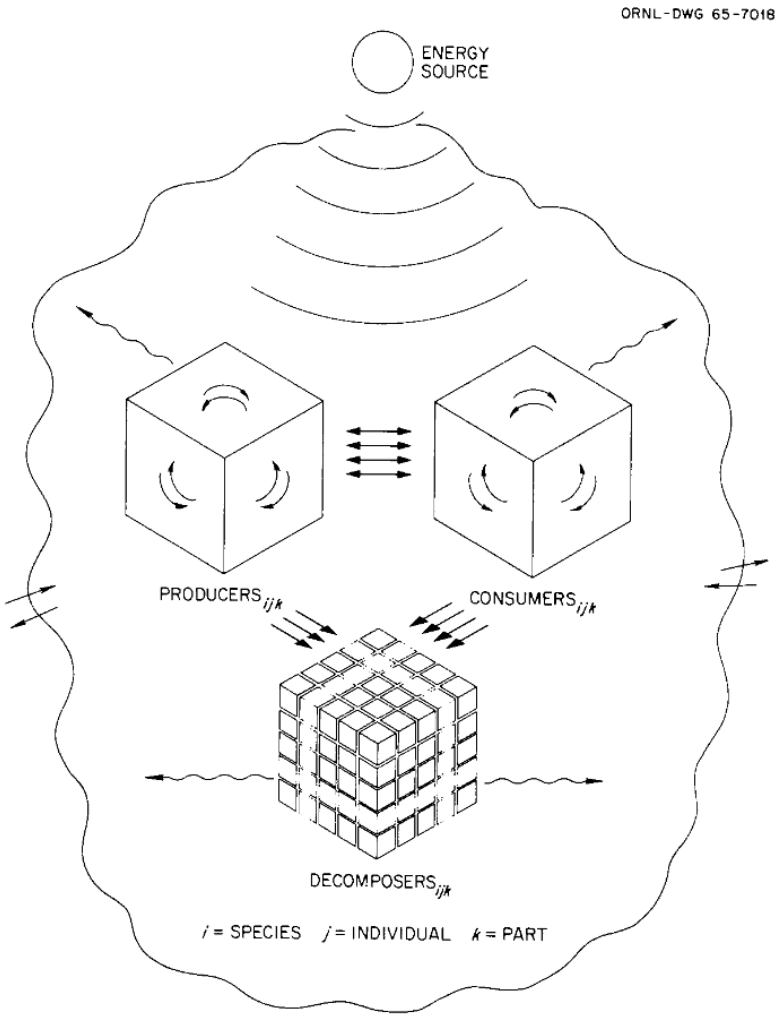

Figure 1: A schematic representation of an ecosystem by ecologist George M. Van Dyne, produced under contract with the Atomic Energy Commission in the mid-1960s, which epitomizes the centrality of systems theories to the environmental sciences as they were defined during the Cold War. Source: Van Dyne, *Ecosystems, Systems Ecology, and Systems Ecologists*, p. 16.

Although the category of the environmental sciences was powerfully shaped by national security concerns, the environmental movement and the expansion of environmental laws, treaties, and regulations associated with it became increasingly important in the latter decades of the Cold War. Among other things, the environmental movement helped create new forms of "regulatory science" for which the needs and aims of environmental regulators — rather than those of Cold War research sponsors — defined the central problems and fostered new forms of interdisciplinarity, and they called for the development of new categories of scientific expertise in the legal arena.[23] Internationally, "environment" became

23 Jasanoff, *The Fifth Branch*; Jasanoff, *Science at the Bar*.

the central concept in a spate of treaties and agreements from the 1970s onwards, with the U.N. Conference on the Human Environment in Stockholm in 1972 serving as a key turning point.[24] Around the same time, the environmental movement was also driving the formation of interdisciplinary departments and degree programs in environmental science and environmental studies within academia.

Outside of the United States, the sciences that were coming to be known as members of the category of the environmental sciences had their own trajectories, some of which were quite distinct from developments within the United States. Scandinavian researchers played a critical role in the development of modern climate science, for example, for reasons linked to their own geography and history as well as to their connections with the broader scientific community.[25] During the Cold War period, many geologists outside of the United States viewed with skepticism the enthusiastic adoption of methods borrowed from geophysics by American geologists who were being generously supported by the US military, and they largely followed their own paths.[26] And of course, in numerous contexts both within and outside the United States, scientists continued to study environmental topics for a wide range of reasons, and as inheritors of traditions that long predated the Cold War.

Nonetheless, if the question is not how and why scientists have studied the environment but why the environmental sciences came to be seen as a useful and even self-evident label for a group of sciences that had not always been seen as closely related, then the United States and its Cold War national security concerns are central to the answer. It was in that context, at a time when the United States was becoming a scientific as well as military superpower, that the environmental sciences were defined as those sciences that studied environments as interconnected systems, using quantitative data produced by a range of instruments and global infrastructures of sensing, communications, and transportation. For the most part, today's environmental sciences continue to embrace interdisciplinarity, to focus on physical rather than social environments and processes, and to privilege the use of quantitative methods and systems theories. All of these enduring (though not uncontested) characteristics of the environmental sciences were forged in the early decades of the Cold War.

THE ENVIRONMENT AS A SCIENTIFIC OBJECT

Scientific objects emerge when "a heretofore unknown, ignored, or dispersed set of phenomena is transformed into a scientific object that can be observed and manipulated, that is capable of theoretical ramifications and empirical surprises, and that coheres, at least

24 Warde, Robin, and Sörlin, *The Environment*; Selcer, *The Postwar Origins of the Global Environment*.

25 See, e.g., Bravo and Sörlin, *Narrating the Arctic*; Anker, *The Power of the Pieriphery*.

26 Oreskes, *The Rejection of Continental Drift*; Oreskes, *Science on a Mission*.

for a time, as an ontological entity," as Lorraine Daston writes.[27] "Environment" is an ontological entity of this sort, with a history of its own — one that long precedes the emergence of category of the environmental sciences in the second half of the twentieth century.[28]

The Organism and its Milieu

As Georges Canguilhem argued nearly three-quarters of a century ago, it was around the beginning of the nineteenth century that the concept of *milieu*, initially borrowed from physics, began to be applied to the domain of life.[29] (*Milieu* was the closest equivalent to "environment" in French until the 1970s, when *environnement* displaced it in many contexts.) Canguilhem saw this development as being closely tied to the emergence of a mechanistic and objectifying mode of studying life, in which the properties of living beings were understood as the deterministic products of their physical surroundings. To this Newtonian view of life, Canguilhem counterposed his own phenomenological view, in which a "living thing is not reducible to a crossroads of influences" but rather remains the center of a meaningful world of perception and action.[30]

For Canguilhem — writing just as the battle lines of the Cold War were being drawn and before the modern environmental movement had emerged — the history of the concept of *milieu* was part of the history and philosophy of biology. It was not part of the history of concern about environmental problems, nor was it part of the history of the yet-to-be-named environmental sciences.[31] In the past several decades, however, historians of science and environmental historians have begun to show how these histories are intertwined — that is, how "environment" as an object of scientific inquiry, within and beyond the life sciences, has developed in close relation to what would now be described as environmental concerns.

Such intertwining is visible in the context in which the concept of *milieu* was first applied to living beings at the beginning of the nineteenth century, that of the Museum of Natural History in Paris. There, luminaries of French natural history such as Georges Cuvier, Jean-Baptiste Lamarck, Étienne Geoffroy Saint-Hilaire, and André Thouin — as well as close correspondents such as the Prussian naturalist Alexander von Humboldt and the Swiss botanist Augustin-Pyramus de Candolle — developed techniques for studying the

27 Daston, "The Coming into Being of Scientific Objects," 5.

28 Benson, *Surroundings*; Sprenger, *Epistemologien des Umgebens*.

29 Canguilhem, "The Living and Its Milieu."

30 Canguilhem, 120.

31 For additional scholarship on the history of milieu and related concepts in the history and philosophy of biology, see Feuerhahn, "Du milieu à l'Umwelt"; Cheung, *Organismen*; Sprenger, "Zwischen Umwelt Und Milieu – Zur Begriffsgeschichte von Environment in Der Evolutionstheorie"; Wessely and Huber, *Milieu*; Barker, Desjardins, and Pearce, *Entangled Life*.

organization of living beings ("organisms," as they were then beginning to be called) in relation to their surroundings and ways of life. These efforts included experiments in the acclimatization of plants and animals transported to Paris from distant climes, as well as efforts to artificially recreate the external conditions they needed to survive. The French state supported such efforts in large part because they promised to help increase agricultural productivity in metropolitan France and its colonies.[32]

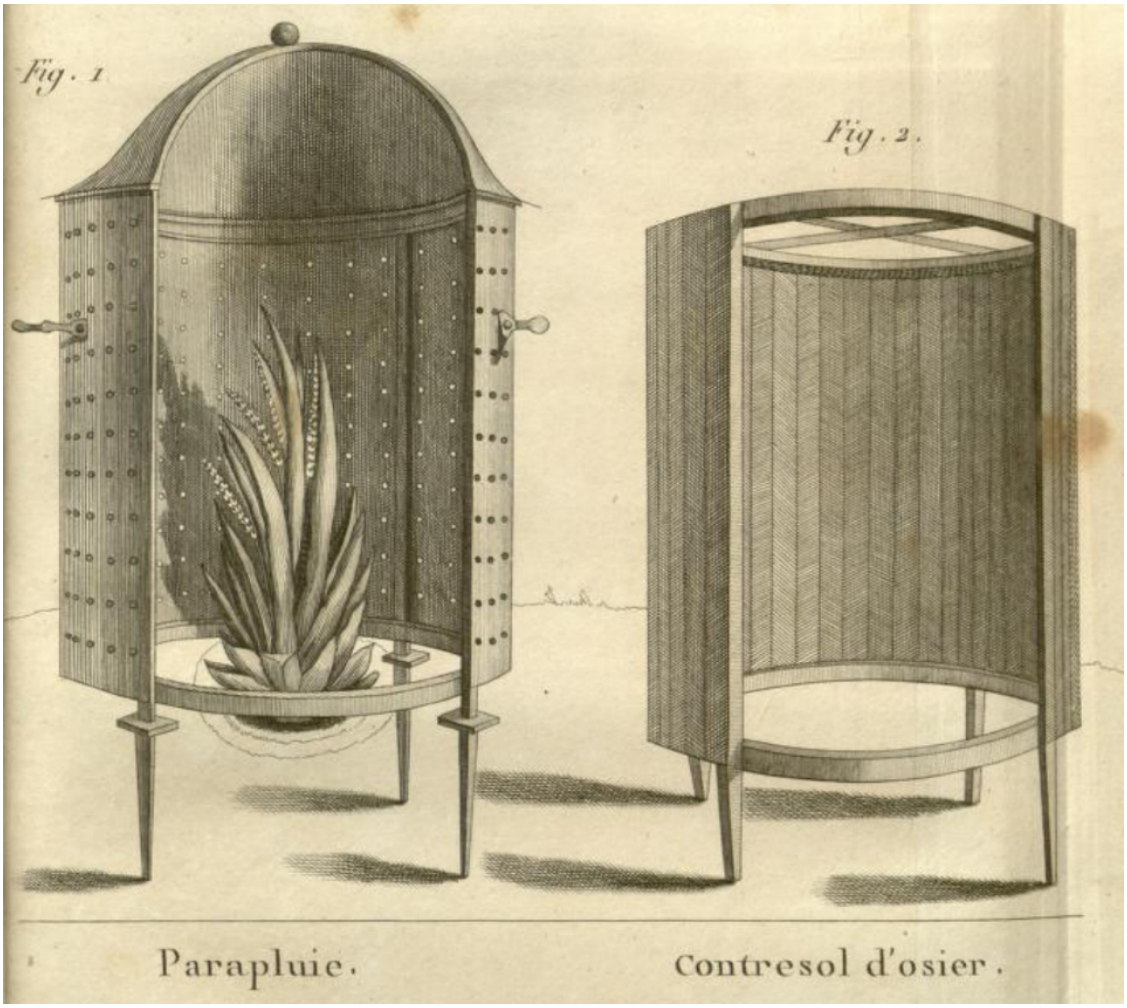

Figure 2: Two of the devices adopted by naturalists at the Museum of Natural History in Paris at the beginning of the nineteenth century to experiment with the conditions required for living beings to survive after being transplanted from their native climes – important tools in their development of the concepts of "organism" and "milieu." Source: *Annales du Muséum d'histoire naturelle* 6 (1805): Plate 47.

32 Spary, *Utopia's Garden*; Benson, *Surroundings*; Robbins, *Elephant Slaves and Pampered Parrots*; Roger, *Buffon*; Blanckaert, *Le Muséum Au Premier Siècle de Son Histoire*; Lacour, *La République Naturaliste*.

It was this tradition of research on organisms and their *milieux* in the service of science and the state, extending roughly from the last decade of the eighteenth century through the middle of the nineteenth century, that inspired Auguste Comte to adopt *milieu* as a central concept of his Positivist system of philosophy in the 1830s and, on the other side of the Channel, led Herbert Spencer to center his own philosophical system on the adaptation of the individual to its "environment" in the 1850s.[33] At that time, the word "environment," despite being present in Anglo-Norman writings as early as the first half of the twelfth century, was exceedingly rare in English-language writing — so much so, in fact, that when Thomas Carlyle had begun using it several decades earlier in a literary context, it had been accounted one of his many "barbarous" neologisms.[34] It was through Spencer's widely read philosophical works, which in turn drew on Comte and the French naturalists, that the term became common in the English language in the late nineteenth century.[35] The fact that "environment" is now a well-accepted, even ubiquitous term in English is ultimately a consequence of the way this originally biological concept was built into the foundations of two of the most influential philosophical frameworks of the second half of the nineteenth century.

The Sciences of Environment

The spread of the term "environment" in the English language in the second half of the nineteenth century — along with its cognates in other languages, such as *milieu* in French, *ambiente* in Spanish, and *Umwelt* in German — was closely linked to the emergence of new scientific disciplines that made environments their explicit objects of inquiry. This was not just a period of terminological transition, in other words, but also a critical moment in the history of what we might call the sciences of environment, as distinct from the later-emerging category of the environmental sciences.

Ecology provides an example. The coinage of the term "ecology" is usually attributed to Ernst Haeckel, who used it in 1866 to describe "the entire science of the relationships of the organism to the surrounding external world (*umgebenden Aussenwelt*), in which we can include, in an extended sense, all 'conditions of existence.'"[36] Despite Haeckel's clear debts to Charles Darwin, whose 1859 *Origin of Species* had made him into a passionate advocate of the theory of evolution by natural selection, this definition of ecology was consistent with a pre-Darwinian tradition of interest in organisms and their *milieux* going back to Cuvier,

33 Spencer, *The Principles of Psychology*; Comte, *The Positive Philosophy of Auguste Comte*. On Comte's use of milieu, see Tresch, *The Romantic Machine*, 270–71.; on Spencer's use of environment, see Pearce, "From 'circumstances' to 'Environment.'"

34 Jessop, "Coinage of the Term Environment." See also the entry for "environment" in the *Oxford English Dictionary*.

35 Pearce, "From 'circumstances' to 'Environment'"; Pearce, *Pragmatism's Evolution*.

36 Haeckel, *Generelle Morphologie der Organismen*, 2:286. My translation.

Lamarck, and their colleagues and correspondents at the Museum of Natural History at the beginning of the century.[37]

Though Haeckel himself did little to further the development of ecological science, this focus on the "surrounding external world" and "conditions of existence" — phrases increasingly contracted to "environment" and its cognates over the following decades — came to be seen not merely as one approach to the study of zoology or botany, but as the foundation of a new discipline in its own right. For this discipline, the organism-environment relation rather than the organism in isolation was the central object of inquiry.[38] To study that object, scientists developed new kinds of research practices, including site-based research that they began to call "fieldwork."[39] At the same time, ecology as a discipline became closely linked to efforts to sustainably intensify the exploitation of living natural resources, from oyster beds in the Baltic Sea to the soils of the Great Plains to plantations in Europe's tropical colonies.[40]

The Social Environment

Environment also became an important object of inquiry for emerging disciplines in the human sciences in the late nineteenth century, including sociology, anthropology, and geography, all of which were responding to the rapid social changes of the period, including mass migration and the explosive growth of urban and industrial environments. In the United States in the 1890s, for example, reform-minded researchers such as Florence Kelley, Alice Hamilton, and W.E.B. DuBois began applying the method of the "social survey" to neighborhoods and workplaces in order to understand the influence of environments on individuals and communities.[41] Around the same time, the anthropologist Franz Boas began arguing that environment, not heredity, was responsible for differences in cranial capacity among immigrants to the United States, while the geographer Ellen Churchill Semple argued that human societies had been shaped by the "geographical environment."[42]

Attending to the way that environment became an object of research not just in biology, but also in the human sciences, broadens the account provided by Canguilhem and other

37 On Haeckel, see Richards, *The Tragic Sense of Life*; Egerton, *Roots of Ecology*. On plant geography, see Browne, *The Secular Ark*; Güttler, *Das Kosmoskop*.

38 Egerton, *Roots of Ecology*; Mitman, *The State of Nature*; Tobey, *Saving the Prairies*; Bocking, *Ecologists and Environmental Politics*; Coleman, *Big Ecology*; Kingsland, *Modeling Nature*; Kingsland, *The Evolution of American Ecology*; Worster, *Nature's Economy*; Anker, *Imperial Ecology*.

39 Kuklick and Kohler, *Science in the Field*; Kohler, *Landscapes and Labscapes*; Kohler and Vetter, "The Field"; Vetter, *Field Life*.

40 Cittadino, *Nature as the Laboratory*; Nyhart, *Modern Nature*; Tobey, *Saving the Prairies*.

41 Katz and Sugrue, *W.E.B. DuBois, Race, and the City*; Bulmer, Bales, and Sklar, *The Social Survey in Historical Perspective*; Sellers, *Hazards of the Job*.

42 Semple, *Influences of Geographic Environment*; Boas, *Changes in Bodily Form of Descendants of Immigrants*.

intellectual historians following in his footsteps, in which the discussion of *milieu* has largely been confined to the history and philosophy of biology. Kelley, Hamilton, Du Bois, Boas, Semple, and many of their contemporaries conceptualized and materialized environments in ways that went beyond the life sciences, and indeed beyond the physical environment. For Du Bois, for example, the urban environment of African Americans included "the physical environment of city, sections, and houses" but also "the far mightier social environment — the surrounding world of custom, wish, whim, and thought which envelops this group and powerfully influences its social development."[43]

Much of the research on the social environment that emerged from the late nineteenth century onward did not fall within the ambit of the environmental sciences as they would later come to be defined during the Cold War, whether by military planners or by environmental activists such as Rachel Carson, whose attention was squarely concentrated on toxic pollutants and other physical environmental hazards.[44] Nonetheless, the human sciences of environment played an important role in the development of the multifaceted concept of "environment," and indeed in some cases social scientists were even more enthusiastic adopters of the concept than their counterparts in the physical and life sciences. In their own time, moreover, the early human sciences of the environment were closely linked to political and ethical concerns that, while overshadowed by the environmental movement of the 1960s and 1970s, regained the spotlight with the environmental justice movement of the 1970s and 1980s.[45] Thus, while anthropology, sociology, cultural geography, and other human sciences may not fall within the category of the environmental sciences as conventionally defined, they have long been central to the sciences of environment and to certain forms of environmentalism.

The Environment of Health and Disease

A number of historians of European medical practice and theory have pointed to the eighteenth century as a crucial period for the emergence of environmental medicine, noting the continuities between the neo-Hippocratic theories of that era, with their emphasis on "airs, waters, and places," and late twentieth-century attempts to challenge modern biomedicine's focus on the internal processes of the body, conceived of as a self-contained if also vulnerable space.[46] By attending to how and why medical practitioners and public health experts adopted the concept of environment, however, it becomes apparent that it was only at the end of the nineteenth century — at the very moment that neo-Hippocratic

43 Du Bois, *The Philadelphia Negro*, 5.

44 Carson, *Silent Spring*. See also Sellers, *Crabgrass Crucible*.

45 Gottlieb, *Forcing the Spring*; Bullard, *Dumping in Dixie*.

46 Jordanova, Porter, and Jordanova, "Earth Science and Environmental Medicine"; Bashford and Tracy, "Introduction."

approaches to health were being displaced and transformed by new theories centered on microscopic infectious agents and their vectors — that environment became an explicit object of medical and sanitary research.[47]

For these researchers, the environment was not a direct cause of disease — as neo-Hippocratic medical theorists had often considered "airs, waters, and places" to be — but rather a context or habitat within which organisms harmful to human health might thrive. As George Sternberg explained in his 1902 account of the U.S. military's efforts to combat disease during the construction of the Panama Canal, "no infectious diseases are directly due to climatic influences, although climate has much to do with the prevalence of some of these diseases when the germs to which they are due are introduced to a given locality."[48] That is, it was not what Sternberg described as the "tropical environment" per se that made people sick; it was the pathogenic organisms that flourished within that environment.[49] Throughout the twentieth century, public health specialists and disease ecologists continued to study the environment as an indirect agent of disease and to elaborate what Linda Nash has called the "germ-theory theory of the environment."[50]

"The" Environment and its Critics

Historicizing the origins and development of environment as a scientific object also sheds light on the emergence of environmental movement and the category of the environmental sciences in the Cold War era, which selectively drew from this long tradition while also introducing new elements. Historians have shown that the idea of "*the* environment" as the singular global object of a particular kind of future-oriented, managerial scientific expertise dates to this period.[51] International organizations such as the United Nations played a crucial role in disseminating this new variation on the concept of environment, helping make the word "environment" into part of the international lingua franca and bringing it into the dictionaries of many non-English languages.[52] At the very same time that the category of the environmental sciences was being developed, then, the environment as an object of

47 Benson, *Surroundings*.

48 Sternberg, "Sanitary Problems Connected with the Construction of the Isthmian Canal," 383. For historical context, see Sutter, "Nature's Agents or Agents of Empire?"; Anderson, *Colonial Pathologies*.

49 Sternberg, "Sanitary Problems Connected with the Construction of the Isthmian Canal," 382.

50 Nash, "Purity and Danger," 651. See also Nash, *Inescapable Ecologies*; Anderson, "Natural Histories of Infectious Disease."

51 Warde, Robin, and Sörlin, *The Environment*. See also Robin, *The Future of Nature*; Sörlin, "Reconfiguring Environmental Expertise"; Sörlin and Wormbs, "Environing Technologies."

52 Selcer, *The Postwar Origins of the Global Environment*.

scientific inquiry was being singularized, internationalized, and rendered the object of managerial expertise in ways that persist today.[53]

That singular, international, managerial concept of environment has, not surprisingly, come in for some criticism in the half-century or so since its elevation to the status of "*the* environment." Recent critiques have focused especially on environmentalism as a social movement and on the deployment of the environment/organism dichotomy within the life sciences. Critics have noted that the postwar notion of "the" environment became tightly linked to technocratic visions of government-by-experts, in ways that lingering associations of the environmental movement with the 1960s counterculture can sometimes obscure, while creating obstacles to more democratic and just ways of defining and responding to environmental concerns.[54] At the same time, they have noted that contemporary environmental discourse, whether popular or scientific, has often had the ironic effect of sharpening the distinctions between organisms and their environments, even while it seeks to emphasize their reciprocal connections.[55] To understand the world in environmental terms, it turns out, often requires first dividing the world into environments and the things they surround — and that division, critics have pointed out, is rarely overcome in the efforts to establish connections that follow.[56]

Much of this critique has been, with good reason, focused on contemporary environmental discourse, which continues to be shaped by the rise of "the environment" as a critical concept for both politics and science in the decades following World War II (along with other critical concepts, such as "biodiversity," "sustainability," and "climate").[57] Once one broadens one's view to include the sciences of environment as they emerged in the nineteenth century, however, it becomes apparent that the definite article in "the environment" belies an almost bewildering variety of ways in which environment has been conceptualized and materialized over the past century and a half, not all of which are equally susceptible to the same critique. Before one can diagnose what is wrong with the concept of environment, the environmental

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53 Höhler, *Spaceship Earth in the Environmental Age*; Grevsmühl, *La Terre Vue d'en Haut*; Benson, *Surroundings*; Camprubí and Lehmann, "The Scales of Experience."

54 Warde, Robin, and Sörlin, *The Environment*. See also Robin, *The Future of Nature*; Sörlin, "Reconfiguring Environmental Expertise"; Sörlin and Wormbs, "Environing Technologies." On U.S. environmentalism and the counterculture, see Kirk, *Counterculture Green*.

55 Bruno Latour, for instance, drawing on James Lovelock's Gaia hypothesis, has suggested that the organism/environment distinction collapses once one recognizes that organisms are always actively reshaping their surroundings; Latour, *Facing Gaia*. For a similar argument, see Haraway, "Tentacular Thinking," 30. On the origins and reception of the Gaia hypothesis, see also Ruse, *The Gaia Hypothesis*; Clarke, *Earth, Life, and System*; Dutreuil, "James Lovelock's Gaia Hypothesis: 'A New Look at Life on Earth' . . . for the Life and the Earth Sciences," 272–87.

56 This point has long been recognized; see, for example, Caldwell, "Environment," 133.

57 Raby, *American Tropics*; Caradonna, *Sustainability*; Howe, *Behind the Curve*.

sciences, or environmentalism, it turns out to be necessary to ask *which* environment is at stake.[58]

HISTORIES OF ENVIRONMENTAL KNOWLEDGE

Over the past several decades, efforts to uncover the Cold War origins of the environmental sciences and to trace the deep and diverse histories of the sciences of environment has made it clear that much can be gained by refusing to take the categories of the environmental sciences and environment for granted. But there is also a rich vein of scholarship that uses contemporary understandings of environment to uncover neglected histories or to reframe oft-told stories. By deploying environment and the environmental sciences as analytic categories for the history of science and environmental history rather than as subjects of historical research in their own right, this scholarship can identify important continuities and make comparisons in ways that scholarship that focuses on historicizing these categories often cannot.

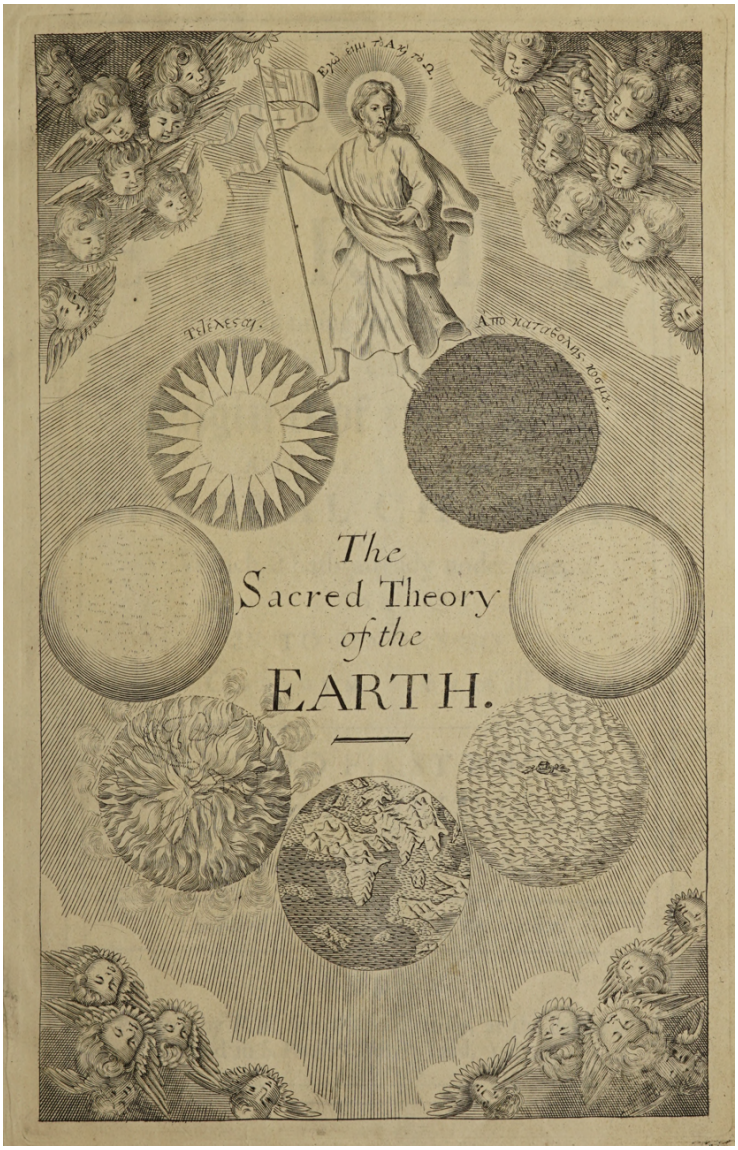
Much is to be gained, for example, by approaching early modern or premodern ways of knowing the Earth as analogous to those sciences that would, centuries later, turn to environment as their central scientific object or be incorporated into the Cold War category of the environmental sciences. Such earlier sciences did not simply anticipate or lay the foundation for later, more properly environmental sciences. They also grappled in their own distinct ways with epistemological and ethical problems concerning humanity's relationship to its surroundings. Recognizing these efforts as part of the history of environmental thought may be presentist in its adoption of today's understanding of the concept of environment, but it usefully opens up possibilities for identifying meaningful resonances between the present and the more distant past.

One of the insights to emerge from scholarship that takes this approach is that while contemporary environmental discourse often suggests that we are only now becoming aware of and alarmed by the extent of human impacts on the planet, concern about the global environment is already centuries old, if not older. The emergence of what has been called "environmental reflexivity" did not await the emergence of the modern environmental sciences, let alone the discoveries of late-twentieth-century ecologists or climate scientists.[59] Early-modern research on the textual and material traces of Noah's Flood among Christian theologians and nationalists in Europe, for example, not only helped lay the foundations for later developments in the scientific discipline of geology but also, in its own time, provided a conceptual framework for understanding how human actions could transform the global

58 Benson, *Surroundings*.

59 Locher and Fressoz, "Modernity's Frail Climate"; Bonneuil and Fressoz, *The Shock of the Anthropocene*; Fressoz, *L'apocalypse joyeuse*.

environment.[60] Naturalists, scientists, and theologians continued to rework concerns about human impacts on local and global environments over succeeding centuries, making the recent discussion of the Anthropocene only the latest in a long series of similar discussions.[61] (See "Anthropocene" and "Cosmology.")



60 Barnett, *After the Flood*.

61 For two nineteenth-century examples, see Coen, *Climate in Motion*; Chakrabarti, *Inscriptions of Nature*.

Figure 3: The frontispiece of Thomas Burnet's *Sacred Theory of the Earth*, originally published in the 1680s, which discussed the origins and development of the Earth within a theological framework that both anticipated and fundamentally differed from the explicitly environmental frameworks that would be developed from the nineteenth century onwards. Source: Burnet, *The Sacred Theory of the Earth*, 3rd edition (1697).

One of the benefits of applying concepts of environment and the environmental sciences to periods and places in which they were not used by historical actors is that it calls attention to people who were not scientists in the modern sense, and who did not conceive of their objects of concern in explicitly environmental terms, but who nonetheless possessed a wealth of knowledge about their surroundings. Historians of natural knowledge among European colonists in North America from the seventeenth to the nineteenth centuries, for example, have shown how those colonists' ideas about fauna, flora, peoples, and climates emerged from their practical experiences as well as their connections to transatlantic networks of learned inquiry.[62] They have noted that the confidence those colonists had in their ability to transform the environments they encountered is a mirror-image of today's anxieties about climate change, while their dismissal of indigenous knowledge about those environments — often uneasily paired to an exploitation of that knowledge — is linked to continuing forms of environmental injustice.

Applying the categories of environmental science and environment broadly also has advantages for the history of more recent periods, bringing into view connections between formal scientific knowledge and various kinds of non-scientific knowledge, including the knowledge gained in the course of practical activity. Historians of fishing and fisheries, for example — who are just as likely to identify as environmental historians as historians of science — have amply documented the rich and complex forms of knowledge that fishers have developed about oceans, rivers, lakes, and their nonhuman inhabitants and ecologies, often in conversation with but also independently of the forms of knowledge developed within the environmental sciences proper.[63] In the twentieth century, for example, oyster fishers working the Chesapeake Bay cultivated a form of knowledge that sometimes agreed with, but more often contradicted, that of scientists seeking to modernize and regulate the fishery.[64] The complex relationship between these forms of knowledge is illuminated by approaching both in environmental terms, even if "environment" was a concept only partially and belatedly adopted by some of the people involved.

Similar advantages arise from using the concept of environment broadly in studies of the participation of non-scientists in scientific research. Many participants in what, in recent decades, has often been called "citizen science" do not possess expertise in the methods of

62 Zilberstein, *A Temperate Empire*; Parsons, *A Not-so-New World*; Parrish, *American Curiosity*; Valenčius, *The Health of the Country*.

63 McEvoy, *The Fisherman's Problem*; White, *The Organic Machine*; Taylor, *Making Salmon*.

64 Keiner, *The Oyster Question*.

the environmental sciences and do not share experts' understandings of the environment as a scientific object — if they consider it to be among their primary objects of concern at all. Nonetheless, framing these participants' knowledge of plants, animals, weather, climate, soil, water, and other aspects of their surroundings as environmental facilitates comparison with the forms of knowledge cultivated by environmental scientists. It also shows how dependent those scientists are on forms of knowledge and relation that exceed the bounds of both the environmental sciences and the sciences of environment.[65]

In theory, a broad definition of environment and the environmental sciences should also support recent efforts to de-center Europe and the West in the history of science, though, to date, the scholarship in this area remains underdeveloped. *Green Imperialism,* Richard Grove's influential 1994 effort to resituate the origins of environmentalism in Europe's colonial peripheries, offers one example of how to pursue environmental knowledge beyond the limits of both the Cold War environmental sciences and the nineteenth-century sciences of environment.[66] Despite its exploration of the contributions of non-Western knowledge systems to the development of European environmentalism, however, it remains centered on the European experience. More recent works have begun to shift the balance, but there remains much to be done in the historiography of non-Western ways of making environmental knowledge.[67]

The project of decentering Europe and the West in the history of the environmental sciences also promises to reframe the histories of both the environmental sciences and the sciences of environment within a broader history of environmental knowledge.[68] From the perspective of the history of knowledge, these sciences, as they have developed over the past several centuries, represent only a subset of the many different ways that human societies have acquired, formalized, and communicated meaningful knowledge about their surroundings. Moreover, situating these sciences within the history of knowledge, broadly conceived, reveals that modern science already depends on and incorporates, though usually unacknowledged, some of these alternative ways of knowing. Such reframings seem critical not only for developing a fuller, more nuanced picture of the past but also for

65 There is a rich historiography on the history of non-expert participation in scientific research; see, e.g., Fleming, *Meteorology in America*; McCray, *Keep Watching the Skies*; Coen, *The Earthquake Observers*; Fan, "'Collective Monitoring, Collective Defense.'"

66 Grove, *Green Imperialism*.

67 E.g., Mavhunga, *The Mobile Workshop*.

68 Burke, *What Is the History of Knowledge?*; Dupré and Somsen, "Forum"; Renn, *The Evolution of Knowledge*.

grappling with present-day conflicts between radically different visions of how to know and relate to environments in the plural.[69]

CONCLUSION

Reflecting the relatively recent emergence of the category of the environmental sciences, it was only in 1992 that a historian of science, Peter Bowler, attempted to survey the historical scholarship in the field.[70] His *Fontana History of the Environmental Sciences* covered "all the sciences that deal with our physical and organic environments, ranging from geography and geology to ecology and evolution theory," with an emphasis on the Western scientific tradition and on the period of disciplinary specialization spanning from the eighteenth century to the twentieth century.[71] It is probably not a coincidence that the United Nations Conference on Environment and Development in Rio de Janeiro, also known as the Earth Summit, took place the same year that Bowler's book was published. As Bowler noted, the "unity of the 'environmental sciences' is not created by the sciences themselves; it is imposed by the public's growing awareness of the threat posed to the environment by our own activities."[72]

Historians' growing awareness of environmental threats has undoubtedly contributed to the subsequent growth of scholarship on the environmental sciences. As that scholarship has made clear, however, the history of the environmental sciences need not be limited to the history of those sciences that are relevant to contemporary environmental concerns. In its broadest sense, it also includes all three of the strands described above: the history of the sciences that were incorporated into the category of the environmental sciences during the Cold War era, for reasons of both national security and environmental management; the history of the sciences that, beginning in the nineteenth century, identified environment as one of their central objects of inquiry; and the various forms of knowledge-making, many of them very different from modern science, that people have used to understand their surroundings over the course of human history.

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69 The history of environmental concepts in the plural intersects, in this way, with recent anthropological and philosophical scholarship on the "pluriverse"; e.g., Escobar, *Designs for the Pluriverse*; Reiter, *Constructing the Pluriverse*; Cadena and Blaser, *A World of Many Worlds*.

70 Bowler, *The Fontana History of the Environmental Sciences*.

71 Bowler, xiii.

72 Bowler, 2.

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