

The Meaning of Uncertainty: Debating Climate Change in the Gilded-Age United States**Joseph Giacomelli**Abstract

Scholars of American history have sometimes characterized late nineteenth-century theories about anthropogenic climate change as testaments to Manifest Destiny hubris and runaway boosterism. But many Gilded-Age climate theorists acknowledged both the uncertainty of their scientific claims and their ambivalence toward capitalist development and its influence on climates and landscapes. Gustavus Hinrichs, George Curtis, and other climate thinkers invoked uncertainty for a wide range of reasons. Sometimes they voiced frustration at their inability to grasp the mysterious agencies shaping climatic change. At other times, they embraced uncertainty as a key component of modern science. This article examines the role of scientific and cultural uncertainty in late nineteenth-century debates about climate and environment. The writings produced over the course of these debates reveal a series of tensions and dialectics at the core of nineteenth-century culture: tensions between visions of environmental utopia and fears of degradation and catastrophe, between positivist science and insecurity about the illusory nature of scientific knowledge, between the confident rhetoric of Manifest Destiny and a persistent ambivalence about the tenability of extractive capitalism.

Questions “forever remain”

In his 1873 report on Golden Gate Park, the engineer William Hammond Hall suggested that “heavy plantations” and other park features would ameliorate San Francisco’s climate conditions. “Certain kinds of trees,” wrote Hall, are “effective in removing moisture, by precipitation, from the lower stratum of the air.” His report argued that a pattern of alternating groves and glades would check excessive winds, induce favorable amounts of rainfall, and regulate humidity levels. According to Hall, park-induced climate change would go hand-in-hand with improvements in the health and moral quality of the city. Indeed, Hall’s theories of anthropogenic climate change were part of a grandiose vision for environmental change.<sup>1</sup>

Unlike some of his contemporaries, however, Hall did not adhere to a straightforward ideology of landscape improvement through human intervention.<sup>2</sup> Hall viewed society as minute before the scale and mystery of nature. In his view, humans were to the environment as “the microscopic polyp to the coral formations of the ocean.” But humanity still functioned as the “great disturber of natural laws” and often exerted a negative influence on the “pristine balance of physical nature.” Hall argued that anthropogenic climate change would help restore the

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<sup>1</sup> William Hammond Hall, “Influence of Parks and Pleasure Grounds,” *Biennial Report of the Engineer of the Golden Gate Park, for term ending Nov 30<sup>th</sup>, 1873*. Reprinted in *The Overland Monthly* Vol. XI, No. 6, (Dec 1873), 535 (pagination is from *Overland Monthly* version).

<sup>2</sup> For an example of this more straightforward improvement ideology, see David Nye, *America as Second Creation: Technology and Narratives of New Beginnings* (Cambridge, MA: MIT Press, 2003), 9, 110, 205. According to Nye, Americans envisioned the natural world as “awaiting fulfillment” through human action. Nye describes farmers, boosters, and industrialists who believed in their ability to dominate and control nature using technologies like the axe, the railroad, or the mill.

climatic and environmental equilibrium that had been disturbed by the “clearing of forests,” the “draining of lands,” and other symptoms of nineteenth-century expansion and industrialization.<sup>3</sup>

Hall’s proto-ecological views on restoration were rooted in contemporary climate science. Like his thoughts about nature, the engineer’s scientific vision reflected a mixture of humility and grandiosity: Hall proclaimed that modern systems of “extended observation and systematic arrangement” had “supplied the data for great advance in meteorological science.” Yet he also emphasized that issues related to “man’s ability to moderate climate” would “perhaps forever remain questions for further investigation and continued dispute.” Hall believed that “natural laws” existed but that many would remain uncertain and unknowable. He accepted the existence of scientific uncertainty and incorporated it into his plan for Golden Gate Park.<sup>4</sup>

### Introduction: the realm of the unknown

Hall’s report was an early salvo in a long and contentious climate change debate which stretched from the years after the Civil War into the Progressive Era. Although Americans had been questioning society’s role in shaping the climate for centuries, starting around 1870, the prospect of Euro-American settlement in the dry Great Plains and Intermountain West galvanized the debate.<sup>5</sup> Hall and many others believed that humans could alter climates through afforestation, deforestation, agriculture, irrigation, drainage, and a variety of other agencies; another group of climate thinkers sought to refute the notion that society could alter climate patterns. The debate was so multifaceted and complex that the use of these two categories – proponents and doubters – risks simplifying the controversy. Even seemingly skeptical scientists, such as William Ferrel, endorsed some forms of anthropogenic climate change. Other climate theorists, like Bernhard Fernow, challenged the hypothesis that landscape changes could increase rainfall levels but supported the theory that forest cover could make precipitation more evenly distributed and less violent.<sup>6</sup>

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<sup>3</sup> Hall, “Influence of Parks,” 527.

<sup>4</sup> Hall, “Influence of Parks,” 527. For more on Golden Gate Park, see Richard Walker, *The Country in the City: The Greening of the San Francisco Bay Area* (Seattle: University of Washington Press, 2007), 59-60. Hall’s foray into climate theory reveals that notions about anthropogenic climate improvement reached beyond the realm of “rain follows the plow” boosters and hucksterish railroad agents. The landscape architect H.W.S. Cleveland, for example, endorsed theories of forest-induced climate change in his 1873 book *Landscape Architecture as Applied to the Wants of the West; with an Essay on Forest Planting on the Great Plains* (Amherst: University of Massachusetts Press, 2002), see 113.

<sup>5</sup> For a discussion of climatic debates in the colonial and Early Republic eras, see James Rodger Fleming, *Historical Perspectives on Climate Change*, (Oxford: Oxford University Press, 1998); Fleming, *Meteorology in America, 1800-1870* (Baltimore: Johns Hopkins University Press, 1990). For examples of older transnational debates about climate, see Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism* (Cambridge: Cambridge University Press, 1995) and Lydia Barnett, “The Theology of Climate Change: Sin as Agency in the Enlightenment’s Anthropocene,” *Environmental History* 20 (April 2015). Nineteenth-century settlement and empire building projects in arid or semi-arid portions of Russia, North Africa, and Australia also spurred debates about climate change, desiccation, deforestation, and climate improvement. See David Moon, *The Plow that Broke the Steppes: Agriculture and Environment on Russia’s Grasslands, 1700-1914* (Oxford: Oxford University Press, 2013); Diana K. Davis, *Resurrecting the Granary of Rome: Environmental History and French Colonial Expansion in North Africa* (Athens, GA: Georgia University Press, 2007).

<sup>6</sup> See William Ferrel, “Note on the Influence of Forests Upon Rainfall,” *American Meteorological Journal. A Monthly Review of Meteorology and Allied Branches of Study*, 5,1 (Feb. 1889). Ferrel argues that the afforestation of

The writings produced over the course of the climate debate are rife with paradox and uncertainty. The scientists, boosters, and surveyors who argued about climate change in the late nineteenth century struggled with, embraced, and used uncertainty in myriad ways. Sometimes proponents of modern science who believed in climate change acknowledged that the causes of the change remained in the realms of the “unknown.”<sup>7</sup> Sometimes ardent expansionists admitted that Manifest Destiny and capitalist expansion had damaged landscapes and climates. And sometimes even determined advocates of human-induced climate change, such as Hall, admitted the insignificance of humanity before the scale and mystery of “nature.” Through an examination of the uncertainties and paradoxes evident in the climate debate, this paper highlights the tensions and dialectics at the heart of Gilded-Age expansionism, the making of late nineteenth-century environmental thought, and the development of modern climate science.

Much of the scholarship on the late nineteenth-century climate debate has overlooked the ambiguity, uncertainty, and complexity exhibited in Hall’s report and in many other climate-related articles and treatises. Historians have emphasized hucksterish theories of human-induced climate improvement, such as the well-known “rain follows the plow” theory. Writing in the 1940s, Henry Nash Smith described Gilded-Age beliefs about human influence on climate as a “footnote to American intellectual history” testifying to “the confidence which pervaded both the agricultural West and the metropolitan centers of economic and political power in the East during the fifteen years following the Civil War.”<sup>8</sup> In the decades since Smith’s work, few historians have challenged his interpretation of climate theory as a symptom of Manifest Destiny hubris.<sup>9</sup> In the 1970s, a group of scholars led by David Emmons and Charles Kutzleb re-examined climate theory but continued to characterize proponents of anthropogenic climate change as “excessively vain” Americans who “seldom...evinced any humility in their dealings with the environment.”<sup>10</sup> Because of their emphasis on the Great Plains, these historians focused

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the Mississippi Valley would increase rainfall levels “as far as the Atlantic Ocean.” For a discussion of human-induced changes in rainfall distribution, see Bernhard Fernow Papers, Cornell University, Box 2, Folder 23, “The Forest as a Condition of Culture,” Undated paper (possibly an address or presentation). Exact date unclear but folder dates attribute it to 1885-1888 or 1892 (most likely the earlier dates), 12.

<sup>7</sup> For some examples of these paradoxes, see *Transactions of the Iowa State Horticultural Society for 1879* (Des Moines: F.M. Mills, State Printer, 1880), 199 and 276-279.

<sup>8</sup> Henry Nash Smith “Rain Follows the Plow: The Notion of Increased Rainfall for the Great Plains, 1844-1880,” *Huntington Library Quarterly* 10 (Feb 1947): 192.

<sup>9</sup> Although few historians have considered the role of uncertainty in Gilded-Age climate debates, in recent decades, several scholars have made significant contributions to the study of late nineteenth-century climate theory in the United States. Lawrence Culver has explored the cultural dimension of climate debates and discussed the significance of climate discourse in the settlement of the West. James Rodger Fleming, meanwhile, has extensively chronicled the increasing bureaucratization and professionalization of climatology and meteorology in the nineteenth century. See Culver, “Seeing Climate Through Culture,” *Environmental History* 19 (April 2014); Fleming, *Historical Perspectives*, 45-54.

<sup>10</sup> “Excessively vain” quote is from David Emmons, “Theories of Increased Rainfall and the Timber Culture Act of 1873,” *Forest History* 15 (Oct. 1971): 14. See also Charles R. Kutzleb, “Can Forests Bring Rain to the Plains?” *Forest History* 15 (Oct. 1971); David Emmons, *Garden in the Grasslands: Boomer Literature of the Central Great Plains* (Lincoln: University of Nebraska Press, 1971); Walter and Johanna Kollmorgen, “Landscape Meteorology in the Plains Area,” *Annals of the Association of American Geographers* 63, (December 1973); Kenneth Thompson, “Forests and Climate Change in America: Some Early Views,” *Climatic Change* 3 (1980).

largely on a group of booster-scientists active in Kansas and Nebraska, such as Charles Dana Wilber, Richard Smith Elliott, and Samuel Aughey, and their allies in Washington, such as the surveyor-scientist Ferdinand V. Hayden. They rarely considered documents such as Hall's report, sources which revealed an undercurrent of doubt beneath the confident climate rhetoric of Elliott, Aughey, and the others.<sup>11</sup>

More recently, historians of the Gilded Age and Progressive Era have challenged characterizations of the late nineteenth century as a time of hubristic expansionism and faith in scientific certainty. Scholars including T.J. Jackson Lears, Robert Johnston, Aaron Sachs, and Drew Gilpin Faust have complicated conventional portraits of the nineteenth century as a century marked by "certainty and progress, and the belief that physical laws as solid and rigid as iron and steel governed nature."<sup>12</sup> Lears identifies a group of "antimoderns" dissatisfied with nineteenth-century positivism; he argues that modernism and antimodernism were not separate and dichotomized but dialectical and mutually constitutive. Working a slightly later era, Johnston describes middle-class Progressive-Era figures who alternately served as the bulwark of capitalism and as its critics. Ignatius Donnelly, Henry George, and other figures analyzed by Sachs worried that Americans had advocated "expansion with too much confidence and certainty."<sup>13</sup> Sachs focuses on a tradition of cultural and social criticism that flourished in the Antebellum Era but persisted, albeit in reduced form, into the Gilded Age. Faust, meanwhile, has described the years after the Civil War as marked by a "more profound doubt about the human ability to know and understand."<sup>14</sup> These scholars' writings reveal that some Gilded-Age Americans questioned the gospel of positivism and individualism. They shed light on paradoxical writings like Hall's piece and on other sources that examined the relationship between scientific mysteries and cultural anxieties about expansion and development.

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<sup>11</sup> Even booster literature like Elliott and Wilber's pieces sometimes betrayed uncertainty about climate knowledge, Manifest Destiny, and human influences on the land. Elliott's writings, for example, show the influence of George Perkins Marsh's conservationist tracts. Elliott acknowledged that "human action has apparently modified conditions, and mostly for the worse, in many parts of the earth's surface." See Richard Smith Elliott, *Notes Taken in Sixty Years* (St. Louis: R.P. Studley & Co., 1883), 300.

<sup>12</sup> The characterization of the nineteenth century as a time of unchallenged certainty and hubris is from John M. Barry's excellent book *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (New York: Simon & Schuster, 1997), 21. For other studies emphasizing late nineteenth century culture's obsession with empire building, conquest, and machismo, see Kristin Hoganson, *Fighting For American Manhood: How Gender Politics Provoked the Spanish-American and Philippine-American Wars* (New Haven, Yale University Press, 1998) and Gail Bederman, *Manliness and Civilization: A Cultural History of Gender and Race in the United States, 1880-1917* (Chicago: University of Chicago Press, 1995).

<sup>13</sup> See T.J. Jackson Lears, *No Place of Grace: Antimodernism and the Transformation of American Thought, 1880-1920* (New York: Pantheon, 1981), 121, 209; Aaron Sachs, *Arcadian America: The Death and Life of an Environmental Tradition* (New Haven: Yale University Press, 2013), 225-236 and 300-307; *The Radical Middle Class: Populist Democracy and the Question of Capitalism in Progressive Era Portland, Oregon* (Princeton: Princeton University Press, 2003), see especially 218. Many of these works have blurred the distinction between the "Gilded Age" and the "Progressive Era." For further explorations of what David Nye has called the "counter-narrative" in American culture during the "long" Gilded Age and beyond, see Christopher Lasch, *The True and Only Heaven: Progress and Its Critics* (New York: Norton, 1991) and Nye, *America as Second Creation*.

<sup>14</sup> Drew Gilpin Faust, *This Republic of Suffering: Death and the American Civil War* (New York: Vintage, 2008), 210.

My goal is not to point out that all late nineteenth century climate theorists expressed their ambivalence about society's ability to understand and improve landscapes and climates. Many Gilded-Age climate writings undoubtedly reflect a belief in certain, empirical science as well as a hubristic attitude toward both "nature" and American expansionism.<sup>15</sup> But I argue that this certain and confident intellectual tradition ran alongside a more uncertain current in an ongoing dialectic. The term "uncertainty" is not a neologism in the context of climate debates: some nineteenth-century climate thinkers relished pointing out the uncertainty inherent to knowledge production. The famed conservationist George Perkins Marsh dedicated a section of his 1864 tome *Man and Nature* to the "uncertainty of our meteorological knowledge" while in 1883 Henry Allen Hazen described "the great uncertainty arising" from climate data.<sup>16</sup> As demonstrated by Hall's report, these proclamations of uncertainty were often closely intertwined with the more certain discourse described by the scholars Emmons and H.N. Smith. The imbrication between certain and uncertain attitudes toward science, climate, and environment reveals the limits of the dichotomies often used to frame the cultural and climatic politics of the Gilded Age – climate skeptics versus climate change proponents, conservationists versus rapacious boosters, and modern science versus naturalistic pre-modern beliefs.<sup>17</sup>

Instead of attempting to articulate a single definition "uncertainty," I aim to explore the meanings and interactions of various uncertainties across a range of analytical scales. My first concern is with uncertainty as it was understood by historical actors. Clearly, late nineteenth-century Euro-Americans expressed their uncertainty about climate data, scientific knowledge, and the course of capitalist development. How were these concerns related and how can the notion of uncertainty help us to better understand the Gilded-Age United States? On a second, more analytical level, I will focus on the interconnections between scientific, environmental, and cultural uncertainties. Lastly, on an epistemological level, I acknowledge the uncertainty of my own interpretations; in doing so, I hope to affirm my argument about the ephemeral and contested nature of knowledge-making.

My approach toward uncertainty is informed by recent scholarship on uncertainty from environmental history, the history of science, climate history, and other fields. Sociologists of science discussed the role of uncertainty in scientific debates as early as the 1980s.<sup>18</sup> More

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<sup>15</sup> There are many examples of this certainty. For one of the most confident voices in the climate debate, see Charles Dana Wilber, *The Great Valleys and Prairies of Nebraska and the Northwest* (Omaha: Daily Republican Print, 1881), 70.

<sup>16</sup> George Perkins Marsh (David Lowenthal, ed.), *Man and Nature* (Seattle: University of Washington Press, 2003; originally published in 1864), 20-28; Henry Allen Hazen, "Variation of Rainfall West of the Mississippi River," Signal Service Notes No. VII, US War Dept. Washington: Office of the Chief Signal Officer, 1883, 3.

<sup>17</sup> James Rodger Fleming has characterized nineteenth-century theories about human-induced climate change as vestiges of a pre-modern "impressionistic" pseudo-science. Lawrence Culver has depicted climate change beliefs as hucksterish theories largely in the service of railroad interests and their booster allies. These scholars' interpretations are valid, but I aim to show how seemingly hucksterish and impressionistic theories were also sometimes intertwined with conservatism and "modern" climate science. See Fleming, *Historical Perspectives*, 53; Culver, "Seeing Climate Through Culture:" 315-316.

<sup>18</sup> See, for example, Susan Leigh Star, "Scientific Work and Uncertainty," *Social Studies of Science* 15 (Aug. 1985); Brian L. Campbell, "Uncertainty as Symbolic Action in Disputes among Experts," *Social Studies of Science* 15 (Aug. 1985); Trevor Pinch, "The Sun-Set: The Presentation of certainty in Scientific Life," *Social Studies of Science* 11 (Feb. 1981). The field of agnotology has also yielded some useful insights for uncertainty studies. See Robert N. Proctor, *Cancer Wars* (New York: Basic Books, 1995); Londa Schiebinger, "Agnotology and Exotic Abortifacients:



recently, Michelle Murphy has addressed the deployment of uncertainty in debates about environmental agency and causality. While Murphy described the creation of “regimes of imperceptibility,” Naomi Oreskes and Eric Conway chronicled the power of “merchants of doubt” who use uncertainty for political and economic ends.<sup>19</sup> Deborah Coen’s work on science in Austria has shown that the use of uncertainty is not always as straightforward and nefarious as in Oreskes and Conway’s account. In *Vienna in the Age of Uncertainty*, Coen describes how nineteenth-century Austrian elites and scientists “built their moral authority as liberals on their personal capacities to confront and manage uncertainty.” Coen reveals a tension between rationalism and a modernist culture of uncertainty. The tension identified by Coen is evident in American climate writings from the same time, as is the link between climate anxieties and uncertainty about modern capitalism described by Fabien Locher and Jean-Baptiste Fressoz in their article on climate theory from the eighteenth and nineteenth centuries.<sup>20</sup>

American environmental historians have also discussed the role of uncertainty in debates about capitalism, settlement, science, and environmental causality. Joel Orth and Robert Gardner have written extensively about forestry and conservation on the Great Plains during the late nineteenth and early twentieth centuries. In addition to exploring the link between climate theory and Great Plains forestry, Orth and Gardner have traced a more uncertain proto-ecological current lurking beneath the seemingly inexorable tide of Manifest Destiny. Orth, for example, asserts that some foresters and scientists “exposed the fundamental uncertainties of science.”<sup>21</sup> Conevery Bolton Valenčius’s *Health of the Country* focuses on an earlier period but challenges simple distinctions between science and folk belief while connecting uncertainties about climate and landscape to the history of settlement.<sup>22</sup> Applying these scholars’ insights and methods to Gilded-Age climate change theory reveals both the power and the protean nature of uncertainty. Then as now, uncertainty held myriad meanings for people struggling to understand the relationship between humans, landscape, and climate. Uncertainty represented everything from a reminder of the limits of human knowledge to a temporary obstacle on the path toward discovery

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The Cultural Production of Ignorance in the Eighteenth-Century World,” *Proceedings of the American Philosophical Society* 149 (Sept. 2005).

<sup>19</sup> For “regimes of imperceptibility,” see Michelle Murphy, *Sick Building Syndrome and the Problem of Uncertainty* (Durham, NC: Duke University Press, 2006). See also Naomi Oreskes and Eric Conway, *Merchants of Doubt: How a Handful of Scientists Obscured the Truth on Issue from Tobacco Smoke to Global Warming* (New York: Bloomsbury Press, 2010).

<sup>20</sup> Deborah Coen, *Vienna in the Age of Uncertainty: Science, Liberalism & Private Life* (Chicago: University of Chicago Press, 2007), 4. Fabien Locher and Jean-Baptiste Fressoz, “Modernity’s Frail Climate: A Climate History of Environmental Reflexivity,” *Critical Inquiry* 38 (Spring 2012): 587.

<sup>21</sup> “Uncertainties” quote is from Joel J. Orth, “The Conservation Landscape: Trees and Nature on the Great Plains,” (Ph.D. Diss, Iowa State University, 2004), 7. For a discussion of an ecological vision alongside expansionist efforts to control landscape, see Robert Gardner, “Constructing a technological forest: nature, culture, and tree-planting in the Nebraska Sand Hills,” *Environmental History* 14 (April 2009). See also Joel Orth, “Directing Nature’s Creative Forces: Climate Change, Afforestation, and the Nebraska National Forest,” *Western Historical Quarterly* 42 (Summer 2011). For another environmental history study dealing with resource management, uncertainty, and changing scientific paradigms, see Joseph E. Taylor III, “Knowing the Black Box,” *Environmental History* 18 (January 2013).

<sup>22</sup> Conevery Bolton Valenčius, *The Health of the Country: How American Settlers Understood Themselves and their Land* (New York: Basic Books, 2002).

to a powerful rhetorical device. My aim is to trace the contested meaning of scientific uncertainty across a range of late nineteenth-century writings on climate and environment. At the same time, I hope to further elucidate the relationship between these scientific uncertainties and cultural uncertainties about progress, expansion, and market-driven environmental change.

### Uncertainty and the construction of science

The volume of late nineteenth-century articles and reports about climate change is remarkable. The debate was national in scale; scientists, surveyors, academics, farmers, journalists, and many others presented their theories about human-induced climate modification. Gilded-Age climate thinkers often derived their theories from a burgeoning collection of climate data and information. In the decades after the Civil War, the US Army Signal Corps, the Smithsonian Institution, state weather bureaus, land grant universities, newspapers, boosters, and independent weather aficionados observed, recorded, and catalogued annual rainfall totals and other climate statistics.<sup>23</sup> Despite the increasing bureaucratization and professionalization of climate science, the boundary between high and vernacular science remained porous. Professional researchers from universities and the federal government usually refrained from connecting their climate theories to specific ventures like land selling schemes. But they often waded into the messy realm of cultural politics inhabited by journalists, boosters and other vernacular climate scientists. Newspaper columnists and pamphlet writers, meanwhile, used climate data and maps with the same facility shown by authors of government reports and *American Meteorological Journal* articles.<sup>24</sup> Late nineteenth-century writers struggled to make sense of the fractious cultural and climatic politics of their time; many voiced their frustration with the cacophonous nature of climate discourse. Some remarked that publications “teemed” with articles addressing the “vexed question” of human influences on climate. Others worried that, since “great corporate or private interests are to be affected by its decision,” the climate debate had devolved into a morass of conflicting opinions. With so many interests and voices involved, it proved difficult to extricate “science” from politics and from cultural editorializing.<sup>25</sup>

<sup>23</sup> For some examples of an individual scientist’s climate observations, see the Franklin B. Hough papers, New York State Library, Box 4. For an example of a climate change report derived from Signal Corps station data, see Adolphus Greely’s *Report of Rainfall in Washington Territory, Oregon, California, Idaho, Nevada, Utah, Arizona, Colorado, Wyoming, New Mexico, Indian Territory, and Texas, for from Two to Forty Years*, Washington: Government Printing Office, 1889. 50<sup>th</sup> Congress, 1<sup>st</sup> Session, Ex. Doc. No. 91. Deborah Coen describes a similar scientific struggle with data collection in her article “Climate and Circulation in Imperial Austria,” *The Journal of Modern History* 82 (December 2010): 848-849.

<sup>24</sup> The *American Meteorological Journal* was the most prestigious Gilded-Age publication dealing with climatological and meteorological questions. For examples of nuanced data discussions in popular publications, see G.E. Tewksbury, *The Kansas Picture Book* (Topeka, Kansas: A.S. Johnson, 1883), 34 and Henry Inman’s article from the March 12, 1879 *Chronoscope* (of Larned, KS).

<sup>25</sup> For “vexed question,” see Joseph T. Lovewell, “Kansas Meteorology.” *Fourth Biennial Report of the State Board of Agriculture to the Legislature of the State of Kansas, For the Years 1883-1884* (Topeka: Kansas Publishing House: TD Thacher, State Printer, 1885), 614. For a discussion of how journals “teemed” with climate theories, see Thomas Meehan, “Forests the Result and not the Cause of Climate.” *Prairie Farmer* 44, 47 (Nov 22, 1873). The quote about “corporate interests” was written by the editors of the journal *Science*, who also complained that the debate “has not been of a purely scientific character.” See “The Influence of Forests on the Quantity and Frequency of Rainfall.” *Science* XII, 303 (Nov 23, 1888): 241.

Most writers focused on the influence of forest culture and agriculture upon climate patterns. Some, like Winslow Watson of New York, asserted that the removal of forests near Lake Champlain had caused climatic desiccation.<sup>26</sup> Others, such as Hall and a group of Great Plains boosters, argued that desiccation or aridity like that described by Watson could be mitigated or reversed with tree plantations or agriculture. Still others denied both theories using a variety of arguments. In 1867, for example, the climatologist John Disturnell argued that surface conditions on the Great Plains were a consequence, and not a cause, of climate patterns. Theodore C. Henry, on the other hand, depicted climate as immutable in a series of addresses delivered in Kansas in 1882.<sup>27</sup> Theories in favor of climate change were even more eclectic; climate change proponents disagreed about the exact mechanisms through which humans could modify atmospheric conditions. Whereas the forester Franklin B. Hough argued that tree plantations or forests initiated a “cooling process” that induced passing clouds to “send down filaments of rain,” agricultural boosters like Samuel Aughey emphasized the ability of newly plowed soil to evaporate humidity into the air and create dew and rain.<sup>28</sup> And theories rooted in forest culture and agriculture only represented one component of the vast panoply of Gilded-Age climate change theses. Fires, artificial ponds and reservoirs, reclaimed swamps, electrical currents, railroads, and other factors shared the stage with trees and crops as potential influences on climate.<sup>29</sup> Writers also disagreed about the definition of “climate” and the scale of any potential climatic change. Hall, Aughey, Hough, and many others conceived of climate in localized or regional terms – they viewed atmospheric conditions as intertwined with local landscapes and environments on the ground. Another cadre of climate theorists, by contrast, described continental and global-scale climate changes. In an 1876 piece, for example, Elwood

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<sup>26</sup> Watson argued that the clearing of forests near the Champlain Valley made the region’s “climate more drouthy.” Winslow C. Watson “Forests – Their Influence, Uses, and Reproduction,” *Transactions of the New York State Agricultural Society for the Year 1865* (Cornelius Wendell, Albany, 1866), 289-290.

<sup>27</sup> See John Disturnell, *Influence of Climate* (New York: D. Van Nostrand, 1867), 105 and Theodore C. Henry (of Abilene, KS), Addresses on “Kansas Stock Interests” and “Kansas Forestry” (Abilene, KS: Gazzette Steam Printing Office, 1882), 2-3.

<sup>28</sup> The “filaments” quote is from “Letter from Dr. Franklin B. Hough, in regard to the effect of forests in increasing the amount of rainfall,” Executive Documents of the House of Representatives for the second session of the forty-eighth Congress. Washington: Government Printing Office, 1885. Appendix No. 14, 130. The agricultural argument is from Charles Dana Wilber, *The Great Valleys and Prairies of Nebraska and the Northwest* (Omaha: Daily Republican Print, 1881), 70. The Timber Culture Act of 1873 highlights the widespread acceptance of theories about afforestation and agriculture-induced climate improvement. The act sought to encourage timber growth and the presumed concomitant climatic amelioration in the Great Plains by granting 160 acres of land to settlers who planted a forty-acre grove of trees and successfully maintained it for ten years. See C. Barron McIntosh, “The Use and Abuse of the Timber Culture Act,” *Annals of the Association of American Geographers* 65 (September 1975): 349.

<sup>29</sup> For an example of fire-based climate influence arguments, see, for example, John Trowbridge, “Great Fires and Rain-Storms,” *The Popular Science Monthly* (December 1872). For ponds, see J.R. Sage “Influence of Forests on Climate in Iowa” in the “Current Notes” section of the *American Meteorological Journal* 10, 14 (March 1894). Sage argues that, when paired with timber belts, ponds and artificial lakes might “exempt from damage by hot winds and drouths and... may even ward off a large measure of danger from tornadoes.” For electricity and railroads, see Richard Smith Elliott, *Notes Taken in Sixty Years*, 309.



Cooper depicted the world as being in a state of climatic and environmental crisis while in 1889, W.D. Bidwell discussed the medical implications of a human-influenced “cooling of the earth.”<sup>30</sup>

The confusing profusion of climate theories is a testament to the uncertainty of scientific knowledge production. Instead of consolidating climate beliefs and stabilizing scientific practice, the data collection efforts of the nineteenth century created a culture of uncertainty, prompting the explorer, geologist, and ethnographer John Wesley Powell to complain about the state of modern climate science. In 1892, Powell wrote an article about flooding and the possibility of anthropogenic climate change. After asserting that the “mighty powers” which determine how “clouds gather and dance in aerial revelry” are beyond the reach of humans, Powell allowed that society might be able to influence climate patterns to a limited extent. Powell believed that climate change theories contained a “modicum of truth” but had been appropriated by a variety of interests and distorted beyond recognition. Scientific knowledge production had thus become too fluid, unpredictable, and prone to reinterpretation. According to Powell, uncertainty was something to be avoided and scientists should resist the urge to delve too deeply into the realm of the unknown.<sup>31</sup> But not all agreed with Powell. Some of his contemporaries acknowledged or even embraced the paradox at the core of nineteenth-century climate science: that the modern drive to understand and control natural forces created new scientific and cultural uncertainties.<sup>32</sup>

The scholar Jamie L. Pietruska has analyzed forecasters’ struggles with meteorological uncertainty. She has shown how, after the turn of the century, meteorologists such as Willis Moore increasingly accepted uncertainty and probability as necessary components of daily and weekly weather forecasting. In present-day science, “climate” generally refers to long-term phenomena while “weather” refers to short-term events. In the Gilded-Age, however, climate writers often used the terms “climate” and “weather” (or “climatology” and “meteorology”) interchangeably. This semantic uncertainty added another layer of mystery to debates about the temporal and spatial scale of any possible anthropogenic climate change. W.H. Larrabee, for instance, remarked upon the uncertain meaning of “climate:” “We are embarrassed when we undertake to define climate and what marks to accept as its characteristics.”<sup>33</sup> Despite the frequent slippage between “climate” and “weather,” the meteorologists described by Pietruska privileged short-term data and predictions. Powell and other theorists interested in longer-term climatic changes had to contend with years and decades’ worth of confusing and sometimes conflicting data. In meteorological forecasting, as Pietruska has shown, a “culture of certainty”

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<sup>30</sup> Ellwood Cooper, *Forest Culture and Eucalyptus Trees* (San Francisco: Cubery and Co., 1876), 10; W.D. Bidwell, “The Relation of Climatic Changes to Disease.” *Kansas Medical Journal* Vol. 1, No. 7 (November 1889): 237-238.

<sup>31</sup> John Wesley Powell, “Our Recent Floods,” *North American Review* 155, 429 (Aug 1892): 152-153. Powell’s erstwhile assistant Grove Karl Gilbert held similar beliefs about uncertainty and the unknown. In a chapter on “Water Supply” which Gilbert wrote as part of Powell’s *Report on The Lands of the Arid Region of the United States* (Cambridge, MA: Belknap Press, 1962, Originally published in 1878), Gilbert addressed issues of uncertainty and anthropogenic climate change. He argued that people should avoid forming conclusions about climate change as long as knowledge of the forces shaping climate remained in the realm of the “unknown.” See Gilbert in Powell, *Report on the Lands*, 94.

<sup>32</sup> For another example of this argument, see Samuel Temple, “Forestation and its Discontents: The Invention of an Uncertain Landscape in Southwestern France, 1850-Present,” *Environment and History* 17 (2011): 15. Temple writes that “modernity, in its quest to control nature, has led to proliferation of risks and uncertainties.”

<sup>33</sup> Larrabee is quoted in *Popular Science Monthly* 40 (April 1892): 804.

predominated in the 1890s. By contrast, possible human-induced climate changes presented such a quandary that they prompted climate researchers to engage with uncertainty even during the late nineteenth century.<sup>34</sup>

In 1888, for example, George Curtis argued that new data-collecting instruments had not eliminated any of the uncertainty surrounding climate change questions. Curtis was a prominent climate theorist affiliated with the Smithsonian and the Department of Agriculture. His 1888 article on potential variations in rainfall in the “Trans-Mississippi” region explained how “it would seem that the...data would easily furnish the means for giving a decisive answer to such questions; yet it has been found that, owing to the changes in observers, instruments, exposures and methods of observing, much uncertainty inheres in the results.”<sup>35</sup> Curtis implied that standardization of observers and instruments might eventually fulfill the promise of modern science to answer climate change questions. Yet five years later, Curtis expressed a deeper skepticism about the ability of statistics to answer climatological quandaries. His article on the “causes of rainfall” explained that since “statistical explanations” do not provide an “explanation of the process by which a change in the rainfall may be brought about, they have not helped clarify the misty meteorological conceptions which are current thereon.”<sup>36</sup> Despite his willingness to engage with uncertainty, Curtis still seemed frustrated by his inability to answer climate change questions.

His contemporary Gustavus Hinrichs, by contrast, savored the seeming inevitability of scientific uncertainty. Something of an iconoclast, Hinrichs resented the Washington-based scientific bureaucracy to which Curtis and Powell belonged. He established the independent Iowa Weather Service in the 1870s and studied a variety of phenomena, ranging from tornadoes and derechos to climate change, during his time as a professor at the University of Iowa.<sup>37</sup> Using seasonal and yearly rainfall data from his network of observers in Iowa, Hinrichs identified an “intimate relation between the percentage of surface covered with timber and the distribution of rainfall.”<sup>38</sup> Although Hinrichs found a correlation between afforestation, deforestation, and rainfall patterns, he believed that the causes and mechanisms behind climate change remained mysterious. In order to finally resolve questions about the nature of climate change, Hinrichs envisioned the creation of a centuries-long climate observation network complete with “self-registering instruments.” Hinrichs was a firm believer in statistics – he derived a logarithm which determined the relative agricultural usefulness of a rainfall event – and in the existence of natural

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<sup>34</sup> Jamie L. Pietruska, “US Weather Bureau Chief Willis Moore and the Reimagination of Uncertainty in Long-Range Forecasting,” *Environment and History* 17 (2011): see 88 for “culture of certainty.”

<sup>35</sup> George E. Curtis, “The Trans-Mississippi Rainfall Problem Restated: The Rainfall in its Relation to Kansas Farming,” *American Meteorological Journal* 5, 2 (June 1888): 66.

<sup>36</sup> George E. Curtis, “Analysis of the Causes of Rainfall with Special Relation to Surface Conditions,” *American Meteorological Journal* 10, 6 (Oct 1893): 274.

<sup>37</sup> For examples of the long-running feud between Hinrichs and the meteorological establishment, see *First Biennial Report of the Central Station of the Iowa Weather Service* (Des Moines: F.M. Mills, State Printer, 1880) in University of Iowa – Special Collections – RG99.0039 – Box 2, 22-23 and Gustavus Hinrichs, “Tornadoes and Derechos,” *American Meteorological Journal* 5, 9 (Jan 1889): 392-393.

<sup>38</sup> Gustavus Hinrichs, *Second Annual Report of the Iowa State Weather Service*, Printed as Appendix to the Report of the Iowa State Agricultural Society for the year 1877, 624.

laws – he claimed that the discovery of “every new law...endows us with new powers of nature.” Hinrichs’s writings reveal that belief in fixed natural laws did not preclude belief in the mystery of climatic agencies. Even as he advocated for an almost high-modern system of data collection that would discover nature’s laws, Hinrichs retained a sense of humility about society’s ability to grasp environmental phenomena. He admitted that his hypothetical observation network would need to be in place for centuries and still might not be able to furnish definite conclusions about climate change.<sup>39</sup> For Hinrichs, uncertainty was not a cause for frustration, but rather a source of relief. In a practical sense, continued uncertainties necessitated the “proper continuation” of his work at the Iowa Weather Service. In a more abstract sense, new questions and uncertainties represented a more useful means of stepping “into realms of the unknown” than any “unwarranted recrudescence of Baconian empiricism.”<sup>40</sup>

Several Illinois climate theorists shared Hinrichs’s fondness for uncertainty. In December of 1871, members of the Illinois State Horticultural Society engaged in a lively debate about anthropogenic climate modification at their annual meeting. Jonathan Periam presented a paper linking “terrific conflagrations” – presumably the Peshtigo Fire and the other great blazes of that year – to “fortuitous circumstances incident to meteorological phenomena occasioned by man himself, in clearing up the country.” In his lecture on meteorology, J.H. Tice introduced the theme of uncertainty. Tice sought to extricate climate science from the “tangled fens of materialism” and railed against “the vicious [a]ssumption that the Universe is a piece of mechanism.” William Baker echoed Tice by arguing that uncertainty and mystery made meteorology a singular and “attractive” subject: “it is the more so from the very little knowledge we have of it, and from the boundless field it opens for theorizing.” At the same time, however, Baker complained about climate theorists who “enjoy mounting a steed which they fancy Pegasus, and careening off through the dim mists of cloudland.” The Illinois climate theorists reflect the tensions and dialectics that marked the climate debate. Periam made his argument in a confident tone, depicting the great fires of 1871 as retribution for humanity’s environmental and climatic sins. His scientific certainty betrayed a cultural uncertainty about the costs of American industrialization and urbanization. Baker, meanwhile, embraced uncertainty as the driving force behind science but also worried that it made meteorology prone to diletantism and amateurish flights of fancy.<sup>41</sup>

In pronouncing the illusory nature of scientific knowledge while upholding distinctions between legitimate and illegitimate producers of information, Baker might qualify as one of the paradoxical “moderns” described by Bruno Latour in *We Have Never Been Modern*.<sup>42</sup> Yet other climate theorists, such as Joseph Lovewell, undertook a more radical embrace of uncertainty than

<sup>39</sup> For “self-registering” quote, see Hinrichs, *First Biennial Report*, 21. For logarithm and natural laws, see Gustavus Hinrichs, *Rainfall Laws Deduced from Twenty Years of Observation*, Published by the authority of the Secretary of Agriculture (Washington, DC: Weather Bureau, 1893). “Every new law” quote is from 11. The comments on the need of centuries of data to understand climate change is from Hinrichs, *First Biennial Report*, 21.

<sup>40</sup> “Proper continuation” is from Hinrichs, *Second Annual Report*, 624. “Baconian” quote is from *Rainfall Laws*, 82.

<sup>41</sup> *Transactions of the Illinois State Horticultural Society for 1871* (Chicago: Reade, Brewster, & Co, 1872), See 34 for Periam, 21 for Tice, and 193 for Baker.

<sup>42</sup> Bruno Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993), see especially 35-38. Latour argues that “moderns” create categories involving “science” and “nature” while at the same time denying their existence.

Baker. Lovewell served as Kansas state meteorologist from 1885 to 1895 and taught a variety of scientific subjects at Washburn College in Topeka.<sup>43</sup> He portrayed human-induced climate change as an unsettled question “well worthy of all the attention” it was receiving. To some extent, Lovewell shared Baker’s paradoxical ambivalence: he speculated about “forces in nature yet undreamed of” without abandoning his belief in objective scientific “truth.”<sup>44</sup> Lovewell differed from Baker in that he challenged distinctions between science and other types of knowledge. He appreciated the participatory and communal nature of data collection as well as popular climate theories and folklore. In contrast to some climate theorists who blamed Indians for damaging the climate by setting fires and cutting down trees, Lovewell admitted that “the Kaws and Pottawatomies who once traversed these prairies were probably wiser in this kind of weather-lore than the present denizens of our State.”<sup>45</sup> Lovewell advocated for a more uncertain, democratic science characterized by popular engagement and a more inclusive attitude toward knowledge production. In an 1882 article, Lovewell’s fellow Kansan H.K. McConnell articulated a vision for climate science in which “theories are no longer authoritatively announced... They are given to the public only to elicit and promote intelligent and fair criticism.”<sup>46</sup> McConnell and Lovewell’s writings demonstrate that the professionalization of climate science did not always entail the abandonment of vernacular and participatory climatology.

McConnell and Lovewell seemed to believe that their uncertainty would not detract from their legitimacy as participants in the climate change debate. Like the Kansans’ work, the climate-related writings of Bernhard Fernow, one of the founders of American forestry, illustrate the power conferred by uncertainty. Fernow wrote extensively about the relationship between society, forests, and climate. In an 1892 report laden with ecological language, he described “the interdependence between vegetations and meteorological, soil, and water conditions.”<sup>47</sup> In Fernow’s view, the complex, mutually influencing relationship among humans, landscape, and weather made it difficult for scientists to identify the exact causal mechanism at the root of any potential climate change. Fernow prefaced many of his statements about climate change with qualifications about the uncertainty surrounding climatic questions.<sup>48</sup> Yet his belief in the

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<sup>43</sup> For biographical information on Lovewell, see Maude M. Bishop, “Joseph Taplin Lovewell,” *Bulletin of the Shawnee County Historical Society* 38 (Dec. 1962).

<sup>44</sup> For the unsettled question and “forces in nature,” see J.T. Lovewell, “Kansas Meteorology,” 612-613. For continued belief in truth, see J.T. Lovewell, “Kansas Weather Service,” *Transactions of the Kansas Academy of Science for 1879-1880* (Topeka, KS: Geo. W. Martin, Kansas Publishing House, 1881), 87.

<sup>45</sup> Lovewell, “Kansas Meteorology,” 612.

<sup>46</sup> H.K. McConnell, “Rainfalls of Kansas,” *Osage County Chronicle*, March 30, 1882 (Kansas Historical Society, “Rain and Rainfall” Clippings, 551.57R).

<sup>47</sup> “Economic Conditions Antagonistic to a Conservative Forest Policy,” Address delivered by B.E. Fernow (US Dept of Agriculture) before the American Association for Advancement of Science, August 1892, Bernhard Fernow Papers, Cornell University, Box 2, Folder 23, 2. Andrew Rodgers’s biography of Fernow offers a detailed description of Fernow’s climate theories and of his climate-related disputes with Henry Gannett during the 1880s and 1890s. See Andrew Denny Rodgers, *Bernhard Eduard Fernow: A Story of North American Forestry* (Durham, NC: Forest History Society, 1991), 146-149.

<sup>48</sup> See B.E. Fernow, “Introduction and Summary of Conclusions,” US Department of Agriculture, Forestry Division, Bulletin No. 7. *Forest Influences* (Washington: Government Printing Office, 1893), 9-10. Before making claims about forest influences on climate, Fernow states that “the crop of incontrovertible facts is still scanty” and that

complexity and uncertainty of climate agencies did not prevent Fernow from making confident policy proclamations. “Whatever the truth,” wrote Fernow, “and neither the claimants nor the objectors in forest climatic influences have brought incontrovertible proof,” the stakes in the climate debate were simply too important for inaction. The probable but still uncertain role of forests as “needful regulators and preservers of climatic and hydrological conditions” necessitated “keeping certain areas under forest cover” as well as an activist public management of forests.<sup>49</sup> Instead of shirking from uncertainty and complex ecological theories, Fernow incorporated them into a powerful forestry and climate change platform.<sup>50</sup>

### Uncertainty and the construction of nature

Fernow’s work on ecology and climate illustrates the links between the development of modern climate science and Gilded-Age debates about “nature.” Climate theorists constantly invoked nature. When, in 1885, Thomas P. Roberts wrote that “arguments can be produced from nature to support any theory,” he testified to both the ubiquity of scientific uncertainty and to nature’s prominent role in the climate debate.<sup>51</sup> Like the meaning of climatic data, the meaning of nature in the context of climate change discourse was contested and uncertain.

For H.R. Hilton, evidence provided by nature clashed with evidence provided by climate statistics. Hilton delivered an address on the “Effects of Civilization on the Climate and Rain Supply of Kansas” in Topeka in 1880. His speech described a quandary: in spite of overwhelming anecdotal evidence of anthropogenic climate change, data in Kansas showed little or no statistical increase in rainfall. In Hilton’s words, “the records of man” – in this case the Signal Service – “and those of nature seem to be in conflict.” Hilton sided with the latter, promising to “take only such proofs as nature itself affords” and implying that the evidence of nature, though uncertain, would eventually trump statistics.<sup>52</sup> Some climate theorists shared Hilton’s view of nature as a benevolent force while others depicted nature as either inscrutable and indomitable or as a domain destined to be conquered by society. Gilded-Age climate thinkers’ portrayals of nature reflect a paradoxical mixture of humility and hubris as well as a tension or dialectic between visions of climatic catastrophe and climate utopia.

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“From the complication of causes which produce climatic conditions it has always been difficult to prove, when changes in a given region were observed, that they are permanent and not due merely to the general periodic variations which have been noted in all climates of the earth.”

<sup>49</sup> “Whatever the truth” is from Fernow, “The Forest as a Condition of Culture,” 13. “Needful regulators” is from Fernow, “Economic Conditions,” 1-2.

<sup>50</sup> Fernow was not the only climate theorist to issue policy recommendations while accepting the uncertainty of the science behind the recommendations. See, for example, the forestry advocate John Warder’s “Address Delivered Before the Otoe County Horticultural Society in Nebraska City, September 12<sup>th</sup>, 1878” titled “The Future Orchards and Forests of Nebraska” (Nebraska State Historical Society, 634.9 W21a), 5. Warder states that “the great question of general climatic influence, need not concern us. Let us meliorate the conditions of our own immediate surroundings by planting groves, shelter-belts and forests.”

<sup>51</sup> Thomas P. Roberts, “Relation of Forests to Floods,” *Proceedings of the American Forestry Congress at its Meeting Held in Boston, September, 1885* (Washington: Judd and Detweiler, Printers, 1886), 101.

<sup>52</sup> H.R. (Hugh Rankin) Hilton, “Effects of Civilization on the Climate and Rain Supply of Kansas,” A Lecture Delivered by H.R. Hilton, Esq, before the Scientific Club Of Topeka, Wednesday Evening, March 31<sup>st</sup>, 1880 (Spencer Library, University of Kansas Archives, RH C4318), 3-5.



Surprisingly, the same people who believed in the enduring mystery of the causes of climate change sometimes advocated complete human domination of nature. J.H. Tice, the Illinois expert who acknowledged the limits of certainty in climate science, envisioned a utopian future marked by the control of nature. At an 1870 horticulturists' meeting in Galesburg, Illinois, one of Tice's colleagues described efforts to "ameliorate our climate" by planting trees as "feeble endeavors" which paled in comparison to vast natural forces over which "human beings have no control." Tice responded by reminding the other horticulturists of the potential of human progress. He argued that society could "[unlock] the mysteries of nature's economy in all her departments" and "not only modify climate, but all the operations of nature."<sup>53</sup>

In contrast to Tice, Lovewell implied that uncertain science could go hand-in-hand with a belief in the insignificance of humanity relative to nature. Lovewell's 1892 article on "Human Agency in Changing or Modifying Climate" stressed that "all the combined power of man is as nothing when brought into collision with mighty forces of nature." Lovewell reconciled his humble view of nature with his belief in anthropogenic climate modification by naturalizing climate change. He argued that "changes of climate occur in the order of nature" while invoking both "human history" and the "geological records" to prove that "changes have occurred in terrestrial climate."<sup>54</sup> But Lovewell never precisely explained at which scale these historical changes took place. Indeed, Lovewell's use of vague temporal and spatial scales highlights the role of scale politics and semantic uncertainty in climate discourse.<sup>55</sup> In addition to assessing climate change possibilities on a geological and global scale, Lovewell also explored microclimatology, arguing that cities influenced local climates.<sup>56</sup> Clearly, nineteenth-century Americans defined "nature" and "climate" across a range of scales. Although Lovewell viewed nature as a potential collaborator in climate modification efforts, his caution and uncertainty prevented him from endorsing grand initiatives to transform the climate of the American West.

More strident climate change proponents, such as the surveyor Cyrus Thomas, depicted nature as a steadfast ally in civilization's quest to convert the Great Plains into a lush agricultural utopia. In a US Geological Survey report, Thomas asked settlers to follow "the plan nature herself has pointed out" and settle the Plains from west to east, starting on the Front Range in Colorado and heading east along the rivers and streams.<sup>57</sup> Thomas and other climate change proponents' anthropomorphized "nature" often remained uncertain even as it collaborated with Euro-American settlers and Manifest Destiny. In 1878, the *Dodge City Times* described a mysterious intercession by nature upon the climate of the Plains: "The advancing waves of

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<sup>53</sup> *Transactions of the Illinois State Horticultural Society for 1870* (Chicago: Dunlop, Reade, & Brewster, 1871), see 177 for "feeble endeavors" and 197 for Tice quote.

<sup>54</sup> J.T. Lovewell, "Human Agency in Changing or Modifying Climate," *Quarterly Report of the Kansas State Board of Agriculture for the Quarter Ending March 31, 1892* (Topeka: Press of the Hamilton Printing Company, 1892), 139-143.

<sup>55</sup> Deborah Coen explores the intersection of climate theory, scale politics, and empire in her article "Imperial Climatographies from Tyrol to Turkestan" *Osiris* 26 (2011).

<sup>56</sup> Lovewell, "Kansas Meteorology," 140.

<sup>57</sup> Thomas in Ferdinand V. Hayden, *The First, Second, and Third Annual Reports of the U.S. Geological Survey of the Territories for the Years 1867, 1868, and 1869 Under The Department of the Interior* (Washington: Government Printing Office, 1873), 236-237.

settlement roll over a country, and are driven back; there seems to be, for a few years, a line dividing the humid from the arid region, and beyond it no settlement or cultivation is possible. Suddenly it vanishes. No one can tell exactly where; on one knows how; no one can explain why.”<sup>58</sup>

Whereas the *Dodge City Times* described a miraculous transformation in the climate of the Great Plains, some climate thinkers articulated visions of environmental degradation and catastrophe. Eastern writers such as Winslow Watson and Hiram Adolphus Cutting followed in G.P. Marsh’s footsteps by linking settlement and landscape modification to climate changes such as increased droughts and violent storms. Cutting described the dire consequences of deforestation-induced climate change in Vermont. Using a local-scale approach, he explained how clear-cuttings had altered “what we might call paths for showers,” leading to the drying up of “formerly perennial” springs and streams. Like Fernow, Cutting warned that the climate changes were still uncertain but too serious to be ignored: “We may call these changes local if we will, and believe their effect on atmospheric conditions will be as difficult to determine in the future as in the past; but let these changes go on for a generation or two longer and as they are now going on, becoming general instead of local, and who doubts their effect on both climate and rain-fall, as well as water-supply?”<sup>59</sup> Easterners like Cutting were not the only ones to characterize nature as vulnerable. Even Kansas and Nebraska – states which historians like Emmons depicted as breeding grounds for “rain follows the plow” hubris – produced myriad theories of climatic degradation.

The Kansan Frederic Hawn, for instance, devised a pan-Western theory of climate change. Hawn believed that precipitation in the Great Plains originated from the evaporation of mountain snows directly into the atmosphere. He advanced this hypothesis in a series of articles culminating in an 1881 piece titled “The Source of Rains in Kansas.” After citing some experiments conducted in the Sierra Nevada, Hawn concluded that the denudation of mountain forests would expose snowfields to more sunlight, shorten the evaporation period, and thus disrupt the “close climatic relations that exist between the mountains and Kansas.” Hawn feared that these “radical changes” would have severe consequences for Kansas agriculture.<sup>60</sup> It is hard to imagine a starker contrast than that between Hawn’s warning and the rosier vision presented by the *Dodge City Times* a few years earlier. Yet Hawn and the newspapermen both believed in some form of anthropogenic climate change and both advocated Westward expansion. The disparity between these two views underscores the tension between anxiety and hope that marked the advent of modern American environmental thought.<sup>61</sup>

<sup>58</sup> *Dodge City Times*, Jan 19, 1878.

<sup>59</sup> Hiram Adolphus Cutting, *Forests of Vermont* (Montpelier: Vermont Watchman & State Journal Press, 1886). See 3 for rainfall “paths” and 5 for discussion of local “atmospheric conditions.”

<sup>60</sup> F. Hawn, “Source of Rains in Kansas,” *Quarterly Report of the Kansas State Board of Agriculture for the Quarter Ending September 30, 1881* (Topeka, KS Kansas Publishing House, 1881). See 45 for “climatic relations” and 48 for “radical changes.” The Sierra Nevada studies cited by Hawn were carried out by a researcher referred to as “Professor Legate.” These experiments are described in Henry G. Vennor, *Vennor’s Almanac and Weather Record for 1878-1879* (Montreal: Witness Printing House, 1879). According to Vennor’s *Almanac*, Legate carried out a series of “thermometrical tests” to prove that a “grand isothermal change” had taken place in the Sierra Nevada because of human influences. I have not been able to find further information about Legate and his experiments.

<sup>61</sup> Ramachandra Guha identifies a similar tension between “apocalyptic” and “redemptive” attitudes among G.P. Marsh-inspired conservationists of the late nineteenth century. See Ramachandra Guha, *Environmentalism: A*

### Conquest and atonement

Hawn's climate writings also reveal the interconnections between uncertainties about science or nature and the broader cultural politics of Gilded-Age America. Professor Legate, the researcher who inspired Hawn's Sierra Nevada-based climate theory, endorsed railroads as potential environmental saviors while lamenting the disastrous climate change caused by expansion and deforestation. He envisioned a modernist solution to a modernist problem. Legate argued that the construction of new railroads toward Oregon would create "another broad belt of denudation, the influence of which will be to...partly restore that equable temperature that formerly prevailed."<sup>62</sup> Nineteenth-century climate theory was rife with restoration rhetoric.<sup>63</sup> Even Cutting, the Vermonter who assailed timber-cutters seeking "immediate profit," held that the money-making potential of reforestation projects would convince Americans to replant clear-cut areas and thereby restore disturbed climates.<sup>64</sup> Legate and Cutting's trust in the possibility of restoration testifies to one of the paradoxes of modern capitalist development. As the scholar Marshall Berman has pointed out, in modern society "catastrophes are transformed into lucrative opportunities for redevelopment and renewal."<sup>65</sup> Climate theorists' faith in restoration highlights the nineteenth-century dialectic between conquest or devastation and atonement or renewal.

Although Legate and various other climate theorists viewed railroads and the profit motive as both the cause and the solution to the problems of climate change, some articulated more fundamental critiques of both the railroad and the plow – another symbol of American

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*Global History* (New York: Longman, 2000), 30. Guha's characterization of nineteenth-century conservationism and environmentalism as scientific movements is valid, but here I am focusing on a broader strain of cultural and environmental thinking, a tradition less strictly rooted in positivism. Most of the figures I describe in this paper endorsed a more expansive notion of both "science" and "nature." Their vision of science allowed room for mystery and folk belief, and their environmental consciousness was not governed solely by notions of efficiency. Books by Philip Pauly, Steven Stoll, and Aaron Sachs have traced the origins of this less positivist environmental current in early-to-mid-nineteenth century America. See Philip Pauly, *Fruits and Plains: The Horticultural Transformation of America* (Cambridge, MA: Harvard University Press, 2007), 63, 80-96; Steven Stoll, *Larding the Lean Earth: Soil and Society in Nineteenth-Century America* (New York: Hill and Wang, 2003); Aaron Sachs, "American Arcadia: Mount Auburn Cemetery and the Nineteenth-Century Landscape Tradition," *Environmental History* 15 (April 2010).

<sup>62</sup> Legate's views are also summarized in a piece from the *Virginia City (NV) Enterprise* reproduced in the *Pacific Rural Press* 20, 19 (6 November, 1880), 291.

<sup>63</sup> For a study of restoration theory in the nineteenth and early twentieth centuries, see Marcus Hall, *Earth Repair: A Transatlantic History of Environmental Restoration* (Charlottesville: University of Virginia Press, 2005). See also David Lowenthal, *George Perkins Marsh: Prophet of Conservation* (Seattle, WA: University of Washington Press, 2000) and Pauly, *Fruits and Plains*, 80-96.

<sup>64</sup> Cutting, *Forests of Vermont*, see 3 for a critique of profit-seeking and 12 for faith in "money-making."

<sup>65</sup> Marshall Berman, *All That is Solid Melts into Air: The Experience of Modernity* (New York: Penguin Books, 1982), 95. See also Kevin Rozario, *The Culture of Calamity: Disaster and the Making of Modern America* (Chicago: University of Chicago Press, 2007). Rozario analyzes the "catastrophic logic of modernity" and the "evolving relationship" between modernity, capitalist development, and catastrophe" (10-12).

progress and expansion.<sup>66</sup> The Iowan J.L. Budd, for instance, argued that the plowing of the Great Plains, along with the “accompanying drainage of sloughs, soils and streams” had damaged the climate by robbing it of moisture. Some of his contemporaries, such as Wilber and Aughey, viewed the plow as an almost sacred instrument of climate improvement. Budd’s rebuke of widespread plowing is proof of a schism among believers in anthropogenic climate change.<sup>67</sup> It also serves as evidence of the cultural uncertainties that accompanied scientific doubts and questions. The fractious cultural politics surrounding the climate debate reveal that some Gilded-Age Americans questioned the core of capitalist and expansionist ideology. Yet scientific uncertainty did not map neatly onto culture. Climate change belief, scientific certainty, and faith in capital and progress did not always go hand-in-hand while scientific uncertainties only sometimes dovetailed with cultural uncertainties about expansionism.

In her book *Manifest and Other Destinies*, Stephanie LeMenager explores the undercurrents within Manifest Destiny while arguing that “self-critical counter-narratives can be generated at the very sites of hegemonic dominance.”<sup>68</sup> The railroad-driven expansion into Kansas and Nebraska during the 1870s and 1880s highlights LeMenager’s point. Climate theorists like “Mr. Holton,” one of Wilber’s associates, believed the conquest of the West to be inexorable and always accompanied by an environmental and climatic transformation: “as civilized man moves westward step by step, possessing the lands conquered from the elements, the red man recedes farther and farther into the wilderness, and as the red man and the buffalo recede before civilization, so the grass of the buffalo and uncivilized life recedes before the vegetation of civilization.”<sup>69</sup> Thus, the Gilded-Age plains stand in as one of the sites of dominance described by LeMenager. And in stark contrast to Holton, some climate thinkers incorporated a critique of American capitalist development into their confident proclamations about settlement and expansion. Even boosters such as Aughey lamented the “vandal hand of man” and its role in “destroying forests.”<sup>70</sup>

Aughey and other climate theorists’ concerns about Euro-American environmental degradation does not negate the fact that climate theory served to legitimize genocide and dispossession. Gilded-Age writers predicated expansion on the notion that only Euro-Americans

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<sup>66</sup> For pro-railroad climate theory, see Elliott, *Notes*, 324. For anti-railroad sentiment, see “Forest Circular No.3,” Issued by Franklin B. Hough in 1877, Box 40, Folder 1, Franklin B. Hough papers, New York State Library and also J. Sterling Morton, “Arbor Day” in *Proceedings of the American Forestry Congress...1885*, 51.

<sup>67</sup> J.L. Budd (Iowa Board of Forestry), “Possible Modification of Our Prairie Climate” in Preliminary Newspaper Report, *Sixth Annual Meeting of the American Forestry Congress*, held in Springfield, IL, 1887 (Springfield, IL: State Register Book and Job Print, 1887), 21. For an example of climate theorists exalting the plow, see Wilber, *The Great Valleys*, 70. As for the schism among climate change proponents, Budd and some other believers in the beneficial climatic influence of trees aligned themselves against agricultural interests. But the lines of disagreement were neither neat nor constant; some climate agricultural boosters, such as Elliott, believed that both trees and crops could improve the climate.

<sup>68</sup> Stephanie LeMenager, *Manifest and Other Destinies: Territorial Fictions of the Nineteenth Century* (Lincoln: University of Nebraska Press, 2004), 8.

<sup>69</sup> Holton in Wilber, *The Great Valleys*, 92.

<sup>70</sup> Elliott, *Notes*, p.300. The phrase “vandal hand of man” seems to have been in wide circulation among climate theorists. Cutting describes the “vandal spirit in man” in his *Lectures on Plants, Fertilization, Insects, Forestry, Farm Homes, Etc.* (Montpelier, VT: Foreman Steam Printing House and Bindery, 1882), 79-80.

qualified as proper custodians of the Western climate. Whereas Holton and some of his contemporaries invoked the trope of the “vanishing Indian” receding before civilization, others portrayed Native Americans as a scourge against climate and environment.<sup>71</sup> In 1889, for example, Adolphus Greely wrote a Signal Corps report arguing that “the confining of Indians to reservations has removed one fruitful cause of fires during the last ten years, so that the stunted forests are having an opportunity of increasing the limit only by the operation of natural laws.” Greely did not feel confident enough to proclaim that the confinement of Indians to reservations would lead to a major climatic improvement. “The effect of forests as factors in the increase of rainfall,” he wrote, “is still more or less questioned.” Hedging his bets, he implied that rainfall levels might “slightly” improve in the future. Despite the uncertainty of his climate science, Greely was resolute in his support for expansion and in his belief that Native American wreaked environmental havoc in the West. Greely’s work demonstrates that scientific and cultural uncertainty did not always overlap.<sup>72</sup>

In contrast to Greely, however, some authors viewed Euro-Americans as the culprits of environmental troubles. Some went so far as to juxtapose Native Americans’ beneficial influences on climatic patterns with the deleterious impact of European societies upon climate. J.H. Tice, the horticulturalist who railed against the idea of the mechanistic universe, cited Mexican history to prove that, unlike many Euro-Americans, Aztecs and Toltecs had learned the climatic benefits of forest conservation. These societies, Tice argued, had inhabited the Great Basin and the “plains of the Colorado” until “great climatic changes” caused by deforestation had forced their retreat to the Valley of Mexico. “They had learned a severe lesson from experience,” Tice went on to explain, and had thus implemented strict “laws against the wasting of forests.” He believed that Euro-Americans should mimic the “civic polity of those nations relating to forests” and asked his readers if they would be as willing to atone for their environmental sins: “will we repair the injuries the thoughtlessness and recklessness of man inflicted upon the earth and its climate? Will we go forth and ameliorate the rigors of climate on our great Western plains?”<sup>73</sup> Few Gilded-Age authors credited contemporary Indians from the Great Plains and Intermountain West with climate improvement. Some of Tice’s predecessors and contemporaries described benevolent and industrious Indians from the past in order to rationalize violence against purportedly nefarious still-extant societies.<sup>74</sup> Though Tice did not articulate a position on Great Plains or Great Basin Indians, he expressed his ambivalence about whether the consequences of expansion outweighed its benefits.

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<sup>71</sup> Steven Conn has discussed notions of the “vanishing race” and the trope of the naturalized, ahistorical Indian in his study of Euro-American depictions of Native Americans in nineteenth-century culture. See Steven Conn, *History’s Shadow: Native Americans and Historical Consciousness in the Nineteenth Century* (Chicago: University of Chicago Press, 2004). Shephard Krech has shown how many nineteenth-century writers advanced the theory that Indians were poor stewards of the land. See Krech, *The Ecological Indian: Myth and History* (New York: W.W. Norton & Company, 1999), 101-105. Krech focuses especially on the notion that Indians set fires indiscriminately.

<sup>72</sup> Greely, *Report of Rainfall in Washington Territory*, 9.

<sup>73</sup> J.H. Tice, “Meteorological Effects of Forests.” *Transactions of the Illinois State Horticultural Society for 1870*, 166-175.

<sup>74</sup> See, for example, C.B. Boynton and T.B. Mason, *A Journey Through Kansas; With Sketches of Nebraska: Describing the Country, Climate, Soil, Mineral, Manufacturing, and Other Resources* (Cincinnati: Moore, Wiltach, Keys, and Co., 1855), 89-91.



The notion of atonement held a strong appeal for Tice and other writers who were uncertain about the social, environmental, and climatic costs of Manifest Destiny but unwilling to renounce the capitalist project wholesale. Many viewed efforts to reclaim the Intermountain West and Great Plains from aridity as a way of atoning for the environmental sins committed by capitalists on the eastern side of the Mississippi. The Kansas newspaper editor Henry Inman denounced the environmental and climatic conditions of the “old States” in an 1879 article: “an impoverished soil induced by their denudation of timber, has reduced their once boasted productiveness to zero, while intense drouths, deluging storms and fitful variations of temperature mark the meteorological conditions of their whole area.” Inman envisioned a future in which the East had been “rendered almost uninhabitable through the wantonness of man” while true “civilization,” along with a more favorable climate, had been transferred West of the Mississippi.<sup>75</sup>

Inman and other critics like Cutting implied that get-rich-quick schemers shouldered most of the blame for environmental and climatic degradation. But climate-based critiques of American society’s “wantonness” sometimes extended to yeoman settlers as well.<sup>76</sup> The New Yorker Franklin B. Hough, for example, called on Americans to “counter the habit of destruction and waste which was acquired by the pioneer.” In some cases, even Westerners were not exempt from blame. Periam, the Illinois-based horticulture advocate, viewed the natural grasses of the prairies and plains as a climatic safeguard regulating atmospheric patterns; without these grasses, climate conditions would inevitably deteriorate. Periam believed that early settlers shared the blame with large capitalists; he argued that Iowa farmers’ “first efforts were to destroy the natural grasses. This they have done without compensating therefor[e], while moneyed corporations were at the same time ruthlessly destroying the timber without replanting. In these respects all are alike censurable.” Periam proclaimed that the “old West is passing away” and urged the inhabitants of the Great Plains to abandon the individualistic and destructive attitude of earlier settlers.<sup>77</sup>

Members of the American Forestry Congress issued an even harsher indictment of Manifest Destiny and its exponents at their 1885 Annual Meeting in Boston. The Congress’s platform viewed “first settlers” with suspicion and declared that their tendency to cut trees and set fires indiscriminately was “criminal.” Like Periam, the Forestry Congress member John

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<sup>75</sup> Henry Inman, *Chronoscope of Larned*, Pawnee County (KS), March 12, 1879 (Kansas State Historical Society, “Rain and Rainfall” Clippings 551.57R).

<sup>76</sup> The meaning and importance of yeoman farming was intensely contested during the climate change debate. Ranching interests often stressed the limits of human interventions on the environment and doubted society’s ability to change climate for the better. See, for example, Silas Bent, “Meteorology of the Mountains and Plains of North America, As Affecting the Cattle-Growing Industries of the United States,” *American Meteorological Journal* 1, 11 (Mar 1885). Agricultural interests countered by stressing the power of farming societies to improve climate and by launching accusations against the monopolist tendencies of large ranchers. For an example of anti-ranching rhetoric, see Uriah Bruner’s testimony in *Report of the Public Lands Commission Created by The Act of March 3, 1879 Relating to the Public Lands in the Western Portion of the United States and to the Operation of Existing Land Laws* (Washington: Government Printing Office, 1880), 387. See also Walter Kollmorgen, “The Woodsman’s Assault on the Domain of the Cattleman,” *Annals of the Association of American Geographers* 59, 2 (1969).

<sup>77</sup> Periam in *Transactions of the Illinois State Horticultural Society for 1871*, 37. Iowa horticulturists voiced similar concerns about the negative influence of agriculture and settlement on grasses and climate. See, for example, the testimony of “Mr. Dixon” in *Transactions of the Iowa State Horticultural Society for 1879*, 280.

Peaslee believed that rapacious, runaway capitalism and the looming dangers of climate change necessitated a cultural change. Peaslee advocated using Arbor Day literature to teach children and the “public at large” about the “great importance to the climate, soil, of the forest conservation and planting soil productions, and to the health and beauty of the country, of the planting of trees, and the cultivation and conservation of forests.”<sup>78</sup> Peaslee and his colleagues hoped that Arbor Day and other celebrations of forest “culture” in the broad sense of the term would transform American attitudes toward landscape and climate.<sup>79</sup>

Despite their seeming radicalism, members of the American Forestry Congress still viewed capital as a necessity. They sought to reconcile conservation with capitalism and stated that one of their goals was to “harmonize the interests of the lumberman and the forester.”<sup>80</sup> The Forestry Congress’s loyalty to the profit motive demonstrates that Gilded-Age cultures of uncertainty were inextricably intertwined with Manifest Destiny and other expressions of American expansionism. But it does not negate the Congress members’ fundamental doubts about the tenability of industrialization and development. A close examination of climate writings reveals that Manifest Destiny was neither as uncontested nor as inexorable as it sometimes appears in the work of New Western historians. It also suggests how nineteenth-century beliefs about anthropogenic climate change – theories usually consigned to footnotes or cursory mentions in histories of the Gilded Age or American West – might prove useful in rethinking contemporary climate discourse and activism.<sup>81</sup>

### Conclusion: reclaiming uncertainty

The pervasiveness of uncertainty in late nineteenth-century climate discourse poses several challenges and questions for scholars: how can we gauge the intentionality behind statements like those made by Peaslee and the Forest Congress? To what extent were expressions of cultural uncertainty subsumed under the tide of development and Manifest Destiny? And did Gilded-Age climate theorists truly believe that facts and truths were liable to “melt into air”? Or did they strategically produce uncertainty to cast doubt on their opponents and to secure more

<sup>78</sup> *Proceedings of the American Forestry Congress...1885*. See 4 for “criminal” quote and 49 for Peaslee quote.

<sup>79</sup> Arbor Day originated in Nebraska in 1872 under the impetus of Julius Sterling Morton and his associates. Many Arbor Day proponents emphasized the importance of the forests’ climatic influence. Arbor Day advocates exemplified the desire to expand and develop Euro-American society on the Great Plains while also attempting to atone for the sins of human-induced climatic and environmental degradation. See, for example, John Peaslee, “Trees and Tree Planting, With Exercises and Directions for the Celebration of Arbor Day” (1884), J. Sterling Morton Pamphlet Collection v. 37, Nebraska State Historical Society. See also James C. Olsen, “Arbor Day – a pioneer expression of concern for environment,” *Nebraska History* 53 (1972).

<sup>80</sup> *Proceedings of the American Forestry Congress...1885*, 4.

<sup>81</sup> For examples of New Western History, see Richard White, *Railroaded: The Transcontinentals and the Making of Modern America* (New York: Norton, 2011) and Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York: Pantheon Books, 1985). Worster’s book dismisses all criticism and uncertainty about Euro-American expansionism in the West as ineffectual and nearly irrelevant. White’s more recent book offers a slightly more generous reading of the critics of railroads and Manifest Destiny, but still subsumes them within a totalizing current of capitalist expansionism. Worster and White’s seminal works offer myriad insights into Western and Gilded Age history, but tend to either dismiss climate theory or cite it as evidence of Gilded-Age expansionist hubris. See, for example, Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (Oxford: Oxford University Press, 1979), 81-82; White, *Railroaded*, 487-488.

funding, support, and legitimacy? Perhaps many or all of these theories apply. Perhaps some nineteenth-century climate theorists embraced both the paradoxes inherent to modern knowledge production and the notion that, as Berman has argued, “modern life...is radically contradictory at its base.”<sup>82</sup> Uncertainty’s meaning was simply too varied and enigmatic for us to grasp definitively. The enduring nature of these questions highlights yet another paradox: that studying uncertainty in the past underscores the uncertainty of our knowledge of the past.

Gilded-Age writers never reached a consensus about the nature of human influences on climate and their socio-political implications. The acrimonious climate change debate persisted into the early twentieth century, amid the increasing industrialization and urbanization of the United States. Sources written after the turn of the century shared earlier documents’ concerns about unchecked resource use as well as their uncertainty about the reliability of climate science.<sup>83</sup> Continuing discussions about human influences – largely through silviculture and deforestation – on local climates would go on to shape twentieth-century conservation programs such as the 1930s Shelterbelt initiative. Over the course of the twentieth century, however, climate discourse shifted away from debates about regional landscape change and toward a concern with emissions.<sup>84</sup> At the same time, the increasing professionalization of climate science, already underway during the Gilded Age, worked to reinforce the elusive boundary between science and politics, between high and popular science.

Despite these changes, the parallels between Gilded-Age and contemporary climate discussions are remarkable. Some ongoing regional afforestation programs echo late-nineteenth century climate-based silviculture initiatives both in substance and in rhetoric.<sup>85</sup> In broader discussions about climate change, cultural and scientific politics remain intertwined in spite of the scientific consensus surrounding global warming. As in Powell and Tice’s time, debates about the implications of climate change hinge on the perceived relationship between capitalist development and climatic conditions.<sup>86</sup> Some contemporary authors view climatic progress and capitalism as irreconcilable. Others echo atonement-minded Gilded-Age theorists who sought to harness market forces and transform them into a beneficial influence on climate.

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<sup>82</sup> See Berman, *All that is Solid*, 19.

<sup>83</sup> See Camden, NY *Telegram*, July 29, 1901; Portland (ME) *Express*, June 26, 1903; Hubbard, IA, *Monitor*, Aug 2, 1901. For scientific writers, the question of forest and other surface influences on climate remained contentious into the 1910s. See M.O. Leighton, A.C. Spencer, B. Mackaye, *The Relation of Forests to Stream Flow* (US Department of the Interior, Geological Survey, 1913), 2. For an early twentieth-century source denying climate influence theory, see Hiram H. Chittenden (Lieut.-Col., Corps of Engineers, US Army), “Forests and Reservoirs in their Relation to Stream Flow with Particular Reference to Navigable Rivers.” *Congressional Record* Feb 9, 1909 (Vol. 43). Chittended challenged “commonly accepted” theories about the negative influence of deforestation on rainfall totals as he acknowledged that “The elements of the problem are so many and conflicting, the necessary evidence so hard to get, and comparative records of such recent date, that precise demonstration is scarcely possible” (925-926).

<sup>84</sup> James Rodger Fleming, *The Callendar Effect* (Boston: American Meteorological Society, 2007).

<sup>85</sup> Official literature on afforestation initiatives by the People’s Republic of China in the Kubuqi Desert cites ecological restoration and climatic improvement as benefits of forest planting. See *Share the Value of the Desert: Ecological Construction Practices in the Kubuqi Desert* (Beijing: China Pictorial Publishing Group), 63; “Document from China Elion Resources Group,” <http://www.uncsd2012.org/content/documents/380Elion.pdf>.

<sup>86</sup> Naomi Klein, *This Changes Everything: Capitalism vs. the Climate* (New York: Simon and Schuster, 2014).

Instead of searching for heroes or villains, it may be more useful to view the nineteenth-century climate debate in terms of a complex cast of characters, each having a multifaceted relationship with uncertainty and the unknown. Today, we know much more about the vagaries of climate than in the days of Gustavus Hinrichs and Bernhard Fernow. Yet many mysteries remain. Forecasts are not always correct, some aspects of global warming are not entirely understood, and scientists still debate whether or not cultivation can alter the climate.<sup>87</sup> Like Fernow and Hinrichs, contemporary people trying to grasp the causality and consequences of climate change must deal in uncertainties and associate with the unknown. And uncertainty is too powerful and protean to be ignored. Rather than ceding uncertainty to the “merchants of doubt” described by Oreskes and Conway, perhaps we should cultivate our relationship with the unknown.<sup>88</sup>

In recent decades, researchers have developed an extensive literature on the possible role of forests as a mitigating influence on climate change. The text of the 2015 Paris Agreement included a stipulation encouraging the conservation and sustainable management of forests.<sup>89</sup> Climatological studies have gathered substantial evidence of forest influences on climate change, but the precise nature of the relationship between forests and climate remains mysterious. As scientists, politicians, and activists work to implement conservation programs based on these findings, they may want to consider the experiences of their Gilded-Age precursors who discussed the contested meaning of scientific uncertainty in light of pressing economic and social problems. Fernow, Hall, and their contemporaries engaged with uncertainty without sacrificing the strength of their environmental proposals. Although they did not substantially alter the course of American capitalism and natural resource extraction, perhaps Gilded-Age climate theorists developed a useful way of incorporating uncertainty into popular environmental and climatic discourse. Their writings show that it may be possible to discuss and address the pressing problems of global warming while also acknowledging the ephemeral nature of expert knowledge.<sup>90</sup>

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<sup>87</sup> Some scientists believe that Great Plains weather and climate can be altered by land use patterns. See, for example, Sid Perkins, “Crop Irrigation Could be Cooling Midwest,” *ScienceNews*, Jan. 22, 2010.

<sup>88</sup> For further discussion of how climate history can inform present-day climate science and activism, see Mark Carey, “Science, Models, and Historians: Toward a Critical Climate History,” *Environmental History* 19 (April 2014).

<sup>89</sup> For some examples of work on the influence of forests on climate, see J.G. Canadell and M.R. Raupach, “Managing Forests for Climate Change Mitigation,” *Science (AAAS)* 320 (June 13, 2008) 1456–1457; C. Streck and S.M. Scholz, “The role of forests in global climate change: whence we come and where we go,” *International Affairs* 82 (October 4, 2006): 861–879; David K. Adams et al., “The Amazon Dense GNSS Meteorological Network: A New Approach for Examining Water Vapor and Deep Convection in the Tropics,” *Bulletin of the American Meteorological Society* 96 (December 2015): 2151–2165. For forests in the Paris Agreement, see *United Nations Convention Framework on Climate Change*, December 12, 2015, <https://unfccc.int/resource/docs/2015/cop21/eng/109.pdf> (Retrieved February 29, 2016).

<sup>90</sup> In discussing the entanglements between humans and non-humans, Latour encouraged us to “suspend our certainties” and develop a more uncertain ethos. His political ecology “shifts from certainty about the production of risk-free objects (with their clear separation between things and people) to uncertainty about the relations whose unintended consequences threaten to disrupt all orderings, all plans, all impacts.” See *The Politics of Nature: How to Bring the Sciences into Democracy*, trans. Catherine Porter (Cambridge, MA: Harvard University Press, 2004), 21 and 25.