TIME AND THE WORLD Interdisciplinary Studies in Cultural Transformations 5

Times of History, Times of Nature

Temporalization and the Limits of Modern Knowledge

Edited by **ANDERS EKSTROM**
and **STAFFAN BERGWIK**

Times of History, Times of Nature

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Introduction

Dividing Times

Staffan Bergwik and Anders Ekström

A distinctive and widely recognized feature of the modern history of knowledge in the last 250 years is the growing epistemological split between the study of nature and the study of human history. This divide emerged from the late eighteenth century and onwards, encompassing a variety of knowledge practices and emerging forms of historical thinking. It was further shaped by disciplinary formations and institutional arrangements in the nineteenth and early twentieth centuries, especially in what became known through this process as the humanities. Earlier schools of thought and knowledge systems that understood their scope more holistically—for instance, natural philosophy, *historia naturalis, historia litteraria*, and universal history—became marginalized and judged as obsolete or amateurish. Eventually, natural and cultural history were drawn apart, and ultimately transformed by being incorporated into or excluded from the modern organization of knowledge.

Central to the theme of this book is that this divide also conditioned different approaches to an increasing variety of time frames and historical durations. Not only human societies but also landscapes, species, and the layers of the earth were increasingly temporalized in the nineteenth century, but within different fields and practices, creating multiple timescales and divisions between the rhythms and paces of nature and culture.

In the twentieth century, major European historians elaborated this distinction, and between them they created an understanding of historical change that excluded the forces of nature from the proper domain of historical inquiry. For instance, this position was clearly expressed in a lecture on the nature of historical change, which was held in 1975 by one of the most prominent Scandinavian historians in the twentieth century, Erik Lönnroth. Addressing the Royal Swedish Academy of Sciences and speaking from more than forty years of experience of historical research, Lönnroth explained that there was a principal difference between human history and events in nature. Changes in climate, volcanic eruptions, earthquakes, and floods could no doubt affect the course of humanity, he argued, but were not examples of *historical* change. Why? Because the notion of history and historical change that Lönnroth and the vast majority of his contemporary historians embraced was restricted to the study of changes and processes that they understood as caused by human activity.[1]

Historians more sensitive to the multiple layers of historical time approached the dividing line between nature and culture differently. Fernand Braudel's epic account of the history of civilizations and their different paces emphasized the rhythms of seas and landscapes, but in a way that amplified the division between times in nature and times in culture. Braudel famously contrasted the rush of the history of events with conjunctural time, located in social patterns, long economic cycles, and the history of infrastructures. Besides these two temporalities, he argued, there was "a history slower still." The French historian described this third temporal layer as the almost immobile "history of man in his intimate relationship to the earth." Its rhythm was cyclical and repetitive. It was, Braudel suggested, a history "beyond time's reach and ravages."[2]

Since the late twentieth century however, things have changed. Through the introduction of anthropogenic climate change as a major theme in public discourse and global knowledge production, the modern distinction between the causes and temporalities of human and natural history has been thoroughly challenged. With growing insights into how human societies act as a major force in geological and atmospheric processes, the idea of human agency as external to floods and rising temperatures is no longer obvious. Neither can nature be conceived of as the slow and repetitive background to historical events. Anthropocene notions of human history in its "intimate relationship to the earth" are significantly different from Braudel's, turning the temporal structure of his conception of history on its head. While nature has become eventalized and described in metaphors of acceleration, feedback loops, and threshold times, human societies appear to be stuck in repetitive structures of the present. The latter is indicated by a lack of political decisions in the face of climate change, alongside the inability of changing entrenched cultural patterns and lifestyles. Most importantly, the shift in temporalities has redrawn and, in some respects, dissolved the boundaries between natural and historical times.

Temporalization

In the last two decades, this shift of temporal perspective has been reflected in an increased scholarly engagement with multiple historical time frames and temporalities. While some arguments start with the assumption of the collapse of modern timescales in the face of climate change, others point to the importance of recognizing how the Anthropocene is rooted in the history of Western capitalism in the last 250 years.[3] Especially relevant to this volume is the work by scholars who have attempted to outline, both historically and theoretically, how anthropogenic climate change creates a different understanding of the relation between a variety of time frames, for example by asking to what extent geological and historical timescales merge in the course of the Anthropocene, or how climate change temporalities are different from the time frames of geological epochs.[4] While it seemed unnecessary and awkward to many historians in the twentieth century to approach the distinction between natural and historical times as unsettled and open to new interpretations, this is now a terrain of intense scholarly exploration. This turn has also fueled a renewed interest in theories of history that grapple with questions concerning the layering and coexistence of multiple paces of historical time. Several chapters in this book will return to the importance of the *Annales* historians in this respect, and the work not only of Braudel but also his predecessor Lucien Febvre, who, together with March Bloch, founded the *Annales* school in the late 1920s. Besides their advanced thinking on the composition of historical and natural times, these historians provide important examples for this book through their resistance to certain forms of disciplinary provincialism, a position that has become more crucial than ever in the twenty-first century.

Another major influence when it comes to ideas about temporal strata, and more elaborated theories of historical time, is the work of the German historian Reinhart Koselleck.[5] In his view, any historical inquiry "need[s] to work, at least implicitly, with a multilayered theory of time." Koselleck famously used the term "temporalization" (*Verzeitlichung*) to describe the progressive nature of history that was applied to Western societies in the late eighteenth century. From that time on, he observes, the present became increasingly defined by its capacity to break with the past. This is the period that Koselleck refers to as *Neuzeit*, and which we might think of as the advent of modern historicity. It opens up what Koselleck and others describe as an ever-increasing gap between historical experience and the horizon of expectation in modern society.[6] From the mid-nineteenth century and onwards, this notion of historicity was more commonly referred to in terms of modernity, and intimately connected to the unifying idea of progress and the envisioning of an open and malleable future.

In this book, temporalization is given a different meaning. Here, it refers to a different but equally pervasive shift in temporal and historical imagination. It started to emerge in the end of the twentieth century, precisely two-hundred years after the foundation of the notion of modern historicity and following the rise of global concern with anthropogenic climate change. Drawing on contexts as diverse as weather news and reports on changing landscapes, everyday intergenerational concerns, new forms of global governance (the Intergovernmental Panel on Climate Change was established in 1988), and an abundance of Anthropocene reflections in art and museums, it is evident that the conflicting temporalities of climate change have become increasingly important to political and cultural imagination. In terms of historical experience, it creates a temporal thickening of the present, which is fueled by the urgent realization of the complex durations and timescales that global society both depend on and influence.[7]

For cultural and historical thinking, temporalization poses a challenge on par with the rise of globalization theories in the 1970s and 1980s. Most importantly, it is equally connected with major recalibrations of scale, and the need to develop alternative ways of imagining and visualizing abstract and multilayered relations between societies and epochs that are separated and yet connected over large distances in time and space. In this book, this sense of shifting scales, and the translations it involves, is analyzed through a variety of modelling, monitoring, and mediating practices that at the same time resonate with contemporary temporalization and display its multiple connections with the past.

Climate change temporalities are composed of a complex mix of time frames and historical rhythms. It fuels a sense of expanding and multiplying times, which is not defined by the long-term alone. It is rather the increasing entanglement of different scales and durations that distinguish contemporary temporalization from the modern regime of progress and its notion of a deepening gap between past and future. But as much as the climate crisis challenges the notion of the malleable future, it also has the effect of opening up different eras to each other, foregrounding the intertemporal dimension of human actions and choices, and bringing the past and future closer to the present. For historical thinking, this shift in temporal sensibilities evokes longstanding debates on, for example, chronology, matters of periodization, modern presentism, and the relation between natural and historical times.[8] It also brings new emphasis on the temporal dimension in politics and how societies are acting on different timescales, making political conflicts and social movements gravitate toward issues of forecasting and intergenerational inequality.

Also, through this experience, and with growing insights into the scale of human impact on earth systems, new aspects of the past emerge through the lens of the contemporary situation. The expansion of geological and cosmological time frames in the period between 1750 and 1850, by which human history was turned into a distinctive epoch in a more far-reaching temporal scheme of an evolving earth, prefigure in important aspects the present engagement with the interaction between geological and historical processes.[9]

This is revealed by new Anthropocene readings of major contributions to natural history from the seventeenth to the early nineteenth century.

One case in point is the work of Georges-Louis Leclerc de Buffon, who famously extended the time span of the history of the earth in his multivolume *Histoire Naturelle* (1749–1804) by reinterpreting the six days of creation as six epochs of considerable duration that preceded human history. Buffon also engaged with the interaction of human and planetary history by conceiving of human activity as an irreversible but temporally limited force in the much longer history of the earth system. His analysis included vivid descriptions of the lasting traces of human history in seas and landscapes, and a prognostication of how the interaction between human societies and their environments caused a warmer climate, and saved the earth from its cooling past. Also, in a similar vein as seventeenth-century natural philosophers such as Nicolaus Steno and Robert Hooke, Buffon approached natural history in the language of an archivist. Bridging natural and historical time frames through metaphor facilitated the understanding of the earth both as a systemic and historical entity, and the idea that system aspects could also change with time and through human impact.[10]

Another example of the tendency of rereading the history of natural history from the perspective of Anthropocene concerns is Alexander von Humboldt's work in South America in the early 1800s, which is increasingly being rediscovered as part of the present-day discourse on global warming. Humboldt is discussed in greater detail in one of the chapters in this volume. Above all, he is now seen as an early founder of what would later become Earth System Science due to his ecological thinking.

It is our contention, then, that the ongoing process of temporalization means that the division between natural and historical times, which marked the nineteenth and twentieth centuries, and became closely attached to modern temporalities, is losing much of its explanatory power. The aim of this book however is not to proclaim an epistemic leap into a new temporal regime. Instead, the volume's chief contribution lies in revisiting the divide between times in history and times in nature since the eighteenth century and up to the present. Taken together, the individual chapters in the book trace three interrelated phenomena: first, we explore practices, tools, media, and metaphors for imagining and studying multiple timescales, paces, and rhythms across human and natural history. Second, we investigate how such practices, tools, media, and metaphors travelled between different fields of knowledge, public discourse, and historical inquiry and prognostication. Third, we reflect on the simultaneous division of knowledge into fields restricted to studying either times in nature or times in culture, and how these boundaries are redrawn in the context of climate change temporalities.

Our outlook and ambition to address these issues is profoundly shaped by present-day experiences of timescales in flux. From this vantage point, we suggest, the past opens up in new ways and displays instances where the boundaries of the modern organization of knowledge were less rigid than most recollections indicate. Indeed, we suggest the value of a simultaneous genealogy and reappraisal of the distinction between historical and natural times, as we turn to the past for ways of comprehending the conflicted temporalities that define the present.

Time-Binding Techniques

Telling time is an act embedded in vast infrastructures and cultural practices. There is a rich and theoretically diverse scholarship on the organization and perception of time in the past, covering the history of timekeeping, clocks and calendars, temporal regimes, and visual imaginaries of time as well as the politics of periodization and historical memory cultures.[11] This volume contributes to this literature in many ways. A recurrent topic is how temporal metaphors and visual media have developed between natural and human history. Several chapters collect and analyze a wide array of what we refer to as time-binding techniques. This concept is meant to bring together two media-theoretical influences. The first is Harold Innis's discussion about the temporal and spatial bias of different modes of communication.[12] The second is Bernard Siegert's analysis of an intriguing range of cultural material practices that he labels "cultural techniques."[13] Giving Innis's distinction between time-binding and space-binding media a cultural twist, we especially focus on a set of technologies and emerging genres that enabled ways of connecting and visualizing different frames, layers, and durations of time.

A case in point is Emma Hagström Molin's chapter in which she investigates how the Habsburg region of Moravia received its first empirical and general history in the mid-nineteenth century. Hagström Molin underscores the importance of knowledge practices at the intersection of nature and culture. The temporalization of nature was vertical through the interest in the Moravian ground, while cultural events were understood horizontally as sources were arranged along a timeline constituting historical time. Nevertheless, the two versions of temporalization were connected, in particular through the interest in archaeological evidence and the usage of geological metaphors for history writing in the work of the Moravian historian Beda Dudík.

Staffan Bergwik's chapter also addresses how temporal media formats have tied natural and cultural history together. His chapter investigates the methods used by early twentieth-century geologists and dendrochronologists to carve out and visualize layers of time from trees and soil. Bergwik discusses literary and visual formats—e.g., the year, the archive, and timelines—that geologists and dendrochronologists engaged with to mediate nature's time and historical time as interconnected.

In his chapter, Adam Wickberg investigates the work of German polymath Alexander von Humboldt and his book *Views of Nature*, published in 1809. Wickberg discusses how Humboldt contributed to the establishment of a cultural technique to visually depict geological matters around 1800, in particular through a visual sign system labelled "pasigraphy" which originated in the Greek words *pasi* (everything) and *graphe* (writing). Humboldt argued that these signs would be universally recognized, thus creating a time-binding technique to show geological features visually rather than verbally. Time charts, according to Humboldt, could be included in atlases for easy comparison of different areas. Indeed, as Wickberg notes, the importance of conveying time in a comprehensible manner was important in a period, and to a scholar, that worked before the modern organization of knowledge into specialized disciplines. Time needed to be legible and intelligible across fields of knowledge.

A media-historical approach is also important for Marit Ruge Bjærke's reading of red-list temporalities. By focusing on the discourse of biodiversity loss and species extinction, Bjærke discusses the characteristics of Red Lists as a time-binding visual genre. The lists appear in her analysis as statements about the interdependence and coexistence of evolutionary and political times, past and future, the long-term and the urgent present, end points and processes of acceleration. Among colors, red is closest to time. As Nina Wormbs shows, matters of color and shape are vital to models of the future. Wormbs studies the time-binding practices of climate modeling, and especially how complex timescales and measurements of changes in temperatures, CO_2-levels and sea-ice minima are translated into prognosis and possible futures. The abundance of record levels, end years, and deadlines in reports of climate change from IPCC and other authorities presuppose particular timelines and temporal targets and appear in Wormbs's analysis as highly mediated phenomena.

As much as the visualization of abstract temporalities is necessary for enabling societies to feel and act upon climate change, it also points to the interplay between science, public authority, and media in turning climate times into a perceptible moment in human history. Eric Paglia and Erik Isberg investigate the 2°C target in climate policy and the inherent multitude of timescales to reach ideas about global warming in the past and the now. The temperature targets of global climate politics rest on a single, linear temporal scale, yet such a scale is the product of a multitude of measurements. The temporal aspect of the "political temperature target" of 2°C is often taken for granted, and Paglia and Isberg wish to historicize its highly diverse set of timescales. They make a particular point of recording temperatures, and "the record" becomes both a genre for temperatures and for temporalities. Moreover, the record has turned the global average temperature into a governable phenomenon. As Paglia and Isberg draw our attention to the ambiguity of the notion of the record and its history as a temporal genre, their analysis also unveils the historicity of political temperature targets.

Another recurring theme throughout the book concerns how timescales have been arranged, separated, and at times conflated since the eighteenth century, and how the need for major recalibrations or the synchronization of time intensify at certain historical junctures.[14] As Helge Jordheim has indicated elsewhere, "practices of synchronization" depend upon material and conceptual tools to coordinate what in the modern era has been multiple, coexisting timescales.[15] In this vein, several chapters analyze what we might think of as the historical production of common times and its infrastructural extensions. One example is Gustaf Holmberg's study of the production and distribution of synchronized time in Sweden in the second half of the nineteenth century. Holmberg points to the key role of astronomical knowledge in the standardization of clock time in the modern period. It resulted in a far-reaching system for homogenizing and representing time across society and constituted a major shift in communicative infrastructures in Europe, connected to the invention of railway time and the introduction of electrical media such as the telegraph.

The theme of synchronizing practices also comes to the fore in Hagström Molin's and Bergwik's chapters. According to Hagström Molin, Beda Dudík approached history as an open category, combining knowledge of mines, landscapes, and archaeological sites in his overall efforts to synchronize the deep time of nature with the religious time of Christianity and the national time of the Moravian region. Bergwik points to how natural and cultural timescales were synchronized through metaphors and visual formats like the calendar and the timeline to bring together the cyclical time of nature with the linear time of culture. In their contribution, Paglia and Isberg show how the 2°C temperature target is the effect of synchronization of many different temperature records, which in turn hide the many timescales that go into it. This is also demonstrated by the range of empirical examples that they engage with: a host of reports, meetings, and discussions that are spread out over time and place have been ordered and synchronized into the legible and political temperature of the 2°C target. Interestingly, Paglia and Isberg also indicate how the political temperature target builds on an amalgamation of records, yet is "compressed" into a single, linear time of Western modernity.

Lise Camilla Ruud discusses synchronization through the idea of "temporal alignment" between the deep time of nature and the deep time of culture in her analysis of naming practices in Norwegian petroleum fields. The chapter focuses on how the rhythms and durations of earthly, industrial, and cultural temporalities are arranged to make each other meaningful and comprehensible in narratives on the Norwegian oil industry. Ruud focuses on technoscientific practices which align the deep and slow time of nature, which has produced the oil in the seafloor, with the rapid industrial time of producing fuel. Secondly, she ties these temporalities to the cultural history of Norway through an examination of how names from the age of Vikings and Norse mythology play a crucial role. A key argument in Ruud's chapter is that while history has often been understood as linear and chronological, the alignment of oil time and the time of Vikings pave the way for a temporal concentration, through which particular parts of the past are brought together and played out against each other. Importantly, Ruud shows how temporal work is necessary for the oil fields to become part of the national self-perception of present-day Norway. Offshore petroleum fields, seldom experienced by people on dry land need to be culturally comprehensible, even relatable or familiar. Accordingly, names from Norse mythology and the age of Vikings are used to tap into, and further create, a collective past and experience of being Norwegian.

This in turn points to how the links between versions of common time and the framework of national history run deep. From the early nineteenth century onwards, archives, museums, statistics, and other visual and literary genres were mobilized in collecting the past of nations to imagine their collective futures. This wave of nationalizing history did not necessarily discriminate between natural landscapes and human societies. In fact, and more broadly construed, this indicates the extent to which the politics of time is a recurring theme in the history of modern temporalities, as well as in this book. The chapters of Wormbs and Isberg and Paglia also exemplify how struggles over the future mobilize the past. Chapters dealing with matters of energy extraction, landscape formation, species extinction, and natural resources inevitably turn to the scales and temporalities of political action and intervention itself.

In her contribution, Julia Nordblad explores the history of how times of nature connect to political and economic time frames through a study of political debates relating to a new French forest legislation of 1827. The intergenerational care of the long-term, what Nordblad calls the "temporal otherness of trees," was contrasted to the temporalities of the market, the liberal economy and private ownership. The question of how forests were to be handled—who decided whether to clear them or not—was profoundly a clash of timescales. Moreover, Nordblad incorporates an analysis of how the issue of conflicting timescales played out as a question of human emotions and passions. To some of the French debaters, material interest in the forests was a wild state of mind leaving men short sighted, and the slow temporality of trees stood in opposition to the short timescale of human interests. To others, the interest in the forest was a cool mode of action paving the way for planning.

The general outlook among French parliamentarians, however, was that a failure to control passions led to shortsightedness and to individuals working against the interests of the collective. Nordblad's case also throws light on the issue of the relation between particular and common interests, between the state as an institution governing time and the freedom of individuals. She argues that the case of forest temporality adds another dimension to this well-rehearsed question in the history of political ideas.

Dividing Temporal Knowledge

As has been stated, the aim in the following is not only to investigate temporal media that imagine and explain multiple paces and rhythms across human and natural history, we also explore how such representational practices travelled between fields of knowledge, indeed how they have served to create a gradual division of knowledge about historical time into fields pertaining to nature and culture respectively. In short, we seek to illuminate aspects of the epistemological divides that eventually shaped the modern knowledge system. Some of the contributions thus draw on the early history of the formation of the natural and human sciences in the eighteenth and nineteenth centuries to discuss the shifting time regimes of the modern organization of knowledge. This includes perspectives on the history of individual disciplines such as geology, astronomy, biology, meteorology, and history, and their various ways of organizing time in layers, scales, and periods.

Approached from this broad perspective, the history of temporal knowledge organization is ambiguous. On the one hand, the following chapters display an increasing division of time knowledge into modern academic disciplines during the nineteenth and twentieth century. In his chapter, Helge Jordheim goes back to the downfall of *historia naturalis* in the eighteenth century as a paradigm for investigating both the natural and the cultural world. A crucial argument in Jordheim's contribution is that parallel to the discovery of geological deep time by the emerging discipline of geology between 1750 and 1850, another science about time was branched out in the modern order of knowledge. This was the discipline of history, which developed around a notion of historical time that separated human events from natural history. In Jordheim's argument, deep time thus slipped out of human view and geohistory became a science without an anthropology. Staffan Bergwik makes a similar argument as he explores how geologists tried to coordinate genres of "earth history" and "world history," precisely at a time of increasing specialization and a growing divide between the disciplinary formations of history and geology in the early twentieth century. Against that backdrop, the vision of history as restricted to human activity—and the strict demarcation of what such activities might comprise, which was elaborated by Erik Lönnroth in 1975—can be understood as part of epistemic and professional norms among historians going back to the mid-nineteenth century.

On the other hand, several of the chapters in this volume investigate instances where models, metaphors, and knowledge practices enabled an exchange between natural and human history. Combined together, these studies thus reveal intriguing continuities across centuries and between different forms of time-binding knowledge. As mentioned, earth scholars in the seventeenth century such as Robert Hooke approached fossils and soil in terms of archives and dust.[16] The exchange not only of metaphors but knowledge practices between the study of nature and culture in the context of natural history prefigured the time-binding work involved in planetary, national, and ecological thinking in the eighteenth and nineteenth centuries. Another example is the idea of stratigraphy. As discussed by Helge Jordheim, stratigraphy is a pattern of thought to handle and describe multiple times, going back to seventeenth-century Danish anatomist and geologist Nicolaus Steno. Moreover, stratigraphy is an example of a language of "layers" and "layering" to address the entanglement or conflict between multiple timescales. In going back to Steno, Jordheim displays a longer trajectory of historiographical movements where geological and phenomenological temporalities were organized.

Another example from that longer trajectory is Alexander von Humboldt, whose work spanned multiple timescales and topics of cultural and natural history. In his chapter on Humboldt, Adam Wickberg discusses the entwined human and geological temporality of the Americas, which emerged from Humboldt's work. Of particular importance is the concept geo-anthropology. The German scholar envisioned a holistic understanding of life through his geological work; and in his publications, geology, environment, and the human sciences are interconnected. Indeed, Wickberg suggests that Humboldt's work encapsulated deep time, natural history, and human history, as well as environmental and social sciences to understand the history of the Americas.

This exchange of ways of imagining traces and layers of time across natural and cultural history continued in the nineteenth and twentieth centuries, both in the context of various forms of general and universalist history writing, as well as emerging disciplines like archaeology. Moreover, latter-day historical scholars have revived ideas about time as layered and repeated stratigraphy as a mode of thinking. For instance, this is illuminated by Jordheim's discussion about the work of Braudel, Koselleck, and Krzysztof Pomian, indicating how they use geological metaphors in their theories and conceptualizations of historical time. Yet another example of an early twentieth-century historian who developed a refined understanding of how landscapes and natural surroundings were affected by human societies was the founder of the *Annales* school, Lucien Febvre. He contributed to a style of historical research that was shaped by the broader traditions of cultural and natural history, and that were seeking conceptual innovation by thinking across the emerging disciplines of the human and natural sciences. Developing a less naturalized version of historiography than Braudel, Febvre tried to trace human agency in the formation of landscapes and the history of the earth. As Sverker Sörlin indicates in his chapter, key to this human-made version of the natural world was the modern concept of the environment. Sörlin's chapter addresses the rise of the environmental discourse by tracing the emergence in the twentieth century of what he calls *environmental times* in a wide range of disciplinary contexts, and how they required synchronization with cultural, social, and political temporalities. The chapter thus makes a crucial contribution to the history of Anthropocene thinking more generally, pointing to the continuous engagement with the interaction between humans and their surroundings in the modern history of knowledge.

Sörlin also proposes a general history that synthesizes the period from the eighteenth century and up to the present in three major waves of temporal synchronization. The first is located to the expanding time frames and globalizing histories of the world in the eighteenth and early nineteenth century, overlapping with the era that Koselleck referred to as the *Sattelzeit*, and in which the idea of progress became the universalizing force of Western historicism. A second wave of synchronization emerges from the infrastructures and technologies of global and commercial timekeeping that developed from the mid-nineteenth century onwards, and that became increasingly linked to and supported by the rise of international organizations, nation states and their institutions, and modern scientific disciplines, as exemplified by the role of astronomers in the standardization of time around 1900. The ongoing integration of geophysical, biological, social, and historical timescales in the context of the Anthropocene can be seen as the epitome of a third wave of major synchronizations, a process that encompassed the formation of environmental times that Sörlin collects in his chapter, and that lead up to present concerns with climate change temporalities.

Taken together, the chapters provide much support for such a periodization, but they also convey a strong sense of coexistent and overlapping temporal regimes. What is clear is that we are currently experiencing a shift in temporal imagination that goes beyond academic knowledge production. In the closing chapter of this book, Anders Ekström takes his point of departure in the abundance of contemporary images and news reports of weather extremes and climate-connected emergencies. Enmeshed in digital infrastructures and mediating technologies, Ekström suggests, contemporary culture has switched into a monitoring mode, increasingly turning to the sky, sea, and ice for knowledge about past and forthcoming events. This elemental turn points to a longer history of cultural responses to nature emergencies and the role of major geological events as sources for imagining temporal complexity. Today, the category of "extreme weather," which was introduced in public discourses on global warming in the 1990s, work as a time-binding medium for visualizing climate change temporalities. Online news coverage of floods, hurricanes, and heat waves simultaneously refer to the accumulation of disasters, accelerating deep time and a warmer future. Likewise, images of vanishing glaciers and rising waters turn the past into a living archive, expanding into and acting on the present in multiple and unforeseeable ways. Ekström argues that this creates a sense of the present as moving into the geological live. This new version of the present merges geological and historical time frames, but also challenges modern understandings of the very nature of "media" and "events." Like many of the chapters in this book, Ekström's discussion points back to the decades around 1800 as an era of major shifts in temporal imaginations, comparing contemporary temporalization to the continuous history of dividing and integrating historical and natural times and temporalities in modern society.

Finally, a word on the arrangement of the book. We have chosen to organize the chapters in four thematic blocs. The first, *Eras of Synchronization*, engages in particular with historical junctures, moments, and waves of intensified temporal division, standardization and rescaling. The second, *Biocultural Times*, turns away from a certain tendency of historicizing Anthropocene ideas from the relation between geological and historical time frames, and focuses instead on temporal conflicts and alignments in the intersection between biological and cultural forms of knowledge and meaning production. The third section, *Time-Binding Knowledges and Visual Genres*, is especially concerned with knowledge making in scientific settings were the invention of particular tools and methodologies for studying, scaling, and representing time also involved the undoing of disciplinary boundaries. Finally, the chapters in the fourth section, *Recording and Envisioning Climate Times*, share a focus on the media history of present modes of prognosticating, modelling and monitoring temporalities of climate change. This is followed by a brief conclusion in which we collect some of the book's findings.

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Staffan Bergwik is Professor of the History of Science and Ideas at the Department of Culture and Aesthetics at Stockholm University. His research focuses on the cultural history of the modern sciences, including topics like science and verticality, science and temporality, history of emotions, history of knowledge, and science and the media. Recent publications include "Elevation and Emotion: Sven Hedin's Mountain Expedition to Transhimalaya 1906–1908," *Centaurus* (2020); "Standing on Whose Shoulders? A Critical Comment on the History of Knowledge," *Forms of Knowledge: Developing the History of Knowledge* (Nordic Academic Press, 2020); and *Domesticity in the Making of Modern Science* (Palgrave MacMillan, 2015).

Anders Ekström is Professor of the History of Science and Ideas at Uppsala University, and currently Professor II of History of Knowledge at Oslo University. He has published broadly on modern cultural and media history and theory for three decades. His most recent work includes a series of essays on time and temporality in the history of natural disasters, which appeared in journals such as *Theory, Culture & Society*, and *Media, Culture & Society*. His ongoing research is focused on two main areas: cultural processes of temporalization in the context of climate change, and the modern history of publicness.

NOTES

1. Erik Lönnroth, *Tidens flykt: Stora historiska förändringar och människor som har levat i dem* (Stockholm: Atlantis, 1998), 21–22.
2. Fernand Braudel, *On History*, trans. Sarah Matthews (Chicago: Chicago University Press, 1980), 12.
3. For example, this point is convincingly made in Christophe Bonneuil and Jean-Baptiste Fressoz, *The Shock of the Anthropocene: The Earth, History and Us* (London: Verso, 2017).
4. See, for example, Dipesh Chakrabarty, "Anthropocene Time," *History and Theory* 57, no. 1 (2018): 5–32; Julia Nordblad, "On the Difference Between Anthropocene and Climate Change Temporalities," *Critical Inquiry* 42, no. 7 (2021): 328–48.
5. Reinhart Koselleck, "Sediments of Time," in *Sediments of Time: On Possible Histories*, trans. and ed. Sean Franzel and Stefan Ludwig Hoffmann (Stanford: Stanford University Press, 2018), 7.
6. Reinhart Koselleck, *Futures Past: On the Semantics of Historical Time*, trans. Keith Tribe (New York: Columbia University Press, 2004), 224.

7. On the “temporal thickening” of the present through climate change temporalities, see Anders Ekström, “Remediation, Time and Disaster.” *Theory, Culture & Society* 33, no. 5 (2016): 119.
8. See especially François Hartog, *Regimes of Historicity: Presentism and Experiences of Time*, trans. Saskia Brown (New York: Columbia University Press, 2015); Dipesh Chakrabarty, “The Climate of History: Four Theses,” *Critical Inquiry* 35, no. 2 (2009): 197–222; Hans Ulrich Gumbrecht, *Our Broad Present: Time and Contemporary Culture* (New York: Columbia University Press, 2014); Helge Jordheim, “Introduction: Multiple Times and the Work of Synchronization.” *History and Theory* 53, no. 4 (2014): 498–518; Stefan Tanaka, “History without Chronology,” *Public Culture* 28, no. 1 (2015): 161–86.
9. This period in the history of the emerging earth sciences is dealt with in Martin Rudwick’s classical study *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: Chicago University Press, 2005), and more recently by the same author in *Earth’s Deep History: How It Was Discovered and Why It Matters* (Chicago: University of Chicago Press, 2014).
10. For an Anthropocene reading of Buffon’s work, see Jan Zalasiewicz, Sverker Sörlin, Libby Robin, and Jacques Grinevald, “Introduction: Buffon and the History of the Earth,” in *The Epochs of Nature* (1778) by Georges-Louis Leclerc, le comte de Buffon, trans. and ed. Jan Zalasiewicz, Anne-Sophie Milon, and Mateusz Zalasiewicz (Chicago: University of Chicago Press, 2018), xiii–xxxiv. On Buffon’s archival approach to natural history, see Rudwick, *Earth’s Deep History,* 62–65.
11. See, for example, Paul Glennie and Nigel Thrift, *Shaping the Day: A History of Timekeeping in England and Wales 1300–1800* (Oxford: Oxford University Press, 2009); Daniel Rosenberg and Anthony Grafton, *Cartographies of Time: A History of the Timeline* (New York: Princeton Architectural Press, 2010); Lynn Hunt, *Measuring Time, Making History* (Budapest: Central European University Press, 2008); Pierre Nora, “Between Memory and History: *Les Lieux de Mémoire*,” *Representations* 26 (1989): 7–24.
12. Harold A. Innis, *Empire and Communications* (Toronto: Dundurn Press, 2007).
13. Bernhard Siegert, *Cultural Techniques: Grids, Filters, Doors, and Other Articulations of the Real* (New York: Fordham University Press, 2015).
14. Deborah R. Coen, “Big is a Thing of the Past: Climate Change and Methodology in the History of Ideas,” *Journal of the History of Ideas*, 77, no. 2 (2016), 312.
15. Jordheim, “Introduction.”
16. Rudwick, *Earth’s Deep History*, 47–49.

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Part I

ERAS OF SYNCHRONIZATION

⟩• 1 •⟨

Stratigraphies of Time and History

Beyond the Outrages upon Humanity's Self-Love

Helge Jordheim

In his recent essay on "Anthropocene time," the historian Dipesh Chakrabarty asks why people in general and historians in particular have such a hard time thinking about "questions of geological time" mobilized by the concept of the "Anthropocene."[1] Instead, he argues, these questions "fall out of view and the time of human world history comes to predominate," with the effect that "we do not take into account Earth-history processes that outscale our very human sense of time," and thus "do not quite see the depth of the predicament that confronts humans today."[2] Chakrabarty goes on to offer several examples of how ongoing debates about climate change and geological periodization fail to reconnect "human-centered and planet-centered time," as he puts it in a paraphrase from Jan Zalasiewicz.[3] As Chakrabarty is well aware, this split between historical and geological time, foregrounded in the concept of "the Anthropocene," has a long history, going back to the eighteenth century and the dissolution of *historia naturalis* as the main paradigm for gaining knowledge about both the natural and the cultural world.[4]

In this chapter, I will discuss how questions of geological time are coming into and out of view at different moments in the history of knowledge in Western Europe, and how they relate to historical, human-centered time. At the center of these historiographical conceptual movements are a set of theories about times in plural, multiple times, organized according to a specific spatial pattern, known as "stratigraphy."[5] Before we can turn to the history of stratigraphy as a theory of time and history, capable of structuring both geological and phenomenological temporalities, we need to take a closer look at one of the most forceful interventions in the history of knowledge giving shape and meaning to the entanglements between geology and human history, by some of the pathbreaking scholars in the field.

The Fourth Outrage upon Humanity's Self-Love

In the historiography of the history of the earth, or in Martin Rudwick's term "geohistory," two classic studies stand out; both want to understand the impact of the radical expansion of the time frame of the existence of the planet, from a few thousand to millions and later billions of years.[6] On the one hand, there is Rudwick's own magisterial work, *Bursting the Limits of Time*, from 2005; on the other hand, there is the even bigger classic, a pioneering study in the history of science *tout court*, Stephen Jay Gould's *Time's Arrow, Time's Cycle* from 1987. Both of them deal with what Gould refers to as "the discovery of geological time," and what Rudwick calls "the reconstruction of geohistory." Another thing they have in common, however, is that both of these luminaries in the historiography of the earth sciences kick off their investigations with reference to a claim made in a very different scholarly context, far removed from eighteenth-century geology—here Gould:

> Humanity has in course of time had to endure from the hand of sciences two great outrages upon its naïve self-love. The first was when it realized that our earth was not the centre of the universe, but only a speck in a world-system of a magnitude hardly conceivable. . . . The second was when biological research robbed man of his particular privilege of having been specially created and relegated him to a descent from the animal world.[7]

Any reader with a general knowledge of the Western intellectual tradition will recognize this quote to be from Sigmund Freud, more precisely from his introductory lectures on psychoanalysis, delivered 1915–17. Most readers will also know perfectly well which two events in the history of knowledge Freud is referring to: first, the Copernican revolution, second, Darwin's theory of evolution. In the next section of the original passage, Freud adds himself to the list, more precisely what he calls "present-day psychological research which is endeavoring to prove to the 'ego' of each one of us that he is not even master in his own house, but that he must remain content with the veriest scraps of information about what is going on unconsciously in his own mind."[8] Picking up directly from Freud's famous summary of Western intellectual history, Gould makes the following addition: "But Freud omitted one of the greatest steps from his list . . . He neglected the great temporal limitation imposed by geology upon human importance—the discovery of 'deep time.'"[9]

This way of restoring geology to its proper place in the history of knowledge, alongside the other revolutions—the cosmological, the biological and the psychological—which fundamentally alter how we humans look at ourselves and our place in the universe, is striking in itself. Especially interesting is the way these four "outrages," as Freud originally called them, all present themselves as reconfigurations of space and time. After Gould added geology, there is even a symmetry: two of them are concerned mainly with space, the space of the universe and the space of the human mind respectively, and two of them mostly with time, the evolutionary and the geological. Even more striking, however, is the way this summary is repeated, almost verbatim in Rudwick's *Bursting the Limits of Time*. The first sentence of the introduction goes as follows: "Sigmund Freud claimed that three revolutions had transformed what his generation—in blissful innocence of modern political correctness—often called 'Man's Place in Nature.'"[10] Then he goes on to explain what first Copernicus, then Darwin, and then Freud did to man and man's self-understanding, adding only the slight caveat that "historians of science are now uneasy about calling any such intellectual changes 'revolutions,' except perhaps to sell their books," thus putting some historical and intellectual distance between himself and Gould.[11] Then he goes on: "But anyway, as Stephen Jay Gould pointed out, Freud's list omitted one major historical change that certainly deserves a place in the same league. Compared to the other three, it has been grossly underexplored by historians, and neglected by those who popularize science and its history . . . , perhaps because it cannot so easily be labelled with the name of any specific Dead White Male."[12]

Even though they focus on different people and events, Rudwick and Gould are in agreement about how this moment in the history of Western knowledge should be framed and placed into a larger narrative. At stake is the "discovery of time," more specifically, of "deep time," when the "deep space" of astronomers was matched by the "deep time" of geologists, to borrow a phrase from a third seminal book contributing to the same story, although without the reference to Freud, by Stephen Toulmin and June Goodfield, published in 1965.[13] To these discoveries of "depths," we can add the mostly unconscious depths of the human mind. Rudwick offers his own formulation, more in line with Freudian idiom about how the human is decentered, both spatially and temporally, when he describes the "dramatic" shift from "regarding human history as almost coextensive with cosmic history to treating it as only the most recent phase in a far longer and highly eventful story, almost all of it *prehuman*."[14]

If our interest was in finding an answer to Chakrabarty's question about our difficulties in combining human and geological time, we apparently need to look no further. Two of the leading historians of science from the last decades seem to agree that the only way to make us appreciate the full implications of what happened in the geological "revolution" is to quote Freud and take his words as their own, adding geology to the list that already includes cosmology, biology, and psychology, or in other words, shaping this event in the history of knowledge in the mold of three previous events. The realization that the earth was not four or six thousand years old, as proclaimed by Biblical chronology, but actually several million, based on the discovery of fossils, dating of rock layers, and a better understanding of the genesis of the globe, is thus understood as an event of psychoanalytical proportions. To really integrate the deep time of geohistory into our human-centered historical worldview would then logically be as hard as bringing to the surface our own personal fears and traumas hidden deep in our unconscious mind. Both of them are called "deep" for a reason; they represent something hidden, invisible, and suppressed, but still active underneath the surface.

Whether it makes sense to theorize our inability to act upon the knowledge involved in renaming our own present, possibly even some centuries of it, "the Anthropocene," as repression in the psychoanalytic terms, is a discussion for another time. My interest here is more historical and historiographical. In this chapter, I take this somewhat strange Freudian element of repetition in the works of generally quite original and innovative scholars as a sign that something might not be completely right with this argument and thus with the way we tend to frame this particular moment in the history of knowledge. Did the discovery of deep time at the end of the eighteenth and the beginning of the nineteenth century really have a similar effect on human self-understanding as the Copernican revolution, the theory of evolution, and the discovery of the unconscious? Presuming that Gould and Rudwick are right and that this fourth "outrage" has not been granted the same prominent place in the history of knowledge as the others, maybe this has other reasons than the historiographical and narrative ones Gould referred to. Did geological time just slip out of view again, almost before it got our attention, to use Chakrabarty's phrase? The point here is not to compare the relative effects of different moments, "revolutions," if you want, in the history of knowledge, nor is it to reject the effect of deep time on human knowledge and understanding. Rather I want to argue that to grasp this particular moment in the history of knowledge and the effects it has had, and still has, on the relationship between human and natural history, other forms and figures of understanding might be more useful than thinking about it as an "outrage against humanity's self-love," since humanity and all its relations to selfs and others might not belong on the same timeline, or in the same narrative as the breakthrough of geohistory.

At the same moment when the limits of time are burst, to use Rudwick's phrase, historical time also splits up into multiple durations, speeds, and rhythms, allowing for different forms of subjectivity and agency.[15] By consequence, what could have been an "outrage against humanity's self-love," displacing man from the center of time, in the same way that man had previously been displaced from the center of space, was literally disciplined by the reordering of the field of knowledge, by which man and earth, whose histories had been completely entangled in Christian historiography, were pulled apart by separate epistemologies and methodologies—what we recognize today as geology and history. These two disciplines, on either side of the gap between what C. P. Snow will later call "the two cultures,"[16] based themselves on two distinct temporal frameworks or arrangements: on the one hand, the horizontal, linear, uniform, homogenous time of historical progress; on the other hand, the vertical, multilayered, heterogenous time of rock and mountain formations in the earth's crust. Whereas the history of humanity was understood according to the first one, for example in the works of Johann Gottfried Herder and Georg Wilhelm Friedrich Hegel, the history of the earth was understood according to the second one. In the following, I will first explore how the collapse of broad integrated knowledge fields such as "natural philosophy" and "natural history" gave rise not just to various disciplines but to different temporal arrangements. Then, I will zoom in on the lesser known of them, at least within the humanities and social sciences, that in the nineteenth century is termed "stratigraphy," and trace the trajectory of this specific temporal arrangement, from its origin in seventeenth century Italy, via the eighteenth- and nineteenth-century rise of geohistory, into twentieth-century historiography and historical theory.

After *Historia Naturalis*

Prior to the eighteenth century, knowledge about the external world had been organized mainly in two large and amorphous fields, "natural philosophy" and "natural history."[17] As Brian Ogilvie convincingly argues, both fields took shape during the Renaissance, drawing on works from Greek and Roman Antiquity, such as Aristotle's *Physics* and Pliny's *Natural History*, in which an encyclopedic view of knowledge was established.[18] Whereas both natural philosophers and natural historians were interested in understanding nature, they based their activities on different concepts of knowledge and method. These conceptual and methodological frameworks found their most distinct and durable forms in the late seventeenth and early eighteenth centuries, with two works that set new standards in both fields: Isaac Newton's *Philosophiae Naturalis Principia Mathematica*, first published in 1687, and Comte de Buffon's *Histoire Naturelle,* published in sixteen volumes between 1749 and 1789.

After Galileo Galilei, the goal of natural philosophy had been to create a quantitative and mathematical science of nature, "based on mathematical principles," as Newton puts it in the title of his work. It "discouraged studying the particular, which was no part of philosophy, and urged instead the ascent to universals, the discovery of natures and essences."[19] Natural history, on the other hand, based its knowledge claims on the practices of observing, collecting, and describing external objects, with the aim to produce an account of the earth and its life forms, their origins and their characteristics. In his own "discourse on method," *Discours de la manière d'étudier et de traiter l'Historie Naturelle*, which opens the first volume, Buffon argues why his work cannot be based on "mathematical evidence."[20] The "true method" for these studies, he states, is not the "mathematical method," but to "make observations, to assemble them and then make new ones, in sufficient numbers to ensure us of the truth of the most principal facts."[21] In other words, *historia naturalis*, which in the eighteenth century enters the vernaculars as *histoire naturelle*, *natural history*, and *Naturgeschichte*, did not originally aim to produce knowledge about the past or about historical changes in particular, except in terms of explanations for present phenomena, like rock formations or fossils.

In his entry on *Geschichte* in the eight-volume *Geschichtliche Grundbegriffe*, Reinhart Koselleck describes what he considers to be the shift from nontemporalized *historia naturalis* to temporalized *Naturgeschichte*.[22] As long as *historia*, in the Aristotelian tradition, meant little more than empirical knowledge, or knowledge about particulars, gained through induction, with no particular ambition of arriving at a general principle or law, neither the temporal distinction past-present, nor the natural distinction human-nonhuman was especially significant. In the entry, Koselleck shows how nature is temporalized, and is invested with a time and a history of its own, linked to genesis, transformation, and persistence.[23] This shift opens the way for theories of evolution that will come to dominate the nineteenth century.

According to Koselleck, temporalization happens in both natural and human history, in parallel. In other essays, he describes how history with a capital H, history as *Kollektivsingular*, emerges through a "destruction of natural chronology"[24] and a "denaturalization" of time.[25] They are replaced by forms of time inherent to history itself, including development, progress, acceleration, revolution, and others. What Koselleck does not discuss at any length, however, is how this parallel, synchronous temporalization of natural history, on the one hand, and human history, on the other, forces the two of them to part ways. As history starts moving, from the past, though the present, and into an unknown future, increasingly picking up speed, accelerating, it frees itself of all the other forms of life included in Aristotelian *historia*, transforming into a history of humans, and humans only. According to Koselleck, this process of temporalization is necessarily linked to human hopes, memories, and actions, or in his own terms, to experiences and expectations.[26]

Temporalization of both natural and human history was a direct cause of the broad integrative knowledge project of natural history, practiced by scholars seeing themselves simply as "naturalists," disintegrating and giving way to a new order of knowledge. Among the new disciplines were those that later came to be subsumed under the label "geology," including mineralogy, geognosy, oryktognosy, and mining sciences, practiced at universities, societies, mining academies and even by artists and authors all over Europe.[27] "Geohistory," which is the term Rudwick uses for these closely related knowledge practices, took it upon itself to organize different forms of knowledge having to do with the earth: how it is put together, its structure and elements, how it came into being and gained its present shape. As emphasized by Gould and Rudwick, geology was a science of time, much more time than any other knowledge projects had ever dealt with. This gestation of geology happened more or less at the same time as another science of time emerged: the modern discipline of history.

The modern disciplines of geology and history are both products of the same process of temporalization, which brought *historia naturalis* to collapse and gave way to a new order of knowledge. If we accept this theory, our view of this historical moment will deviate radically from the Freud-inspired idea of the four outrages to human self-confidence. My claim here is that the rise of geology in the late eighteenth and early nineteenth century was a very different type of event than the Copernican revolution, the emergence of the theory of evolution, and the exploration of the human unconscious. To conceptualize this difference, I want to argue that whereas the three latter in different ways came with an anthropology, a theory of human life and behavior, geohistory did not—at least not to the same extent. Cosmology offered a view of humanity from outside, relative to other forms of possible life in the universe, exemplified for instance in Bernard de Fontenelle's *Entretiens sur las pluralité des mondes* from 1686—what Michael Sauter has called a "celestial anthropology."[28] Evolution, on the other hand, understood humans as a product of a long succession of often microscopic changes, mutations and struggles for survival, and gave rise to a new anthropological literature, by scholars like August Comte, Herbert Spencer, and others. Finally, Freud expanded human consciousness to include the unconscious, responsible for many, if not most of our feelings, needs, and even actions. Geology, however, does not seem to make a similar anthropological claim, at least not at the moment of its emergence, discussed by Gould and Rudwick. Apparently, the breakthrough of geohistory failed to produce or give rise to a new anthropology, which would have been not a "celestial" but a "terrestrial" one, in the most literal meaning of the word. Instead, at the end of the eighteenth century, terrestrial anthropology found its disciplinary home within another field of knowledge: *Geschichte*, History with capital H.[29]

In the eighteenth and early nineteenth centuries, the various research interests and forms of scholarship that had made up the field of "natural history" or "natural philosophy" disentangled and branched out in a series of disciplines: mathematics, astronomy, physics, chemistry, but also history, philology, and philosophy.[30] Undoubtedly, and as discussed in detail by Rudwick, eighteenth-century geology involves a temporalization of life, both in its human and natural forms. Whereas the temporalization of nature found its primary disciplinary form in geology, which organized itself around a deep and multilayered time, the temporalization of the human found another form altogether, namely the modern concept and discipline of history. In other words: one reason why geology never developed an anthropology was that the anthropology of the radically temporalized human being found another home: in the discipline of history, which developed a very different way of organizing, or indeed synchronizing the heterogeneous times, rhythms, durations, and speeds of human life—namely according to the model of progress.[31] Whereas geology opened up to a field of different forces—Neptunists giving priority to water, Plutonists to fire—in the evolution of the earth, also including climate, planetary movements etc., history turned to nations, cultures, and individuals. By consequence, the genre of universal history was systematically stripped of its universal ambitions, and reduced to "world history," which in fact was a history of nations and empires, expanded by migrations and imperial and colonial endeavors.[32] In most cases, world history was either the successive histories of nations and cultures dignified enough to have a history, or it was the history of civilization, in its Western mode, spreading and expanding across the globe.[33] In this way, time was made linear and homogenous, governed by the forces of progress, very different from the multilinear, heterogeneous time of geology. For history then, as the vestige for human anthropology in its modern temporalized form, the limits of time does not seem to have been "burst" at all, as Rudwick claimed in the title of his work; on the contrary, historical time remained safely "in the grip of sacred history," to use a phrase from Andrew Shryock and Daniel Lord Smail.[34] The majority of historians kept their work within the boundaries of those six thousand years, at the most, which was the temporal framework of Biblical history.[35]

Moving out of the eighteenth and nineteenth centuries, what we can observe is not an integrative science of time, replacing the Early Modern *historia universalis*, but several disciplinary undertakings, which deal with time in different ways, including biology, geology, chemistry, cosmology, and history. Two of these disciplines, geology and history, develop their own specific theories of historical time. Whereas the modern discipline of history explores pasts, presents, and futures by means of a singular, future-directed timeline, doubling as the vector of progress, the discipline of geology bases all scientific endeavors on a multilayered, vertically oriented time, from deep, hidden pasts to superficial, visible, and tangible presents. But what if it had been different? The second part of this chapter explores some of the possibilities of thinking about stratigraphical, not linear, time as the primary temporal form structuring all kinds of historiography, both natural and cultural, nonhuman and human.

Steno and the Origin of Stratigraphy

According to *OED*, the term "stratigraphy" refers to a "branch of geology that is concerned with the order and relative position of the strata of the earth's crust," and was coined in the mid-nineteenth century.[36] "Strata," plural of the Latin "stratum," originally referred to something spread or laid down, such as a piece of bedding, coverlet, bed or couch, saddlecloth, horse-blanket, level floor, or platform. In the second half of the seventeenth century, this word took on another kind of meaning, which we today identify as geological: "a natural layer or bed of sediment or rock having a consistent composition and representing a more or less continuous period of deposition."[37] The first work to bring forward something similar to a theory of stratigraphy and stratigraphic superposition, today recognized as the origin of this basic tenet of geological thinking, was *Nicolia Stenonius solido intra solidum naturaliter contento dissertationis prodromus,* mostly abbreviated as *Prodromus*, published in 1669.[38]

The idea that the earth is made up of layers and that these layers vary in age, according to a specific pattern, the oldest at the bottom, the youngest at the top, was first given systematic expression by the Danish anatomist and geologist Nicolaus Steno, or in Danish Niels Stensen. Steno's career as a scholar took him from Copenhagen to Amsterdam and Leiden and onwards through France to Italy, before he settled in Padua, then in Florence. He began as an anatomist, and wrote books on the origins of tears and saliva, as well as on the anatomy of the brain. Then his interest turned towards the sciences of the earth, today's paleontology and geology.[39] What caught Steno's attention was what Rhoda Rappaport in her book *When Geologists Were Historians* refers to as "the fossil question."[40] In October 1666 two fishermen caught a huge female shark near the town of Livorno, and Ferdinando II de' Medici, Grand Duke of Tuscany, ordered its head to be sent to Steno. Dissecting it, the Danish scientist noted that the shark's teeth bore a striking resemblance to certain stony objects, found embedded within rock formations, that his contemporaries referred to as *glossopetrae* or "tongue stones." At the time explanations for this peculiar natural phenomenon ranged from the suggestion by Pliny the Elder that these stones had fallen from the sky, to more recent ones, for example by Athanasius Kircher, who considered the building of fossils to be an inherent characteristic of the earth.[41] Steno's conclusion, in a paper published in 1667, was that the *glossopetrae* must be shark's teeth. This led him to ask the more general question, namely how any solid object can be found embedded within another solid object. The answer came in a work published in 1669, in Latin, but with a title that was later translated into English as *The Prodromus of Nicolaus Steno's Dissertation concerning a solid body enclosed by process of nature within a solid*. In it, he writes:

> The first question was, whether *Glossopetrae Melitenses* were once the teeth of sharks: this, it was once apparent, is identical with the general question whether bodies which are similar to marine bodies, and which are found far from the sea, were once produced by the sea. But since there are found also on land other bodies resembling those which grow in fresh waters, in the air, and in other fluids, if we grant to the earth the power of producing these bodies we cannot deny to it the possibility of bringing forth the rest.[42]

An earth that brings forth solid bodies is by necessity also an earth, in which the forces of time are at work and have been for a long while already. Steno's *Prodromus* is a book about "the process of time," by which animals, plants, shells, and mollusks change into rock, and become contained within other rocks, while they are still in their fluid state.[43] Thus, in Steno's work, we find the first comprehensive draft of what will become the framework of modern geology, including the law of superposition, the principle of original horizontality, as well as the principle of lateral continuity—in other words, a full-fledged theory of rock layers or strata and their position relative to each other, known today as stratigraphy.[44] In the following I will take a closer look at how Steno conceives of his different layers or strata, what kind of times he grants them, and how they are present in any historical moment.

To start with the final point, the historical moment that Steno wants to understand is Italy around the middle of the seventeenth century, more precisely the landscape of Tuscany: "In what way the present condition of any thing discloses the past condition of the same thing," he writes, "is above all other places clearly manifest in Tuscany."[45] Steno also has a theory of how this kind of history of the present can be practiced, by observing "inequalities of surface" that "in their appearance today contain within themselves plain tokens of different changes."[46] In this tentative language and probing formulations, the concepts of surface and depth are introduced as a way of thinking about history, or in Steno's words, "different changes." For Steno, the materiality of history consists of rock strata and formations. What he wants to understand is how these strata are formed and what is their relationship to time. In his attempt to explain how one solid body, a tooth, a crystal, a diamond, an animal, or a plant can be contained within another solid, that is, within a layer of rock, Steno argues that all solid bodies have been produced from fluids, by way of sedimentation, thus creating the strata of the earth. The position of the strata, above and underneath each other, is entirely a question of time. Thus, when Steno formulates what is later referred to as "the law of superposition," it all depends on when—at what time—the different strata in the earth's crust were formed. That Steno's "theory of the earth," to use Rudwick's term,[47] is also a theory of time is first signaled by the fact that in his list of claims, on which he bases his theories, all start with "at the time," as in these two examples:

> 1. At the time when a given stratum was being formed, there was beneath it another substance which prevented the further descent of the comminuted matter . . .
>
> 4. At the time when any given stratum was being formed, all the matter resting upon it was fluid, and therefore, at the time when the lowest stratum was being formed, none of the upper strata existed.[48]

In other words, the most important characteristic of the different rock layers identified by Steno is that they have been formed at different times in the history of the earth and thus they have different durations and periodizations inherent in their matters and forms. Then, Steno continues to discuss and systematize what he calls "the matter of the strata," which depends on when the strata were formed as well as their diachronic succession:

> 1. If all the particles in a stony stratum are seen to be of the same character, and fine, it can in no wise be denied that this stratum was produced at the time of creation from a fluid which at that time covered all things . . .
>
> 2. If in a certain stratum . . . the parts of animals and plants are found, it is certain that the said stratum must be reckoned among the strata which settled down from the first fluid at the time of the creation.
>
> 3. If in a certain stratum we discover traces of salt of the sea, the remains of marine animals, the timbers of ships . . . it is certain that the sea was at one time in that place.[49]

This enumeration goes on, also including trees and ashes, indicating that there has been fires, etc. In this way Steno tells the history of the earth, from creation, when a fluid "covered all things," until the emergence of plants and animals, as well as humans, evident in Steno's reference to "ships," as documented in the different rock layers.[50] All these layers are present at the same time in the mountainous landscape of Tuscany. Even though the strata have formed regularly, according to laws, creating a seemingly stable structure of superposition, there are also more sudden events, such as volcanic eruptions and collapsing caves, which give rise to valleys and mountains.

For reasons I cannot go into here, it took more than a hundred years before anyone picked up where the Danish anatomist and geologist left off. According to Rudwick, it was not until the early nineteenth century that stratigraphy and the law of superposition became the foundation for what was to become the modern science of geology.[51] However, as the Danish historian of science Jacob Bek-Thomsen has argued convincingly, Steno does not present us with a modern science *in nuce*, which just needs some more time to come into its own. Instead, he is significantly indebted to the Early Modern *historia naturalis*, which rather than to look for laws and establish cause-and-effect chains, practiced the art of description and categorization, based on external characteristics.[52] In the middle of the eighteenth century, natural history branched out into multiple fields of knowledge dealing with minerals and rocks, practiced and taught at so-called *Bergakademien* (mining academies), across the European continent and England, such as in Freiberg in Germany and Kongsberg in Norway.[53] Practitioners of these fields, mineralogy, geognesy, and oryktognesy, which later became part of the modern science of geology, adopted the stratigraphic theory of time at the end of the eighteenth and the beginning of the nineteenth centuries, as can be recognized in the works of famous geologists such as James Hutton, Charles Lyell, and later William Smith.

Stratigraphies of Time and History

In seventeenth- and eighteenth-century natural history, natural and human events were taken to belong to the same group of particulars, which could be studied according to their temporal and spatial coordinates in the prism of Aristotelian *historia*.[54] As can be seen from works by Steno, Buffon, and others, the dramatic expansion of the earth's temporal scale as well as the introduction of the stratigraphic theory of time affected the human and the nonhuman equally. Due to the emergence of the uniform and linear time of historicism, multilayered time never came to dominate the increasingly professionalized discipline of history in the same way as the discipline of geology.[55] It was not until approximately 150 years later that the first systematic attempts were made to regain the theory of multiple layers of time, in other words, the stratigraphy of time, pioneered by Steno, for human history.

In his groundbreaking, but often overlooked work *L'ordre du temps*, published in 1984, the Polish philosopher and cultural historian Kzrysztof Pomian launches his conception for what he calls a "stratigraphy of time and history."[56] According to Pomian, the phrase marks a shift from a "diachronic" to a "purely synchronic analysis" of historical events in order to understand "the fundamental reasons for the polysemic nature of the word 'time.'"[57] Still, Pomian's choice of a term to name his exploration of this polysemy of time in social and human sciences comes as something of a surprise. Three centuries after the principles of stratigraphy were first formulated, Pomian takes it upon himself to introduce strata and stratigraphy in human historiography and theory of history. In his work, the term represents a way of thinking about what he refers to as "the polysemic nature of the word 'time,'" which in a less semiotically, more ontologically determined idiom would be simply "multiple times" or "times in plural." In this sense, "stratigraphy" emerges as an alternative theory of the multiple, often nonsynchronous, or even conflicting times inherent in any historical moment, irreducible to chronological succession or linear progress.[58]

Pomian is not the only historian who has thought of human history in terms of geological layers or strata. Almost at the same time, but in a different language, the German historian Reinhart Koselleck developed his "theory of historical times," which, however, was not systematized in geological terms until more than a decade later, in the introduction to the first volume of his collected essays, published in 2000 with the title *Zeitschichten*, "layers of time."[59] In the recent, excellent Anglophone edition of Koselleck's selected essays, the translators have made this reference to geology even more explicit, when they selected for the German coinage *Zeitschichten* the English equivalent "sediments of time," as the title of the collection.[60] Based on these readings, I would argue that Koselleck and Pomian, and before them the last great historian of the French *Annales* school, Fernand Braudel, who I will return to soon, are involved in similar intellectual undertakings. All three of them borrow terms and expressions from natural history and geology, describing layers in the earth's crust, in order to suggest alternatives to historicism's addiction to singular chronologies and narratives. In short, what the three of them argue is that human history has the same multilayered character as the history of the earth, or at least can be analyzed in this way, and that in every historical moment there are various times, durations, rhythms, and speeds at work, operating in different strata of the historical present. The "matters of these strata," to use Steno's terms, vary. In the case of Koselleck's *Zeitschichten*, the layers are made up of meanings, experiences, and patterns of action organized by what he refers to as *Wiederholungsstrukturen*, "structures of repetition," which differ in their historical origin, duration, and rhythm.[61] In the case of Braudel and Pomian, these strata may consist of different kinds of historical material, depending on the position and origin of the strata themselves.

The work that kicks off this reorientation in the relationship between geology and history, at the same time reintroducing the eighteenth-century genre of natural history into twentieth-century history writing, is Braudel's *La Méditerranée et le Monde méditerranéen à l'époque de Philippe II*, first published in 1949.[62] Originally, Braudel wanted to write a dissertation about diplomacy in the Mediterranean area during the reign of Phillip II, supervised by Lucien Febvre. Encouraged by his supervisor, who together with Marc Bloch was in the process of developing an alternative to the dominating positivist trends in French historiography, known today under the name of the *Annales*, Braudel shifted the balance of the project, away from Phillip II, toward the Mediterranean Sea, which more and more turned into the protagonist of the story. He spent twelve years gathering material, then the war came, and the two first parts of the work were written in captivity in Germany. When the book finally was published in 1949, it was comprised of three parts:

Le part de milieu; *Destins collectifs et mouvements d'ensemble*; and *Les événements, la politique et les hommes*. The first part deals with the environment, mountains, plains, coastlines, islands, climates, but also routes and cities. The second is dedicated to economies and demographies, resources, trade, and transportation, whereas the third and last part treats the topics that were originally supposed to fill the entire dissertation, mostly wars, treatises, and the lives of people in power. By banishing the historiography of people and events to the final volume, Braudel made common cause with Febvre and Bloch, against traditional event-focused historiography. What interests us here, however, is less the historiographical trench wars and more the way Braudel frames his transformation of the discipline of history, which in the mid-twentieth century was still practiced much in the same way as during the late eighteenth and the nineteenth centuries.

In *La Méditerranée*, Braudel revives two eighteenth-century formats in order to write a new kind of history: one is the genre of natural history, the other is a system of layers or planes of time. He combines objects of study that by now belong to different disciplines, like mountains, oceans, and cities. These objects are no longer Aristotelian particulars, like in the *historia naturalis*, but invested with times and histories of their own, like emergence, transformation, and persistence, and thus form parts of multiple temporal movements. In order to create a new framework for writing natural history in the twentieth century, Braudel needs to find a principle for organizing these multiple times, inherent in his various objects of study. This principle is the stratigraphy of time and history, which Steno applied to the history of rocks and minerals and which Braudel introduces as a metatheory of all historiography.

Stratigraphy as a general theory of history is implemented already on the level of the chapters of the book, which renders it even more important to remember that there is nothing self-evident about this way of theorizing. Encouraged by his supervisor Febvre to deal not only with people and events, Braudel organizes his material into three chapters, discussing environment, social structures, and events respectively. Even at this point in the work, Braudel could very well have chosen to theorize these multiple "matters" in many different ways, for example according to dichotomies like human/nonhuman, or life/nonlife; but instead he decides to make multilayered time, a stratigraphy of time and history, the overarching structural principle of his work and lays it out in the introduction.

The first part, Braudel writes, "is devoted to a history whose passage is almost imperceptible, that of man in his relationship to the environment." Then he goes on to qualify this particular form of time, which in addition to the "almost imperceptible passage" is characterized by slowness, "constant repetition," and "ever-recurring cycles." Hence, the part of the book that deals with "mineral deposits, types of agriculture, and typical flora" contains an "almost timeless history."[63] The way in which Braudel uses stratigraphy to imagine the multiple times of history is made explicit when he introduces the second part of the book, containing the history of economies, resources, and demography. This history, he writes, takes place "on a different level from the first."[64] These differences in levels are differences in time, in duration, speed, and rhythm. Braudel hesitates to call it "*social history*," because of the usage of that term in contemporary historiography, and rather adopts the phrase "the history of groups and groupings."[65] Again, he looks for ways to qualify the specific form of time at work on this level of history. Time moves in "swelling currents" and at "slow but perceptible rhythms," influenced by "deep-seated forces."[66]

Finally, Braudel explains the plan for the third part of the book, written after he had come back to France and in which he returns to the topic he originally was planning to write about: politics, war, and diplomacy in the Mediterranean region during the reign of Phillip II. This form of historiography he labels "traditional history."[67] Before he goes on to describe the specific form of time associated with traditional history, he gives it another significant spatial and indeed ontological definition: "history, one might say, on the scale not of man, but of individual men." In other words, this kind of history writing is fitted to describe events that happen to or are caused by the actions of specific individuals, typically kings, princes, ministers, and generals. At this point in the introduction, he introduces the term "*histoire événementielle*," which later will be closely associated with his own work, but which he inherits from another French historian, Paul Lacombe.[68] At the end of the nineteenth century, Lacombe had been leading in the exchanges between historians and sociologists, recapitulated by Braudel in his 1958 essay on the *longue durée*, in which Lacombe faces off with the sociologist François Simiand. But Braudel does not content himself with flatly rejecting the primacy of events in history.[69] He also wants to understand the specific form of time that event-history gives rise to: "surface disturbances, crests of foam that the tides of history carry on their strong backs," in other word, a "history of brief, rapid, nervous fluctuations, by definition ultrasensitive; the least tremor sets all its antennae quivering."[70] Towards the end of this chapter, I will come back to this surprising conflation between rapid temporal movements, sudden changes, and fast rhythms with nervous responses and specific forms of heightened human sensibility. This conflation also appears as striking because it picks up on the alignment between the discovery of the human subconscious and the discovery of geological time that we find in the introductions to the books by Gould and Rudwick.

In his introduction to *La Méditerranée*, Braudel does not limit himself to describing three forms of time, linked to three different sets of historical matters, already a major theoretical innovation compared to the work of his supervisor, the co-founder of the *Annales* journal and school. Already in his first work, he goes a step further, combining them all and relating them to each other in what we recognize as a full-fledged stratigraphic system:

> The final effect then is to dissect history into various planes, or, to put it another way, to divide historical time into geographical time, social time, and individual time. Or, alternatively, to divide man into a multitude of selves. This is perhaps what I shall least be forgiven, even if I say in my defense that traditional divisions also cut across living history which is fundamentally *one*.[71]

The key word in this summary are "planes" and "levels," by which Braudel launches his stratigraphic theory of history, which will later emerge as his most influential contribution to the history of historiography. At the top are a plane of quick rhythms of events and individual actions; underneath it we find a plane of somewhat slower rhythms of various groups and collectives, whereas the bottom level are "those underlying currents, often noiseless, whose direction can only be discerned by watching them over long periods of time."[72] However, these planes or levels are not disconnected from one another; on the contrary, Braudel suggests that "resounding events are often only momentary outbursts, surface manifestations of these larger movements and explicable only in terms of them."[73] In the language of geology, into which Braudel is clearly tapping here, the "outbursts" refer to volcanic eruptions, by which lava, or occasionally just gas, is expelled from a volcanic vent or fissure in the earth's surface, mostly caused by compression and decompression of gas within magma. "Surface manifestations," on the other hand, might also include other effects caused by movements of tectonic plates, on which the land masses of the earth rest, like earthquakes. Even though the planes or levels of time are distinguishable from one another, since they are made up of different events and processes, there exist connections, even causal relationships between them.

From the Human into the Natural, and Back

In Braudel's later work, especially in his famous 1958 article on the *longue durée,* his appeal to a stratigraphy of time adopted from geology, appears as less dynamic and more designed to change history from an ideographic to a nomothetic science, in accordance with structuralist dogma.[74] In his *magnum opus* on the Mediterranean, however, his goal appears to be to develop a theory of multiple times that is able to reconnect traditional event-history with the slower rhythm of social and economic structures and cycles, as well as with the *longue durée* of landscapes, geography, and climate. Historians like Pomian and Koselleck, who do not share Braudel's structuralist leanings, later take up this idea, thus bringing the exchanges between the human world and the natural world back into play, in ways that have been absent from historiography the last two hundred years.

In his work on eighteenth- and nineteenth-century geohistory, Rudwick traces how the "novel geohistorical approach was derived from transpositions from the human world into the natural."[75] At the same time as history was transposed into the inside of the earth and became multilayered, history on the surface lost its temporal complexity and became unified and uniform. For Koselleck, developing his theory of *Zeitschichten,* "layers" or "sediments of time," represents an attempt at "transferring" geological time, now in terms of a stratigraphy of time and history, "back" into history.[76] This transposition from the natural to the human is described in Koselleck's introduction to the article collection *Zeitschichten* from 2000, when he observes how "'layers of time,' just like their geological prototype, refer to various temporal levels of diverse duration and diverse origin, which still exist and are effective at the same time."[77] Koselleck begins by pointing to the origin of this "spatializing" metaphor in geology. Then, he makes a series of brief references to the late eighteenth century, to Kant and Buffon who "opened a new temporal horizon" by putting the earth into "historical perspective," by temporalizing creation and replacing it by a long process, spanning millions and millions of years, during which the mountains were formed.[78] In a next step, these long time spans were "transferred back," as he puts it, into human history, for instance, when the German author Joseph Görres makes the point that "in the history of the earth the period of the original granite rock relates to the period of the sedimentary rock like old times to new times."[79] Thus, he concludes, the historical concept of structure, what we here call "stratigraphy," has geological origin. This is as far as Koselleck's interest in geology goes. Instead he shifts his line of argument and stresses that from the late eighteenth century on "historical times can be fundamentally separated from natural time," before he jumps two hundred years ahead to pay homage to Braudel's *longue durée.* What he leaves out, is how from the seventeenth century onwards a theory is developed, in which time is relative and multilayered, and which at the end of the eighteenth century catches the imagination of geohistorians all over Europe, at exactly the same time as Herder and others begin championing the one, linear, homogenous, teleological time of historicism. At this moment in the history of historiography, when the history of man and the history of nature, and thus natural time and historical time, were still part of the same narrative continuum, historians of the human could reasonably have chosen to think about time in layers, instead of choosing the Newtonian option of absolute, linear, homogenous time. Or, to put it another way: when modern historians in the postwar era return to the image of layers and sediments they are not really transferring a metaphor from another science, but recuperating a way of thinking which once emerged from within Western historiography.

Even though the theory of multiple layers of time, in terms of Braudel's *longue durée*, Pomian's "stratigraphy of history," or Koselleck's *Zeitschichten*, offers a comprehensive and coherent solution to the predicament of multiple temporalities and their nonsynchronicity, the question remains of what it fails to include and describe. Does it really make sense to think of time and history as layered—with the quick rhythms of human actions and events, including the life of the everyday, at the top, fully visible and even tangible, and then a set of progressively slow, progressively long-term, and progressively unexposed layers, until we reach the bottom, where we find the incredibly slow, almost imperceptible changes of landscapes and civilizations? A counterexample can be found in the current debates on climate change. All of a sudden the longest, slowest, and most imperceptible layers take on event-character, in the form of extreme weather and natural catastrophes, increasing CO_2-levels in the atmosphere, political decisions or non-decisions etc., whereas the fast-paced events of the everyday sink down through the layers of time until they disappear into the almost unchanging mythological layer of nature, well-known from Roland Barthes' work on mythologies of the everyday.[80]

At the end of the eighteenth century, conceptualizations of the multiplicity of times were displaced from the academic world by the new order of knowledge, in which the lifetimes of human actors were separated from the lifetimes of species, minerals, and planets. The all-encompassing genres of natural history and natural philosophy collapsed, giving way to the modern order of disciplines, in which geology, biology, and cosmology broke loose from the study of man. At the center of this process of reordering knowledge were the convergence of timescales and life scales, giving rise to new disciplinary lifetimes, with their own finitude. Since then, the nexus of clock-time and historical time called "modern," spreading across the globe on the back of capitalism and imperialism, has made up the temporal framework within which human actions and events have been understood.[81] At present, this seems about to change: on the one hand, "the modern temporal regime," or in short, "progress," is losing much of its explanatory value, because it is no longer able to synchronize all the different aspects of human life into a progressive narrative; on the other hand, other chronologies are returning to the scene.[82] These are bio-, geo-, and cosmochronologies, which have in common that they subject humans to the scales, rhythms, and durations of nature—not original nature, but nature as it has been produced by scholars and scientists during the last three hundred years. On the one hand, chronology, the question of time reckoning and time organization is returning to the study of the human[83]; on the other hand, "nature," in the form of the biological body of man, the geological body of the earth, or the cosmological body of the universe, is imposing itself onto the temporal configuration of global society in ways that can no longer be ignored.[84] In this situation the most important aspect of "the stratigraphy of time and history," as it has been conceived by Braudel, Pomian, Koselleck, and others, might be the ability to reforge the connections between natural and human history. As long as human history is measured by a clock or by the standard of civilization and progress, nature will continue to be shut out, as by necessity. But if, on the contrary, human history is again included into a much more comprehensive theory of scales of life and scales of time, in which historical time is perceived as multilayered, in a continuum with the times of rocks and sediments, a different and broader set of possibilities for reconnecting the human with other parts of nature emerge. At least this is one way of answering Chakrabarty's question.

Conclusion: Passions, Papers, and Human-Centered Time

According to Freud, the last half millennium has seen three "great outrages" upon mankind's "naïve self-love"; to which Gould and Rudwick added a fourth. As I have tried to show in this chapter, however, human self-love was never really outraged, or even seriously afflicted by the radical expansion of time produced by the knowledge of stones, rocks, and minerals, both horizontally into deep pasts and futures and vertically into the lower strata of the earth's crust. In fact, there is little indication that eighteenth- and nineteenth-century geohistory actually displaced humanity from the center of the temporal universe, in the same way as the Copernican revolution displaced it from the spatial center. On the contrary, historians all over Europe—Giambattista Vico in Italy, Edward Gibbon in England, and Johann Gottfried Gatterer and August Ludwig Schlözer in Germany—construed a new, alternative universe, in which man could still occupy the center, and in which all dimensions were fitted to human reality. This alternative temporal universe acquired the label "history," and was inhabited by actors, events, nations, and empires. From the late eighteenth century onwards, "history" in this particular sense—"time fitted to human dimensions"—came to dominate the explorations and representations of the temporalized and accelerating human world. What Braudel first suggests to his supervisor in 1929 is clearly "history" in this traditional, human-centered sense; however, as we just saw, it is also what he ends up rejecting, or at least radically decentering. Based on this, we can at least suggest that the fourth "outrage upon humanity's naïve self-love," presented by geological time, did not happen in eighteenth- or nineteenth-century geological texts, from Steno to Lyell, but only much later, in Braudel's *La Mediterranée*. In the introduction, he distances himself not only from political event-history, but from any kind of history designed to fit the dimensions of the human:

> We must learn to distrust this history with its still burning passions, as it was felt, described, and lived by contemporaries whose lives were as short and as short-sighted as ours. It has the dimensions of their anger, dreams, or illusions. In the sixteenth century, after the true Renaissance, came the Renaissance of the poor, the humble, eager to write, to talk of themselves and others. This precious mass of paper distorts, filling up the lost hours and assuming false importance. The historian who takes seat in Phillip II's chair and reads his papers finds himself transported into a strange one-dimensional world, a world of strong passions certainly, blind like any other living world, our own included, and unconscious of the deeper realities of history, of the running waters on which our frail barks are tossed like cockle-shells.[85]

In making the Mediterranean his object of study, Braudel mobilized a new and different concept of space, and thus suggested a novel way of relating to history and geography; but in the paragraph above, taken from the introduction, the dimensions at stake are not spatial, but temporal. According to Braudel, the temporal dimension of traditional human history is one of "burning passions," of "anger, dreams, and illusions," and, not least, of papers. What they all have in common, is that they are short-lived: passions burn out, anger recedes, dreams end, and illusions are broken. Although papers are kept, assembled, and archived for a certain period of time they will eventually become brittle, faded, and then disappear. Anyone who enters this world of passions and papers, a politician or a historian, becomes shortsighted, blind, or at least one-eyed, and the world turns "one-dimensional." Braudel wrote this passage more than half a century ago, but even today we would be hard-pressed finding a better answer to Chakrabarty's question of why "questions of geological time" keep falling "out of view and the time of human world history comes to predominate."[86] To change this, to reintegrate individual human lives, with their passions and papers, into the history of nature, human-centered time needs to be expanded not only horizontally, but vertically, and be reconnected with the times of nature by means of stratigraphies of time and history.

Helge Jordheim is Professor of Cultural History at the University of Oslo, Professor of German Studies at the Norwegian University of Science and Technology, and head of the research project and collective LIFETIMES. He has published extensively on eighteenth-century intellectual culture in Europe. Among his latest publications are global histories of the concepts of civility and civilization (*Civilizing Emotions*, 2015) and the world (*Conceptualizing the World*, 2018) as well as a history of universal history (*Universal History and the Making of the Global*, 2018). He has written extensively on time and concepts in journals such as *History & Theory* and *History of the Present*.

NOTES

1. Dipesh Chakrabarty, "Anthropocene Time," *History and Theory* 57, no. 1 (2018): 6.
2. Chakrabarty, "Anthropocene Time," 6.
3. Chakrabarty, 6.
4. Wolf Lepenies, *Das Ende der Naturgeschichte: Wandel kultureller Selbstverständlichkeiten in den Wissenschaften des 18. und 19. Jahrhunderts* (Frankfurt am Main: Suhrkamp, 1976).
5. Helge Jordheim, "Multiple Times and the Work of Synchronization," *History and Theory* 53, no. 4 (2014): 498–518.
6. Martin Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005), 1–2.
7. Freud, quoted in Stephen Jay Gould, *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time* (Boston: Harvard University Press, 1988), 1.
8. Sigmund Freud, *A General Introduction to Psychoanalysis* (New York: Horace Liveright, 1920), 247. A few years ago, James Horgan made the point in an article in *Scientific American* that this idea does not really stem from Freud at all, but from the German physiologist Emil du Bois-Reymond. Cf. James Horgan, "Copernicus, Darwin and Freud: A Tale of Science and Narcissism," retrieved August 10, 2019 from https://blogs.scientificamerican.com/cross-check/copernicus-darwin-and-freud-a-tale-of-science-and-narcissism/.
9. Gould, *Time's Arrow*, 2.
10. Rudwick, *Bursting the Limits of Time*, 1.
11. Rudwick, 1.
12. Rudwick, 1.
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2

The Production and Distribution of Synchronized Time in Sweden, 1850–1914

Gustav Holmberg

What time is it? The answer, on a scale of seconds, at the turn of the twentieth century was provided by the combined workings of a heterogeneous system of technological artifacts and instruments, scientific knowledge, and experts in academic astronomical observatories and nautical schools, firms, state regulation, all forming a machinery for the definition, production, and distribution of precise time.

On the larger scale, railroads and telegraph systems were factors in the process of time standardization in many countries.[1] In the early modern period, each locality had its own local time, and it did not matter much that these differed within a country when it took days for a letter or a horse-drawn carriage to travel. The railroad and the telegraph changed this. Solutions differed. German railway timekeeping was initially especially complicated, with officials running the trains on five different times, while passengers kept to local time. In France, clocks inside stations had a special railway time (five minutes slow compared to Paris time), while clocks outside the station showed the local time, different at each particular city. Not to mention the challenges of the US railway system, with a difference of more than three and a half hours between the coasts. Many cities kept their own time, and traveling from Maine to California by train entailed changing the passenger's watch about twenty times.[2] There were reasons for the processes that saw nations standardize on a national time and, eventually, the whole world standardizing time to the Greenwich meridian. While the latter part of the nineteenth century saw the emergence of unified time zones on national and international scales, it is the more fine-grained synchronization of reality, on the order of seconds, that is the topic of this chapter.

Time was intimately coupled to nature. The rotation of the earth around its axis made the sun and the stars pass through the sky, and observing this passage defined the rotation of the earth and thus accurate time. Astronomers were the link between the rotation of the earth and time spread throughout society, they *produced* time.

The production and distribution of time can be seen as a public infrastructure of precision. Hannah Gay has noted that synchronized and precise time transformed from something that existed mostly within the walls of specialized astronomical observatories to something that was present throughout societies during the second part of the nineteenth century; synchronized time was vital for efficiency in workplaces and communication systems where an ethos of precision was a key part.[3] Time standardization became, in the words of Vanessa Ogle, "one of the major preoccupations of nation-states eager to cast a technocratic grid of time over national territory."[4] It was public and provided routines, signals, utilities for companies, citizens, organizations living the life of a modern society. It was also an infrastructure. Even if one might hesitate to add "infrastructuralism," as John Durham Peters has proposed, to the historian's collection of -isms, it is nevertheless possible to claim that infrastructures developed to such a degree during the nineteenth and twentieth centuries that in important ways they can be said to characterize the modern world.[5] Seeing these as emblematic parts of modernity, Paul N. Edwards has discussed the co-construction of infrastructures and modern societies. Infrastructures link macro-, meso- and microlevels of time, space and social organization, thereby providing a base for modern societies: "To be modern is to live within and by means of infrastructures, and therefore to inhabit, uneasily, the intersection of these multiple scales."[6] Time was such an infrastructure.

Edwards's multilevel perspective on infrastructures is evident in time synchronization in Sweden around 1900. The pedestrian on the streets of Stockholm gazing towards a public time signal in order to set the pocket watch to the correct time; national political processes giving a mean Swedish time and funding national standard organizations such as observatories and telegraphic networks; international conventions and conferences regulating time over global distances: all are examples of how time as an infrastructure works on various scales. It was an infrastructure built on precision. Experts played a central role, scientists handled these standardized technologies and produced time. It is to these scientists, especially astronomers, that we now turn.

Astronomers Producing Time

A newsreel from 1935 shows the Navigational School of Stockholm. The cameraman has zoomed in on the tower of this center of maritime expertise, and the twenty-five seconds of black-and-white footage shows a large metal ball hoisted to the top of a pole, silhouetted against the clear sky. Suddenly the ball drops. The camera pans over the surrounding cityscape and the waters of Riddarfjärden, where a ship is heading out to sea.[7] What the citizens of Stockholm—or at least those that cared enough about having correct time on their watches that they took to observe the Navigational School at the right time—witnessed was a time ball in action, signaling far and wide that the time was, at the moment the ball fell, 12.00.00 Greenwich Mean Time. It was an optical signal that allowed captains aboard ships moored in the nearby harbor to synchronize their clocks, thus securing proper navigation for the ships on the high seas—a method of determining position at sea hinged on having calibrated precise chronometers on board—and for civilian and modern urban life to be synchronized with high precision.

The prerequisite for dropping the time ball was to have precise time available locally, produced by way of astronomical techniques, and therefore such techniques and the standard-producing institutions that housed them is a part of this story. For a visitor to an astronomical observatory during the nineteenth century the flow of time was most audibly present; one could hear the time ticking away. Observatories had accurate clocks permanently mounted at the telescopes, and there were also portable chronometers that allowed the astronomers to move time about. The observatory was a milieu where time literally ticked away. "The clockwork mechanism with its conical pendulum works so silent and smoothly, with a soft sound making for a special atmosphere," as the physicist (and friend of August Strindberg) Vilhelm Carlheim-Gyllensköld articulated it in a fictional but fact-based short story about the experience of observing celestial objects during long nightly vigils at the Stockholm observatory, where he had worked as an assistant astronomer early on in his career.[8]

In principle the technology for producing precise time was straightforward. The astronomer observed standard stars with well-known positions as they passed through the meridian, that is, due south. In these observations of the star's passage through the meridian, a transit instrument was used, a telescope that was positioned in the north-south direction. The astronomer used a chronograph with a rotating drum that moved a paper tape in even speed over a pencil tip, forming a line on the paper. The pencil was hooked up to an electrical circuit coupled to the pendulum on a pendulum clock; at every beat of the pendulum the circuit closed, and the pencil made a small mark on the paper, forming a graphical representation of the seconds on the paper. The observer, placed at the eyepiece end of the transit telescope, observed the passage of the star through the meridian. In the field of view, a micrometer thread—often made out of spider's web—defined the meridian, and as the star passed it the observer pressed a button and an electrical switch coupled to the chronograph made a mark on the paper tape. Since the star's position was precisely known—it would pass due south at a time that was known in advance—an analysis of the marks made it possible to calibrate the mechanical clock against the ultimate time-reckoning device: the earth's rotation as mirrored in the stars gliding through the sky.

These clocks were in themselves important astronomical instruments, and a nontrivial part of astronomical technological development during the nineteenth century was constructing such clocks and keeping them well regulated, and several ways of eliminating inaccuracies because of temperature variations etc. were conceived.[9] Such observations were part of the standard practice at an astronomical observatory, often performed by an assistant astronomer.[10] Thus precise time was produced. But this time existed within the walls of the observatory only, and ways to move it out of the observatory were developed. Such a distribution of the time made the work of astronomers into something useful for non-astronomers, enhancing the role of the observatory as a standard-bearing institution in modern society. The production and distribution of precise time from observatories could be part of astronomy's contribution to colonial practices, of making and spreading a European order outside of Europe.[11] Sometimes such time distribution involved collaboration between state, academic, and commercial actors on local, regional, and national levels. In the United States where a multitude of such actors were active—universities such as Harvard where the observatory functioned as a standard-bearing institution, national academic standards organizations such as the US Naval Observatory, commercial companies in telegraphy, local astronomical observatories—all cooperated in a complicated way in spreading precise time.[12] British time standardization coupled a government-run institution of high standing, the Greenwich Observatory, with the surrounding society: clocks were transported by foot from the observatory to London's clockmakers, for them to synchronize their clocks; a publicly visible clock that showed the time was outside the observatory; time balls were mounted to send out optical time signals; and telegraphic time signals were sent out via the telegraph wires.[13] With these international examples as a background, let us look at time-standardization practices in Sweden.

Places for the Production of Time: Astronomical Observatories and Navigational Schools

Astronomical observatories at the Lund and Uppsala universities and the observatory of the Royal Academy of Sciences in Stockholm performed observations for the production of time. An accurate time was produced at observatories functioning as nodes in the networks of time regulation, by distributing time signals through time balls, telegraphic signals, and public clocks.

Figure 2.1 Public clocks were one of the technologies used for distributing synchronized time. They also symbolized, for the surrounding society, values of precision connected with science in general and astronomy in particular. This clock, at the gates of the Lund Observatory, was set up by Carl Charlier and synchronized by radio time signals from the Eiffel Tower and a transmitter at Norddeich, Germany. The citizens of Lund called it "rättaste klockan i Lund" (the most accurate clock in Lund). © Gustav Holmberg.

While astronomical observatories were time-producing standard-bearing institutions, another category of standard-bearing institution important for the chronometric network that made it possible to produce and distribute time appeared during the nineteenth century: the navigational schools. Founded as a result of a government decision in 1841, these schools were to provide training for personnel for Swedish merchant shipping.[14] They were located at the major seaports on the Swedish coast and enter this story as providers not only of trained personnel but also of precise time for the Swedish shipping industry. They were financed by the state and formed by state mandate, but there was also a local agency involved in their history; in several instances, leading political and commercial actors at the city level had an interest in and cared for the schools' well-being.[15] The navigational schools in Stockholm, Malmö, and Gothenburg, major port cities, are relevant for the history of time standardization and synchronization in Sweden. Here teachers taught astronomy, mathematics, and navigation; there were astronomical instruments such as transit instruments and refractors, as well as octants, sextants, artificial horizons and other astronomical and navigational equipment. They also had libraries stocked with relevant astronomical literature.[16]

In Gothenburg, the school had a transit instrument made by E. Jünger, a Copenhagen firm that produced scientific and nautical instruments for observatories, university laboratories, schools, and shipping companies. The transit instrument was permanently mounted in the school's observatory, and observations of standard stars with the instrument were used to regulate an astronomical pendulum clock with a mercury pendulum.[17] Similar observations were also performed at the Stockholm school.[18] Thus, the major navigational schools and astronomical observatories—at universities of Lund and Uppsala and the Royal Academy of Sciences in Stockholm—were producers of precise time. But what interests us here is not only the production but also the distribution of this time to non-astronomers. One was by way of telegraphy.

Telegraphic Time Signals

In the mid 1860s, "a special telegraph wire was installed, connecting the observatory to the Stockholm telegraph station."[19] The astronomical observatory of the Royal Academy of Sciences began in 1860 to exchange meteorological observations with the Paris observatory, and every day observations were sent to Paris, which functioned as a center, collecting such meteorological data from many European stations. Stockholm also got observations in return, and some of these could end up in Swedish daily newspapers. Data were initially sent by foot, the messenger walking to the telegraphic station, but soon it became evident that it would be better to send them directly from the observatory, thus the special wire.[20] The Stockholm observatory became connected to an infrastructure of data handling that tied together the local—what was the weather like on Observatory hill in Stockholm at a certain time?—with a transnational Pan-European level with France as a leading nation. The astronomer Urbain Jean-Joseph Le Verrier had suggested to Napoleon III that the country should organize an international telegraphic network for the exchange of meteorological data, and such a network came into existence during the latter part of the 1850s.[21]

Further on, the observatory began to use this telegraphic connection for time standardization purposes. It transmitted regular time signals to the telegraphic central station and to the national naval base in Karlskrona. These signals were sent to stations in Sundsvall, Gothenburg, and Malmö, and from these main stations time signals were further distributed to stations in cities connected to them.[22] In the early twentieth century, the number of connected stations included Luleå, Umeå, Härnösand, Sundsvall, Norrköping, Stockholm, Gävle, Kalmar, Malmö, Halmstad, Gothenburg, Karlstad, and Örebro.[23] Signals were sent each Monday at 08:20:00 Central European Time and were preceded by a warning signal. The receiving station became, one can surmise, a node in a local network of precision providing people passing through the station with the possibility to calibrate their pocket watches. The reliability is difficult to judge, but suffice it to say, it did not always work properly: one source remarks that the "signal is sent from the Stockholm observatory, but is sometimes lost along the way."[24] Keeping the functionality up was a nontrivial task, but nonetheless the combination of astronomical observations at one of the leading observatories in the country and the telegraph network gave a time-synchronizing effect on a national scale. A grid of precise time was laid over the country.

Time Balls

Time signals also came in an optical version: time balls, which were installed in many countries from 1829 and onwards, often in close proximity to harbors, used for calibrating chronometers aboard ship for navigational purposes.[25] This maritime connection also occurred in Sweden. The Navigational School in Stockholm mounted a time ball on its roof soon after its founding. It became a beacon of time in Stockholm, signaling Stockholm mean solar time "to the second," as a newspaper notice put it in 1849.[26] To this was added a time ball over the Stockholm cityscape when the observatory of the Royal Academy of Sciences began such a service in the winter of 1860.[27]

In Gothenburg, home to much of Swedish shipping exports and imports, the Navigational School had a time ball, initially in use three times per week: Tuesdays, Thursdays, and Saturdays. The financing and organization of the time ball service in Gothenburg shows the combination of the Swedish state and local actors. Both local and national actors cared for the installation and maintenance of chronological infrastructure. In Gothenburg, the installation was funded by a grant from local businessman Gustaf Lindström, a philanthropist who had made his money producing tobacco products and donated substantially to social issues in the city of Gothenburg.[28] The maintenance and running of the time ball service cost 600 riksdaler yearly, paid by the state on a grant applied for by the city's Commercial society (Handelsförening).[29]

By 1914, there were time balls in Stockholm, Karlskrona, Malmö, and Gothenburg, all dropping the ball at 13.00.00 Swedish Mean Time, signaling that it was 12.00.00 Greenwich time. The time ball was hoisted some minutes before this, and when it dropped, ships' crews could calibrate chronometers aboard ship. In Stockholm, the ball was at the Navigational School, in

Karlskrona by the military wharf, in Malmö by the harbor's pier, and in Gothenburg at the Navigational School.[30]

Time balls were of use for the shipping industry, but also became a fixture in the skyline of the city; they were observed by people other than ship captains. "Unfailing like destiny, the time ball is active every day at 1 o'clock over the roof of the navigational school. Then Stockholmers stands with watch in hand, eyes gazing towards the height to compare and adjust one's personal watch in accordance with the time ball."[31] Time balls also became something of a metaphor, as when a journalist described the collapse of a twenty-meter high chimney as a sublime spectacle with "the certainty of a time ball," or when another journalist describing a sunset wrote that the sun "set like a golden time ball" on the horizon.[32] In a somewhat flowery language a journalist described how not only watchmakers but also many others interested in time waited in anticipation of the fall of the time ball at the roof of the Navigational school in Stockholm, "a daily decree that each and every one of us must follow."[33]

In 1912, the daily newspaper *Aftonbladet* ran a large article on modern pocket watches that discussed how to best keep one's personal watch calibrated, in which it was pointed out that it was important to compare the watch not just with any public clock "but instead with a public clock that was controlled by an observatory, otherwise one might think that there is a difference in time, that does not exist in reality."[34] In the same issue of *Aftonbladet*, there is also an article about a company that delivers time controlled by an astronomical observatory: Swedish Normal Time, Inc. (Aktiebolaget Svensk Normaltid, more on it in the next section), "a modern, practical and reliable organization," of utility for people in a society where time is money.[35]

One feature of infrastructures is that they are discussed publicly when there are glitches, disturbances, or outright failure. And the same is true for the time service by time balls. When the Navigational School in Stockholm in connection with a change in staffing decreased the days of the week with service in 1866, complaints were voiced since then the ships' officers could not synchronize the ships' clocks often enough.[36] When the time balls stopped working—for a variety of reasons, such as a failing motor, or when heavy blasting because of construction work close to the school disrupted the precise astronomical observations—people complained, and journalists reported on it.[37]

Time in the Cityscape: Swedish Normal Time, Inc.

So, the time balls were of use for merchant shipping, for clock makers, and also for ordinary citizens minding their lives with watch in pocket, navigating urban modernity. Gazing towards a dropping time ball once a day was supplanted by another way of distributing synchronized and precise time signals throughout the cityscape, a technology that provided a steady stream of precise and observatory-controlled time throughout the day, not only once a day. It was provided by a collaboration between a private company and a professional observatory: Aktiebolaget Svensk Normaltid—Swedish Normal Time, Inc.—appears on the time-standardization scene in Sweden at the turn of the century. While the state, scientific expertise, and standards-setting bodies are active in the creation of the infrastructures of modernity, companies could also play a role. Aktiebolaget Svensk Normaltid was founded in 1901 by John Andersson, an engineer who worked in telephony and telegraphy, as well as in the development and installation of lightning rods by the thousands, a successful engineering business that won him prizes at exhibitions in Stockholm 1897 and Paris 1900 and also commercial success, eventually making it possible for Andersson to donate substantial funds for a professorship in lightning research at Uppsala University. Andersson's company was influenced by systems of time synchronization already installed in the United States, Germany, Finland, and Denmark.[38] Customers subscribed to the company's time service in the form of clocks. The clocks were connected to the ultimate arbiter of turn-of-the-century timekeeping—the sky—through a network that contained astronomical instruments and professional astronomers at the observatory of the Royal Academy of Sciences, the Swedish telegraph system, as well as Swedish Normal Time, Inc. A clock placed by the company in the Stockholm observatory was calibrated by the astronomers by way of observations with transit instruments. From the observatory, time signals were sent by telegraph wires to the central station of Aktiebolaget Svensk Normaltid in central Stockholm, regulating a master clock, and secondary clocks throughout the city where regulated from the master clock via telegraph wires to march in synchronicity. In their advertisements, the company emphasized that the clocks displayed Swedish standard time, that they were automatically synchronized via time signals from a central clock and, furthermore, that they were automatically winding up; precise and synchronized time without fuss was the product.[39]

Thus, the combination of astronomers, the telegraphy grid, and Aktiebolaget Svensk Normaltid meant that a precisely calibrated and synchronized time became available in public spaces such as railway stations, shops, banks, etc. One example was the new and large central post office inaugurated in Stockholm in 1903; it contained about seventy-five clocks in various places throughout the large and modern building, synchronized from Aktiebolaget Svensk Normaltid. In the commemorative publication hailing the post office building as a modern working environment serving a vital communication technology, it was pointed out that the large building had access to precise time from the Royal Astronomical Observatory.[40]

Aktiebolaget Svensk Normaltid sold a time service, quality guaranteed through astronomy and the Royal Academy of Science's observatory. In its publications it pointed out the value of the service for modern life; their "electrical clocks, regulated in full with a normal clock at the Stockholm observatory, play a large and practical role in general life."[41]

Time Synchronization by Radio

Time balls and synchronization by telegraphic networks were eventually supplanted with wireless technologies. Signals, thus, could be used for calibrating ships' chronometers at sea, far away from the time balls in the harbors. Some years into the new century, most larger passenger ships crossing the Atlantic were equipped with morse telegraphy equipment. From 1905, time signals were sent by radio from the US Hydrographic Office, in 1907 the Marconi Wireless Telegraph Company sent out signals from a station in Halifax, Nova Scotia, and by 1910 two powerful transmitters, one in Norddeich by the German Baltic coast and another in the Eiffel Tower, distributed time signals reaching large parts of the Atlantic ocean and the landmasses surrounding it. The grid of time synchrony, earlier tied to visual closeness to time balls or by actual wire hookup, spread further to places not within sight of time balls or outside of the telegraphic system.

The first three stations sent signals at specified whole hours according to Greenwich time, while the French station sent signals according to mean Paris time. Having used that convention for slightly more than a year, the Eiffel station on July 1, 1911 switched over to sending telegraphic time signals that were "the mean time of Paris, retarded 9 minutes and 21 seconds," that is Greenwich time.[42] The French had to accept the emerging practice and convention of transmitting in Greenwich time, but this unpleasantness (for the French) was partly compensated when politicians and scientists took an initiative that aimed at placing Paris at the center of a Pan-European system for the production and distribution of standardized time signals.

The Bureau des Longitudes therefore wanted to gather official delegates to an international conference on the topic of time signaling by radio.[43] This involved diplomacy and national prestige: should Greenwich or Paris take center stage; should the treaty text even mention Paris explicitly or not, keeping open the possibility that the International Geodetic Institute (in Berlin) would take over as host for such a time service; could the French state really guarantee access to the privately owned Eiffel tower in the future?[44]

The French state, on the initiative of its Bureau des Longitudes, thus convened an international conference to discuss time standardization via radio, with the aim of forming a future international time service. The conference met for one week in October 1912 and a second time the year after, with representatives from sixteen countries.[45] The Swedish part of the conference entailed a collaboration between scientific expertise and public administration.[46] The Ministry of Education and Ecclesiastical Affairs sought the advice of the Nautical-Meteorological Bureau, the Royal Academy of Sciences, and the chancellor of the nation's universities, who, in turn, collected the opinion of the mathematical-scientific sections of the philosophical faculties of Uppsala and Lund Universities. The result of this deliberation was that the state appointed the astronomer and Lund University professor Carl Charlier to be Sweden's delegate at the conference.[47] At the conference in October 1912, a provisional committee for an international commission on time was inaugurated, charged with planning the next conference in 1913. At the second conference, also with Charlier as Sweden's delegate, an international convention for an international time organization was put in place, and the task to organize such a bureau was given to the Paris observatory.[48] Charlier could not sign for Sweden, but to the proceedings he added that Sweden's government had an interest in this international convention for providing time signals and intended to later ratify and join. This also happened in January 1914. Sweden was now part of "an international collaboration with the task of providing unity to time signaling in various countries through the transmission of radiotelegraphic signals, useful for scientific uses of time with high precision, as well as for the demands posed by navigation, meteorology, seismology, railways, postal service and telegraphy and so on."[49] Sweden had agreed to a yearly payment of eight hundred francs and also to provide a delegate in the permanent board of the organization, a post for which Charlier was intended. This decision had been the result of deliberations between the minister of education and ecclesiastical affairs and the Royal Academy of Sciences through its members Magnus Nyrén, Karl Bohlin, and Vilhelm Carlheim-Gyllensköld. Charlier already had plans for the Lund Observatory, where a receiving station for these signals was to be installed, paid for by Lund University.[50]

In the process of Swedish participation in the international organization for producing and distributing precise time signals via radio there was a collaboration between the public administration and the Royal Academy of Sciences. While the foreign office and ministry of education and ecclesiastical affairs handled the matter in a formal sense, the Royal Academy of Sciences was an important advisory body, acting as a representative for the country's scientific expertise, choosing a suitable expert, the astronomer Charlier, to help the state in these matters of standardization of time on an international level. This collaboration was rather close, with Charlier meeting with the foreign minister and the minister for education and ecclesiastical affairs for verbal reports of the work in Paris.[51]

Charlier, being an astronomer, had ample expertise in matters of time determination and standardization. He was also at the time working in a field that demanded time synchronization on an international scale. Charlier's intention was to expand astronomy by adding seismology to the domain of astronomy. The emerging field of seismology was not yet fixed in the taxonomy of disciplines, and Charlier thought that it should belong to astronomy, one argument being that knowledge of the interior of the earth would help the studies of other planets. Representatives of other disciplines thought otherwise, and in the faculty at Lund the physicist Albert Victor Bäcklund argued that it belonged to meteorology and the geographer Hans Hugold von Schwerin instead wanted to place seismology in physical geography. Charlier came out as a (partial) victor in this academic turf war: in 1912, the Parliament provided funding for mounting a seismograph at the Lund observatory.[52] Measurement of seismographic signals had a use for precise and globally synchronized time, and thus the work in Paris suited Charlier's local interests in Lund. Also his part of the proceedings in Paris meant that Sweden had a representative that knew the technicalities of time synchronization, and that he could play a part providing scientific expertise to the state, something he also did in other areas such as the implementation of statistical methods in areas such as demography, pension schemes, and railway economy. Charlier was—and perceived himself—as a society-oriented astronomer, providing scientific expertise for societal uses.[53]

Thus, Sweden in January 1914 became part of an organization providing precise time signals via radio telegraphy. Soon, however, European countries had other and more dire things to handle, and finalizing the international collaborations on time signals via radio had to wait until after the war. One outcome, though, was strengthening the use of the Greenwich meridian for international time reckoning.[54] After the war, organizing such activities fell under the domain of IAU, the International Astronomical Union, and its commission.[55]

But that is another story. As is the story of the emergence of the atomic clock in the mid-twentieth century, keeping time more accurately than both astronomical observations and the rotation of the earth, whose rate of rotation is variable for various geophysical reasons. Time is now produced in a laboratory rather than an observatory.

Acknowledgments

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Gustav Holmberg is Associate Professor in the History of Science and Ideas at the University of Gothenburg. He has published on the history of modern astronomy, futures studies, food conservation technologies, commemorative practices, and astrobiology. Publications include: "The Momentum of Maturity: What to Do with Ageing Big Science Facilities," in *Legitimizing ESS: Big Science as a Collaboration Across Boundaries*, edited by Thomas Kaiserfeld & Thomas O'Dell (Nordic Academic Press, 2013), and "The Future: Historians Look Forward," in *Prepared for Both: Lund University and the Surrounding World*, edited by Gunnar Broberg and David Dunér (Lund University, 2017).

NOTES

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Environmental Times

Synchronizing Human-Earth Temporalities from *Annales* to Anthropocene, 1920s–2020s

Sverker Sörlin

In recent years it has been proposed that the advent of the Anthropocene may profoundly affect the human sciences, including, perhaps most significantly the field of history and many of its subfields such as economic, environmental, world, and colonial history. The Anthropocene is a concept no older than this century, coined by atmospheric chemist and Nobel Laureate Paul Crutzen and ocean scientist Eugene Stoermer in 2000, followed by a far more widely circulating article by Crutzen in *Nature*.[1] It has quickly received a considerable following and critical reflexivity among social scientists and humanists. Since 2009 the International Stratigraphic Community has been preparing a proposal to the International Geological Union as to whether the Anthropocene should be considered an official geological epoch with a likely start at some point in the middle of the twentieth century.[2]

Although the Anthropocene idea was discussed by humanities scholars earlier, it was an essay in *Critical Inquiry* 2009 by Dipesh Chakrabarty, "The Climate of History," that in earnest raised interest among historians.[3] Chakrabarty argued that the writing of history will become deeply affected by the new Anthropocene condition, especially global climate change, and that our understanding of freedom and the entire metaphysics of time will need to be reconsidered. He also suggested that the divide between natural and social history must be breached and he advocated a new "negative" universalism that would construct a global "us," united by the "species" contributions that we humans make to the planetary change, regardless of class, gender, or nation. Chakrabarty did not have much to say, however, about *who* would write the new history or *how* it should be done, although it is clear from his later, recent work that he thinks knowledge from the sciences must inform a desired more total earth and species history. Such novel "human-earth historiography," as we may call it, would entail significantly new ways of looking at times and temporalities, beyond conventional structuring of time based on cultural and political chronologies and established archaeologies of the past.[4]

While acknowledging that there is a potential for change, perhaps even radical change of the social temporalities that can guide humanity and human societies in our troubled times my purpose with this chapter is rather to reexamine some of the historical and scientific contexts that can help us understand the current transformations of historiography. For some time now, times and temporalities in relation to earthly conditions, have emerged as just as important as more conventional preoccupations of historians such as periodization and social explanations.[5] The possible implications of this "temporal turn" of the environment is vast. If the concept of the Anthropocene becomes canonized not only as a geochronological idea but as a framing concept of "our times" on the global scale it will influence how we conceive of future directions for societies and perhaps even what it means to be human in this world.

Even without a full canonization of the Anthropocene by the geoscientific community, environmental times are bound to affect human societies more and more as societal and natural processes increasingly resonate and entangle. The temporalities of "natureculture" will affect politics, mentalities, and our perceptions of past, present, and future.[6] Or, in other words, how we temporally structure our thoughts, lives, and societies, what Reinhart Koselleck (1979) called *Erfahrungsrahm* and *Erwartungshorizont*, frame of experience and horizon of expectation.[7] What sort of temporalities do such concepts activate? Where do they come from? What kinds of knowledge are they based on? Who is providing the elements of these temporalities? Historians will typically play a role in the assemblage of temporalities, but other experts, many of them scientists and notably—as I shall return to—those who make up the Earth System Science community, have already appeared as candidates for the roles as environmental timekeepers of both the past and the future.

Time and Judgment in the Time of Numbers

Our times are numbered, and the Anthropocene is a quantified epoch. Its characteristics are the result of carefully measured and monitored geological, geophysical, and biological impacts of human activities on the earth, ultimately producing what has been called a "computational" or a "mediated" planet.[8] Biostratigraphy, chemostratigraphy, and lithostratigraphy have been studied for a long time but with a marked increase in the modern era, especially the period since 1950, which has been termed the Great Acceleration.[9] In this respect the concept comes out as typical of a long-standing trend in the emergence of modern expertise on global change.[10] In a growing literature it has been demonstrated that the very notion of expertise is predominantly reserved for certain categories of knowledge. This literature tells us that expertise and evidence are concepts that tend to favor the quantifiable and formal.[11]

The reasons are many: one is that expertise is a sociologically determined category that reflects the relative proportions of educated people who have gradually shifted expertise to expanding fields such as science, engineering, and economics. Other reasons are based on popular assumptions and expectations. Numbers seem to many, *prima facie*, to carry more credibility and precision than what is expressed in words. Numbers are also portable. A widespread perception is that numbers are somehow more neutral and therefore more useful, as Theodore Porter described it in his analysis of nineteenth-century social and engineering projects.[12] These assumptions may be regrettably superficial, some even plain wrong, but they must nonetheless be considered as circumstances, well known from the history of statistics and social numbers.[13]

A central feature of the extended practice of time making that preceded the Anthropocene concept was "the environment." The word itself is old but used in this way, as a particular singular noun, it appeared in the twentieth century.[14] The concept entered into circulation gradually and its usage increased dramatically, especially after World War II. A characteristic feature was its integrative capacity. Once it became established that humans impacted nature on a massive scale, often with problematic effects, the idea of this kind of dynamic relationship between humans/societies and their "surroundings" could be applied to almost any activity and place, from agriculture to zoonosis, from indoor to outdoor, and from the smallest molecular features to the atmospheric scale and beyond.[15] It was integrative, mobilizing expertise first in the natural sciences of human-nature interaction (biology, ecology, hydrology, strands of medicine), then gradually expanding into the social sciences and humanities, a process that covered the entire second half of the previous century.

A core element of the environment was time. The concept itself was as much temporal as it was spatial. The basic idea was that the environment "out there" was not static but that it was vulnerable to human influence and that it changed as a result of it. The rate and direction of that change became important; one could even say that environment was "nature with velocity." The changes in velocity were contributed by humans, and they typically went beyond the rates of change that could be attributed to natural variability. So, *temporalities and nature were welded together in the concept of environment*. These "environmental times" were not uniform, they appeared in different shapes and guises and they also scaled in different ways. Impact could be immediate if a city expanded into a new area. Impacts could be slower if a river was polluted by chemicals, and slower still, on time scales of generations and centuries, if humans were emitting carbon dioxide from fossil fuels. They could be essentially nonlinear and unpredictable if tropical rainforests were cut or burned and brought homeless animals closer to humans and, seemingly randomly caused viral epidemics to spread in human populations.[16] Environmental time could be any pace or scale of time, but whatever the time, it was closely interwoven with human timescales, from the processes of causation of change to the impacting phases of different duration, and to the temporalities of effect and long-term change. Since timescales were different, a major scientific and, later, policy change mounted: how do these times relate to each other and what does it mean for the effects of the environment, in part and *in toto*?

This chapter aims to address some temporal dimensions of the rise of the environment and of environmental discourse and to suggest some ideas for how we can regard the emergence of "environmental times" as an element of this historical process. Given the plethora of possible illustrations to the basic point of departure—that environmental times are a product of the twentieth century and that they have gradually become part of the structure of contemporary *Zeitlichkeit*, to use Koselleck's term[17]—I will have to limit myself to a stylized approach using a small number of examples from a subset of geological field sciences, glaciology, quaternary geology, and paleodisciplines which focused on materialities of time as represented by layers, strata, and archives and produced a rich variety of visual representations of local and distributed time records. I will juxtapose these with a more theoretically oriented, physics-based atmospheric science where temporalities were understood as more universal and became increasingly seen as parts of changes on a planetary scale, including the stabilizing orthodoxy on anthropogenic climate change during the latter decades of the twentieth century. I have previously drawn attention to how disciplines and fields of knowledge responded very differently to the new understanding of comprehensive anthropogenic environmental change.[18] The Anthropocene idea may serve as the epitome for irreversible human intervention on the planetary scale, but the main thrust of my argument here is rather that it should be seen as a late, and quite extreme case of environmental times that had by the early 2000s already grown over the course of a century. We may even wish to characterize the work conducted on interactions of environmental—and elemental—timescales during the twentieth century with the concept Proto-Anthropocene.[19]

The emergence of environmental times has led to profound alterations of how we (and here I mean large parts of humanity) experience our being in the world. Certainly, human deeds in the Christian tradition always had a relationship to Divine intervention and punishment, but the science-based hegemony of a dynamic, humanized nature that changes in problematic ways over time and that was possible for humans to understand and assume responsibility for was very different.[20] Disasters, cataclysms, upheavals that used to be called "natural" or, indeed, "acts of God" have been gradually moving towards the realm of the human and the societal and should be seen not just as part of the *zeitlich*, or temporal, in Koselleck's sense, but also of the affective and existential, along the lines of what Raymond Williams called "structures of feeling," deep perceptions of the regulating features of social existence.[21]

The more-than-a-century-long process whereby this new environmental dimension of modern temporality has played out *qua* history—that is, not just as a phenomenon to be studied by natural science—should be a matter of more detailed historiography. I posit that, apart from a shifting notion of causation and scale, there would be certain formats of knowledge that play a role.[22] One would be "technologies of prediction," such as models, assemblages of data, and methods for processing these, and the institutions, i.e., the "technologies" whereby environmental changes were negotiated and defined and hence the size and level of human impact, theoretically underpinned by an increased mathematization of "rates of change," prominently by Alfred Lotka, in the early 1920s.[23] Another is "mediated expertise" which may refer to the visualization and communication of results (figures, images, keywords, etc.) and to manifestations of environmental change. These and other "environing technologies" are in turn connected to temporal tropes and scales in religion, ideology, social and historical theory, and also to activism in policy formation and advice.[24] In this respect it may be useful to regard environmental times as continuously intervening in and responding to other times, and therefore requiring active "synchronization"[25] with social, cultural, and political time scales and temporalities, in ways that reach beyond the scope of this chapter but that hold a lot of promise for future reflection.

Temporalizing the Environment—Febvrian Enthusiasm

Given the copious influence of the sciences for the formation of the environment and its multiple times, it is illustrative of the concept's complexity that we may meaningfully choose a work of the deep humanities as our starting point. It needs to be said at the outset: temporalization of the environment as a broad process encompassed numerous agencies, including both the sciences and the humanities, from the very early decades of the twentieth century. A unifying link between the two was the French historian Lucien Febvre, later founding father of the *Annales* school, and his book *La terre et l'évolution humaine* (1922), translated into English as *A Geographical Introduction to History* (1925).

Febvre articulated the modern anthropogenic "environment," his favored concept, against the backdrop of an earlier understanding of the word as a deterministic external force, working on humans and their entire societies and civilizations. Other words commonly used for this determining influence were "earth," "geography," or "climate," words found in the work of Friedrich Ratzel and Ellen Churchill Semple, whose key work *Influences of Geographic Environment* (1911) drew heavily on Ratzel, and in the work of Ellsworth Huntington, famous for his ideas of the strong influence of climate on human societies in *Civilization and Climate* (1915) and other books.[26] In acknowledging their intellectual diversity, it may be worth noting that they were primarily anchored in nonscience fields, with Huntington as a liminal figure, a metaphysical geographer of a kind not unusual in the first half of the twentieth century: a Griffith Taylor, a Vilhjalmur Stefansson.[27]

At about the same period, geographical factors such as populations, pests, harvests, and famines were adopted by French historians, later to become important for the *Annales*. The journal itself didn't start until 1929 but already in 1913 Febvre, then a rising star on the French historical firmament, had been commissioned by Henri Berr, the wide ranging and well-connected philosopher who started *Revue de synthèse*, to contribute a volume to his book series *L'histore de l'humanité*, or *The History of Civilization* in its English version. Its stated aim was to present in accessible form "a library of masterpieces," "results of modern research throughout the whole range of the Social Sciences," in the kind of synthesis vision that Berr had proposed as an ideal for history.

Febvre's *La Terre et l'Évolution Humaine* is a massive, repetitive, powerful, polemical, yet modest and polite, yet also brutal and pitiless rejection of the Ratzelian tradition. And not only that, it is in this volume, not published until 1922, after five years of a writing pause during World War I, that we envision the shift of direction of the concept of the environment. No longer is the environment only something "around" that influences "man" and human societies. On the contrary, the relationship is mutual, and, above all, the impacts run in the other direction as well, and according to Febvre this has been going on throughout human history.

Several features of the book point in the direction of a refashioning of historical temporalities: first of all, Febvre's acknowledgement of anthropogenic change. Febvre is remarkably sparse in his usage of the word "nature"—he prefers earth, geography, and, above all, environment, or *milieu*, in Febvre's French. Because, as he remarks, there is not much untouched nature, what humans relate to is mostly environment, that which is already transformed. This is also what Berr had commissioned him to do, as he writes in the foreword, entitled "The Effect of Environment on Man and Man's Exploitation of the Earth."[28] In a series of repetitions throughout the volume Febvre juxtaposes "man" and "environment"—"two groups of obscure forces," as these were addressed in the deterministic tradition, going back not only to Ratzel, but also to Hippolyte Taine, who used environment to explain art and literature, and from Taine's professor in turn, Victor Cousin, an arch-determinist, to Montesquieu, whose understanding of environment Febvre ridicules as simplistic and superficial, and ultimately to Jean Bodin, whose circular way of reasoning is exposed in good-humored polemical irony.[29]

The chief concept that had linked "environment" to "man" in the Ratzelian tradition was "influence," which he rejects as a superstitious idea. How, Febvre asks, can soil and climate influence people and societies? How does temperature enter the minds of humans? How is it that cold and damp can make people slow, dull, and lacking, that warmth makes them spiritual and philosophical, according to Hippocratic tropes that had circulated since Antiquity? Febvre found such beliefs unfounded and therefore unscientific. What did exist were "relations" between the environment and humans and their societies, and these relations were empirical and should be researched as such.

That Febvre attacked a deterministic understanding was crucial, because it paved the way for a possibilist version of history which was also about environment and geographical factors but retained the essential property of human agency, crucial to most historians and a matter of epistemic life and death for Febvre. If Febvre's enemies were Ratzel, Semple, and Huntington, his hero was Paul Vidal de la Blache who had written seminal works on French regional history.[30] Vidal, just like Fernand Braudel some decades later, presented geographical factors as framing conditions which, essential for Febvre, humans constantly surpassed in their development of society, through knowledge, technology, social relations, that is, everyday life, and what Vidal and his followers called *genres de vie*.[31]

At the same time that Febvre refuted determinism as bad science (underpinning false and dangerous political ideas), he also embarked upon a completely new and complementary understanding of environment, namely as the object of human impacts and thus best studied with a broad range of approaches to these impacts. Humans acted consciously, historically, in time. In the final parts of his book he turned increasingly to anthropology, psychology, history, and other human sciences. It was necessary to widen the methodological arsenal, because, as he noted, "Between man and his natural environment, ideas are always creeping in and intervening."[32]

In turning the tide away from environmental determinism, which made humans smaller than the forces of nature, Febvre argued that humans played a mighty role in shaping the earth, essentially suggesting that change, and the times of change, in the environment were closely linked to human agency, hence to historical time, and therefore to history. This becomes evident right at the beginning of the book in his description of Comte de Buffon—the optimistic aristocrat, polymath natural historian, and director of the Jardin du Roi in Paris—and from his description of the earth and life cosmography in Buffon's *Les Époques de la Nature* (1778).[33] "Buffon's man," Febvre says, "is no creature of putty to be shaped by nature. He is a doer. He is literally one of the forces of nature." In the following he cites Buffon at length: "The entire face of the earth bears today the imprint of man's power. . . ." Man is in this superior to all other species; "animals are, in many respects, productions of the earth; man is in every way the work of Heaven." Buffon had found anthropogenic climate change already demonstrated, especially in a densely populated and culturally vibrant city such as Paris, where temperatures grow thanks to conviviality and intimacy in *les salons*! That Febvre appreciated Buffon is beyond doubt. He was an eighteenth-century natural historian, but, akin with Vidal de la Blache, he "thinks like a modern." Furthermore, Buffon does not belong among the "'Church Fathers' of the theory of 'environment.'" Because, according to Febvre, "he marks the starting-point of another idea than theirs—the complete antithesis of their idea. The earth, fashioned, altered, adapted, humanized by man."[34]

Buffon, nowadays presented as the early Arch-saint of the Anthropocene—named as such in 1956 by Clarence Glacken and cited as an authority already by George Perkins Marsh 1864—was attractive to Febvre because Buffon did away with determinism and at the same time enhanced human agency.[35] In this he served as the perfect template for Febvre's own welding of environment, time, and agency. It is equally obvious why other social scientists and humanists, including many historians, have remained less convinced. Buffon's "man" is, after all, not very historical in the common sense, rather a singularity, like "humanity." He (most likely a he) pursues his pure agency universally in the world, transforming it as if "man" was just another natural force at play. So, paradoxically, from this agency follows a universalism that runs the risk of becoming both flat, one-eyed, and too powerful to realistically represent historical change, a standing trope in the recent humanist critique of the Anthropocene.[36]

Febvre launched a possibilist crusade against a geographically and biologically determined understanding of history. First and foremost, his work made the environment historical: he inscribed it with the potential of times and timescales that related to human agency, and he did so in ways that until then had not been attempted. The concept of environment before World War I was predominantly seen as variations on the Hippocratic theme.[37] Febvre's more dynamic outlook was brought to the *Annales*, the journal he founded, but only found its way slowly into *Annalistes* practice which did not release the full potential of Febvre's anthropogenic environmentalism.

Environment *Quasi Immobile*—Braudelian Stability

Even Fernand Braudel's *History of the Mediterranean* (1949), which begins with a huge 350 page "introduction" entitled "The Role of the Environment" (*La part du milieu*), managed to move the idea of anthropogenic environmental change into the background. This is, somewhat ironically, carried out through his famous tripartition of historical time: the *longue durée* as the backdrop to the faster events; *l'histoire événementielle*, a concept he had borrowed from François Simiand, on the shortest time scales up to decades; and *les conjonctures,* which encompassed several decades up to centuries.[38]

At first blush, Braudel's strong preference for long duration historical analysis where the environment plays a structuring role in the affairs of mankind, seems akin with Febvre's ideas in *La Terre*. But, on closer scrutiny, they are quite different. Febvre presented an immediate and comprehensive impact from human action, and one where human agency reached deeply into the heart of nature and its workings. The Mediterranean geography portrayed by Braudel—and hence the relationship of mankind to its environment—reflects rather an equilibrium-oriented natural world characterized by relative stability, in today's Earth System Science parlance perhaps to be likened with the postglacial "stability domain" of the Holocene. In the light of our current understanding of climate and geophysical change as rapid and dramatic it is remarkable how Braudel depicts the tranquil *longue durée* of the Mediterranean world, not only changing very slowly but hardly changing at all. He says in the preface, still repeated in the 1966 edition, and in the 1972 translation into English, that "I did not wish to overlook this facet of history, which exists almost out of time and tells the story of man's contact with the inanimate" (*quasi-immobile* is his word in French).[39]

In Braudel we have an author who is not aware of the Great Acceleration that started just as his book went to press, or of the canonization of *Man's Role in Changing the Face of the Earth*, the core idea (and title) of the influential, multidisciplinary Princeton conference in 1955 on humanity as geophysical agent, manifesting anthropogenic environmentalism in the sense that Febvre had suggested. Nor does he seem interested in the budding applications of the word "environment" as an integrative concept for the many dimensions of the natural world that were threatened by human expansion.[40] Braudel is, we can say, writing in a state of innocence and also disjoint from the most recent French debates since he did much of the actual work on *La Méditerranée* in a German prison camp in Lübeck. From our 2020s Anthropocene viewpoint, we can see Braudel balancing precisely on the moment of both knowing and not knowing, without knowing, as we do, that this was the case. He wrote about environment and time, but he did so before the increasing velocity of environmental times had fully started to gain visibility and traction and the scale of anthropogenic influence had become known.

Braudelian historiography, this is the point here, stands in a special relation with non-historian actors, such as the community of earth system scientists that advocate adopting the Anthropocene as a new geological epoch in periodizing the past, comprehending the present, and projecting the future. One particular concept to consider in this regard is "crisis," discussed so vividly by Koselleck.[41] Crisis, according to Koselleck, can be comprehended as a time-compressing force in that it evokes urgency and a threatening instability that is the antithesis of long-term socioecological sustainability. Environmental and climate crises are, however too often taken as natural facts, without adequate reflection on the human agency behind the construction of the social concept of crisis. Within a prevailing crisis discourse, singular *events* (such as hurricanes or droughts) have been linked to climate change but must be managed in the moment, while societal *adaptation* is called for over the medium term, and deeper socioeconomic *transformation* is portrayed as humanity's only hope for long-term survival.

Koselleck's distinctions may seem reminiscent of Fernand Braudel's division of episodic (*événements*), social (*conjonctures*), and slow (*longue durée*) timescales. They are, however, very different: compressed by the acceleration of human environmental impact—as elaborated through concepts such as the Great Acceleration and the Anthropocene—on the one hand, and the perception of subsequent environmental and climate crisis on the other. Earth System Science studies extremely long durations, which, for a long time, few historians found useful to consider except as general background information. Those who did were often influenced by science, or working in close collaborations with scientists. Their results sometimes supported social interventions intended to elicit rapid societal change across short time horizons.[42] Institutions and individuals associated with the community of Earth System Science, including the supporting technological instruments, models, and visualizations, are hence key aspects of what might be regarded as a rising "crisisfication."[43]

Although there are similarities between Braudelian and Earth System Science in the tripartition of time scales, the differences are striking. Anthropocene nature is prone to dramatic change at unpredictable moments. These moments of crisis are directly or indirectly induced by human activities, but they are also "anthropocenic events" that in many respects require human science and technology (instruments, monitoring) to become perceivable. Climate change is the obvious case in point. Despite being visible at certain "truth spots" where glaciers are melting and islands are overtaken by the ocean, climate change typically needs careful monitoring and masses of scientific data and theory to become comprehensible.[44] At the truth spots and through the instruments, there is thus also a repeating, or a perpetuating, of the human agency that initiated the change, thus building time into the environment as an essential factor of understanding.

Expanding Environmental Time

Seen from the vantage point of our contemporary situation a hundred years later, the attempts by the *Annalistes* to naturalize historiography seem too modest to capture the increasingly complex and entangled relationships between time scales of nature and culture. "The environment" had established the existence of a human-made version of the natural world where change is just as present and marked by human agency as it is in society or culture. That was the central message of Febvre's *La Terre*. However, it was at least partly overlooked, and it is clear that his student and protégé, Braudel, became a much larger presence in modern historiography than his mentor ever did. That does not mean that Febvre's book is unknown. It has been well cited for example in the literature about the background to environmental history that emerged as a field around 1970.[45] But it has not been used anywhere near as much as Braudel's work which has been regarded as the perhaps most important contribution by any historian in the twentieth century. Furthermore, Febvre's anti-determinist stance, which became a standard part of historical virtue was typically not derived from him but rather from R. G. Collingwood and typically adopted without the keen interest in the environment that Febvre advocated.[46] A result was the fact that environmental times, especially as they brought profound interaction with human agency, did not become a concern in the humanities and social sciences until fairly recently.

Further work on environmental times, after Febvre, instead occurred in the sciences while the humanities and social sciences opted to largely remain in the waiting room for several decades. That time was a critical factor in almost any natural process was of course well-known, and had been built into science and natural history since the Early Modern period. Geological strata and fossil records increased earthly times and Buffon himself famously created a proxy for the age of the once heated earth by heating iron balls on his estate and measuring the time it took them to cool; a bit more than 70,000 years.[47] Natural selection and evolution demanded far longer timescales to be realistic—Darwin famously suggested in *The Origin of Species* that the age since the dinosaurs alone would require at least three hundred million years.[48] Thomas Hunt Morgan's study of *Drosophila* flies made it apparent that a "generation" could mean anything from hours (in flies) to decades (in humans). Literally any dimension of the natural world expanded in time, down to the smallest fraction of a second and up to the time of the universe itself that grew with millions, soon billions of years.[49] But these times were not yet environmental times—they lacked the presence of human agency.

At about the time when Febvre finished his book for Berr this started to change. Alfred Lotka's work on population dynamics in the 1920s demonstrated how oscillating fluctuations that he found in predator-prey distributions were extremely time sensitive. They could also affect the result of human interventions in lakes and other habitats that were soon to be called "ecosystems," Arthur Tansley's 1930s concept, "of the most various kind and sizes." Ecosystems as well were subject to temporalities: "those which can attain the most stable equilibrium survive the longest." Tansley had already taken a deep interest in the concept of "succession."[50] Much of the work on relations between populations and their external conditions hinged on models, abstractions of principles that could be tested statistically. Charles Elton built models of animal populations and used them to write his influential *Animal Ecology* (1927). The idea that external conditions were influential could be used equally well on human populations, as in the work of Alexander Carr-Saunders, who trained as a zoologist and worked under statistician Karl Pearson and together with him published *The Population Problem* (1922), the very same year Febvre published *La Terre*.[51] Demographers and zoologists were still not always "possibilists," they would rather see constraints than opportunities, but at least the focus had started to move away from separating humans from natural processes. They were increasingly seen as connected, and time was of the essence. Most of the functions had time on the x-axis, but what if time itself was a variable?

Early examples where this was the case occurred in the soil sciences. Already in the interwar years deserts and erosion became acknowledged concerns. The Dust Bowl of the American west turned into a national crisis and human neglect of soils became a political issue. Ecologist Paul Sears wrote *Deserts on the March* (1935), literally depicting a perfectly natural habitat, drylands with extremely limited vegetation, that had started to break away from modeled expectations, leaving their ordinary grounds and heading west with the winds. They were deserts on speed, and what usually took decades or centuries, or perhaps shouldn't happen at all, happened in days and weeks, once the protecting trees and grasses were eliminated to clear land for agriculture.[52] Erosion harried Russian and Ukrainian steppes, and American grasslands. It had happened in the past in the Roman Empire, the Nile Valley, India, Sudan. There were times when even the most stable of agricultural civilizations seemed to drive up the rate of change in landscapes to threatening levels.[53]

Issues such as these, only years later, right after the coming World War, would be called "environmental problems" and thus entered into a soon familiar vocabulary of the environment as a sensitive, yet opportunity driven relationship between humans and their surrounding climate and life conditions. Climate itself became an issue where time was quickly going out of hand. Swedish chemist Svante Arrhenius had calculated the greenhouse effect in a paper published in 1896. His interest was not climate change as we now know it, on the contrary, he was keen to learn about the causes of ice ages.[54] But the principles were correct and after several decades of relative silence a British steam engineer, Guy Stewart Callendar returned to Arrhenius's paper and made a calculation to connect the observed, ongoing warming around the world and connected it to emissions of CO_2 from the combustion of fossil fuels.[55] Again, time was the most immediately affected variable. Natural variability that produced, and reduced, ice ages over time scales of thousands and tens of thousands of years could now be replaced by anthropogenic effects with temperatures growing tangibly and with dire consequences over timescales as short as (human) generations, decades, or even years.

These were not just times that were a-changin'—they were new, environmental times, produced by human societies, shifts in agriculture, principles of land distribution, changes in energy provision, and behind it all a growing demand for food and livelihoods and power to engines and industries in turn driven by increasing populations, and the greed and creative destruction of capitalism. They were environmental because they were produced in that critical zone of interaction where human societies met with surrounding nature. In fact, these early instances of environmental times contributed to the shift in usage of the word environment from the Ratzelian external influence that Febvre fought so forcefully against to the soon to emerge new orthodoxy of environment as vulnerable life condition and possibilist responsibility that Febvre favored.

An Earth Time Machine

Environmental times were to a large extent established through empirical relationships and these could be translated into models. Lotka's population dynamics is a case in point. His models became a mainstay of systems ecology, which modeled energy flows and food chains in ecosystems. Introduced in the 1920s, they had been codified into textbook knowledge by the 1950s.[56] It didn't take long until these models were also directed towards the future, projecting or predicting more changes to come as rates of change themselves changed, mostly upward. The challenges that societies faced in their provision of energy, food, textiles, and natural resources such as water and timber and other raw materials were no longer framed by linear thinking, but rather by multidimensional mathematics. A key element was the increasing awareness that what made these interactions nonlinear was human activity. Societal metabolism, consumption, and production, hyperactivated natural processes, or in some instances halted or even killed them. This was the case with species extinctions, then still a not so much modeled issue but steadily growing and inspiring many postwar conservationists, including ecologist William Vogt, a cofounder of the rising and soon prevailing understanding of "the environment."[57]

Furthermore, the rates of change in the many conditions of the earth—erosion, salinization, the accumulation of chemicals in water and soil, growth of atmospheric CO_2, etc.—formed patterns of *covariation*. A challenge, but also a pathway to success, was to conceptualize these as integrated phenomena across borders formerly guarded by different experts. The notion that oceans, atmosphere, ice sheets, soils, forests, wildlife, and even public health were interdependent, demanded a merger of disciplinary understandings of each, and the development of new principles. That human agency was recognized as a key factor behind the change helped explain the interest. Slowly but surely it became evident to these early environmental experts that they were trying to come to grips with the future of the earth as an integrated product of human impact. Ecology, which was so important to the self-understanding of the later environmental awakening, was part of this rapid evolution—as the work by Vogt and his contemporary fellow ecologist Fairfield Osborn testified—but by no means the only discipline involved. When, for example, systems ecology became important in the postwar years, much fueled by the war effort, it mirrored the same pattern that had already become established in other disciplines, with far reaching quantification based on comprehensive data collection in order to monitor change.[58] Sooner than one might think, "Anthropocene" impulses were released, as if the idea, once time and human agency had been combined in this environmental way, could only lead to the conclusion: humankind was "becoming for the first time *a large-scale geological force*."[59]

It soon became fairly commonplace to make this kind of statement. Geographers in particular made it a special tradition to identify the remarkable agency of human societies of all possible kinds and how they, aided by time and technology were able to transform nature into landscapes quite radically. The Princeton conference in 1955 abounded with examples of this metanarrative, which sat well with the equally prevailing modernization theory. Still, the latter had very few elements of environmental concern.[60] From the emerging environmental sciences came a very different message. Theirs were not necessarily times of progress. Vogt's and Osborn's books in 1948 already abounded with narratives of gloom and destruction. As the modern understanding of "the environment" came into circulation, more systematic predictions of future environmental change started to appear, soon providing a temporal genre of its own. It built on older tropes of decay, decline, or apocalypse, but now it was supported by equations and masses of data and was persecuted by new strands of self-professed environmental expertise.[61] An early prediction of an ice-free Arctic sea in fifty years was made by US physicist Paul Siple in 1953.[62] The modeled temporalities could reach back to explain the past as well once it had been established that there were environmental times involved, based on human agency that had always been there. A seminal debate was conducted in the United States from the 1920s to the early 1950s when Berkeley geographer Carl Sauer could finally demonstrate that much of the American prairies were the result of elaborate aboriginal fire regimes, an understanding that ecologist James C. Malin and others had found implausible: primitive tribes just could not achieve such comprehensive undertakings.[63]

The middle decades of the twentieth century were important for this emerging environmental reading of material change and therefore, by implication, the idea that bio- and geochronologies were interwoven with societal times. This was a sea change, a profound disruption of the human-earth stability. The taken-for-granted nonanthropogenic orthodoxy still reigned as the dominant outlook, and although landscape change was accepted as a human achievement, the large majority of scientists held it out of the question that, as Nobel laureate physicist Robert Millikan put it in 1930, humans could bring "any titanic physical damage" to something as large as the earth, for whose protection God must also surely have provided "foolproof mechanisms."[64] But there were already then dissenting voices. One came from Russian scientist Vladimir Vernadsky who coined the concept biosphere in his book *Biosfera* (1926, in Russian), translated into French 1929; it was not translated into English until much later (1998), once the concept had already been adopted by UNESCO and Vernadsky had started a global career.[65]

In the 1940s, Vernadsky's ideas on the biosphere entered wider English-language circulation via Yale ecologist Evelyn Hutchinson. Modern man was eroding his own survival by wasting "parts of the *biosphere* which provide the things that Homo sapiens as a mammal and as an educable social organism needs or thinks he needs. The process is continuously increasing in intensity as population expands."[66] Of particular influence for this line of thought was the use of energy budgets, revived in the 1920s and with Lotka again in a pivotal role.[67] The temporal articulation was aided by the parallel, partly related process of configuring the biosphere into an "environmental object," which was yet another major scaling effort that asserted a sense of context or even holism.[68] Vernadsky held that human activities could affect the biosphere on a grand scale and that they had already done so through mass extinctions and the release of greenhouse gases. Many deviating voices were refuted or marginalized at the time, but in retrospect it is possible to see them as an inexorably assembling choir whose resounding voice would soon be heard.

Environmental times, without anyone ever using the concept, were in the mid-century decades from turning into a common understanding, a giant earth time machine, or rather a massive array of different temporal processes from the tiniest cell to the entire atmosphere or geological strata that all shared only one thing in common—their blind watchmaker who was neither God nor natural selection, but humans.

The turning point came right after World War II and meant a decisive turning away from previous orthodoxy into an understanding that humans could indeed, as it was to be framed in the Princeton 1955 conference, play a major role in "changing the face of the Earth." The conference was organized by broad-minded thinkers such as Carl Sauer and Marston Bates in Geography and the polymath planner and historian Lewis Mumford. A few quotes from the many contributions to this conference might serve as a token of the new orthodoxy that was now taking shape, or rather spreading to become an orthodoxy. In a powerful essay, by far the longest included in the conference proceedings volume and heralding his forthcoming *Traces on the Rhodian Shore* (1967), Berkeley geographer and intellectual historian Clarence J. Glacken observed that ever since Charles Lyell and his *Principles of Geology* (1830–33) there had been an understanding, percolating under the surface, that humans served as a geological force of some magnitude, and already in the early twentieth century "several geologists were calling man the dominant geological force of the planet." Terms like "psychozoic era," "anthropozoic era," and "mental era" were suggested by different authors. Vernadsky proposed "noosphere," echoing Jesuit paleontologist and philosopher Pierre Teilhard de Chardin's idealistic perception of the world humans shared with God.[69]

Climatologist C. Warren Thornthwaite, also president of the World Meteorological Organization since its inception in 1951, voiced skepticism to major human influence on climate but cited, in awe, a Soviet textbook of climatology from 1952: "Only under socialism has it become possible to exert a systematic and planned influence upon nature: draining marshes, lowering the level of permanent ice, irrigating deserts, and planting forests. The supreme form of planned influence upon nature and climate is a system of scientific procedures which the people have named Stalin's Plan for Reforming Nature."[70] In general, Thornthwaite disbelieved the prospects for such schemes, as much as he disbelieved the necessity for George Perkins Marsh's calls for prudence a century earlier. We may be able to change the face of the earth, but humanity will not be able to change climate, Thornthwaite still argued in 1955, when evidence to the contrary was emerging that indeed it was possible, perhaps inevitable, for humankind to massively impact future global temperatures.[71] In several other contributions to the Princeton meeting large-scale geoengineering projects were advocated to manipulate precipitation or the climate of towns. Conventional modernization still held most of the turf, but the ice was about to break, quite literally.

Extending Times in Ice

So far in this chapter we have observed a set of critical moments in time when a range of economic, social, and epistemic contexts became manifest where the new *awareness* of the growth of anthropogenic times and rates of change took place in the environment. A question comes out of this observation: how did all these times relate to one another? One answer has already been implied: they were all part of the emerging environmental understanding of human surroundings and life conditions, which provided them with a common framing. If *Drosophila* multiplied in hours, soil erosion happened in days, glacial retreat required years, and an ice-free Arctic ocean could happen in just a half century. This endless variability of timescales still didn't hinder understanding since they all belonged in the same category of man-made temporalities that ultimately set new standards for societies as well as for life on earth in general as the human enterprise kept growing.

But there was another answer. The timekeepers of science were aware of the differences in timescales and they realized that there was a potential to be released if these could be better understood, perhaps even calibrated. Such "synchronization" sometimes expanded to translations of timescales discovered in one element, such as ice, clay, soils, or seeds to one of the others, or to processes such as melting, erosion, diffusion of vegetation, or the spread of disease.[72] Sometimes even the conflicts between proponents of different timescales of change worked on such translations to justify their argument. Such was the case with Sauer and Malin on the issue of the American prairies, and they were not alone. Scientists who had been working on natural variabilities in the Quaternary were understandably affected, sometimes provoked when botanists and ecologists arrived and suggested that what had been regarded as "natural" time was in fact part of the human and cultural timescale, hence environmental.

In the remote North Atlantic region, the production, and applications, of environmental times became unusually active in the postwar years. The geopolitical interest in the region was strong during the Cold War and resources flowed to geophysical research, including glaciology, but also to other environmental field sciences, and to climate science.[73] Decades of glaciological work in Svalbard and Fennoscandia had produced detailed knowledge on the decadal and centennial timescales, supplementing paleo-ecological time layers that went much further back in time and also encompassed vegetation studies. Interpretations could not always speak well to the rising environmental approaches which led to epistemic isolation and few contacts between meteorologists and geophysical theorists who had already advanced far in the quest to understand climate variability over longer timescales, including anthropogenic climate change.

In only a few years this northern region became the place of multi-scientific approaches to temporal problems.[74] In the early 1950s Danish, Swedish, and American palynologists and botanists researched Greenland's paleoecology, observant on temporal comparisons. In addition, Danish, Swiss, and US glaciologists used the massive engineering infrastructures in the Camp Century site in northwest Greenland to produce the tallest ice core to date, almost 1400 meters.[75] What both of these lines of research offered was a temporal expansion, allowing for a climatic record reaching a hundred thousand years back in time.[76] In the 1960s and 1970s it was already well established that the rates of change of climate in the present was well in line with the most rapid changes in the past, hence ice cores could also become "climate change messengers."[77] These new rates of change were a case of environmental times, which led to new translations of recorded time into fields of knowledge far away from the ice, such as oceanography.[78] It was even possible to translate the ice core record to Greenland's short cultural history, as did Danish geophysicist and ice-drilling pioneer Willi Dansgaard who in his later career almost turned into a full-fledged historian chasing the roots of the demise of the Norse colonization in the Middle Ages.[79]

Environmental times led in many directions. The common denominator of these translations was that they enhanced possibilities of comparing and calibrating timescales that emerged from very different geographies and materialities so as to enable a comparative synchronization of the times that had become increasingly man made, but still required nonhuman, nonenvironmental baselines to make sense of and to determine the level of impact that humans had wrought. A community that specialized in this approach to time and materialities was Earth System Science, which started to form institutionally around 1980 and in due course produced a new, decisive articulation of the idea of the Anthropocene.

Environmental Times in the History of Synchronization

There is an even larger question coming out of this story that has to do with history as we conventionally understand it: these things that take place in the ordinary world of humans. If we accept, for the sake of the argument, that the characterization of environmental times and their emergence given above is reasonably true, how should we understand *this case* of synchronization work in relation to others? Or, of what larger pattern of synchronization is the synchronization of environmental times a part?

The concept "synchronization" was articulated by Norwegian Germanist scholar Helge Jordheim in the 2010s in a string of studies in the context of world and global history. Jordheim identified a particular need for synchronization of "the world" in the era of Europe's Early Modern global expansion. A first major process of creating a general time frame of a common humanity took place when Biblical time gradually collapsed and was replaced by times of cultures, "races," and nations unified by ideas of progress that would transform into a "modern" interpretive frame of time.[80] Multiple groups of actors contributed during this process and thus served as what we might call global synchronizers. Eminently of course, philosophers of time such as Giambattista Vico in the early and Johann Gottfried Herder in the late eighteenth century, but also navigators, mapmakers, and geographical thinkers such as Kant and Buffon, worked tirelessly to combine natural and geological timescales across world regions.[81]

Using Jordheim's concept, could we conceive of other strands and periods of synchronization work? As Vanessa Ogle has demonstrated, a wave of "pluralization" and "transformation" of time followed with the formation in the nineteenth and early twentieth centuries of a universal time linking continents and economies under a regime of global time zones, calendars, and rapidly developing communication technologies.[82] We could see this as a second wave of synchronization with primary agency now performed by astronomers and observatories—as described by Gustav Holmberg in Chapter 2 of this volume—representatives of major religions (Islam, Christendom), engineers, trade and shipping companies, banks, international organizations, and nation states. But, again, geographical knowledge played an important role by providing "new ways of thinking about global space" that brought geopolitical elements to universal time zoning (Alfred Mahan, Friedrich Ratzel, Albrecht Haushofer), or popularized versions of synchronized "Worldwide Interchange" (Friedrich Naumann).[83]

In the decades around 2000 the Anthropocene became what may be seen as the conceptual epitome of a third wave of synchronization. Although the Anthropocene concept itself appeared quite recently, the synchronization it represents had significant antecedents in the twentieth century, through material and geographically bounded work in the field. Anthropocene discourse, as it has been generated chiefly among the institutionally alert and successful Earth System Sciences, has rested on an integrative understanding of geophysical, biological, geo- and biosocial timescales, and how it informs the human-earth relationship thus has a prehistory with different sites and constellations.[84]

An essential precondition for this recent and still ongoing synchronization was the environmental times that had been articulated over the preceding

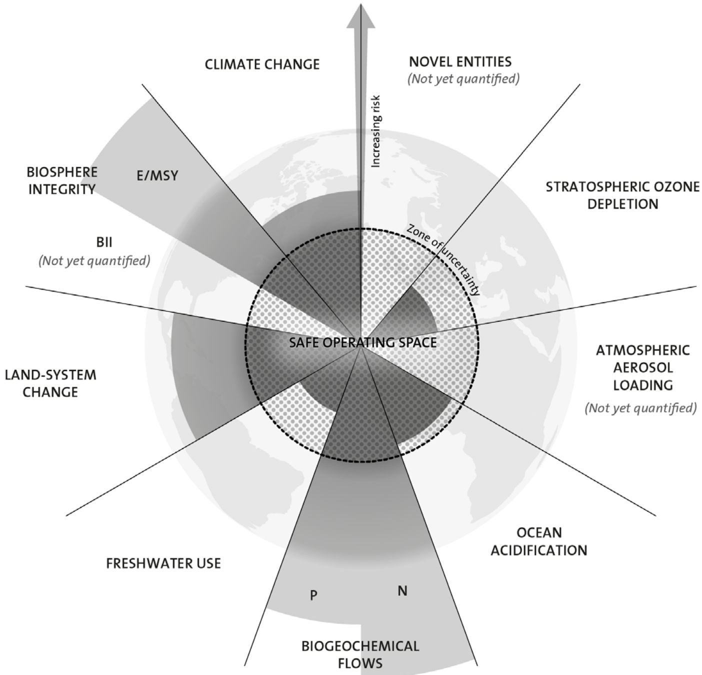

Figure 3.1 The Planetary Boundaries Diagram as a synchronizing device. The diagram summarizes the idea that the earth system has inbuilt boundaries, which must not be transgressed. The inner circle shows the safe operating space for nine planetary systems, while the darker wedges show estimated current positions for each variable. Although there are no numbers in the diagram, eight of the nine boundaries have been assigned a digit, for example 350 ppm for atmospheric CO_2. With rates and directions of change of the nine systems known, the diagram could also be read as a perpendicular "clock," synchronizing human-earth relationships in one single chart. The chart would then show how soon a boundary is likely to be reached. Or, for those earth system indicators where boundaries have already been transgressed, how soon the system can be brought within limits again, if effective environmental governance is provided. Credit: J. Lokrantz/Azote based on Steffen et al. 2015.

decades of the twentieth century. A case in point of one of the most significant achievements of Earth System Science is the idea of "Planetary Boundaries" published as an article in *Nature* in 2009 with many follow-up studies since then.[85] It argues that planetary stability can be subsumed under nine critical dimensions—such as rate of species loss, CO_2 levels in the atmosphere, ocean salinity, and six others—for which quantified boundaries are presented.

Each of the boundaries has been calibrated against a background of previous change and conclusions drawn from their past "performance." Their time scales of change differ wildly, and they did so in pre-Anthropocene, or even prehuman, times of (mostly) natural variability as well. The now emerging Anthropocene *Weltanschauung* builds significantly on environmental times identified and investigated in the past. More than that, without multiple environmental times established by previous work over generations, the idea would not have been conceivable. Hence, the planetary boundaries diagram with symmetry across all nine boundaries in a circular pattern can be readily seen as a *synchronizing and time-binding device*, a chart which brings on a seemingly uniform timescale to rates of change that actually differ considerably. Such devices are abundant in Anthropocene research where they serve the purpose of demonstrating, often in sharp, sometimes baffling detail how environmental times are predicated on human agency.

To understand these processes fully, and especially their interactions, it is required to pursue synchronizing work and to push it even further than the Planetary Boundaries chart, which is little more than a stylized sketch, suggests. That kind of work is necessary for us to understand more fully "the environment," "climate," and other major conditions of the world that humans inhabit and interact with. In fact, these conditions are now of such a major significance that we can consider their synchronization into a comprehensive understanding linked to human economic, social, and other processes of the planetary metabolism on a par with synchronizing "the world" and "global time" in preceding centuries. Ultimately, synchronization practices are necessary for humans to continue to inhabit the world where they are becoming more numerous, more mobile, and more demanding of resources and space for their *genres de vie*. The three waves of synchronization suggested here are neither exhaustive nor consecutive; there will surely be more waves articulated, and they will overlap to a larger or lesser degree. Their rationale may also be different. Environmental times and social times are rapidly becoming ever more integrated and both of them are times we cannot escape living in.

Sverker Sörlin is Professor of Environmental History in the Division of History of Science, Technology, and Environment at the KTH Royal Institute of Technology, Stockholm. His ongoing research includes the historical and contemporary science politics of climate change, the cryosphere, and the Anthropocene. He currently directs the European Research Council Advanced Grant project SPHERE (Study of the Planetary Human-Earth Relationship). Among his recent books are the coedited *Grounding Urban Natures: Histories and Futures of Urban Ecologies* (MIT Press, 2019), and *Ice Humanities: Living, Thinking and Working in a Melting World* (Manchester University Press, 2022).

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71. C. Warren Thornthwaite, "Modification of Rural Microclimates," in *Man's Role in Changing the Face of the Earth*, ed. William L. Thomas, Jr. (Chicago: University of Chicago Press), 567–83; Alisov, Drozdov, and Rubinstein, *Kurs*, quote on 570.
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Part II

BIOCULTURAL TIMES

⊱• 4 •⊰

Forest Time and the Passions of Economic Man

Julia Nordblad

Troubled Times

Our current moment of escalating degradation of the natural world and at best partial understanding of the dangers building up in the earth system destabilizes many of the languages we have for organizing and making sense of our lives and activities in time. One of the characteristics of this crisis is that it activates new timescales, particularly long-term timescales, often on different orders of magnitude compared to the ones that have been current in political and social institutions.[1] In matters of climate change, nuclear waste, and species extinction, the timescales at play range from tens of thousands years into eternity.[2] The tools we have for addressing them remain within the short-term however, such as legislatures and economic cycles. One of the challenges facing our societies seems to be whether we can reconstruct our political and economic systems and institutional frameworks so that they are able to encompass the kinds of timescales at play in the natural world and earth system, and thereby match the temporal reach of our technological, scientific, and industrial agency, and the aggregated effects of our societies' extractive and consuming behaviors. At the heart of this issue is the question of whether it is possible to extend the sense of connection, community, and responsibility in time and construct institutions that can responsibly govern times not only beyond the current election cycle, but beyond the present generation, times that reach into a deep future.

This problem appears in different versions in different academic disciplines. For example, philosophers have discussed the tyranny of the present as a kind of construction defect in democracy, and economists have used the concept of discounting to monetize the rate at which our bond to future people fades with temporal distance.[3] Increasingly, this problem has also become of interest for historians. For example, the works of Michelle Bastian, Duncan Kelly, and Deborah Coen convincingly demonstrate that how the problem of reconciling timescales has appeared in different historical contexts may inform our own historical moment. As it turns out, the problem of temporal disconnect has a history.[4]

The challenge of making the times of nature connect with political and economic time frames has been an important aspect of concrete political questions and has been recognized as such by actors in the past. This chapter takes us to one such context, namely the political struggle over the forest in early nineteenth century France, more specifically the debates preceding a new comprehensive forest legislation in 1827. These debates dealt explicitly with how the emerging economic and political time frames could be reconciled with the intrinsic long-term temporality of the forest. Interestingly for our purposes, this problem of reconciling clashing temporalities played out in part as a question of human emotions.

The French Forest Code of 1827

In the 1820s, the French forests were at a low point, both in terms of the surface they covered, and the condition they were in.[5] There had long been calls for a new forest legislation, and in 1827 such a law was passed. The 1827 Forest Code is generally regarded as a compromise between the state and private landowners at the expense of the peasant population who lost their long-established use rights to the forest. Traditional practices essential to rural populations' life support, such as collection of wood for fuel and grazing of cattle (often goats), were outlawed. All usages of the forest were now regulated by the law, enforced in the courts, and all forests belonging to the crown, the state, or the communes were put under the control of forest administration.[6]

The Forest Code is a prime example of how the history of the politics of nature as a resource is also social history. It represents an important step in the shift away from a relationship between society and nature in which the commons played a central role. In France, this was not a peaceful shift. John Merriman argues that the Forest Code of 1827 was part of a "significant social, economic, and political crisis in France that lasted from 1827 to 1832." And even if "the combination of a developing rural capitalism and a centralized, bureaucratic state, which protected and sponsored it, was winning its struggle with the French peasantry," that winning indeed took a struggle. The crisis sparked grain riots, tax rebellions, and, importantly, several revolts in forests around the country.[7] Most famous of these was the so-called *guerre des demoiselles* in the region of Ariège on the Spanish border where, as described in official reports, "groups of armed men, disguised as women," their faces painted in red and black, took to defending their traditional rights to the forest by threats and violence against forest guards and charcoal makers.[8]

The Forest Code was an important step in the introduction of rural capitalism, and the forcible integration of the peasant population into the new economy.[9] This conflict was articulated in the parliamentary debates preceding the passing of the new legislation, but it did not dominate it. In the National Assembly, the principal conflict was instead to what extent the state should be able to overrule the private land owners' property rights. Property rights were held high in the discussions, but the concern for the degrading conditions of the forests in the country and the supply of wood for the navy motivated the imposition of a twenty-year moratorium on the clearing of private forests, and a reinstatement of the old prerogative of the navy to purchase timber from private woodlands when deemed necessary. Apart from these two measures, the code reinforced the rights of private land owners.[10] But the Forest Code debates were about other things as well: not least, what the presumptions of the new liberal economic language were; what that language said about human nature and passions; and how this played out when a temporally idiosyncratic piece of nature was to be turned into a commodity. Also, just like all attempts to manage forests, the political project of creating a new forest legislation in 1827 confronted the politicians involved in it with the temporal otherness of trees.

Time of the Forest, Time of the Market

In the nineteenth century, as in previous ones, the glory and might of the French nation depended on a group of species that took its time. Trees—wood and timber—were a fundamental resource for France's military power, for private land owners, and the expanding iron industry.[11] Acutely, the forest was also a cornerstone in the life support of the peasant population, who used it for food, fuel, construction material, and pasturage. But trees were also the source of valuable symbolic power. Trees' incarnation of stability and endurance, their extension in time and transcendence of generations and centuries, their embodiment of a present rooted in the past and the projection of organic growth into the future may have been the reason for the delight in all things arboreal among French royalties of the seventeenth and eighteenth centuries. One of the more spectacular instances of this was the night in late February of 1745, when the French king Louis XV showed up at a ball to celebrate the marriage between his son the Dauphin of France and Maria Theresa, Infanta of Spain, dressed as a pruned yew tree. (This was also the night when the king met his future advisor and lover, Madame de Pompadour).[12] And as the old regime had tapped into the temporal otherness of trees to gain symbolic power, so did the new. With the revolution came an intensified need for practices and symbols that created legitimacy for the new political system, and projected its reach into the future. The revolutionaries cultivated a practice of planting "trees of liberty" at numerous places in the republic (some of them are still standing), and this practice was revived later, for example by the revolutionaries of 1848.[13]

Time is central to politics as an activity and mode of communal life, and doing politics is always a matter of governing time.[14] In politics concerned with the forest, this dimension is particularly present, given the forest's own transgenerational temporality that often disturbs or resists political temporal frameworks. Many of the trees that were most precious for human activities took centuries to reach the desired dimensions. Oaks for example, needed to stand for at least two hundred and fifty years.[15] The government of the forest as a resource meant to govern long timescales stretching over several generations. Against the sylvan longevity stood another temporality that had entered the minds and plans of the bourgeois and aristocratic men that made up the National Assembly, namely the temporality of the market. At this time, new theories put forward that the economic liberty of individuals was the most effective way of engendering riches in a country. In *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776) Adam Smith had famously argued that society as a whole would benefit if individuals were allowed to freely pursue their own economic interests. As a consequence, the market place, and by extension society as a whole, would spontaneously and benignly self-organize. Following historians of the subject, I refer to this idea as spontaneous order.[16] French liberals picked up on these ideas, especially the aspect of a strong protection of private property, which had ardent advocates in the National Assembly. Important to the purposes of this book, spontaneous order is also a type of temporality, one in which the aggregated unrestricted behavior of individuals replaces direct steering and planning. The dynamics of the market promise a future of balance in resource supply and order, if only private property and economic liberty are protected in the present.

The new ideas of spontaneous order and economic liberty that emerged out of the Scottish Enlightenment was a language of abstraction that equalized all phenomena and processes. But in the French National Assembly, everyone did not find this equalization entirely convincing. One of the central questions in the debates on the Forest Code was precisely whether the benign dynamics of spontaneous order was operable in the case of all commodities and resources, and in all areas of society and economy. More specifically, would it work in the case of the forest? The crucial factor that many feared could disturb the dynamics of spontaneous order was time. Did freedom of property really produce a stable future supply of a resource with such extraordinary temporal characteristics? Could individual land owners handle the timescales at play in the forest?

The refusal to take the specificities of the natural world into account was in effect one of the core characteristics of the new economic language of spontaneous order. As several historians of economic thought have drawn attention to, classical political economy seems early on to have rejected taking the restraints and limits of nature and the organic economy as its starting point. This is part of its break with earlier economic schools of thought such as the physiocrats, who built on the idea of agriculture as the sole genuinely productive factor, and are generally regarded as a cul-de-sac in a tradition of thought whose future supposedly lay in the theorizing of labor and industry.[17] Questions of limits were glaringly absent from the emerging new and powerful language of political economy. It is indeed ironic, Paul Warde argues, that the "photosynthetic constraints" of the organic economy played no role in this emerging body of thought: "classical political economy emerged precisely at the time when such limits were first becoming a matter of concern—and yet barely considered them."[18] The forest is a case in point. Emblematically, Adam Smith saw no reason to conceptualize wood in any different way than other commodities.[19] In contrast, Fredrik Albritton Jonsson argues that during the very same period the forest came to play a central and morally charged role for Scottish elites and natural historians as they discovered deforestation in the eighteenth century—hundreds of years after most of it happened. The loss of forests was interpreted as a moral failure as well as the cause of several of Scotland's problems including its rough climate, and wood was therefore a commodity of a specific patriotic and moral importance. As natural history and the emerging classical political economy parted ways, the forest question ended up on the side of natural history. Moreover, the forest was key in that very process of partition: "the anxiety about forest clearance thus served as a wedge that helped drive apart the enlightened sciences of natural history and classical political economy." This meant that "the same social and political forces that mobilized Scottish elites around the problem of deforestation rendered it invisible in Smith's *Wealth of Nations*."[20]

The emerging classical political economy was a language of abstraction, which disregarded intrinsic characteristics of natural and organic phenomena. In France however, this abstraction was met with skepticism from different directions. As we will see, Smith's most important disseminator in France, Jean-Baptiste Say (1767–1832), was not convinced by the exclusive focus on (human) labor as a productive force in Smith's theory, and the blindness for the value created by nature.[21] But Say also expressed skepticism towards what we might call Adam Smith's anthropology, his understanding of human nature and human motivation. The idea that trees could fit easily into a market model also met with suspicion in the National Assembly. Several deputies expressed concerns over the roles played by trees and forests beyond that of a resource: the forest filled sanitary and aesthetic functions, and it was also a stabilizing environmental factor, both as a protection against erosion and to maintain a favorable climate. Most interesting for our purposes however, was the temporal critique that different deputies articulated against the language of spontaneous order as applied to trees. Detailed concerns were raised over the operation of abstracting different timescales and subjecting them to the same market dynamic. These concerns were articulated with an eye to the specific long-term timescales of trees, but first and foremost targeted the particular understanding of driving forces of humans that underpinned the idea of market-induced spontaneous order. In other words, the question of time, the clashing temporalities of forest time and the time of the market, played out as a question of human emotions.

Emotions in History

For scholars in the humanities and social sciences, emotions have emerged as an important theme in relation to problems of climate change. Psychologists, behavioral economists, philosophers, and others have explained the lack of adequate responses to the knowledge of climate change in terms of human emotional responsiveness, psychology, or even nature.[22] Emotions have played a central role in scholarly discussions of the spectrum of climate change denial.[23] Academics have examined the role of fear and alarm, and the effects of psychological distancing mechanisms and other affective misfires in reaction to information about climate change.[24] The interest in emotions can be seen as a reaction to decades of focus on reason and rational deliberation as the basis for democracy and political behavior. This reaction has led to a revival in political theory of ancient questions of whether reason and emotions are to be understood as opposites, or on the contrary as intertwined and perhaps inseparable.[25]

Just like time, emotions have a history. The inquiry into the history of emotions rests on the idea that at least some aspect of our emotional life is dependent on culture, and thus subject to historical change.[26] This has proven a fruitful perspective not least for the study of political life in the past, and historians have explored such aspects as the style, expression, intensity, and role of emotions in different political contexts.[27] As I have already hinted at, human emotions play a central role in the early nineteenth century debates about the French forests. Here, I suggest that the most pertinent perspective is not to focus on the rhetorical use of emotions in the debates, and what that might mean, but rather to concentrate on the theories and ideas about emotions that were articulated and used in the debates.

As discussed, Adam Smith's new language of spontaneous order had entailed a simplification, which disregarded the specificities of the natural world. But it was not just the conception of nature that was simplified in this way, simplification also applied to a pre-existing nuanced language for the dynamics of human driving forces and motivations in social life. In a now classic book, Albert O. Hirschman traces the rather intricate history of this tradition, a sprawling but influential set of political problems that originated in a sixteenth-century reflection on statecraft. Two Renaissance ideas were of importance here: first, that disorderly human passions could be managed successfully only by a careful direction of other passions to countervail them[28]; second, the doctrine of the *ragione di stato* that the prince's person embodied the interest of the state.[29] During at least two centuries, philosophers combined elements of these two lines of thought and developed a vocabulary that opposed human passions to human interests. Successively and by twists and turns, the sin formerly known as avarice was rebranded as interest, and turned into something that was not only accepted but thought of as a benign force that could be deployed to hold back other, worse, passions.[30] Societal order could be achieved by letting money-making as a calculating and rational motivation keep in check other possibly incendiary and chaotic passions, such as the pursuit of glory or pleasure. This particular line of thought came to an end with Adam Smith, Hirschman argues.[31] In *The Wealth of Nations* Smith abandoned the distinction and dynamic between the passions and the interest, and instead constructed his economic theory around one sole human driving force: the "desire of bettering [one's] condition" by "an augmentation of fortune." By amalgamating interest and passions, Smith short-circuited the counter-weight tradition and thereby reconfigured the semantic field around these issues. For him, all passions and drivers of human action could be channeled and expressed through private acquisitive interest, which is a particularly calm and societally benign driving force that should—famously—be embraced and liberated.[32] Emma Rothschild argues for a similar interpretation of this aspect of Smith: for him, commercial judgment was a faculty that amalgamated reason and sentiment, nourished by the warm feeling of self-interest or self-love.[33]

But Adam Smith certainly did not settle the question of the passions and the interest once and for all. In the French debates on the forest legislation of 1827, the nature of that "desire of bettering [one's] condition" was a profoundly contested question. Also, with the new ideas on economic liberty that emerged by the late eighteenth century, the question of human character as a decisive factor in politics was no longer a matter of only the passions and interests of those in power, but it became an issue concerning people in general.[34] In the French forest debates of 1827, the issues of what kind of driving force the pursuit of economic gain really was, and how it affected the community, were issues very much under contestation.

The Pursuit of Material Gain, a Hot or a Cold Passion?

As mentioned, the Forest Code overruled the freedom of private property by two measures, first by imposing a twenty-year moratorium on land owners' right to freely clear their forests, and second by giving the navy the first right to select and buy timber from private sellers.[35] The dominating argument for these measures was that private forest owners were unreliable suppliers of timber of mature age. In the parliamentary debates, private land owners were frequently depicted as easy prey to uncontrolled impulses and temptations. Xavier Chifflet, ultraroyalist and member of the Chamber of Deputies' committee on the Code, lashed out against the liberty of the property owners as the cause of the wood scarcity currently plaguing France.[36] The property owners had misused their freedom, he argued, "they have abused it with an excess that has been fatal to the public interest, by carelessness, by false speculations, by this greedy haste to pleasure that characterizes our time."[37] Another deputy talked about a "clearing mania" that had stricken forest owners in the country.[38] The pursuit of private gain was identified not only as the cause of the current state of the French forests, this pursuit was also talked about as a stormy passion overwhelming individuals. The feelings surrounding private property were also rendered as potentially destabilizing politically. The conservative deputy Rey de Saint-Géry depicted these sentiments as ambiguous, and susceptible to easy political tricks: "nothing is easier than to strike a chord as sensible as the love and independence of property; nothing is sweeter to man than the possibility to do what pleases him, and nothing appears more difficult to him than to be disturbed in the use of his property."[39] But to live in a society, he explains, one must suppress, or at least harness, such feelings.

Against the image of tormented land owners unable to resist the desire for quick profit, other deputies defended the sanctity of private property by painting its emotional underpinnings in very different colors. Horace François Bastien Sébastiani—former general in Napoleon's army, and soon to become minister in the bourgeois July monarchy that followed on the July revolution in 1830—argued that the premature felling of trees only emerged out of a state disturbance of private owners' natural instincts. If left to his own judgment, the land owner would be guided by his paternal instincts that would make him see ahead and let his trees stand to grow tall. His motivation for this was the future material benefit of his children. It was on these grounds that Sébastiani opposed all restrictions on the land owner's right to do as he pleased with his forests. "Why," Sébastiani rhetorically interrogated his peers: "do you assume that he has such lack of foresight for his children? Have more confidence in his paternal solicitude, and watchfulness."[40] The problem that today's philosophers sometimes refer to as intergenerational buck passing, the temptation to leave environmental costs and problems to future people, could in Sébastiani's eyes be avoided by keeping the generational bond private: nobody would deprive his own children of wealth and property for his own good.[41]

For Sébastiani, the good society was a calm society in which individuals could plan for their families and property. Politically, this calmness was achieved simply by not governing and not administering, since it is "by wanting to govern too much that [the government] lets this inconvenient multitude of laws gush," and it was "by stirring up itself that the government stirs up society." Such agitation in turn destroyed the calm and preserving force of private interest: "by wanting to over-administrate, [the government] penetrates into the lives of the families and substitutes the interest of the private individuals."[42] Sébastiani defended a position close to the one defended by Edmund Burke in *Reflections on the Revolution in France* (1790): that private property and especially the transfer of that property across generations in the form of inheritance constituted an essential cohesive and stabilizing force in a society.[43] The freely pursued material interest was here imagined to produce order and tranquility in society. Purposefully or not, Sébastiani tapped into a tradition of conceptualizing the desire for wealth as a particularly calm passion, characterized by its calculation and rationality, and thus having a stabilizing effect on society in the long term.[44] The deputy de Saint-Géry expressed a similar view: private property must be protected from state interference in order to safeguard his natural propensity for foresight, "with which an individual naturally complies, when he wishes to put his affairs in order."[45] For de Saint-Géry, Sébastiani, and others like them, individuals were calculating and farsighted, if only left to their own devices, and private property thus had an orderly influence, cooling the heads of men.

In the debate, the differing views on what status private property should have in society seems closely intertwined with the question of what kind of passion the pursuit of material interest really is. What forces drive and structure individuals' economic behavior? Under the surface of the Forest Code debate brewed the question of whether the pursuit of private gain is, so to speak, a hot or a cold passion. Is it an incendiary drive that takes over man and makes him act blindly; or is it a cooling force, composing man and making him calculate and see clearly. The question has a distinct temporal component: does material interest render man farsighted and prone to planning, or wildly rapacious and blind for anything beyond immediate satisfaction? This problem greatly worried many of the participants in the debates: how would an individual land owner typically understand and act when left to plan his own future, thereby unknowingly deciding the future of the nation as a whole. Many deputies expressed a fear that individual land owners would be blinded by a desire for quick economic gain, and thereby cause severe problems for the country—if not its outright ruin. The question of whether material interest was a wild passion or a cool and calculating mode, whether it made men shortsighted or planning, informed the conflict over the liberal idea of spontaneous order, that individual material interest would somehow merge into a greater good on a societal level.

The Qualities of Passionate Time

The language of passions was also permeating the report on the Forest Code crafted by the special parliamentary committee charged with examining it. In a long historical overview of the forest legislation in France the report argued that the crucial mistake over the decades had been to believe that the land owner's "interest is a guide that will not lead him astray: he will not tear up his trees unless with the hope of a better product." Experience had now proven this idea wrong, the report stated, and it has instead turned out that "the hope of increased revenues has thrown many forest owners into the clearing mania." Stricken with this mania, land owners had logged forests without informing themselves properly and "without checking the nature and position of the soil," with the result that not even "trees sitting on mountain slopes have escaped this kind of legal devastation." The consequences had been ruinous, the committee argued: fertile soil had eroded in many areas, and land owners "have seen their property, which not long ago was productive, *suddenly* stricken with *eternal* barrenness."[46]

The committee in this way depicted the land owners' miscalculated shortsightedness as caused by a failure to keep the passions in check. The wording suggests a rapacious material motivation, a voluptuous shortsightedness to which a moment of surrender results in a destruction from which there is no turning back. The question of time is here a matter of government of the passions, and forest time appears as an almost insurmountable challenge to human self-control. Further, the passage paints a striking contrast between the suddenness with which the land is changed, and the eternity of devastation. It suggests a temporal quality in which the short and the long term are connected in a specific way. Moments unfold into eternities, and abrupt outbursts of human greed can cause irreparable and infinite damage to the natural processes that guarantee that humans can support themselves, that societies can prevail and prosper.

The argument that the management of forest time, as intergenerational and fragile, cannot be entrusted to individual property owners and their material driving forces suggests a conception of long-term forest time as something qualitatively different from short-term time as opposed to just more of it. Forest time is not just many short time spans added up, but qualitatively specific, intrinsically long-term time. Forest time is nonscalable in Anna Tsing's sense of the term. In her vocabulary, the concept of scalability denotes the possibility to "change scales smoothly without any change in project frames."[47] For Tsing, expansion through scalability has been a prominent feature of capitalist modernization.[48] This is certainly also true in terms of temporality. Market time is scalable in that it can be expanded without adjustment of any of the mechanisms that govern it. The temporality of spontaneous order presupposes scalable and linear time, one in which the market governs all commodities in the same way, whether they take a day or a century to produce. In contrast to this stands the kind of temporality that the parliamentary committee suggests, one in which a moment of folly can unleash an eternity of barrenness.

The Moratorium as Temporal Politics

To sugarcoat the meddling with private property, the Forest Code deployed a specific politics of time, namely a moratorium, a time-limited freeze of private land owners' clearing rights.[49] Arguing that the restrictions on property freedoms were only momentary, the parliamentary committee pointed to a future in which such measures would no longer be necessary, since the economic agents of the future would be better informed and have stronger self-control. Combined with the general progress in agricultural and technological methods, the practices of more virtuous and wise land owners would substantially decrease the pressure on the French forests. This "happy future" would bring "a better type of exploitation, better educated agents, reforestations executed with care and discernment, the abundance of our coal mines, the decrease in fuel use due to new processes, the construction of new canals and roads making possible a more equal distribution of our forest products; and finally, the ever growing progress in agriculture, arts and sciences."[50] The moratorium was used as a way of suspending the inviolability of private property without having to abandon it in principle. This principle was instead moved to the future: it would be put into practice when technological development and the characters of the land owners had sufficiently matured.

Not everyone in the National Assembly shared the fundamentally Enlightenment expectation that the sheer passing of time would bring not only technological advancement but also progress of mores and human character. The royalist deputy of Doubs, the marquis de Terrier-Santans, did for example argue along those lines that the devastation of the forests must be stopped, or else "we will see in this country, as in all others, the destruction of forests march with civilization, and that the wood is inversely proportional to the needs of man; because the more industrious they are, the more they cut down, the more eager they become to seek pleasure."[51]

The advancement of civilization risked coming at the prize of the devastation of nature, and this was due to the increasing desire for pleasure that rising industriousness brought about. In de Terrier-Santans' view, civilization did not bring about a more well-tempered and farsighted character, but on the contrary fed a self-destructing insatiability. There was nothing calm about the pursuit of material advancement; on the contrary, it drew with it and fueled limitless pleasure seeking, and would not stop unless made to. De Terrier-Santans also raised the issue of the relationship between civilization and nature, which was yet another point of contestation in the Assembly. As a mirror image of de Terrier-Santans's argument, Sébastiani held up the countries with the largest and most powerful fleets as examples to follow: "in England there are no forests anymore; and none in Holland. We have to admit, gentlemen, that the great forests are a certain sign of barbarity and poverty." At this point, the parliamentary protocol reports murmur from the chamber. "As countries move forward in civilization they abandon the big woods and instead use isolated plantations that the cultivation of the soil and the fertilizers will quickly develop."[52] For Sébastiani progress simply meant ceasing to see the forest, and instead to start calculating the value of the trees.

Private Time, Common Time

The debates in the National Assembly in the 1820s were also a debate about the relation between particular and common interest, often expressed as a question about the proper role of the state vis-à-vis the freedoms of the individual, or about the real effects of monarchy. These themes are well covered in political and intellectual historiography, but the forest question adds a new dimension to this familiar territory, and rearranges its topography. Repeatedly, the deputies that debated the new Forest Code recognized that the dynamics between the private and the common interests had an important temporal dimension. The future and the long term were presented as analogous to the common interest, and the present and the short term to the individual interest. So did Antoine Bonnet de Lescure, for example, preface his discussion of the Code with the remark that all his comments would "have as their object the defense of the state against the private interests, and the needs of the future against those of the present."[53] This trope was perhaps most elegantly turned by the baron du Teil, who put forward the notion that the present is private whereas the future is collective: "it is only with pain that the individuals sacrifice the present, which is entirely theirs, for a future, which is really something only for the masses."[54] Another iteration of the idea that forest temporality was to be understood as inalienably communal was expressed by the former minister Sylvère Gaye de Martignac, director general of the *Enregistrement* (the body responsible for collecting dues on properties owned by the state).[55] Addressing the issue of whether the forests owned as commons by the municipalities could be divided and shared among the inhabitants of the municipality in question—a procedure that had been practiced during the revolution—he made the case for transgenerational ownership as necessarily nonprivate: "the properties of the communes belong to the inhabitants of the commune, and not to the present generation. The generations following on each other are successively its usufructuaries: it is a perpetual replacement that should last as long as the commune. Consequently, none of the passing generations have the right to change this right and constitute itself as proprietor in its private authority."[56]

The minister of the navy, Christophe Chabrol de Crouzol, defended the navy's prerogative to overrule private land owners' rights to sell to whoever they wanted. He held that only the king and nobility could in effect be farsighted enough to plant and care for forests, and thus effectively exercise concern for the future. Since the revolution, shortsightedness had reigned. Chabrol continued by identifying the calculations of profit as a force that overtakes all other motivations and "have entered even the projects of embellishment and pleasure. Only trees that are expected to be cut are planted, and pleasure is taken, as it were, in disinheriting those who come after us." For Chabrol, the calculated pursuit of material interest was opposed to other human sensibilities, such as prudence and the aesthetic appreciation of beauty. The individual calculating mode did not aggregate a farsighted and spontaneously ordered temporality, but was precisely the force that leads to devastation. In a language that mixed spatial and temporal images, Chabrol advanced the view that small-scale private forest owners could not generate a common good and a prosperous future for the nation by following their own interests and private temporalities: "one does not look into the future, because everyone traces a circle for himself, and makes it as narrow as possible."[57] As discussed, this view did not go uncontested: deputies like Sébastiani on the contrary held that responsibility for the future and the long term could only spring from private considerations.

Jean-Baptiste Say's Rare Exceptions

We have seen above that several deputies, and the parliamentary committee charged with the Forest Code, expressed the view that the failure to control one's own passion for material gain caused individuals to be shortsighted and miscalculate their own interests—or to calculate them correctly but to the detriment of the community. This fear also caused headaches beyond Parliament, not least for the well-known economic thinker Jean-Baptiste Say. The first professor of political economy at the *Collège de France*, Say was equally a businessman, a foreign member of the Royal Swedish Academy of Sciences, and a prolific writer, and he is today held by many to be the most prominent French classical political economist.[58] Say was an early reader of Adam Smith, and introduced many of his economic ideas in France. Like Smith, Say believed that the dynamics of the market could by itself create beneficial outcomes for society as a whole, and it was therefore important to guarantee economic freedom and protection of private property. Yet, Say was not an uncritical disseminator of Smith's economic theories. In contrast to Adam Smith's sole focus on labor as a generator of value, Jean-Baptiste Say repeatedly underlined the productive role played by nature in society and the economy: "when one tears down a tree, nature's spontaneous product, does not society then acquire a product superior to what only the industry of the woodcutter can produce?"[59]

Further, Say did not believe that private property should be protected in all situations, but that there were cases when it was beneficial for the state to interfere in the relation between an individual and his property. In his 1826 fifth edition of the *Traîté d'économie politique*, published a year before the Forest Code was passed in the National Assembly, Say listed a number of such exceptions to the otherwise fundamental principle of the inviolability of private property. Strikingly, one of the "excessively rare" cases Say brought up was forest management. Why forests? The reason Say gave was the important functions forests filled for societies: "the necessity to provide society with timber for the navy or wood that it cannot do without, makes regulations of clearings of private forests tolerable."[60] Because of their vital role for society, the government of forests could not be completely left to the individual land owner's calculated interest. But it is not convincing that the central role of wood for the national economy was the only reason for Say to exempt silviculture from his otherwise liberal economic principles. Other goods and resources played a similar essential role in the economy—grain for example—but are not on his list of exceptions. The next case on his list concerned mining, and it might give us a clue about the principal rationale behind the exceptions. Say argued that it is beneficial for the state to interfere with private property in cases when a land owner deploys mining methods on his property that exploit shallow reserves in a way that makes it impossible to later reach deeper lying and possibly more valuable findings.[61] Say described this type of miscalculation as being triggered by "an overly impatient greed."[62] Crucially, Say here pointed to weakness in character and deficiency in moral stamina and self-control as motivating state meddling with private land. It is plausible that this kind of human weakness is the underlying problem that Say is addressing by providing exceptional restrictions to the principle of property rights. In fact, the third of Say's three examples also points to inadequate character as the implicit risk that state interference should hold back.[63] Difficult to digest for a modern reader, Say's third exception concerns slavery, in which case he argues that: "in the countries that recognize the unfortunate right of man on man, a right that harms all others, certain limits are nonetheless posed to the power of the master over the slave."[64] In 1826, France was again among the countries recognizing that "unfortunate right," allowing racialized enslavement of humans in its Caribbean colonies.[65] This case is vexing, and would alone deserve extensive discussion that cannot be provided here. But seen in the light of Say's position on slavery and engagement in the abolitionist movement, this case of legitimate state interference could be understood as pointing in the same direction as the cases of silviculture and mining. A popular argument among those opposing slavery at the time was that it should be abolished because it was less profitable than free labor. Slavery was held up as a kind of miscalculation and an effect of an inefficient mercantile economic system.[66] This view—famously advocated by Adam Smith—did not convince Say, who in his *Traîté* calculated that an enslaved worker was in fact more profitable than a free one, but that slavery should be abolished anyway because it was immoral.[67] For Say, the matter was "not only a question of at what price you can make a man work, but at what price you can make him work without offending justice and humanity."[68] The interaction between and effects of moral arguments and economic calculation in the long debate over French slavery is an intriguing question.[69] Here, I will however content myself with observing that Say's intervention in that debate reinforces the argument that for him, other values such as moral considerations or environmental functions might be at odds with economic interests. Therefore, not all desires and sentiments could in fact be channeled into material gain seeking, and thereby aggregated to produce a societal outcome for the benefit of all.

In line with this, I argue that the rationale behind Say's exceptions—including the case of the forest—is that there are limits to the human capacity of self-control and farsighted economic sentiments, and that this has to be reflected in the laws that regulate economic life. For Say, the protection of private property and principled liberty of economic activity were not sufficient to produce a benign outcome for society as a whole.[70] And the cause of this was the individual's flimsy capacity to navigate and control his own driving forces and desires. In the mining example, the landowner's freedom had to be circumscribed so that he did not give in to the "overly impatient greed."[71] For Say, just as for some of the deputies in the National Assembly, economic agents were easily overtaken by their material desires. And again, this risk was amplified in the case of forests.

Further, in the light of other passages in the *Traîté* where Say discussed wood, his defense of state control over sylvan matters could be interpreted as having to do with time. In one such passage, Say argued that trees have a specific advantage as economic assets in that the production of wood is "almost entirely the work of nature." If the tree had only been planted, it would eventually reimburse man with "the treasure of its wood." But there was one condition: "the tree asks of man only to be forgotten for some years."[72] Say described the challenge in managing this as a temptation: "one must not be tormented by desire to cut down [the tree]." It thus seems plausible that to forget the tree, in Say's words, is a matter of virtue and resisting desires—just as in the mining example.[73] The virtue of forest management lies in the ability to adapt oneself to nature's temporality, to willfully forget, wait, and let time do its job. In Say's *Traîté*, just as in many of the arguments presented in the National Assembly, the forest appears as a failed gigantic marshmallow test for economic men coming of age.

Emotional Temporalities

Today, the complexity and unprecedentedness of the climatological and ecological processes in motion pose an extraordinary challenge to us in terms of understanding them: how they are interconnected, what dimensions of human and societal life they concern, and the historical trajectories that brought them about. In this work, history can inform how we perceive and understand these problems, and thus, hopefully, how we formulate responses to them. The nineteenth-century discussions treated in this chapter show that the problem of reconciling clashing temporalities is not new. The challenge of how to connect the times of the natural world with political and economic times has a history of its own. In the past, the forest question confronted politicians and economists with a radically different timescale and temporality that forced them to articulate their view on whether the long term changed anything in the economic and political mechanics that structured society, whether their economic and political theories were temporally scalable or not. But not only that, the forest question was thematized as a problem that connected the question of time to that of human passions and character. What the 1820s debates reveal to us is that the question of how nature's temporalities relate to cultural temporalities has been closely intertwined with the question of who the human is, what drives and moves her, what incites her to seek immediate satisfaction, or to organize her actions on a long timescale. The French parliamentarians from two hundred years ago offer us questions of how time and emotion relate to each other, and they propose and deliberate answers to those questions. Although the law that the National Assembly was debating and passing was a hard blow on the peasant population and its often much gentler and sustainable uses of the forest as a commons, and although many of the deputies represented a worldview utterly alien to modern political sensibilities of meritocracy and equality before the law, the questions they posed, and the ways they turned the relationship between the temporalities of the market and the natural world in a language of human emotions constitute, I think, a lesson in how the reconciliation of times can be approached. A lesson that should interest us in our moment of ecological insecurity and danger.

Julia Nordblad is Associate Senior Lecturer at the Department of History of Science and Ideas at Uppsala University. She has been a visiting researcher at the EHESS, and a visiting fellow at the Max Planck Sciences Po Center on Coping with Instability in Market Societies, in Paris. She works on different historical aspects of the contemporary ecological crisis, especially its temporal dimensions. Her essay "On the Difference between Anthropocene and Climate Change Temporalities" recently appeared in *Critical Inquiry*.

NOTES

1. Michelle Bastian, "Fatally Confused: Telling the Time in the Midst of Ecological Crises," *Environmental Philosophy* 9, no. 1 (2012): 23–48; Bill McKibben, "Worried? Us?" *Granta* 83 (2003): 7–12; Deborah R. Coen, "Big is a Thing of the Past: Climate Change and Methodology in the History of Ideas," *Journal of the History of Ideas* 77, no. 2 (2016): 306–8.
2. Deborah B. Rose, Thom van Dooren, and Matthew Chrulew, "Telling Extinction Stories," in *Extinction Studies: Stories of Time, Death, and Generations*, ed. Deborah B. Rose, Thom van Dooren, and Matthew Chrulew (New York: Columbia University Press, 2017), 8–10; Dipesh Chakrabarty, "Anthropocene Time," *History and Theory* 57, no. 1 (2018): 22; Peter U. Clark et al., "Consequences of Twenty-First-Century Policy for Multi-Millennial Climate and Sea-Level Change," *Nature Climate Change* 6, no. 4 (2016): 360–69.
3. Dale Jamieson, *Reason in a Dark Time: Why the Struggle Against Climate Change Failed and What It Means for Our Future* (Oxford, UK: Oxford University Press, 2014), 132, and the chapter "The Limits of Economics," 105–43.
4. Duncan Kelly, *Politics and the Anthropocene* (Cambridge, UK: Polity Press, 2019); Bastian, "Fatally Confused"; Coen, "Big is a Thing of the Past."
5. Kieko Matteson, *Forests in Revolutionary France: Conservation, Community, and Conflict, 1669–1848* (Cambridge, UK: Cambridge University Press, 2015), 159.
6. John M. Merriman, *History on the Margins: People and Places in the Emergence of Modern France* (Lincoln: University of Nebraska Press, 2018), 4.
7. Merriman, *History on the Margins*, 2.
8. Merriman, 7–8; Peter Sahlins, *Forest Rites: The War of the Demoiselles in Nineteenth-Century France* (Cambridge, MA: Harvard University Press, 1994), ix.

9. Merriman, *History on the Margins*, 2.
10. Merriman, 197; Sahlins, *Forest Rites,* 18–19; Curtis Sarles, "The Instatement of Order: State Initiatives and Hegemony in the Modernization of French Forest Policy," *Theory and Society* 35, no. 5/6 (2006): 573–74, 577–80.
11. Sahlins, *Forest Rites,* x; Matteson, *Forests in Revolutionary France*, 161.
12. Giulia Pacini, "The Monarchy Shapes Up: Arboreal Metaphors in Royal Propaganda and Court Panegyrics During the Reign of Louis XV," *Journal for Eighteenth-Century Studies* 39, no. 3 (2016): 431, 442.
13. Giulia Pacini, "Arboreal Attachments: Interacting with Trees in Early Nineteenth-Century France," *Configurations* 24, no. 2 (2016): 176; Erik Fechner, "L'Arbre de la liberté: Objet, symbole, signe linguistique," *Mots* 15 (1987): 41.
14. Kari Palonen, "Political Times and the Rhetoric of Democratization," in *The Ashgate Research Companion to the Politics of Democratization in Europe: Concepts and Histories*, ed. Kari Palonen, Tuija Pulkkinen, and José María Rosales (New York: Routledge, 2008), 151.
15. Joachim Radkau, *Wood: A History*, trans. Patrick Camiller (Malden: Polity Press, 2012), 176.
16. Evelyn L. Forget, "Jean-Baptiste Say and Spontaneous Order," *History of Political Economy* 33, no. 2 (2001): 193. Forget makes a clear distinction between the two parts of this idea: the notion that the marketplace self-organizes on the one hand, and that the self-organizing market leads to the emergence and evolution of social institutions, on the other. For the purposes of this chapter it is not necessary to observe that distinction.
17. Catherine Larrère, *L'Invention de l'économie au XVIIIe siècle: Du droit naturel à la physiocratie* (Paris: Presses Universitaires de France, 1992), 5–6.
18. Paul Warde, *The Invention of Sustainability: Nature and Destiny, c. 1500–1870* (Cambridge, UK: Cambridge University Press, 2018), 266.
19. Fredrik A. Jonsson, "Adam Smith in the Forest," in *The Social Lives of Forests: Past, Present and Future of Woodland Resurgence*, ed. Susanna B. Hecht, Kathleen D. Morrison, and Christine Padoch (Chicago: University of Chicago Press, 2013), 52.
20. Jonsson, "Adam Smith in the Forest," 45.
21. François Vatin, "Le produit de la nature et le temps des hommes: Don, service et rendement," *Revue du Mauss* 42, no. 2 (2013): 228.
22. See for example Stephen M. Gardiner, *A Perfect Moral Storm: The Ethical Tragedy of Climate Change* (Oxford, UK: Oxford University Press, 2011); Per E. Stoknes, *What We Think About When We Try Not to Think About Global Warming: Toward a New Psychology of Climate Action* (Vermont: Chelsea Green Publishing, 2015).
23. Kari M. Norgaard, "Making Sense of the Spectrum of Climate Denial," *Critical Policy Studies* 13, no. 4 (2019): 437–41.
24. Susanne C. Moser and Lisa Dilling, "Communicating Climate Change: Closing the Science-Action Gap," in *The Oxford Handbook of Climate Change and Society*, ed. John S. Dryzek, Richard B. Norgaard, and David Schlosberg (Oxford, UK: Oxford University Press, 2011); Jennifer Jacquet, *Is Shame Necessary?: New Uses for an Old Tool* (London: Penguin Books, 2016); Stoknes, *What We Think About*.

25. For a critical overview of the return of the question of reason and emotion in democratic theory, see chapter 3 in Cheryl Hall, *The Trouble with Passion: Political Theory Beyond the Reign of Reason* (New York: Routledge, 2005).
26. For many in this field, the history of emotions promised a possibility to build scholarly work in the humanities on firm scientific grounds, and that historical studies could be combined with a neurological understanding of the nature of emotions. As it has turned out, this project proved to be if not unmanageable then at least more difficult to navigate than expected. The question of how human emotions should be understood biologically and neurologically seems far from solved, and this complicates matters for historians who wish to start from the scientific state-of-the-art. For a thorough and clarifying analysis of this problem, see Ruth Leys, *The Ascent of Affect: Genealogy and Critique* (Chicago: University of Chicago Press, 2017).
27. Ute Frevert, *Emotions in History: Lost and Found* (New York: Central European University Press, 2011); Jan Plamper, *The History of Emotions: An Introduction* (Oxford, UK: Oxford University Press, 2012), especially the chapter "Perspectives in the History of Emotions," 276–93.
28. Albert O. Hirschman, *The Passions and the Interests: Political Arguments for Capitalism Before Its Triumph* (Princeton: Princeton University Press, 1977), 24–27.
29. Hirschman, *The Passions and the Interests*, 33–35.
30. Hirschman, 32, 42.
31. Hirschman, 93.
32. Hirschman, 66, 107–9.
33. Emma Rothschild, *Economic Sentiments: Adam Smith, Condorcet, and the Enlightenment* (Cambridge, MA: Harvard University Press, 2001), 27.
34. Hirschman, *The Passions and the Interests,* 69–70.
35. Matteson, *Forests in Revolutionary France*, 197.
36. Matteson, 193.
37. Marie Bénigne Ferréol Xavier Chifflet d'Orchamps, Chambre des députés, March 20, 1827, tome 50, 448. All subsequent references to parliamentary sources refer to the *Archives parlementaires, recueil complet des débats législatifs et politiques des Chambres françaises de 1800 à 1860. 2e série, 1800–1860*, ed. Jérôme Mavidal (Paris, 1882). Information about the biographies and political careers of French members of Parliament come from the National Assembly website, *Base de données des députés français depuis 1789*, retrieved October 6, 2021 from http://www2.assemblee-nationale.fr/sycomore/recherche.
38. Parliamentary committee's report, March 12, 1827, tome 50, 230.
39. Jean Jacques Augustin Rey de Saint-Géry, Chambre des députés, March 21, 1827, tome 50, 455.
40. Horace François Bastien Sébastiani, Chambre des députés, March 20, 1827, 431.
41. See for example Gardiner, *A Perfect Moral Storm*, especially chapter 5 "The Tyranny of the Contemporary."
42. Sébastiani, Chambre des députés, March 20, 1827, 429.
43. Edmund Burke, *Reflections on the Revolution in France* (1790), ed. Frank M. Turner (London: Yale University Press, 2003), 44.

44. Hirschman, *The Passions and the Interests,* 65.
45. de Saint-Géry, Chambre des députés, March 21, 1827, 454.
46. Parliamentary committee's report, March 12, 1827, tome 50, 230. Emphasis added.
47. Anna L. Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton: Princeton University Press, 2015), 38.
48. Tsing, *The Mushroom*, 40.
49. Matteson, *Forests in Revolutionary France*, 197, 203.
50. Parliamentary committee's report, March 12, 1827, tome 50, 230.
51. Marie Antoine Charles Suzanne de Terrier-Santans, Chambre des députés, March 20, 1827, tome 50, 458.
52. Sébastiani, Chambre des députés, March 20, 1827, tome 50, 430.
53. Antoine Bonnet de Lescure, Chambre des députés, March 20, 1827, tome 50, 436.
54. Marie Césaire Du Teil, Chambre des députés, March 20, 1827, tome 50, 435.
55. Matteson, *Forests in Revolutionary France*, 147, 193.
56. Matteson, 133–35; Jean-Baptiste Sylvère Gaye de Martignac, Chambre des députés, March 28, 1827, 582.
57. Christophe Chabrol de Crouzol, Chambre des députés, March 31, 1827, 662.
58. Evert Schoorl, *Jean-Baptiste Say: Revolutionary, Entrepreneur, Economist* (New York: Routledge, 2013), 19.
59. Jean-Baptiste Say, *Traité d'économie politique, ou simple exposition de la manière dont se forment, se distribuent et se consomment les richesses*. Tome 1. 5th ed. (Paris: Rapilly, 1826), 39; Vatin. "Le produit de la nature et le temps des hommes," 227.
60. Say, *Traité d'économie politique*, Tome 1, 171.
61. Say, 171–72.
62. Say, 172.
63. Say discusses the three cases in an order different than presented here. He also mentions two other cases, taxation and interference with private property for reasons of public safety. Say, 170–73.
64. Say, 171–72.
65. After the world-changing events in the colonies during the French revolution, when the enslaved of Saint-Domingue revolted and liberated themselves in 1791 and made France abolish slavery in 1794, Napoleon reinstated it in 1802, which eventually led to his defeat in Saint-Domingue, and the subsequent proclamation of Haiti as an independent state in 1804. Slavery persisted in the remaining French colonies until 1848. Laurent Dubois and John D. Garrigus, *Slave Revolution in the Caribbean, 1789–1804: A Brief History with Documents* (New York: Bedford/St. Martins, 2006), 197–99.
66. Caroline Oudin-Bastide and Philippe Steiner, *Calcul et morale: Coûts de l'esclavage et valeur de l'émancipation (XVIIIe–XIXe siècle)* (Paris: Albin Michel, 2015), 104–8.
67. Say, *Traité d'économie politique*, Tome 1, 357–64.
68. Say, 363.
69. See Oudin-Bastide and Steiner, *Calcul et morale.*
70. This more general argument is also presented by Evelyn L. Forget in "Jean-Baptiste Say and Spontaneous Order," 200.
71. Say, *Traité d'économie politique*, Tome 1, 172.

72. Say, 162.
73. Say, 161.

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5

Little Red Ring Binders

Early Red List Temporalities

Marit Ruge Bjærke

In 2019, the UN Global Environmental Outlook report stated that "a major species extinction event, compromising planetary integrity and earth's capacity to meet human needs, is unfolding."[1] However, already in the early twentieth century, a number of scientists were expressing concern about the extinction of other species by humans, and these concerns were an important part of the background for the establishment of organizations such as the International Union for the Protection of Nature (today, the International Union for Conservation of Nature [IUCN]) in 1948 and their production of the first lists of threatened species.[2]

The discourse on biodiversity loss has never been solely a scientific discourse. It is entangled with politics, values, and the expectation of large-scale future consequences. This also means that a number of different understandings of time are at play within the biodiversity discourse. Although the idea of a massive, ongoing loss of biodiversity and the production of threatened species lists are based on information on geological, evolutionary, and ecological timescales, historical and political timescales play important roles as well.[3] Also, during recent decades, understandings of biodiversity loss have become closely intertwined with the expectation of future climate change, adding yet another set of temporal logics to the bargain.[4]

Since threatened species lists have such a complex temporal background, these lists may reveal multiple ways in which people have tried to grapple with time and the relation between past, present, and future, when faced with environmental problems. Different temporal logics can be found within the lists themselves, within the media the lists are presented through, and within the technologies and practices of which the lists are parts.

In her book *Imagining Extinctions,* Ursula Heise claims that there is a narrative structure of elegy and "a focus on nature in decline, on decrease, disappearance, and the past" in Red Lists, although the elegy is intermingled with encyclopedic and epic genre components.[5] Heise suggests that in the endangered species discourse there is an ongoing shift away from the elegy and toward the epic and encyclopedic elements.[6] Focusing on the temporal logics of the genres Heise discusses, I will argue that an epic temporal pattern, with its present heroic struggle toward a future goal, was a more important part of the early discourse on threatened species than the elegy, the focus being toward the present and the near future, rather than toward a lost past.

The history of contemporary threatened species databases and Red Lists can be traced back to the late nineteenth and early twentieth century, while the first lists of threatened species were compiled in the 1940s.[7] Studies of the technologies of the discourse on threatened species have, however, mostly concentrated on contemporary and near contemporary versions of electronic biodiversity databases and lists of threatened species. In this chapter, I will instead explore threatened species lists and documents from an earlier part of the discourse on biodiversity loss, namely the period from 1950 to approximately 1980. Arguing that how threatened species lists were designed and presented affects what meanings were produced, I investigate the temporal logics that can be found within the texts themselves and within the textual media of early threatened species lists. Both media and paratexts, such as titles and the placement of certain species or categories of species, can indicate what temporal scales and time frames were considered important and how these understandings influenced and were influenced by the gathering and sorting of knowledge.[8] Uncovering the temporalities of the early biodiversity discourse may also provide a richer historical background to understanding the relations between past, present, and future in environmental discourses today.

The IUCN Red List—A Short Background

There are several different lists and databases of threatened species around the world, but the most influential and broadly known is the IUCN Red List™, compiled by the International Union for Conservation of Nature (IUCN).[9] Today, the IUCN Red List is a web-based information system, which is updated with new information and new assessments approximately twice a year. According to their own website, the IUCN Red List is "the world's most comprehensive information source on the global conservation status of animal, fungi and plant species," and it contains the conservation status of more than 96,900 species. About 26,500 of these are considered to be threatened with extinction.[10] The criteria and guidelines behind the IUCN Red List are used extensively, both for global assessments of biodiversity and for producing regional and national Red Lists.

IUCN was established in 1948 as the International Union for the Protection of Nature (IUPN).[11] Martin Holdgate, in his book *The Green Web: A Union for World Conservation* dates the beginning of the conservation movement back to the early nineteenth century and relates it to three sources: romantic views on nature, scientific explorations of the natural world, and the decline and extinction of specific wild species; whereas William M. Adams has stressed the influence of colonial interests in the hunting of big game on the African continent.[12] The conservation movement was centered in North America and Europe, and two early forms this movement took were national societies for the protection of certain species groups, such as birds, and the creation of national parks and nature reserves.[13] From the end of the nineteenth century, however, organizations with a more international scope started to appear, and from the beginning of the twentieth century work was in progress to establish an international organization for the protection, preservation, or conservation of nature. Species threatened by extinction was one of the main focuses of the IUCN from the start. Already in 1949, the organization established "The Survival Service" (SSC) and produced its first lists of threatened mammals and birds.[14] During the following years, the Survival Service kept a filing system, and later a card index, with information on the species on their lists.[15]

From the 1960s onwards, it is possible to identify three separate media through which IUCN have presented their data on threatened species. The first Red Data Books, which were published from 1966 to the late 1970s, were ring binders with a loose-leaf system. In the late 1970s bound volumes replaced the ring binders, and in the 1990s the IUCN decided to move the Red List to the internet, together with the underlying electronic species database. The *1996 IUCN Red List of Animals* and the *1997 IUCN Red List of Threatened Plants* were the first Red List publications to be made available on the internet through online searchable databases.[16]

These three different media—the ring binder, the bound volume, and the electronic database—make some practices possible, while hindering others. Thereby, they also enable different temporal logics to come into play. While differences between printed lists and electronic databases have been addressed earlier,[17] there has been little discussion as to how the medium of the early threatened species lists, namely the ring binder, influenced and was influenced by understandings of past, present, and future within the conservation community. In this chapter, I will therefore concentrate on the ring binders, their format, and the knowledge practices and different conceptions of time they reflected and enabled.

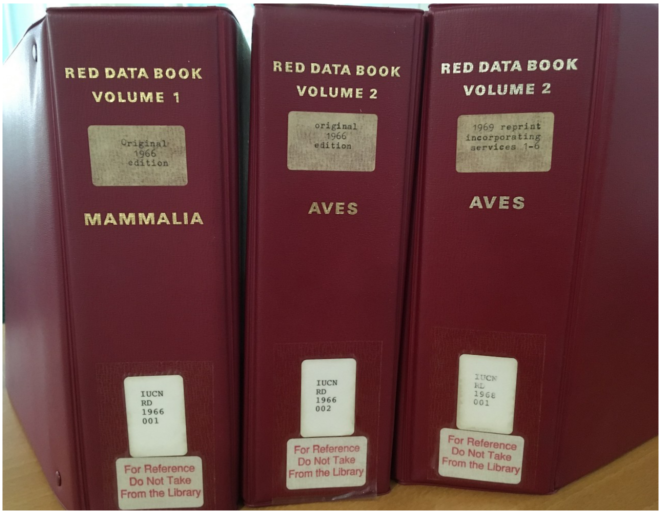
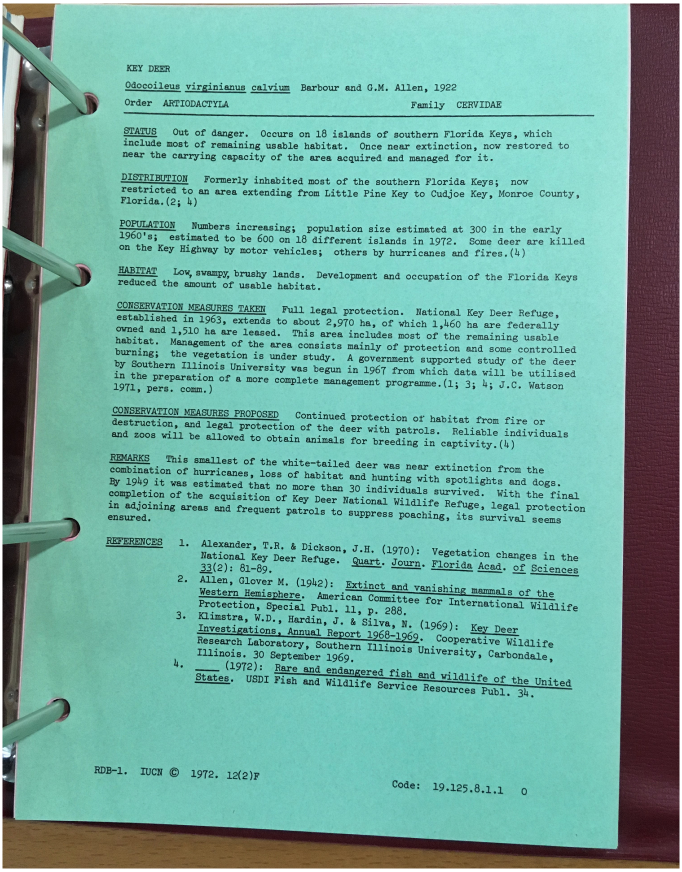


Figure 5.1 Red ring binders with identical design. Noel's *Red Data Book. Volume 1. Mammalia* (1966), Vincent and Noel's *Red Data Book. Volume 2. Aves* (1966), and Fisher's *Red Data Book. Volume 2. Aves* (1968). © Marit Ruge Bjærke.

The Format and Practices of Red Ring Binders

The first Red Data Books, *Red Data Book. Volume 1. Mammalia* and *Red Data Book. Volume 2. Aves*, were published in 1966. They were presented in an A5 loose-leaf format, kept in red ring binders (Figure 5.1).[18] The structure of the different volumes and editions of the Red Data Books is quite consistent throughout the 1960s and 1970s. Each Red Data Book contains a set of introductory pages, usually with information on the purpose of the volume and how to use it, species indexes, explanations of categories and symbols, and a bibliography. The information on each threatened species or subspecies is placed on separate data sheets, with subheadings such as "Status," "Estimated numbers," "Reasons for decline," etc. Most of the Red Data Books contain several hundred such data sheets. In addition, some of the editions also include one or more appendices.[19]

An important tool for organizing and keeping track of the many data sheets within each ring binder is the index system. In the 1966 editions each data sheet has a date on the top right corner of the sheet and a code number at the bottom right corner (e.g., B/167/PSITT/PSI for Bird/Family number/genus *Psittirostra*/species *psittacea*). The threat status of the species is shown in the lower left corner of the sheet. It consists of a number from one to four or



KEY DEER

Odocoileus virginianus calvium Barbour and G.M. Allen, 1922

Order ARTIODACTYLA Family CERVIDAE

STATUS Out of danger. Occurs on 18 islands of southern Florida Keys, which include most of remaining usable habitat. Once near extinction, now restored to near the carrying capacity of the area acquired and managed for it.

DISTRIBUTION Formerly inhabited most of the southern Florida Keys; now restricted to an area extending from Little Pine Key to Cudjoe Key, Monroe County, Florida.(2; 4)

POPULATION Numbers increasing; population size estimated at 300 in the early 1960's; estimated to be 600 on 18 different islands in 1972. Some deer are killed on the Key Highway by motor vehicles; others by hurricanes and fires.(4)

HABITAT Low, swampy, brushy lands. Development and occupation of the Florida Keys reduced the amount of usable habitat.

CONSERVATION MEASURES TAKEN Full legal protection. National Key Deer Refuge, established in 1963, extends to about 2,970 ha, of which 1,460 ha are federally owned and 1,510 ha are leased. This area includes most of the remaining usable habitat. Management of the area consists mainly of protection and some controlled burning; the vegetation is under study. A government supported study of the deer by Southern Illinois University was begun in 1967 from which data will be utilised in the preparation of a more complete management programme.(1; 3; 4; J.C. Watson 1971, pers. comm.)

CONSERVATION MEASURES PROPOSED Continued protection of habitat from fire or destruction, and legal protection of the deer with patrols. Reliable individuals and zoos will be allowed to obtain animals for breeding in captivity.(4)

REMARKS This smallest of the white-tailed deer was near extinction from the combination of hurricanes, loss of habitat and hunting with spotlights and dogs. By 1949 it was estimated that no more than 30 individuals survived. With the final completion of the acquisition of Key Deer National Wildlife Refuge, legal protection in adjoining areas and frequent patrols to suppress poaching, its survival seems ensured.

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4. ____ (1972): Rare and endangered fish and wildlife of the United States. USDI Fish and Wildlife Service Resources Publ. 34.

RDB-1. IUCN © 1972. 12(2)F

Code: 19.125.8.1.1 0

Figure 5.2. Green for "Out of Danger": data sheet on *Odocoileus virginianus calvium* with code number in lower right corner. From Goodwin and Holloway's *Red Data Book. Volume 1. Mammalia* (1972). © Marit Ruge Bjærke.

from one to five indicating how rare the species is and whether its abundance is increasing or decreasing. There is also a "star-listing," where each species is given one, two, or three stars. The number of stars indicates the degree of perceived importance of the threat: one star for species/subspecies "giving cause for some anxiety," two stars for species/subspecies "giving cause for considerable anxiety," and three stars for species or subspecies "giving cause for very grave anxiety."

From the 1972 edition, the numbering and star-listing were merged into one set of categories: Endangered, Vulnerable, Rare, Out of danger, Indeterminate. At the same time, the coding system underwent several changes and became even more complex than before. It was still on the bottom of the data sheets, but it could now look like this: "RDB-3 IUCN (c) 1975. 9(2)F Code: 1.2.2.1.1 I," letting the expert reader recognize at a glance that this is the Red Data Book volume 3, copyright IUCN, data sheet from 1975, issued in September, the second issue of this page, the Front page of the data sheet, the species *Andrias davidiamus* of the class Amphibia, order Caudata and family Cryptobranchidae, and that the Red Data Book category of this species is "Indeterminate" (see Figure 5.2 for another example).

"The index lettering at the bottom right-hand corner of each sheet is important, so that when future pages are distributed they may be filed in their correct order," the author of the 1966 *Red Data Book. Volume 2. Aves* writes.[20] Twice a year, circular letters were sent out to subscribers, containing new data sheets that the subscribers themselves were supposed to add to their ring binders, either replacing old data sheets or adding to the data sheets already present. Thus, the complex coding system and the loose-leaf format of the Red Data Books reflect an expectation of a rapid increase in knowledge. The Introduction to the 1966 *Red Data Book. Volume 1. Mammalia* states that: "The list is . . . intended to be flexible, additions or deletions being made as and when sufficient firm evidence is obtained to enable a more accurate assessment of each animal's status to be made. Adoption of a loose-leaf format allows each report to be replaced whenever new data warrant the publication of a more comprehensive or more up to date sheet."[21]

The ring binder medium made it possible to adopt a system of sending out new information and changing the contents of the Red Data Books with greater frequency than would have been feasible with most other formats at the time. The medium demonstrates that the gathering of knowledge on threatened species was to a high degree considered an unfinished and maybe unfinishable task, and that even information considered valid enough to be presented to the scientific community, might change shortly. However, the practice also highlights a disregard of knowledge concerning the history and changes in abundance of each species. "To avoid the possibility of confusion it is recommended that the relevant original sheets which are now being replaced should be removed from the volume and either destroyed or kept separately," IUCN writes in their "Circular Letter no. 1" from 1967.[22] Thus, earlier versions of the data sheets were neither available for comparison nor for any study of changes.

Red for Danger

The first use of the color red in connection with the lists of threatened species, was in 1962 when red A4 ring binders with loose-leaves were used for internal compilations of information on threatened species within the IUCN system.

In 1966, red was chosen both as the color of the ring binders themselves, and as part of the title. The connection between the color red and danger has been recognized for a long time and is probably the reason for the choice of color.[23] In addition, differently colored data sheets made up the color scheme within the Red Data Books. In the first editions, the data sheets were pink, white, and green, respectively. The different colors indicated the degree of conceived threat. Pink sheets were for species that had been assigned three stars ("Giving cause for very grave anxiety"), and green sheets indicated "those forms which were formerly rare, but have recovered, to an extent that they are no longer in danger." In Red Data Book editions from 1972 onwards, a more complex color scheme was used, with pink, amber, white, green, and grey sheets. Each color corresponded to a threat category: pink for Endangered, amber for Vulnerable, white for Rare, green for Out of danger, and grey for Indeterminate. The colored sheets gave an easy overview over the number of species in each category, giving direct access to the most threatened species through the use of pink, the color closest to red.[24]

The color red was chosen to alert the users to danger, but it also has certain temporal features interwoven with it. The color suggests an emergency, and as such can be understood as a call for action. In both cases the focus is toward the present and the future. Red is not a color associated with commemorating the past.[25] However, the red color of the medium did allow for an exception to this future-oriented view—namely the highlighting of stories with a happy ending through data sheets of green color (Figure 5.2). Although there are only a few green data sheets present in most editions of the Red Data Books, the fact that species no longer in danger were assigned data sheets of a certain color and kept in the Red Data Books, shows that stories of species that *had been* threatened but were now recovering, were considered important.

IUPN/IUCN was an organization based on ecology and ecologists, and the people working at the SSC were mostly natural scientists.[26] The lists and Red Data Books were practical tools, and the members of the SSC themselves, and ecologists appointed by them, both compiled the lists, did field trips to countries all over the world to make new assessments of species, and proposed recommendations to governments in the various countries they visited.[27] The format and practices associated with the ring binders reflect the important role of natural scientists' knowledge gathering in the early biodiversity discourse, as well as the increasing amount of data they gathered.[28] As working documents for conservationists, the little red ring binders were designed for effective knowledge retrieval and searchability. Colored sheets, lists, and coding at the bottom of each sheet made it easy for the expert to quickly gather important points. The increasing complexity of both the coding system for data sheets, the threat categories, and the color scheme reflect increasing difficulties in getting an overview of the material, due to the rapidly growing number of red-listed species.

The importance put on frequent updates of the Red Data Books during the 1960s and 1970s, highlighted through the ring binder medium, underscores the sense of urgency permeating the discourse on species extinction. New knowledge of threatened species must be spread as fast as possible. This urgency was not, however, connected only with the wish to spread the information among the scientists who were the target readers of the Red Data Books. "All too often it is justifiably suspected that urgent representations are necessary to save a species or subspecies from extinction, but action by some responsible authority is inhibited by a lack of truly reliable facts on which to plan it," Vincent and Noel wrote in the Introduction to the 1966 *Red Data Book. Volume 2. Aves.* The need to provide updated information was closely connected with the SSC's aim and practice of gaining contact with and making recommendations to political authorities, although the Red Data Book format was itself too scientific to be easily read by a general public.

The Names of Early Red Lists

Lists streamline, they preserve, they store, they include and exclude, they administrate, and they control. Lists also convey some basic relations to time: to the past by storing knowledge, to the present by serving specific functions, and to the future by claiming action.[29] Temporal logics within the lists themselves often become visible through paratexts such as titles and introductions, through the ordering of items, and through the use and placement of categories. When established in 1948, IUCN based their work on threatened species on two lists: *Extinct and Vanishing Mammals of the New World* by Glover N. Allen (1942) and *Extinct and Vanishing Mammals of the Old World* by Francis Harper (1945).[30] Both lists had titles that pointed toward the past. The species on the lists were either already extinct or they would become so presently. The titles show an emphasis on the storage function of lists, they are compiled to store knowledge, rather than for any present or future action. This is also the case with the book title *Les fossiles de demain* (The Fossils of Tomorrow) from 1954, the first publication by the SSC.[31] Although the title actively points toward the future and the list does not contain species that are already extinct, it also indicates that it is too late to do something about the problem. Still, these early list names activated the present in at least one sense. By joining species that were already extinct with species that still existed but were vanishing, the early lists furthered the idea that there is a certain category of species that are on the verge of becoming extinct.

The first lists made by the IUCN (then IUPN) were drawn up at a Technical Meeting in 1949. In a resolution (no. 16), the General Assembly agreed to draw up a "partial list of examples of vanishing species of birds and mammals, the survival of which is a matter of international concern."[32] In this title (and in the list of species that followed), extinct species were not included. The species on the list were still described in the title as "vanishing," but with the removal of extinct species the focus was moved away from the storage function of the list toward a function of "claiming action" as Young puts it.[33] The title suggests a possibility that the species on the list might survive, and thereby also changes the temporality of the list. Its function is not to name species and store those that will disappear, but to underscore that it is important and possible that they survive, and thus implicitly that something must be done to make this happen.

As a "partial list of examples," the list title displays the character that Umberto Eco describes as foregrounding its own incompletion.[34] This was probably to a certain extent meant to reassure the participants of the Technical Meeting who were afraid of accidentally excluding some important and threatened species by adopting the list then and there.[35] On the other hand, it can also be seen as a call for new knowledge, and was regarded as such by the SSC, which at the next General Assembly in 1950 reported that "in accordance with the spirit of the discussions at the Technical Conference at Lake Success, we have done our utmost to obtain all possible ecological data on threatened species."[36]

The focus of the list as unfinished and the need for more knowledge was kept up in the names of what is today regarded as the first Red Lists by the IUCN, two lists published in 1964. These were called "A Preliminary List of Rare Mammals including those Believed to be Rare but concerning which Detailed Information is still Lacking" and "List of Rare Birds, Including Those Thought to be so but of Which Detailed Information is Still Lacking," respectively.[37] The threatened species are now "rare" instead of "vanishing," downscaling the expectation of their imminent disappearance even further. However, most importantly, the names of these lists convey the same call for knowledge as the partial list of the 1949 Technical Meeting. The lack of knowledge is underscored thrice: with the use of the word "Preliminary," with the use of the words "thought" and "believed," and in the statement that "detailed information is still lacking."

The titles *Red Data Book. Volume 1. Mammalia* and *Red Data Book. Volume 2. Aves* from 1966 represent a move away from the focus on lack of knowledge, and also mark a definite step away from the storage function conveyed by words like "extinct" and "vanishing." The focus is now on danger and a need for action, signaled through the word "red." The conversion from explanatory to more metaphoric titles also indicates that the category "species threatened by extinction" was now firmly established. However, it also shows that the Red Data Books were meant for people already working with threatened species, as the concept of Red Lists of threatened species was not generally known at the time, and as the titles included Latin names for the species groups surveyed in each volume.

During the same period of time, the number of listed species was gradually increasing. The first IUCN list from 1949 had consisted of thirteen birds and fourteen mammals. However, this list was entitled a "partial list of examples," and as such, the species on the lists were not only vanishing themselves but were part of a much larger category of vanishing species that would be listed eventually.[38] The increase in numbers was slow at first. For instance, the list presented to the Seventh General Assembly in Warsaw in 1960 contained thirty-four species, as well as a list of nine species that were suggested to enter the list.[39] However, when the Red Data Books were published in the 1960s and 1970s, they consisted of more than a hundred species in each of five different species groups—mammals, birds, reptiles and amphibia, freshwater fishes, and flowering plants—and the numbers were increasing rapidly.

Delbourgo and Müller-Wille has underlined that as lists draw things together spatially, they "construct groupings, yet in doing so they provoke questions about those groupings."[40] The various early list titles can be seen as attempts to define both the name and the limits of a category of species threatened with extinction. Should it include species that were already extinct? Should the focus be on rare species? Or should it be on species that were of concern to the international community? The Red Data Books' shared name and identical format across species groups gave the process of identifying threatened species a uniform touch. It now encompassed all kinds of species from all kinds of places under the common headline of "danger." In this way, the Red Data Books started turning preliminary lists of extinct and vanishing species into the large, unobservable and global phenomenon that is now called biodiversity loss.

The Early Red Lists and the Past

When the IUCN Technical Meeting in 1949 compiled its lists of mammals and birds, they omitted "certain very rare species and others whose situation seemed hopeless" as well as some for which "it appeared that everything that could conceivably be done for them was being done at present."[41] Still, the IUCN scientists continued to interest themselves in extinct species as well as in threatened ones. In the internal document *Animals and Plants Threatened with Extinction* from 1962, data sheets on extinct species were included as a separate group of sheets, placed on the same level of organization as for instance birds or amphibians. Although data sheets on extinct species were not included in the Red Data Books from 1966 onwards, they were still kept along in the margins. The 1968 edition of the *Red Data Book. Volume 2. Aves* included a "List of Birds Either Known or Thought to Have Become Extinct Since 1600" as an appendix. In the 1977 edition of the *Red Data Book. Volume 4. Pisces*, the Preamble stated that "two taxa, not listed previously, are not included in the present volume because they are either known to be extinct or are probably extinct." Although these examples affirm that extinct species were considered relevant, they also show that even the probability of being extinct was enough to be excluded from the Red Data Books.

The way the category of extinct species moves in and out of the early material on threatened species reflects an ambivalence toward the past ingrained in the discourse on threatened species. While the knowledge that humans have exterminated other species in the past is a necessary backdrop to the understanding that humans can exterminate other species in the future, it may also indicate that the extinction of species is inevitable. For the IUCN in the 1960s and 1970s, the Red Data Books were means to solve a problem, by increasing knowledge and producing action, as stated in the introduction to the 1966 *Red Data Book. Volume 2. Aves*: "The object of these lists and sheets of threatened species is not only to draw universal attention to the dangers facing some unique creatures, which will be for ever lost unless timous protective measures are taken, but also to provide the factual information necessary for action by those who are in a sufficiently authoritative position to be able to influence the future." With this aim in mind, there was no need to include extinct species in the Red Data Books, and it was not until 1982 that the category Extinct (Ex) was again included in a Red Data Book on the same level as the other categories.[42]

However, when the readers could not be taken for granted to share the knowledge and belief that a lot of species are threatened by extinction—and the aim was thus mostly educational—the IUCN found it necessary to present the two categories in light of each other. In a popularized bound volume entitled *The Red Book: Wildlife in Danger*, from 1969, the existence of extinct species was thus commented upon more directly: "The S.S.C. has another list, which could be called Black for Death, or rather extinction; organisms extinct since 1600 (or believed to be so)," the authors explain in the introduction to the book.[43] This shows that, in the late 1960s, extinct species and threatened species were seen as two different categories, kept in two separate lists that were named "black" and "red," respectively, and that, in addition to their scientific functions, the black list was mostly educational, while the red list was political. The IUCN invoked the list of already extinct animals to show the general public who were not already familiar with the issue, the consequences of not doing anything to save the species of today. And they invoked the black color of sorrow and death.

Thus, the past is used mainly as an educational backdrop to the biodiversity discourse in the 1960s and 1970s, a tool for presenting the subject of species extinction to the general reader. However, there is more than one past at play—some near and others distant—in *The Red Book: Wildlife in Danger*. A year that has a prominent place in the story is the year 1600, IUCN's chosen starting point for the modern extinction:

> The year 1600 might be thought an arbitrary date; but it has been chosen for a good reason. . . . Virtually all the mammals and birds known to have become extinct since 1600 are identified by adequate descriptions or portraits, nearly all of them by skins, and a considerable number also by subfossil bones; all but two that we can critically admit have acceptable Linnean or scientific names. The two will doubtless soon be formally named. The year 1600 is the year after which zoologists know at least the colours (more than less) of the extinct birds and mammals. Of course zoologists know of very many animals extinct in historical times, though before 1600: but only in a few exceptional cases, based on very rare early documentary evidence, do they know the colours of these; and only very exceptionally do they possess their skins, or parts of them. So 1600 is accepted by the S.S.C. as the reckoning date for modern extinction. It is a practical date that happens to coincide with the approximate beginning of the civilized epoch's own special attack on wild nature.[44]

The citation shows how the story of nature is coupled to recent human history in two significant ways, one belonging to the development of science and one to the development of society. First, there is a methodological link between species loss and the year 1600. The year 1600 is as far back as methods such as descriptions, skins, bones, Linnean names, and color can give information on the extinct species. Thus, the scientific methods available influence which species are included in or excluded from a list of extinct species. Second, civilization since the year 1600 is a historical epoch characterized by a "special attack on wild nature." After listing the numbers of different species groups that have gone extinct or are threatened since 1600, the authors continue: "As will emerge, this is a state of affairs which is quite without parallel in the former span of man's life with nature, that is to say, in his less civilized history before 1600."[45] Civilization since 1600 is the reason behind the threats toward species and wild nature. In this, the period since 1600 is radically different from earlier periods of time.

The two ways the year 1600 is important in the authors' story about extinct species highlight an ambivalence toward civilization, which becomes even more obvious when the "civilized period" is compared to the Stone Age:

> We have seen that Stone Age people all over the globe attained the power to over-kill and extinguish at varying times in the Pleistocene and the prehistoric epochs; and our ancestors learnt wisdom from the warning. This

> wisdom appears to have been widely forgotten again in our later years of post-Renaissance exploration, and particularly since the Industrial Revolution, and the rapid refinement of guns and other hunting tools, in the early nineteenth century.[46]

While Stone Age humans exterminated other species just like modern humans, the authors underscore that these people actually learnt something from their over-killing. They gained wisdom, a wisdom which was later forgotten. Here, the authors present a very typical picture of the twofold aspect of modernity: although characterized by progress, humans in the period since 1600 have lost something important that was older and more real, and thus failed in making the world a better place.[47] To the IUCN, however, the production of lists of threatened and extinct species still shows the usefulness of scientific methods, and thereby puts forward the expectation that scientific knowledge might be able to fill in the gaps that were created by the loss of wisdom.

Ring Binder, Bound Volume, and Database

The ring binder medium was in use until the late 1970s, when the SSC started to publish the Red Data Books as bound volumes. IUCN states that the reason for the change in medium was that the loose-leaf system was less suited for institutions, since it was difficult to maintain.[48] The change in format was also a result of the increasing number of species in the Red Data Books, as well as the amount of data on each species. While the information in the ring binders had been updated twice a year, the change in format to bound volumes and the increasing number of red listed species led to a considerable increase in the time lapses between updates, and in the late 1980s and 1990s updated Red Lists were published only every second year.[49] Thus, during the 1980s the information published on each species was much less dynamic than it had been in the 1960s and 1970s. The new format meant that the information within the Red Data Books was no longer changeable and possible to update, as in the ring binders. It was fixed once and for all—at least until the next volume was published.

Even the change in format was not enough to cope with the mounting data, however, and in 1986, after some years of publishing the Red Data Books as bound volumes with several pages of information on each species, the IUCN reverted to the pre-1966 practice of publishing simple lists of species instead. The lists were now long enough to fill bound volumes in and of themselves. Where the ring binders were complicated systems of information, based on shorthand and knowledge of taxonomy, the bound volumes were easier to handle and thus more accessible to a larger public. At the same time, however, most of the information on each species had now disappeared. Although the

IUCN had by this time established word-processing facilities and a computer to process the emerging database, the information stored in the database was not accessible to the public during the 1980s.[50] Neither could scientists subscribe to quick updates any longer. Thus, the amount of data accumulated in the 1960s and 1970s outgrew both the format and the practices of the little red ring binders. Species extinctions had been shown to be a massive environmental problem, but also massive in the amount of data produced and the question of how to store these data.

In the late 1990s, the data on each red-listed species again became available, through a searchable electronic database. This change from list to a general information system on species is considered one of the major changes in the history of the IUCN Red List, and there are obviously several important differences between a list and a database that support this claim.[51] While a threatened species list is a static tool as long as it is not revised, threatened species databases seem to be constantly changing. As Ursula Heise writes: "Digital databases, to which new items can always be added, have this incompletion hardwired into their basic structure."[52] However, this change from something static to something changeable is only visible when the database is compared with the bound volumes directly preceding it. Although vastly different in materiality, the ring binder format of the Red Data Books from the 1960s and 1970s have many aspects that put them closer to the database than to the bound volume Red Lists of the 1980s. First, their information was updated and replaced with almost exactly the same regularity as today's database (twice a year). Second, it was difficult to retrieve old/discarded information since the owners were actively advocated to throw out old data sheets. Third, the ring binders, like the database, came with various technologies for effective searches: colored sheets, indexes, and an ingenious system of coding on the bottom of each data sheet. Most importantly, however, like the database, but unlike the bound volume, the incompletion of the work was "hardwired" into the structure of the red ring binders: both the ring binder medium and the format of the Red Data Books signaled that knowledge was changing and expanding.

John Miles Foley has made a related argument regarding the similarity between oral tradition and internet media technologies, namely that they share the same functionality of being open-ended and under construction, and thus differ fundamentally from bound volumes.[53] By choosing ring binders rather than bound volumes in the 1960s, the IUCN signaled the expectation of rapid change and increasing knowledge. They signaled that spreading scientific knowledge that could lead to action and political results was more important than storing information on extinct species, mourning the past, or registering changes for the worse. The change from ring binders to bound volumes changed the balance between these different functions.

As the bound volumes were updated less frequently, the Red Data Books' function as state-of-the-art notes for scientific lobbyism disappeared. On the other hand, the storage function from the lists of extinct and vanishing species from the 1940s and 1950s returned. When included in bound volumes, the state of a certain species at a certain time would be saved and accessible even after future updated volumes had been published. The fact that the change in format coincided with the reintroduction of "Extinct" as a species category in the IUCN system, indicates the close link between the storage function of the bound volume format and the understanding of what Red Lists were for.

The Biodiversity Discourse of the 1960s—A Belief in Progress?

As mentioned earlier in this chapter, lists construct groupings and then provoke questions about those same groupings.[54] While the early lists produced by the IUCN constituted different attempts of defining a group of "species threatened with extinction," the Red Data Books, with their identical formats and titles across taxonomic boundaries, gave uniformity to "species threatened with extinction" as a group that now included all kinds of species. The ring binder medium also made possible a rapid increase in the number of species that the group consisted of. Thus, the Red Data Books constitute an important part in the production of species extinctions as an environmental problem: from the 1960s, it encompasses all species groups, is global, and grows so rapidly that special measures are needed to organize it. Thus, these little red ring binders point actively toward what is now, in the aforementioned words of the UN Global Environmental Outlook, considered a "major species extinction event, compromising planetary integrity."[55]

Young has argued that lists are easy to mobilize for political ends as they are so flexible and seem to be simply enacting a categorization of subjects that has always been.[56] While the enactment of a global category of "species threatened with extinction" was definitely one political aspect of the Red Data Books, their main intended political function seems to have been to present conservationists with the best possible scientific data, so that they could promote the right solutions to "those who are in a sufficiently authoritative position to be able to influence the future."[57] There was a short way between new information, the sharing of the information in the conservation community, and the use of the information in political work. Thus, in the Red Data Books, the political and societal functions of the information converged with the scientific wish for new and updated knowledge.

This, of course, served to frame the question of species extinctions within temporalities oriented toward the political present and the near future. Present action and ongoing change were the dominant temporal frameworks, both of the format of the Red Data Books, the names of the lists, and in the practices connected with the material. By combining scientific practices directly with political aims, the Red Data Books represented and reinforced a set of temporalities that were extremely short term compared with the long geological and evolutionary timescales necessary to grasp the idea of a general increase in the rate of species extinctions. With little room to include information on the past, or of change of any kind but the positive, the Red Data Books also encouraged the idea that it was possible to do something about the problem of species extinctions, if only one acted fast enough.

Irus Braverman has advocated species extinctions as one of four major threats to liberal democracy where anticipatory action has been formalized, the three others being terrorism, trans-species epidemics, and climate change.[58] Such potentially catastrophic, imminent disasters require action, but since they are placed in the future, they are inherently uncertain, and there is a need for certain practices to render the future actionable.[59] According to Braverman, in the biodiversity discourse, this need for practices has largely been answered by creating threatened species lists.[60] Although the Red Data Books were definitely designed to produce action, I will argue that the making of Red Data Books and lists of threatened species in the 1960s was not a practice mainly aimed toward a future disaster. Rather, species extinctions were regarded as an ongoing phenomenon. As the lists were directly fueling other practices, such as field trips, and contact with governments and politicians, the conservationists were more concerned with the actual present and immediate action on behalf of specific species, than with a potentially catastrophic future.

Studying narrative genres, Ursula Heise has noted a recent move from elegy to epic and encyclopedia in the textual material from the IUCN database. I agree with her that the move toward encyclopedia seems to be a relatively recent change, stemming partly from the changes that were made in IUCN's methodology in the 1990s, when they went from basing species assessments on existing concern to doing assessments by species groups regardless of initial expectations. However, the formats and media that threatened species were presented through in the 1960s and 1970s definitely contain more epic temporal elements than elegiac. Especially, the focus on collecting and spreading a rapidly increasing amount of knowledge is in line with the temporality of the epic struggle. The removal of extinct species from the Red Data Books, and the inclusion of green pages on species recovering from the threat of extinction also show that elements of sorrow and grief were actively played down in these publications. The IUCN and SSC did not promote a narrative of scientists sitting about lamenting extinct species, but of scientists gathering knowledge as fast as they could, while having to "count the stamps, think twice before telephoning, and hitch-hike to conferences and field programmes."[61] The red ring binders, with their circular letter system and interspersed green sheets, told an epic tale, with the possibility of victory at the end of the struggle.

I think one of the reasons why there is so little focus on loss and lamentation in the Red Data Books is the fact that, during the 1960s and 1970s, the educational and scientific purposes of IUCN were separated by the use of separate media. While today the two purposes are merged in one electronic database, which is searchable for the public and strewn with photos and easily accessible information in addition to the scientific data, the red ring binders of the 1960s and 1970s were almost unreadable for the general public. Instead, the public was presented with bound volumes such as *The Red Book: Wildlife in Danger*. Here, the elements of past extinctions and sorrow were invoked to serve as pedagogical measures. *The Red Book: Wildlife in Danger* drew up a picture that included both the historic past and the future of humankind.

Thus, the increasing number of species in the Red Data Books played into two different stories of biodiversity loss at once. On one hand, the fast increase in the number of sheets in the Red Data Books was a measure of a successful approach to a scientific and political problem. On the other hand, the increasing problems of organizing, containing, and updating the number of species in the Red Data Books, corroborated the conception that the problem of biodiversity loss was huge and difficult to cope with. The format and practices of the Red Data Books thus, at the same time, served to underscore an accumulation of knowledge and the acceleration of a problem.

In his article "The Climate of History: Four Theses" from 2009, Dipesh Chakrabarty argued that "Anthropogenic explanations of climate change spell the collapse of the Age-old humanist distinction between natural history and human history."[62] Chakrabarty contended that: "In unwittingly destroying the artificial but time-honored distinction between natural and human histories, climate scientists posit that the human being has become something much larger than the simple biological agent that he or she always has been. Humans now wield a geological force".[63] However, as has been pointed out by Bonneuil and Fressoz (2016), the distinction between natural and human histories, and the idea of an awakening of humans to their massive effects on nature only with climate change and the establishment of the Anthropocene concept, is a simplification.[64]

Although the temporalities of the Red Data Books are scientific and political, the biodiversity discourse in the 1960s, when presented in *The Red Book: Wildlife in Danger* is clearly based on a grand narrative similar to that of the Anthropocene. In the introduction to the book, history is presented as a history of the human species as a collective actor, as in "man's life with nature," "Stone Age people all over the globe," and "our ancestors." It is presented as a story of a human species that has affected nature since its very emergence, but it also underlines that the effects of humans on nature have accelerated since the seventeenth century and links this to modernity and the refinement of technology. Due to human actions, the present historical period is thus considered different from earlier ones. The global scale and the acceleration of the problem are underscored through the view from "outside" the planet: "When the first men shortly reach the moon, they will probably be able to see the forest slashes of the last century with the naked eye, so accelerated have been the environmental changes of the Industrial Age" the authors write.[65] Like climate change, the extinction of species is a phenomenon that exists on a global or planetary scale, the size of which is only possible to grasp through technologies.

The case study of the little red ring binders, then, underscores that many of the ideas that are now connected with climate change and the Anthropocene were at work among conservationists during the 1960s. This includes an acceleration in environmental changes since the Industrial Revolution, environmental effects on global and planetary scales, the human species as a collective actor, and a redistribution of temporalities between nature and history. Both the format and practices connected with the Red Data Books and the narrative of *The Red Book: Wildlife in Danger* serve to evoke the idea that nature is changing as fast as, or even faster than, the political and scientific communities are able to act.

Although the chemical and physical components of climate change sets it apart from the discourse on species extinctions, this case shows that the collapse in the distinction between natural and human histories has not developed solely as a result of climate change, but draws on a set of ideas already at play within the general environmental discourse. The force that the authors of *The Red Book: Wildlife in Danger* consider the human species to be wielding has more in common with humans being "a geological force" than with us being, in Chakrabarty's words, a "simple biological agent." The Red Data Books from the 1960s, with their rapidly growing number of species threatened with extinction, highlight the challenge that we also face today; of navigating between an almost deterministic worldview where the human species drives nature to change faster and faster, and an optimistic belief that it is still possible to find solutions to environmental problems with the aid of science and politics.

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Marit Ruge Bjærke is a postdoctoral Research Fellow in Cultural Studies at the Department of Archaeology, History, Cultural Studies, and Religion at the University of Bergen, Norway. Her research interests lie within the environmental humanities, with a focus on biodiversity, biodiversity loss, and so-called invasive species, as well as on how different environmental problems are understood and communicated. Bjærke holds a PhD in Marine Biology and an MA in the History of Ideas, and she has recently coedited the book *Climate Change Temporalities: Explorations in Vernacular, Popular, and Scientific Discourse* (Routledge, 2021).

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46. Fisher, Simon, and Vincent, 18–19.
47. Peter Watson, *The Modern Mind: An Intellectual History of the 20th Century* (New York: Harper Collins Publishers, 2001), 52.
48. Thornback and Jenkins, *The IUCN Mammal Red Data Book: Part 1*, i. The problem of maintenance was also clearly visible in the copies of Red Data Books examined in this study (cf. note 19): some contained original data sheets and circulation letters, but not the updated sheets, some were sorted in new ways (for instance according to color instead of taxonomy), while others again lacked some or all of the explanatory pages.
49. Smart, Hilton-Taylor, and Mittermeier, *The IUCN Red List,* 18–19.
50. Thornback and Jenkins, *The IUCN Mammal Red Data Book: Part 1*, ii–iii; The IUCN Conservation Monitoring Centre, *1986 IUCN Red List of Threatened Animals* (Cambridge, UK: IUCN, 1986), Preamble.
51. Dr. Thomas Brooks, personal communication.
52. Heise, *Imagining Extinctions,* 65.
53. John Miles Foley, *Oral Tradition and the Internet: Pathways of the Mind* (Urbana: University of Illinois Press, 2012), xi, 13.
54. Delbourgo and Müller-Wille, "Introduction," 711.
55. UN Environment, *Global Environment Outlook—GEO-6: Summary for Policymakers*.

56. Young, "Un-Black Boxing the List," 503–4.
57. Noel, *Red Data Book. Volume 1. Mammalia*, Introduction.
58. Braverman, "Anticipating Endangerment," 134.
59. Ben Anderson, "Preemption, Precaution, Preparedness: Anticipatory Action and Future Geographies," *Progress in Human Geography* 34, no. 6 (2010): 777–98.
60. Braverman, "Anticipating Endangerment," 134.
61. Fisher, Simon, and Vincent, *The Red Book,* 20.
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6

Oil and Vikings

Temporal Alignments within Norwegian Petroleum Fields

Lise Camilla Ruud

Petroleum fields result from deep and long-term natural rhythms. Over millions of years, organic matter exposed to underground heat and pressure has been transformed into oil and gas contained in deep subterranean reservoirs. The first major oil discovery in Norway was made in 1969. Since then, approximately 120 petroleum fields have been discovered on the Norwegian continental shelf, 112 have been put in production, and approximately ninety are currently operative.[1] When humans explore for and extract petroleum, a temporal alignment is imperative for industrial success and the accompanying societal wealth: the slow, ancient processes, which produce petroleum and the speedy rhythms of industry and policy must adapt and be made to correspond. Petroleum fields are temporally complex, and cultural history and heritage contribute to how Norwegian offshore fields are understood. As part of industrial development, a field name must be chosen and approved by the Norwegian Petroleum Directorate. In 1973, a field in the North Sea was named Tor, after the Norse god Thor. Since then, about seventy of Norway's petroleum fields have been given names derived from the national golden age of the Vikings and Norse mythology.[2]

The contributors to this volume explore entanglements of time scales and different temporal durations, and argue that natural and historical temporalities interact and depend on one another. This chapter develops the concept of "alignment" as a tool for exploring practices, in which temporal rhythms of nature and culture are connected, arranged, and made compatible. To align means to arrange or adjust, to order elements continuously, or to place something in line. To align may also mean to support, to follow, or to associate with. The analysis of temporal alignments within petroleum fields will focus on rhythms, tempos, directions, and qualities of different timescales and durations, and explore how geological, industrial, political, and cultural

Figure 6.1 Platform on the *Oseberg* field, named after a Viking ship from the ninth century. Photograph by Harald Pettersen, © 2013. Equinor, used with permission.

temporalities are arranged, adapted, and manipulated in ways that make them correspond and support one another.

Since the dawn of the Norwegian oil age, the national government has stressed that the "petroleum resources belong to the Norwegian people and shall benefit the entire society."[3] The state-controlled petroleum industry and the spectacular profit resulting from it have transformed Norway into a wealthy country able to provide its citizens with a generous social welfare system.[4] The country's petroleum fund, one of the largest funds in the world, was established in the 1990s to ensure future welfare, and has, by 2021, grown to more than 12,000 billion kroner.[5] Offshore petroleum fields are key to this economic success, and this chapter explores the temporal work needed for fields to emerge. The invisibility of oil is an often repeated issue within petrocultural research, and a starting point for the analysis is that fields are difficult to comprehend: they are located far away at sea and deep down in the ground.[6] Petroleum fields must be translated and given some form and content to be exploited industrially as well as understood culturally.[7] Such translations involve transformations and temporal alignments, and this chapter elaborates on two translational practices, through which fields are temporally aligned.

The first part of this chapter explores technoscientific translations, more specifically a series of four definitions presented in the vocabulary of the "ABC of Oil," elaborated by the Norwegian Petroleum Directorate, hereafter

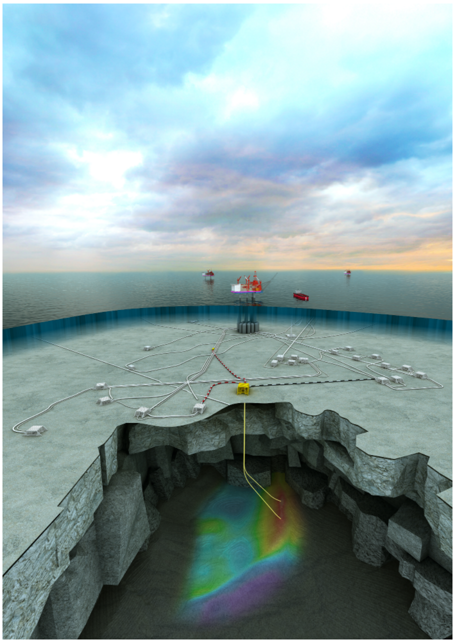

Figure 6.2 Conceptual cross section image of the Gullfaks oil field, named after a Norse horse. © Equinor, used with permission.

referred to as the ABC.[8] The second part of the chapter elaborates on temporal alignments emerging with the Viking and Norse naming practice. The technical and naming practices are different, but they are also similar in how the alignments of durations and rhythms take place. Both practices involve a moving back, or a moving down, in time. The petroleum industry drills down into earth's deep time, and naming practices are anchored in the depths of national culture and history. Time-aligning work implies direction, and the direction from the present into the past, or from the past into the present, may take on vertical and linear shapes. The tempos of such movements through time may be characterized by the very slow pace of geological processes, by the accelerating speed of industry and politics, or by the steady, exemplary, and repetitive time of national identity. The concept of alignment will identify interplays and discuss the efforts needed to move down in time. Such efforts consist of processes of identification, selection, and isolation of distinct elements and qualities of the past. The aligned times may run parallel, or they may coincide in some specific period. Central to the analysis is the idea that aligned natural and cultural times need to be both similar and different, and that the industrially successful alignment involves a massive temporal concentration.

The Alignment of Industrial and Natural Timescales

Offshore petroleum fields are located far away and deep beneath the earth's surface.[9] Through an airplane window, we might see platforms on the sea surface, but technological installations are only one part of a petroleum field. While other types of industrial environments more openly manifest traces of interplay between industry and nature, we cannot see the full extent of these fields or how they are marked by human industry. Oil and gas fields are oriented more vertically than horizontally. From rigs or ships, or installations on the seafloor, the fields stretch down through the water, cables, and pipes, reaching deep down into underground sedimentary layers. Oil workers get to see minor parts of their distributed components, but for most of us, fields appear as remote, almost abstract places.[10] Fields extend vertically and they come into being when humans and technology explore downwards into earth's sedimented layers.

The distant, deep character of offshore petroleum fields necessitates translations, and translations adapted to industrial practices involve alignments: the slow time of oil and gas formation is arranged and adapted to the accelerated rhythms of industry. The cross-section image above (Figure 6.2) is one such translation. In it, slow and fast time neatly adapt to each other, as they both happen simultaneously within the same vertical, processual, and industrial visualization.[11] The image demonstrates how petroleum is made to flow when temporal alignment is industrially successful. The online ABC published by the Norwegian Petroleum Directorate is another effort to make petroleum fields comprehensible. In this section, the ABC's vocabulary forms the point of departure for exploring alignments between rhythms and durations of petroleum fields.

The ABC presents a series of definitions to establish the oil field as a named geological, industrial, and bureaucratic reality.[12] The four definitions of "play," "prospect," "discovery," and "field" are phases describing interplays between a broad range of actors and elements: hydrocarbons, layers of rock, geologists, bureaucrats, engineers, rigs, pipes, science, and technology must connect and adapt, support each other and collaborate well, for a petroleum field to come into existence. Temporal work is at the center of these interplays: the petroleum industry seeks to align the slow time of geological processes with the accelerated time of modern technology so that oil and gas may be extracted. A first step towards the conceptualization of an oil field is defined by the ABC as a "play." This is defined in part as a "geographically and stratigraphically delimited area where a specific set of geological factors is present so that petroleum should be able to be proven in producible volumes. Such geological factors are a reservoir rock, trap, mature source rock, migration routes, and that the trap was formed before the migration of petroleum ceased."[13]

Throughout the earth's history, its crust has been in constant movement. Tectonic movements and continental collisions between what later came to be North America (Laurentia) and Europe (Baltica) resulted in large mountain chains in what is now Norway. As the continents started to drift apart after the collisions, oceanic crust formation produced the lowlying ocean basins surrounding Norway. Erosion later transported rocks, sand, and soil from the mountains to the northern seas, where they were deposited in sedimentary layers along with salt produced by evaporation and chalk from dead organisms. Remains of organisms are buried within the sedimentary layers. In areas with little oxygen, large quantities of organic remains may be preserved and transformed into oil and gas within the sedimentary layers, as occurred on what later became the Norwegian continental shelf, particularly through the late Jurassic and Cretaceous periods and at the outset of the Cenozoic Era. As millions of years passed, new sediments covered the layers in the basin area rich with organic material, and, as the temperature and pressure in the lower layers increased, the organic material buried within them transformed into petroleum. Oil and gas are thus located deep beneath the surface and are created by extremely slow processes: over millions of years, remains of microscopic sea plants and animals, buried under layers of salt, sand, and rocks, have transformed into petroleum by underground heat and pressure.[14]

Petroleum geology and the ABC focus on very specific parts of these long-lasting earthly processes. Four geological factors are isolated and arranged with the definition of a play: a source rock, a reservoir rock, a migration route, and a trap. Oil and gas are generated within a source rock, and being lighter than the water in their surroundings, they migrate upwards into overlying sediments, which are termed reservoir rocks. The reservoir rocks are porous, fit to contain the moving substance. If the sedimentary layer above the reservoir rock is sufficiently impervious to flow, it is called a petroleum trap, or caprock, and it serves as an impermeable trap forcing the petroleum to remain inside the reservoir and preventing its further escape upwards and into the water.[15] Three geologically defined types of rock, and the petroleum migrating between them, all still slowly evolving according to their own paces and durations, are potentially present within the play. In this first phase of timescale alignment, humans using advanced technology and science observe how these layers preserve and reflect earth's history.

Alignment implies a search for correspondences between different rhythms and durations. The vocabulary work involves inclusion and exclusion: the definition of a play isolates some relevant natural elements, while much of their surrounding environment is left out. The focus is set on layers and mechanisms of nature that result in specific types of rocks. The specialized geologists and technologists of the oil companies will test, calculate, and model the characteristics of sedimentary layers, which are used in the next step towards defining a petroleum field, the "prospect." A prospect is located within the larger area of the play and is defined as "a possible petroleum trap with a mappable, delimited volume of rock." The sedimentary layers produced slowly over long timescales are interpreted, and the presence of a mappable trap—a caprock—impermeable enough to have blocked the upward migration of hydrocarbons is crucial. If the trap is estimated to have been effective in stopping the continued upward migration of petroleum, then the next translating and defining step will be the "discovery." This is defined as a "petroleum deposit, or several petroleum deposits combined, discovered in the same well, and which testing, sampling or logging have shown probably contain mobile petroleum. The definition covers both commercial and technical discoveries."[16]

The play defines a connection between the long-lasting temporal interplays among some isolated layers of rocks and the introductory industrial phase of observation. If the sedimentary characteristics reveal the potential to harvest the products of deep time processes through industrial drilling, one can move into the next phase: developing the prospect. The prospect further narrows the focus onto one specific sedimentary layer from a specific geological period, with the capacity to keep petroleum in place. The following definition, the "discovery," establishes a tighter correspondence between the deep time of the rocks and the much speedier technology. In this phase, test drilling and computer modeling have demonstrated the presence of petroleum as part of a search for economically profitable future fields. Many drill stem tests will lead to dry wells, and there is a high risk that the reservoir rock has been unable to absorb profitable amounts of petroleum or that the caprock has not trapped enough of the migrating hydrocarbons. These are, however, calculated risks, and in the discovery phase, it becomes clear whether there is a good chance that crude oil or natural gas might be extracted.[17]

Lastly, test results are carefully evaluated by oil companies, and it is decided whether the discovery should be developed as a petroleum field or not. In the ABC, a petroleum field is defined as "One discovery, or a number of concentrated discoveries, which the licensees have decided to develop and for which the authorities have approved . . . a Plan for Development and Operation (PDO)."[18] If a discovery appears to be sufficiently promising, the oil company will elaborate a PDO, which must be approved by the Ministry of Petroleum and Energy, or if it is an extensive project, by the National Parliament. When a field is finally put into production, a process often taking many years, the extracted petroleum testifies to the successful alignment of nature's slow time and the faster pace of the industry. The steps to defining an oil field in the ABC represent a line of phases, through which petroleum, through the passing of geologic time, is subjected to investigations. These investigations aim at temporal alignment: to identify and arrange compatibility between geologic time and the desires of modern, industrial times.

To align means to arrange or to place something in line, and one could think of temporal alignment as a vertical line starting from today's industrial installations and extending downwards into earth's deep time, or as a line stretching from one geological period upwards to today's offshore installations. The paces of the processes operating at the start of each of these two directions are radically different, and it requires a great deal of work to make them compatible. The image of the petroleum field shown in Figure 6.2 depicts a successful alignment, and in it, the temporal qualities of earth and industry have become compatible. The vertical linearity of this image adds a place-like character to the petroleum field. It conveys a translation of the established, successful alignment. The progressive definitions of the ABC, on the other hand, add a more processual character to petroleum fields and enables insights into different phases where temporal differences are investigated and handled. The need to establish correspondences between sedimentary qualities established over geological periods and human industrial timescales is a temporal work, and it happens step by step, definition by definition. The ABC translates oil fields as a process, and it makes clear the phases leading towards the above image of a temporally aligned, productive field.

The rhythms and durations of nature and industry correspond and support each other along vertical lines. Drilling and pipelines enable the industry to penetrate downwards into oil reservoirs and petroleum to move upwards, followed by distribution of the oil globally.[19] However, one could also describe the temporal work of the oil industry as focused on temporal coincidences. Earth's time is extended and deep, and the industrial focus is set on specific sedimentary layers and geological periods. The subterranean geologic time progresses constantly and slowly from the depths and upwards, and oil and gas are materialized effects of distinct periods of deep time. The industry, for its part, accelerates through millions of years as it drills downwards. Drilling moves through and into geological periods, and the industrial pace is decisively focused in its search: it is mainly interested in how deposits of some specific geologic periods have accumulated and layered over time. The desired petroleum is trapped by caprocks and has not been able to move upwards and into the rocks of later periods. As the industry drills down, it searches for temporal coincidence with the late Jurassic and Cretaceous periods, or the beginning of the Cenozoic Era, and it aims at enabling the further and accelerated movement of petroleum upwards. The modern industry drills through rocks representing millions of years, and it extracts the results of specific periods and incorporates these into our present.

"Nature becomes real through various forms of apparatuses or instruments," and the ABC's definitions designate a gradual alignment of industry and policy with the long duration of petroleum.[20] Different types of rocks are identified and investigated, and they must have specific and slowly gained

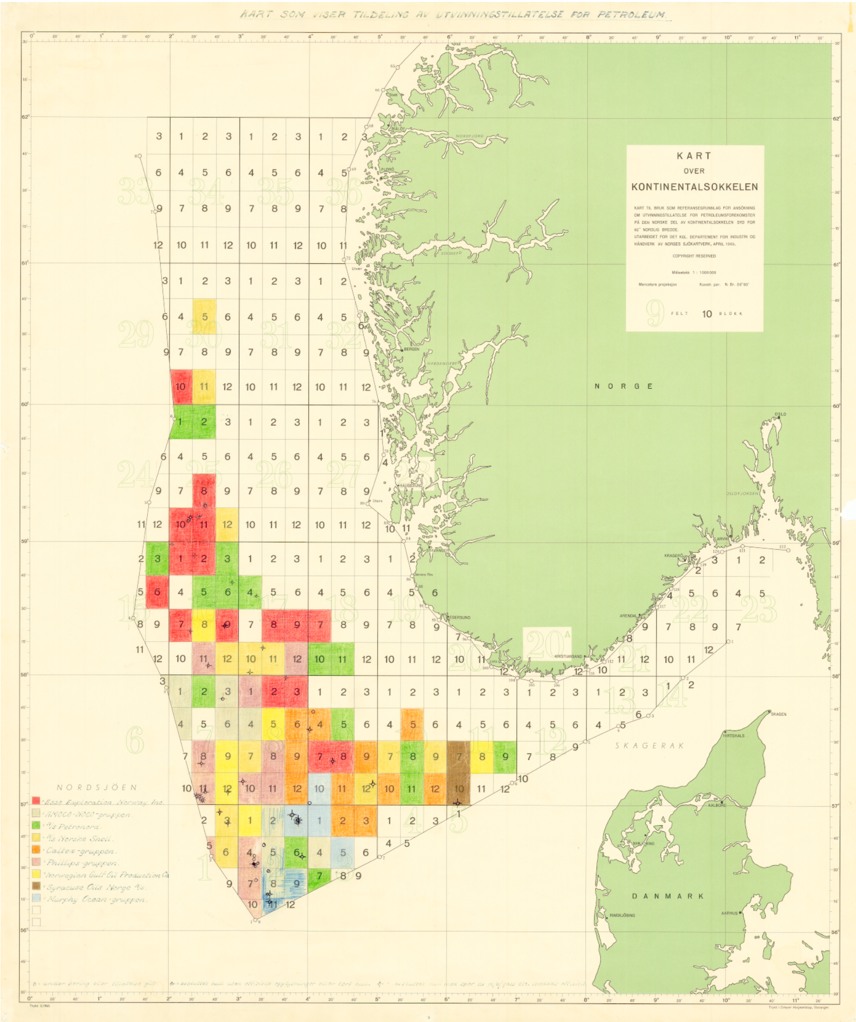

Figure 6.3 Map of the Norwegian continental shelf. © The Norwegian Petroleum Directorate, 1965.

qualities if industrial extraction is to be realized. Industrial success means that industrial and geologic timescales are made to support each other in the sense that materialized results of geologic time are brought into the present. For millions of years, oil and gas were maintained in their sedimentary layers and within their own time. The ABC is a translating apparatus that contributes to grant acute realness and agency to petroleum. The temporal work performed by modern technology and industry, and the resulting alignment with ancient, geological times, is followed by a release of massively concentrated time.[21] Such concentration will be discussed in the following section.

Temporal Concentration

A productive petroleum field depends on successful temporal alignments. In the early years of the North Sea offshore industry, the encounters between geologic and industrial rhythms did not always work out well. Aligned temporal interplays would sometimes be interrupted, as people, technology, or natural forces could swerve and fall out of the arrangement. The Bravo blowout on the *Ekofisk* field in April 1977 is one example. During maintenance work on a drill well, rig workers failed to stabilize the pressure in the well with drilling mud, and a downhole safety valve was not installed correctly. This resulted in an uncontrolled blowout of oil and gas lasting eight days.[22] A far more catastrophic event was the Alpha Piper accident in the UK sector of the North Sea in 1988. During maintenance work on a high pressure condensate pump, workers disenabled a safety valve during a day shift, and information on the work was not sufficiently communicated to the workers on the following night shift. The disenabled valve allowed gas to enter the pump, leading to overpressure and to the following disastrous explosions that caused the deaths of 167 persons.[23]

Human failure has been identified as a chief cause of both of these accidents. Some nuances may be added with the concept of alignment as it focuses on the temporal work needed to make natural elements compatible with the human industry. The deep time of the sedimentary layers materializes within oil and gas, which, lying deep beneath later deposited strata, experience extreme pressures. The use of drilling mud and safety valves are industrial means for countering the fatal effects of these pressures. In the case of the two accidents, the previous alignment of natural and industrial rhythms was disrupted when humans failed to adapt to and control the effects of the earth's concentrated time. Temporal alignments do not happen by themselves; a great deal of industrial work is needed to control the ancient, concentrated time.

Disrupted alignments may have disastrous effects locally.[24] In the context of climate change, however, the most fatal effects are global, stemming from successfully aligned petroleum fields "working all too well" and the sequential combustion of fossil fuel.[25] While past geologic time is located in the depths and slowly builds upwards, industrial time moves from the present and downwards, and this temporal difference is crucial to the modern petroleum enterprise. The tempos of earthly and industrial times are very different: it takes the industry little time to drill down into the earth's slow time, and successful fields cause the release of massively concentrated time. "Oil is very literally time materialized, time that has pooled in the form of a liquid," argues Andrew Pendakis.[26] Petroleum "is the energy made possible by eons of concrete dying," and it comes "dressed up in the very form of time."[27] Petroleum is temporal concentration, and it can be envisioned at the level of a single human as in a comment made by environmentalist Rob Hopkins: "This liter of petroleum contains the same amount of energy that would be generated by me working hard physically for about five weeks."[28] It can also be envisioned in the context of earthly duration, such as when Timothy Mitchell describes the exhaustion of the earth's stock of petroleum: "organic matter the equivalent of the earth's entire production of plant and animal life for 400 years was required to produce the fossil fuels we burn in a single year."[29] The temporal alignment of fields implies that very different time spans are made industrially compatible, and it results in the release of densely concentrated time, which disrupts the earth's carbon balance. The temporal qualities of petroleum emerged millions of years ago, and the "only thing humans add to it that is truly important—and unnatural—is to burn oil. And with that profoundly artificial act, we change the climate and impose a catastrophe upon ourselves and the rest of the world."[30]

Modernity, according to Anna Tsing, is "the triumph of technical prowess over nature." This triumph requires that nature be cleansed of other transformative relations; "otherwise it cannot be the raw material of techne."[31] One could also say that such technical prowess is temporal: sedimentary layers were deposited over the earth's timespan, and petroleum resulted from the transformative relations between layers and rocks. As these layers, in our times, have been incorporated in new transformative relations, the expeditious combustion and unleashing of deep earthly time is the result. Petroleum is concentrated time: it takes a very long time for it to emerge, which is why oil and gas are defined as nonrenewable resources. Discussions of peak oil reflect this point, and while Norwegian oil production peaked in 2000/01, gas production is still increasing.[32] Petroleum is a tremendous source of income, and as extraction technology improves, continued exploitation is made possible.

Scholar of environmental studies Stephanie LeMenager has asked why "oil remains so beloved" and why there is such a "strong resistance to the imagination of alternatives, even as we recognize its unsustainability."[33] On the front page of the Norwegian Petroleum Directorate website, under the heading "Barely Halfway," it is explained that fifty-two percent of Norway's petroleum resources are still to be found and extracted from the ground. The Director General of the Directorate is quoted: "Production forecasts for the next few years are promising and lay a foundation for substantial revenues, both for the companies and the Norwegian society."[34] Future alignments are within sight, and the Norwegian authorities show few signs of wanting to restructure the country's economy away from fossil fuel reliance. Extraction and love of petroleum in a country with elaborate and costly welfare systems are deeply connected with the economy. However, these also relate to petrocultural narratives that support and add culturally comforting rhythms to oil and gas. The following sections explore temporal alignments between the petroleum industry, the Viking Age, and Norse mythology.

Offshore Names and Cultural Depths

As part of the PDO, operating oil companies must suggest a name for the field they are developing. For security reasons, field names must be brief and easy to pronounce in various languages, and the names cannot be confused with existing place names or names of other fields.[35] During the first years of the Norwegian oil age, petroleum companies developed their own logics for field naming. The national petroleum company Statoil (later Equinor) intended to use "Stat" as a prefix followed by terms for natural environments, emphasizing the central role of the state as well as a connection between state and nature. Only one field, however, was named accordingly: Statfjord. Shell wanted to use names of shells, resulting in a field named Albuskjell (common limpet). Philips Petroleum named their discoveries after Norwegian fish names, ordered alphabetically after the blocks the fields were located in, such as Brisling and Flyndre. However, it was difficult to find suitable Norwegian names, and English ones were also used (Anchovis, Cod, Dace, Eel).[36]

Partly due to the companies' toponymical creativity, bureaucratic procedures for approval caused delays. Another reason for the delays was that three governmental agencies, the Petroleum Directorate, the Language Council, and the Ministry of Petroleum and Energy, all took part in the evaluation process. In 1984, the Directorate was set as the sole approving authority, thus cutting the need for final approval by the Ministry, while the Language Council continued as the advisory agency. Around the same time, the Language Council created a list of preapproved field names, from which the operators were urged to choose.[37] The list, which contributed to reducing the bureaucratic delays, consisted of names from Viking Age and Norse mythology, names of figures from folktales, and names of sea birds. The first category has become the most frequently used by far. Two fields are named after birds, and thirteen have been given names from folktale figures, while around seventy fields have been given names stemming from Viking Age and Norse mythology.[38]

The first field given a Viking or Norse name was Tor, named after the hammer-wielding Norse god associated with natural forces, as well as the maintainer of worldly order and protector of mankind. The field is located in the southern part of the North Sea, and the PDO and name were accepted in 1973. Both the Petroleum Directorate and the Language Council lent their support to the toponymical practice, as seen with the incorporation of these names on the preapproved list. As offshore petroleum fields are typically located deep beneath the sea and far from shore, people outside the industry see few signs of production and need cultural connections to comprehend the oil fields.[39] Place names imply power over place and time, and the standardization of offshore appellations by authorities connected petroleum to the national golden age of the Vikings.[40] Petrocultural scholar David McDermott Hughes has noted that oil and gas "often enjoy the most support precisely at the point of their production" where the natural resources benefit "from the entire sentiment of local belonging and history."[41] In Norway, names from the national past have brought petroleum fields and petroleum culturally closer to the population by their incorporation into broader heritage practices. Fields are placed in parallel with pleasant and familiar memories of what it means to be Norwegian, and they become culturally and historically recognizable.[42]

Place naming "is a powerful vehicle for promoting identification with the past and locating oneself within wider networks of memory," argues cultural geographer Derek Alderman.[43] Names lend comfortable cultural rhythms to industry, the economy, and politics. While the use of Norse mythology and Viking Age names is specific to Norway, the subterranean depths of petroleum are associated with culture and history differently in other places.[44] For example, anthropologist Douglas Rogers, in a study of the postsocialist onshore petroleum industry in the Perm region, sheds light on how oil relates to various culturally significant depths, called "glubinka" in Russian.[45] Regional backwardness in Perm is seen as one related kind of depth; the intellectual and personal depth that traditionally signals an authentic Russian identity is another. Further associations with the depths of oil are the valuable things people buried in the ground to hide them from the former socialist government, as well as the large numbers of buried victims of the socialist regime who were dug up from the ground.[46] Petrocultural scholar Elana Shever has shown how sentiments of kinship and familial associations of property in Argentina characterize the petroleum industry.[47] In Nigeria, environmentalist Michael Watts has noted how the subterranean origin of oil resonates with "extraordinary magic events," such as the ability to live without having to work, or the capacity "to tarnish and turn everything into shit."[48] Another association with cultural depths, also mentioned by Watts, is how a former Venezuelan president described oil as "the Devil's excrement."[49] The following section explores how deep petroleum and the cultural depths of the Viking Age align.

Cultural Depths: "So Very Norwegian"

Various Norwegian petroleum fields are named after Norse gods and goddesses, such as Tor, Odin, Vilje, Frigg, Frøy, Balder, Hod, and Brage. Others take their names from the mythological creatures *jötnar*, such as the Yme, Trym, and Hyme fields. Other fields are named after mythical objects, like Odin's spear Gungne, or after longships, such as Ormen Lange and Oseberg (see Figure 6.4). Names of Norse mythical animals are used, such as the goat Heidrun, the horse Gullfakse, and the deer Dvalin. Also, mythical as well as historical place names designate fields such as Valhall, Gimle, Åsgård, Alvheim, and Sygna. Snorre, author of Norse literature, and his prose work, Edda, are also used as field names.

A brochure titled *Gudar i oljå* ("Gods within the oil") was published in 2002 by the Norwegian Petroleum Directorate for its thirtieth anniversary. In the introductory part of the approximately forty-page brochure, the question is raised: "what on earth do we mean by using names from Norse mythology on something as modern and international as the petroleum industry?" The author then explains how she had asked around, presumably within the petroleum industry and bureaucracy, and concluded that "probably, one did not think very much about it. It was just so very Norwegian—and so very strong!"[50]

Field names connect the present with the past, and as with many other place names, they "resonate in myth, history, worldview, and heritage."[51] The use of Viking and Norse names involved a reformulation of an already much reshaped historical period. From the early nineteenth century onwards, the Viking Age has been understood and shaped in different ways and it has served various political purposes. The excavations of ships and objects from the 1860s until the beginnings of the twentieth century fell in line with Norwegian cultural and political struggles towards independence after half a millennium of being governed first from Denmark and then from Sweden. The ships pointed back to the Viking Age as an epoch of national independence and pride, and the period turned into a chief origin myth for the Norwegians.[52]

When Norse and Viking Age field names were used in the 1970s, only a few decades had passed since the historical period had been used as an ideological source by the political party Nasjonal Samling and by Nazism. While this previous use came to be associated with brutality and plundering, historians and archaeologists introduced a new focus on journeys and exploration from the 1960s and onwards.[53] The renewed academic focus has been explained as a way of taking back ownership of an important part of national history.[54] The use of Norse and Viking names ran parallel to more conventional heritage practices, and the petroleum industry and policy contributed to mold a more suitable and less brutal past, adapted to the needs of contemporary society.

Figure 6.4 The *Oseberg* ship was excavated in 1904 and is displayed in the Viking Ship Museum in Oslo. Photo: Mittet & Co., 1957. National Library of Norway, public domain.

A highly significant moment in Norwegian petroleum history was the first major discovery of oil in 1969. The drill rig used then was named Ocean Viking, and the field naming practice followed afterward. The Norse and Viking names preceded, or one could even say paved the way for, more conventional heritage practices. Archaeologist Nanna Løkka pinpoints an initiating moment in the transformation of Viking Age heritage to be the 1983 unveiling of the commemorative monument "Sword in Mountain."[55] The monument consisted of three large bronze replicas of Viking swords anchored in rock slopes at the seaside, located just outside Norway's "oil capital" Stavanger and near the site of the Hafrsfjord battle of 872, a battle said to have enabled Harald Fairhair to unite Norway as one kingdom. Heritage involves a manipulation of the past, and Løkka quotes a speech made by King Olav at the unveiling ceremony: "the time for peace and cooperation has come. Let it be a symbol for agreement, peace, and solidarity among the Norwegian people."[56] Contemporary culture needs historical continuity, and peaceful democracy and collective solidarity need historical roots. The Viking monument offered evidence from the past: these national qualities had indeed existed in Norway for a very long time. Offshore naming practices contributed, and the idea of a democratic and solidary Viking past resounded well with the idea of the Norwegian citizens' collective ownership of the petroleum resources.

Like deep and far flung petroleum fields, Vikings and their Norse mythology extend deep into history, and their ships and treasures have been brought up from the underground. These resemblances promote alignment: both petroleum and Vikings are distant and deep. In a preface to the abovementioned anniversary brochure, an assistant director at the Petroleum Directorate commented on the distant character of petroleum: "Most Norwegians don't know much about the wealth hidden in the seafloor. Every day we read about value creation, oil fortune, sale of gas, production numbers and prognoses." He continued by drawing a bigger picture: "Actually, it is all so much more powerful—the dimensions, the pressure, the sea, and the work culture." The natural and industrial grandeur, according to the assistant director, inevitably suggested the naming practice: "No wonder most oil and gas fields have their names from Norse mythology." Petroleum was logically and inevitably connected to the national golden age, a "world with mighty natural forces and a persisting life struggle."[57] Such understandings contributed to aligning the deep time of oil with the deep time of national culture: the magnitude, the natural forces, and the impressive strength of human and godly struggles were distinctive qualities chosen to describe them both, and these resemblances aided in establishing a supportive relationship of similarity between past and present.

While humans appeared in the territories that came to be Norway some eleven thousand years ago, the first culturally and nationally significant Norwegians were the Vikings. One could say that it does not make much sense to move further back or deeper down in Norwegian history in search of national origins or pride. The petroleum industry formed part of a broader heritage movement, and the skilled mastering of the seas was another contemporary quality in need of historical roots. An exhibition on offshore technological progress at the Norwegian Petroleum Museum in Stavanger may illustrate the point. Most of the exhibit is dedicated to oil history, but it is introduced with a glass case titled "A Floating Empire," decorated with Norse runes picturing ships. Historical models of ships are displayed in the glass case, and the accompanying text explains that "Norway was in contact with the outside world by sea as far back as the Stone Age. But the Gokstad ship is representative of the swift sails, which carried the Vikings abroad as warriors, explorers, traders, and settlers, a thousand years ago. Their shipbuilding skills allowed them to conquer the seas, and even to reach North America." While seafaring Norwegians existed in the Stone Age, they flourished during the Viking Age. Warfare is mentioned, but the text places the most emphasis on technological skills, international orientation, and more peaceful ways to conquer and explore the seas. The Viking Age and the present oil age thus align and show similarities; they both belong within a national history of increasingly skilled sea exploration.

The naming practice establishes a connection between the past and the present that seems obvious and indisputable. A reflection on the suitability of Viking and Norse names is made in the anniversary brochure: "The oil adventure on the Norwegian shelf has probably, to a great extent, taken over the function as a national myth. It seems reasonable to draw the lines back to the ideas of a dynamic, expansive Viking Age as another great epoch of our history."[58] The grandeur of the contemporary oil age is shaped and conveyed as mythical as well as energetic, modern, and expansive, to such an extent that it surpasses most other periods of national glory. Only the Viking Age can manifest a historical magnificence comparable to the contemporary oil society.

Exemplary Temporal Concentration

In the above quote, a "line" is drawn between the present and past grandeur. This could lead one to think of time as a linear and continuous progression: the Vikings mastered the ocean with great success, and the contemporary Norwegians do it just as well, or even better. Linear time tends to be flattened out horizontally, ordered progressively and chronologically, and within such an understanding historical periods are often presented as different rather than similar. This does not seem to be the case with petroleum and the Viking Age. Instead, as in the earlier discussions of vertical linearity, one could envision a more vertically oriented national history, one that stretches down into cultural depths and to a very specific period. A vertical connection between past and present, aided by the naming practice, could be thought of in terms of temporal concentration. Earlier in this chapter, petroleum was discussed as a densely concentrated form of time. Here, a temporal concentration of exemplary national qualities will be elaborated on as a similar kind of alignment through an analytical tour into an earlier understanding of history.

Within the *Magistra vitae* tradition, which governed history writing from Antiquity until the late eighteenth century, history functioned as a guide and a "teacher of life": history was understood as a reservoir of good and bad examples to be learned from, demonstrating moral virtues or depravity, and wise or unwise decisions. Contrary to a modern understanding of history as a unitary process made up of sequential and fundamental differences between historical periods, experiences of the past were considered relevant for dealing with present and future situations, thus implying a fundamental resemblance between past, present, and future.[59] Applying these insights to the connection established between past and present with offshore names, one could describe the Viking and Norse past as a source of excellent examples to be learned from, with examples of relevance for industry both today and in the future. The Vikings and their gods fought continuously and successfully against nature's forces, the Vikings mastered the sea, and they came to represent a historical origin for Norway as a great democratic nation. These exemplary qualities repeat within the contemporary oil industry; the Viking Age supports and aligns with present qualities.

Examples are repeated rhetorical figures, in the form of specific, individual instances pointing towards and confirming the validity of a general statement. They function "as illustration, as an aid in understanding, in visualizing" a general statement.[60] In the present case, the general statement would be that Norway and Norwegians are successful in their mastery over nature and the sea and that they constitute a democratic collective. The Viking Age, as well as the present oil industry, would then be specific instances supporting this general idea. Also, when an example alludes to a whole series of similar incidents, it implies repetition.[61] Here, this would mean that Norway and its inhabitants repeatedly show, independently of the passing of time, that they are very capable in their mastery of the seas and in their struggles against the forces of nature. Often, however, when examples are used persuasively, such repetition is "abandoned in favor of a single instance that stands for many similar cases," and examples are chosen among exceptions rather than from common occurrences.[62] Examples may thus be paradoxical as they are "arguing in favor of a norm while displaying the fascinating exception."[63]

The rhetorical strength of examples is both fascinating and paradoxical. Both the Viking Age and modern industry are identified as outstanding incidences of national glory, and typical national qualities concentrate within and characterize them. But even though these are considered typical and defining qualities of what it means to be Norwegian, they rarely seem to appear in history. Instead, the Viking Age and the present industry function as examples of historical periods, in which outstanding national qualities are massively concentrated. Perhaps, if the presence of these qualities throughout Norwegian history had been emphasized and posed as an example, the significance of these two specific periods would be reduced, and they would instead represent typical historical occurrences. When national grandeur is to be proved, temporal concentration seems to work better than explicit repetition. The two historical periods, which are strikingly different, align through the claimed, shared presence of these qualities. Moreover, these qualities are at the same time exemplary exceptions and general, reiterated national qualities. The naming practice establishes continuity within national history, and it also bears the promise of future alignments as these qualities are destined to repeat again and again.

Petroleum is concentrated in subterranean reservoirs, and, similarly, the Viking Age is situated in the cultural depths of Norway. The exemplary national qualities of mastery over the sea, struggling against nature, and popular democracy have been densely concentrated within the Viking Age, and through temporal alignment these qualities are made to be reproduced within the contemporary petroleum industry. Petrocultural histories normalize our reliance on fossil fuels and naturalize the role of petroleum within social orders, and a central part of such histories is how they allow us to not see, to forget, and to overlook our deep reliance on petroleum and the environmental damage it involves.[64] In an earlier section, it was shown how the release of concentrated time depended on both the similarity and difference between industrial and geologic timescales. The same could be said here: the alignment between Viking past and industrial present involves identification and selection of a very limited set of qualitative similarities. Such selection contributes to diminishing the visibility of differences between past and present. Vikings and Norse gods did not only master the sea and struggle against natural forces; many other things went on in their times. The same is valid for today's industry, and among the destructive effects of the limited focus on mastering nature and the sea are the ways in which Norwegians are made to overlook and forget the environmental damages that occur when the massively concentrated time of earth is unleashed.

Conclusion

Throughout Norway's oil age, the government has stressed how petroleum collectively belongs to the Norwegian people, and the economic resources stemming from it have been used to secure a high level of welfare. Heritage practices incorporating petroleum contribute to anchoring these ideas and welfare. The Viking Age and its mythological universe offer a comfortable cultural rhythm that counters the speedy and destructive rhythm of the petroleum industry and combustion.

This chapter started by exploring technoscientific practices and continued with cultural and historical practices incorporating petroleum fields. These practices belong within different disciplines, and they integrate earthly timescales in different ways; this chapter has aimed to investigate how natural and historical temporalities align within petroleum fields. The concept of alignment functions as a tool for exploring some similarities as to how temporal durations and rhythms are connected, adapted, manipulated, and made compatible. Both industrial and cultural engagements with petroleum fields involve a moving downwards or backward in time. The petroleum industry drills down into layered periods of geologic time, and offshore naming practices stretch back into the depths of national culture. Alignment also involves direction, and petroleum fields emerge both upwards from deep layers of earth and from today's industrial installations, and downwards into time and sediments. Temporal directions may be horizontal or vertical, and industrial exploration stretches through kilometers and across geological epochs, guided by the societal desire to locate, extract, and combust the materialized time within specific sedimentary layers. Temporal alignment involves processes of identification, selection, and isolation of specific elements and qualities of the past. Such processes establish supportive similarities between radically different timespans, but they also disguise destructive differences. The invisibility of such differences is heavily supported by the manipulative use of heritage and history. Offshore naming practices concentrate exemplary time and provide culturally comfortable rhythms to the broader population. They also enable the transformation of petroleum into a specifically Norwegian resource, politically, popularly, and destructively understood to be collectively owned by all Norwegians.

"The gods remember a golden age": the concluding words of the anniversary brochure published by the Petroleum Directorate concern the petroleum field Åsgard, named after the home of the Norse gods, and they are strangely apocalyptic. While the gods' present is characterized by a constant struggle, their past is described as much more harmonious. The goddess Idunn used to secure apples of youth for her godly fellows so that they would maintain their strength and health and could live in "a state of innocence in perfect, static equilibrium between the forces." But the times changed, and the apocalypse is now approaching: "the *Jörmungandr* encircles the human world, *Hel* rules in his kingdom, and the *Fenrir wolf* is tearing away his shackles. Beasts are gnawing on the roots of *Yggdrasil*. Like a smoldering fire, *Ragnarok* is about to emerge." Chaotic, threatening interplays between dangerous forces have come to define the present of the Norse gods, it is explained, but in this troublesome world, a new dream prevails: "After *Ragnarok*! A new heaven and new earth will emerge. The gods shall once again gather in the yard . . . recover their golden boards in the grass from the good old times and continue their divine plays in perfect harmony. The new *Åsgard*!"[65] Horrible natural disasters characterize the Norse apocalypse Ragnarok. The world is submerged in water, many gods will die, and humanity will nearly be exterminated. After Ragnarok, however, the world will resurface, green and fertile, the remaining gods will meet up, and the two human survivors will repopulate the world.

Why the Petroleum Directorate chose to end its anniversary brochure in this way is not explained, but it is very unlikely that the closing words were intended as a mythological parallel to the catastrophic environmental consequences of fossil fuel combustion. The depths of national history may be understood and molded in different ways, and petrocultural scholars stress the need to rethink "how oil everywhere has social, aesthetic, and historical forms" and argue that we need to recode "these forms through an environmental narrative."[66] Investigations of cultural histories that legitimize and support the oil industry and its politics form part of such recoding efforts as they may identify temporal mechanisms that work well within a broader audience. While the temporal alignments between earthly timespans and the Viking Age heritage could be described as shameful and manipulative, these alignments may provide lessons for such recoding and for establishing new histories of how we act and see ourselves in nature.

Lise Camilla Ruud is a Postdoctoral Researcher in Cultural Sciences at University of South-Eastern Norway. She has written extensively on the early modern history of knowledge and material culture, as well as on oil culture and the heritage sector. Her recent publications include "The Oil Adventure: A Timeline Exhibition at the Norwegian Petroleum Museum" in *Nordisk museologi* (2019); and "Materializing Circulation: A Gigantic Skeleton and a Danish Eighteenth-Century Naturalist," in *Explorations in the History of Knowledge*, edited by Johan Östling et al. (Nordic Academic Press, 2018).

NOTES

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3. The quotes are from the most recent white paper on petroleum policy and industry, see: Norwegian Ministry of Petroleum and Energy, *An Industry for the Future: Norway's Petroleum Activities. Meld. St. 28 (2010–2011) Report to the Storting (White Paper)*, retrieved from https://www.regjeringen.no/contentassets/19da7cee551741b28edae71 cc9aae287/en-gb/pdfs/stm201020110028000en_pdfs.pdf.
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8. "ABC of Oil," Norwegian Petroleum Directorate, Retrieved January 3, 2021 from http://www.npd.no/en/About-us/Information-services/Dictionary/.
9. Compare Pendakis, "Being and Oil," 387.
10. Lise Camilla Ruud, "Oil as Heritage: Temporalities and Toponymies on the Norwegian Continental Shelf," *Ethnologia Scandinavica* 49 (2019): 143–61; Macdonald, "Containing Oil"; Rogers, *The Depths of Russia*.
11. Compare Tim Kaposy, "Petroleum's *Longue Durée*: Writing Oil's Temporalities into History," in *Petrocultures*, ed. Wilson et al., 389–406.
12. "ABC of Oil."
13. "ABC of Oil."
14. Knut Bjørlykke and Per Avseth, *Petroleum Geoscience: From Sedimentary Environments to Rock Physics* (Berlin: Springer, 2010), 8–10; David McDermott Hughes, "Petro-Pastoralism: Agrarian Hydrocarbons in South Trinidad" in *Petrocultures*, ed. Wilson et al., 411; see also Marcia Bjornerud, *Timefulness: How Thinking Like a Geologist Can Help Save the World* (Princeton: Princeton University Press, 2018).
15. Bjørlykke and Avseth, *Petroleum Geoscience*, 10–19.
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33. Lemenager, "The Aesthethics of Petroleum," 61.
34. "Norwegian Petroleum Directorate," retrieved January 3, 2021 from https://www.npd.no/en/.
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36. Vikør and Ølmheim, "Namn på oljefelt," 13.
37. Eli Ellingsve, "Lovløse Stedsnavn i Norske Farvann—et Minefelt," *Lokalhistorisk magasin* 4 (2012): 14–17.
38. Information on the names is retrieved from the application "Oil Facts" provided by the Norwegian Oil Directorate. In addition to these naming categories, six fields are named after persons associated with nineteenth-century and twentieth-century nation-building (such as Johan Sverdrup, or Johan Castberg). Around twenty fields have names from other categories. Some are constructed names such as Statfjord, Eldfisk, and Ekofisk. Some are named after seabirds (Skarv and Ærfugl) and others have fish names (such as Cod or Marulk). One is named after the wild cat species Gaupe, and another bears an old name for wolf, Varg. Some names relate to the UK sector of the North Sea, such as Murchison, Islay, and Morvin, while others are given traditional female names (Kristin, Oda, and Maria). Two fields are named after biblical figures (Enoch and Goliat) and another two after stars (Nova and Vega).
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40. Amit Pinchevski and Efraim Torgovnik, "Signifying Passages: The Signs of Change in Israeli Street Names," *Media, Culture and Society* 24, no. 3 (2002): 367; Vikør and Ølmheim, "Namn på oljefelt."
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55. Løkka, "Dagens Vikingtid."
56. Løkka, 54.
57. Taksdal, "Gudar i Oljå," 2.
58. Taksdal, 7.
59. Anne Eriksen, *From Antiquities to Heritage: Transformations of Cultural Memory* (New York: Berghahn Books, 2014), 21; Alexander Gelley, ed., *Unruly Examples: On the Rhetoric of Exemplarity* (Stanford: Stanford University Press, 1995), 5.
60. John Lyons, *Exemplum: The Rhetoric of Example in Early Modern France and Italy* (Princeton: Princeton University Press, 1989), 33; Gelley, *Unruly Examples*, 3.
61. Lyons, *Exemplum*, 26.
62. Lyons, 26, 237.
63. Lyons, 33–34.
64. Wilson et al., *Petrocultures*, 133; Malouf, "Behind the Closet Door," 146.
65. Taksdal, "Gudar i Oljå," 37.
66. Macdonald, "Containing Oil," 55.

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Part III

TIME-BINDING KNOWLEDGES AND VISUAL GENRES

⊱• 7 •⊰

Temporal Poetics of Planetary Transformations

Alexander von Humboldt and the Geo-anthropological History of the Americas

Adam Wickberg

> As a historian of America, I wanted to clarify facts and specify ideas by means of comparisons and statistical data.
>
> —Alexander von Humboldt, *Political Essay on the Island of Cuba*

While Earth System Science has created a more holistic view of the interconnection of all the aspects of our ecological crisis, it seems that particularly humanistic knowledge is still largely missing from the equation.[1] The truly integrative connecting of the human and natural sciences largely remains to be done, and an important obstacle is arguably the prevailing will, within academia and beyond, to keep these large disciplinary cultures separate (interdisciplinarity has been implemented to a relatively large extent within the disciplines of the humanities, but less so between the humanities and the natural sciences).[2] This divide emerged in the second half of the nineteenth century, and was reinforced with C. P. Snow's notion of two irreconcilable cultures in the 1960s, and many attempts have been made to overcome the divide in the past decades.[3] This inability to integrate epistemic cultures has been gaining more attention over the past decade, notably with regards to history and geology.[4]

How does this great epistemic divide relate to the current status quo paralysis and lack of proper response to the eco crisis, in spite of the massive scientific knowledge amassed and presented over the past fifty years? One possible answer is that scientific reductionism and specialization bears responsibility on an epistemic level.[5] According to this hypothesis, the ever increased specialization of the natural sciences led to an obscuring of the planetary dimension of the imminent threat, which was made worse by the fact that many of the consequences are effects of feedback loops between the earth's systems, so that that the instability of one inevitably destabilizes another. The same tendency applies to world history, where smaller and smaller units of specialization prohibited a view over longer timespans.[6]

Against this background, this chapter revisits the geological work of Alexander von Humboldt (1769–1859), who saw it as his mission to develop a holistic and global understanding of life on earth. Despite being world famous and hailed as a leading scientist at his death in 1859, Humboldt fell into oblivion soon thereafter and it would take until the turn of the twentieth century until his reappraisal could begin. This is likely due to the tradition of scientific reductionism and specialization that have viewed synthetic scientists like Humboldt with great suspicion. The same scientific qualities that made him incomprehensible then are now driving the reappraisal of him as a founder of Earth System Science.[7] Given the importance of Humboldt and later integrative scientists like James Lovelock for a unified perspective on the earth's atmosphere, hydrosphere, cryosphere, and biosphere, it is relevant to also combine this perspective with the more humanistically oriented aspects of Humboldt's thought and see these not as curiously different but rather integrated with and defining for his hypothesis about the global environment.

At the time of writing in 2019, Humboldt's 250th birthday is celebrated with a new interest in his work resulting in symposia, publications, and translations. Most scholars have focused on his understanding of space and the ecological connections between different places on earth, but hardly anything has been said about his work on history and geology, even though they were arguably core parts of his scientific project. It is particularly visible in his work on the natural and cultural history of the Americas, which was the subject of a major debate of the time. In this chapter I will discuss Humboldt's work on the entwined human and geological temporality of the Americas and his interdisciplinary methods moving from poetry to geology in a geo-anthropological poetics of the planetary. The term "geo-anthropology" goes back to the era of Humboldt but has not been current since the nineteenth century. Now the concept is being revived as a way to integrate geology, environment, and human sciences to understand the conditions of living in the Anthropocene. Jürgen Renn has proposed geo-anthropology as an emergent transdisciplinary research field of human-earth interaction, which is meant to be truly integrative of human and natural sciences and provide a common theoretical framework. The aim of this framework is to enable the address of multiple scales from micro- to macrospheres as well as various temporalities of deep time, history, present, and future.[8]

In the following, I focus on how Humboldt historicizes the American continent and responds to the debate about the geological age of the so-called New World that had started with propositions by Comte de Buffon towards the end of the eighteenth century about American environmental degeneracy.[9] While Humboldt's embryotic understanding of climate change in the early nineteenth century is now widely acknowledged, my focus is on how the conflation of geological time, natural history, and human history, as well as environmental and social sciences enabled him to grasp global change in a unified vision of planet earth and its history. An essential point of departure is that change is always the effect of time, and that the way changes in climate, ocean, biosphere, and geology are currently understood still suffer from the lack of integration between human and nonhuman timescales.[10] In this way, change in world history and geology follow the same rules. We try to find a marker of transition between periods in order to make sense of large chunks of time. As the Anthropocene has become an important historiographical concept in addition to being a geological epoch, and since it is defined by the mark of man, it offers an interesting case of conflation of human and geological timescales. The work of establishing the Anthropocene as a geologic unit requires the identification of a Global Stratotype Section and Point (GSSP). All geological temporal subsections require a GSSP to mark the transition from one stratigraphic layer to another, but the case of the Anthropocene challenges our preconceptions because we need to find a geological signal of human impact that is global. That is, we need to combine a sensible interpretation of global history with a nuanced view of geological transitions. The two strongest candidates for a GSSP for the Anthropocene are probably the so-called Bomb Spike of 1952 that uses the signal from nuclear bomb testing and the Orbis Spike of 1611, which finds its signal in a marked dip in global CO_2 preserved in two Antarctic ice core cylinders. This decline in CO_2 has been demonstrated to be due to the rapid depopulation and mass death of about sixty-five million humans in the Americas, whose farmland was therefore abandoned and allow to rewild, resulting in a quick CO_2 uptake.[11] Depending on which GSSP is chosen, we get different conceptions of the Anthropocene—one associated with World War II and the onset of the Great Acceleration and one connected to Early Modern globalization and colonialism. This issue, which currently occupies many minds of academia, seem to me to resonate with Humboldt's work on defining geological and environmental changes as global, and his historicizing of the Americas as both world and geological history as a form of geo-anthropology. How did Humboldt historicize the Americas on various timescales to relate the New World to a sense of global time? What was the role of geology in Humboldt's integrative cosmographic vision as he presented it in *Views of Nature* (1809)? How did he integrate knowledge across human and natural sciences?

This chapter sets out to test the hypothesis that Humboldt, as a polymath and global thinker working just before the great epistemic divide and then largely in the shadows until recently, offers an interesting example of the integrative thinking that is needed today to tackle the challenges of dealing with climate change, mass extinction, and living in the Anthropocene as exemplified in the concept of geo-anthropology. For the purpose of delineation, I will focus on Humboldt's *Views of Nature* (1809) and supplement it with material from his *Geognostical Essay on the Superposition of Rocks in Both Hemispheres* (1822).

Geological Time and the New World

Which place did time and temporality occupy in the work of Humboldt? Trained as a mining inspector in Freiburg, and later a student with the leading geologist Abraham Werner, Humboldt was always interested in relating the earth's deep time with that of human history. Like his fellow students, Humboldt initially subscribed to Werner's then dominant theory of Neptunism—the idea that all solid rock formation originated in a vast super ocean—but later switched to Volcanism (plutonism) and Uniformitarianism after having studied the volcanoes of the Americas and compared them to those found in Italy. Together with the geologist Leopold von Buch who had also been a student of Werner, Humboldt embarked on an expedition to Italy where they witnessed an eruption of Vesuvius, which changed their view of geology. Humboldt had already seen the power of the internal forces of the earth at work in the Quito earthquake in 1802. Volcanoes became key for his understanding of the formation of the earth and he noted that they were often formed along straight lines rather than randomly and often close to the oceans, an observation that prefigured the discovery of plate tectonics in the shaping of the earth.[12]

Humboldt and von Buch developed the principles of stratigraphic layering—which they called formations—in a way that is foundational to our current geological columns of globally valid systems like Jurassic or Cambrian corresponding to relative timescale periods with the same name.[13] The chronostratigraphic term Jurassic is derived from the fossil-bearing Jura mountains in Switzerland, which Humboldt was the first to recognize as a separate stratigraphic formation in 1795 and published a paper on in 1799. The stratigraphical position of Jura limestone named by Humboldt was then used as the basis in von Buch's definition of the still valid three part Jurassic system of *lias*, *dogger*, and *malm* in Lower, Middle, and Upper Jurassic stratigraphic formation corresponding to Early, Middle, and Later Jurassic epochs of geological time.

Geology—or geognosy as Humboldt and many Germans preferred to call it—was at the heart of Humboldt's scientific journey to the Americas and his global worldview. The rise of this field of study and the efforts to determine the history of the earth would over the course of the nineteenth century lead to a split and strict separation between the two temporal regimes of world history on the one hand and geological history of the planet on the other. Although this tendency was already apparent in the mid-nineteenth century, Humboldt was a strong advocate of unity in knowledge both with regards to space in geographic positioning and with regard to time as he saw the entanglement of the earth's history and the history of man, particularly in the Americas. Moreover, he insisted on the feedback between systems, such as how geological formations of deep time shaped botanical green-layering, which in turn corresponded to and shaped climate zones, all of which affected and were affected by human endeavors like farming and deforestation.

Around the time of Humboldt's voyage to America there raged a debate in Europe on the epistemic status of the New World. Several well respected scholars insisted on the inferiority and degenerative nature of humans and animals in the Americas, for which they gave an environmental explanation in insisting that it was the undeveloped nature of the environment there that led humans and animals to be smaller and less productive. Interestingly, the debate was consistently cast as an entwinement of human history, natural history, and earth history. Comte de Buffon was the first to insist on this difference between the animals of the old world and the new and was followed by Cornelius de Pauw who became the main and most aggressive propagator of Buffon's notion that the New World was also new in a geological sense and had emerged from the world ocean at a much later time than the old.[14] Particularly, Buffon and de Pauw linked this geological newness to the relative humidity and dampness, which favored only cold-blooded animals like crocodiles and snakes in their view. Since they departed from the Neptunist view that all solid land had once been formed at the bottom of an ocean and then emerged, the humidity they associated with the American continent was explained by the continent's more recent formation as land. However, Buffon also expressed the view that the American continent would never reach the mature point of the European:

> In this state of abandonment, everything languishes, decays, stifles. The air and the earth, weighed down by the moist and poisonous vapors, cannot purify themselves nor profit from the influence of the star of life. The sun vainly pours down its liveliest rays on this cold mass, which is incapable of responding to its warmth; it will never produce anything but humid creatures, plants, reptiles, and insects; and cold men and feeble animals are all that it will ever nurture.[15]

Humboldt was one of the few European opponents to Buffon's widespread theory, which coincided with a peak in European interest in the Americas. Humboldt, who could speak from the vantage point of firsthand empirical observations of the geological makeup of the new continent deemed these views unphilosophical and contrary to the laws of physics. That Buffon, G. W. F. Hegel, de Pauw, and others were wrong about both the geological and the world historical age of the Americas could be proved with reference to the monuments of the Indigenous people and the many volcanoes that that he had studied up close.[16]

Geo-anthropology and Integrative Views of Nature

In *Views of Nature* (1808) Humboldt wanted to convey the aesthetic pleasure of scientifically understanding the interconnected forces of nature in a combination of literary style and knowledge advancement. Apparently, such a project—which we would now recognize as transdisciplinary—resonated with the taste of the wider audience as it became his best known and most influential work as well as his own favorite; it was soon translated into English, Spanish, and French from the original German. This approach gave Humboldt the opportunity to counter notions of the geological youth of the Americas put forward by Buffon. By the time of the first publication of *Views of Nature* in 1808, these ideas had become rather widespread and championed by de Pauw. Humboldt used his accessible prose to act as a debunker of geological myths:

> If one side of our planet is thus said to be more humid than the other, then the observation of the present state of things is sufficient to solve this problem of inequality. The physical scientist need not wrap the explanation of such natural phenomena in the garb of geologic myths. It is not necessary to assume that the destructive battle of the elements upon the ancient Earth was settled at different times in the Eastern and Western Hemispheres, or that America emerged from the chaotic covering of water later than the other parts of the world, as a swampy island, home to alligators and snakes.[17]

This paragraph is a direct response to the geological foundation of Buffon's theory of American degeneracy, which stated that the humidity and swampiness of the continent favored only cold-blooded animals and was due to it being in a different geological epoch than the European continent. As the *Views of Nature* was meant to be read in an aesthetically pleasing manner without compromising the scientific basis of the knowledge conveyed, Humboldt used his footnotes in an exemplary manner. Often, the most interesting discussions are found in these notes that spawn several pages. They create a sense of horizontal and vertical motion in the essays, which are held together with a single thematic focus like "Concerning the Steppes and Deserts." As the narrative progresses horizontally through an overarching focus where the theme is connected on a global scale, the footnotes allow for vertical dives deeper into the wells of the underlying science. While Humboldt did not name the propagators of the new world degeneracy theory in this essay, he used a footnote to develop the counterargument and explain the global nature of geological time.

> All too often, generally praiseworthy authors have repeated that America is, in every sense of the word, a new continent. The luxuriance of the vegetation, the enormous amounts of flowing water, the disquiet of mighty volcanoes announce (so they say) that the continually quaking, as not yet dried out Earth is closer to the chaotic, primordial state than it is in the Old continent. Such ideas, long before the beginning of my trip, seemed to me to be as unphilosophical as they were at variance with generally accepted physical laws. Fanciful images of youth and unrest, of increasing dryness and inertia of the ageing Earth can arise only among those who easily snatch up contrasts between the two hemispheres without making the effort to comprehend in a general way the construction of the planet. Should one presume that southern Italy is newer than its northern regions because it is almost continuously shaken by earthquakes and volcanic eruptions?

In this quote, Humboldt counters Buffon's and de Pauw's notions of more recent American geochronology as unphilosophical and at odds with the laws of physics. He observes the mistake made by these authors and their followers in assuming a connection between geology and climate without any scientific basis. It is interesting to see that the failure of Buffon and de Pauw comes down to their lack of effort to understand local geophysical phenomena in relation to *the construction of the planet*. It is striking how Humboldt's analysis of temporality constantly falls back on a planetary perspective, just like his geographical insights. As he made these points, he had just established the connection between geology and climate in *the Geography of Plants* (1807) with the iconic profile view of vegetation zones of Chimborazo. But the connection he established between the climate, vegetation zones, and geological makeup was instead based on the observation that as mountains are elevated geologically they push through the atmosphere and change the barometric pressure and temperature of the vegetation zone, which in turn picks up meteorological patterns circulating the planet. An isolated phenomenon like a volcano could not be explained geologically without connecting it to deep time and planetary logics of magma flows. His sarcastic comparison with the Italian volcanoes and the geological age of the region makes this point a rather poignant critique.

Humboldt continues his discussion about the geochronology of the American continent by conflating volcanic eruptions as events of world history with the transformations in geological time. "Moreover, what trivial phenomena are our current volcanoes and earthquakes in comparison to the revolutions of Nature that the geognost must postulate when pondering the chaotic conditions of the earth at the lifting, the solidification, and the fracturing of the mountain masses?"[18] In this temporalization of the entangled timescales of world history and geochronology, Humboldt posits the geological live of volcanic eruptions and earthquakes in relation to the geological time of the slow formation of the earth's crust.[19] They are not posed as separate, but rather the scale of deep time (which in Humboldt's time was considerably shorter, or more shallow, amounting to about seventy-five thousand years, compared to the 4.5 billion years we count today) puts the human experience of an individual phenomenon into perspective, which serves the argument in pointing out the mistake in drawing a conclusion of the formation of continents based on singular volcanic eruptions.

In 1803 Humboldt had witnessed the eruption of the young volcano of Jorullo—formed only in 1759—and was the first to ascend the still active volcano with his companion Aimé Bonpland. This volcano became an exemplary model for earth science and earth history in Humboldt's work, as he was able to form a very personal experience-based relationship to it.[20] In this effort to reliably historicize the earth at this time, Humboldt was far from alone. Rather, as Martin Rudwick has demonstrated, the period coinciding with Humboldt's scientific career and the revolutions in Europe gave birth to the conceptual framework of geochronology, in which earth came to be understood as having its own deep history, in which humans were but a recent inhabitant.[21] Still, these synchronistic efforts of merging human and geogical time by Humboldt, his colleague Leopold von Buch, Georges Cuvier, and others have been largely overshadowed by the dominant narrative of linear and teleological historicism.[22] But these shadows are also due to the great epistemic divide that emerged just after this period.[23]

Continuing his argument, Humboldt offers a more solid explanation of the strong volcanic activity of the American continent. "In the new continent, the volcanoes continue to burn longer because the high mountain combs, upon which they burst forth in rows following long faults, are closer to the ocean, and because with few exceptions this proximity, in a way that has yet to be explained, seems to modify the energy of the subterranean fire. Also, the activity of earthquakes and fire-spewing mountains is periodical."[24] Humboldt thus notes that the volcanoes in the Americas are placed in straight rows close to the ocean, which increases the intensity of magma flows in a way that "has yet to be explained." Indeed, the discovery of plate tectonics a century later would explain that these meeting points of continental plates are weak zones where subduction and melting rocks feed explosive volcanism, like in the Andes where the South American plate meets the Nazca plate.[25]

> Now physical unrest and political calm prevail in the New continent, while in the old, the devastating conflicts of the people disturb the enjoyment of

> a Nature at peace. Perhaps times will come when, in this curious conflict between the physical and moral powers, one part of the world will take over the role of the other. Volcanoes rest for centuries before they erupt anew; the idea that in the older country a certain peace in Nature must prevail is based on a mere flight of our imagination. No reason exists to presume that an entire side of our planet is older or newer than the other. . . . Also, the order and identity of the sedimentary layers, like the organic remains of prehistoric plants and animals contained within them, show that many great geological depositions occurred almost simultaneously over the entire surface of the Earth.[26]

In this passage, the tradition of a nontemporal nature is dismissed as fantasy and the earth is cast as having a history of its own, in which continents and mountains formed in deep time are related and humans are understood to be recent inhabitants. The conflation of timescales connects human revolutions with geological unrest and Humboldt eloquently contrasts the recent American independence against the eruptions of volcanoes and earthquakes while noting a converse situation in Europe where Napoleonic wars and revolutions rage while geological action is relatively sparse and limited to Etna and Vesuvius. This, he reminds his readers, may change soon enough as volcanic cycles of eruption happen over centuries, and the nature of the European continent is as much a part of earth's longer history as the American. The scientific basis for his claims is presented with reference to the fossils found in sedimentary layers on both continents, which again temporalizes a global geological history.

The geological myths Humboldt set out to debunk supposed a connection between humans, animals, climate, and geology that imagined that the humidity of the climate and the activity of volcanoes resulted from the fact that the Western hemisphere was still in the process of formation while the old world had dried up and calmed down. These Eurocentric notions of natural history and geology were of course mirrored by notions of Western superiority in terms of taming nature in agricultural practice.[27] Humboldt could not have known that the Neolithic revolution, which until the end of the twentieth century was still generally held to have occurred first in the European continent and then much later in the Americas, would also be proven to have been global and occurred simultaneously in the Americas and northern Africa about ten thousand years ago. There is no consensus on a single explanation for why the transition from hunter-gatherer to farming happened, but taken together the more accepted theories suggests global environmental conditions on the planet played the major role, much in line with Humboldt's planetary vision of human environmental history. The end of the Pleistocene and beginning of the Holocene saw environmental change globally in the form of climate change, creating warmer, wetter, and more humid air with a higher concentration of carbon dioxide as the ice sheets began melting away, which favored growing processes. These new climatic conditions twelve thousand years ago also led to a rapid relative population growth, causing a food crisis, which led humans to look for new sources of nourishment. An ecological theory holds that the extinction of so called megaherbivores, like mammoths, opened a large niche, which was filled by humans.[28]

In the essay "Concerning the structure and action of volcanoes" in *Views of Nature*, Humboldt comes back to his globalizing argument about geology. While Buffon had characterized the earth's history as Epochs and defined humans within deep time in a manner that prefigures the concept of the Anthropocene, he was clearly not able to grasp this history as planetary in the manner required for a GSSP, since he insisted that the Western hemisphere had formed its continents at a much later stage.[29] This other aspect of the intellectual history of the Anthropocene finds its formulation in Humboldt's global geology:

> The same sorts of stone, seeming to attract and repel one another in groups, occur in both hemispheres from the equator to the poles . . . This reveals rather a consistency in the constituent minerals, the stratification of various masses, and their periodic reappearance, which excites the wonderment of the geognost. In the Andes chain, as in the central range of Europe, one formation seems to some degree to call forth another . . . Thus, every mountainous region of considerable extent reflects, with greater or lesser clarity, the entire inorganic world; yet to recognize completely the important phenomena of the composition, the relative age, and the emergence of various types of rock, observations from the most disparate regions of the planet must be compared to one another. If the distant zones, as has often been noted, present to us no new types of rock, i.e., no unknown combinations of basic materials, then they teach us rather how to unmask the great laws that are the same everywhere, the laws by which the layers of the Earth's crust alternately support one another, break apart into channels, or are lifted by elastic forces.[30]

The consistency of the order of stratigraphic layering is taken as a point of departure for a global understanding of geology. Humboldt rightly insists that to gain better insight into geochronology, stratigraphic layering must be compared across the globe to find not just the common geochemical principles of rock formation but also the deposits of organic remains in each layer. This is precisely what the GSSP does today as biostratigraphic definitions based on the emergence or disappearance of specific life-forms across the globe are used as beginnings and ends of time units like epochs and eras.[31] Since 1977, the International Union of Geological Sciences (IUGS) has tasked the scientific body of the International Commission on Stratigraphy (ICS) with preparing and suggesting GSSPs for all geological stages. The GSSP fixes the lower boundary of the stage and the upper boundary is defined by the lower boundary of the overlying stage. Most of the GSSPs have at least one marker and use the top or bottom range of a fossil species, but multiple markers are understood to improve a GSSP.[32] An essential criterion for a GSSP is "global correlation" of the stage boundary, meaning that the identified marker is compared in sections in different areas and preferably on different continents. This complex process is also the basis for the current debate around the formal adoption of the Anthropocene, as discussed above, for which the end of the Holocene will be defined by a global human marker, where the ICS currently favors the radiographic signal of the atom bomb. From this perspective, Humboldt's geochronological endeavors appear highly relevant today. By arguing from a standpoint where human and natural sciences were not separated, he was not an eccentric exception but rather someone who pushed a general tendency of geochronology further in the first half of the nineteenth century. As Rudwick explains, "ideas, concepts, and methods for analyzing evidence and for reconstructing the past were deliberately and explicitly transposed from the human world into the world of nature, often with telling use of the metaphors of nature's documents and archives, coins and monuments, annals and chronologies."[33] He further explains that those who were most prone to pursue the idea of the earth having its own history were those who already had a profound historical perspective, not only on world history but also of the place of the human in cosmos as a part of an unrepeated sequence of contingent events. It was thus on the basis of a planetary perspective of searching for interconnections and comparing phenomena across the globe that Humboldt comes to see a global geochronology with regards to the formation and composition of strata. It was not a coincidence that he named his final integrative and synthetizing five-volume magnum opus *Kosmos* (1845).

Globalizing Deep Time

After his return from the five-year expedition to the Americas, Humboldt settled in Paris, the capital of science at the time, and worked on transforming all the scientific insights of his travels into publications. He was prolific, and published numerous works across disciplines during the first decades of the nineteenth century. In 1823, his major contribution to geology was published as *Geognostical Essay on the Superpostion of Rocks In Both Hemispheres*. This book had first been printed as a very long article in the *Diccionaire d'histoire naturelle* published 1822 in Paris by professors of the Museum of Natural History and then reprinted as a stand-alone book, which was immediately translated into English and German. Humboldt had been working on the manuscript for some time and already in 1814, when he shared the manuscript with his English colleague Georges Bellas Greenough, he expressed that understanding the stratification of rocks and the identity of formations had been the goal of all his fieldwork since the end of the eighteenth century. While this book today is largely forgotten and overlooked in Humboldt's vast scientific œuvre, it was one of the most important geological works of its time.[34]

Among the many highlights of this book, is his early notation of how the Atlantic coasts of West Africa and South America fit together like a jigsaw puzzle and must have at some point in deep time been joined together. He presented the idea that the Atlantic Ocean has the features of a great valley formed as the two continents must have been ripped apart. The coasts of Brazil find their counterpart in the Gulf of Guinea while the shores of Mexico seem to fit with coastal formations on the corresponding latitude, which leads him to the idea that these corresponding land masses must once have been one. In pointing out these geohistorical circumstances Humboldt again prefigures the modern theory of continental drift, which explains how the world's last supercontinent Gondwana fell apart 130 million years ago and formed the American and African continents.[35] As in the cases discussed above, it is by constantly connecting and comparing geochronological phenomena on a global scale and refusing the emerging specialization that he is able to make these assessments. Instead of trying to dig deeper into one narrow field of science, Humboldt constantly tries to put his insights into relation with other knowledge. In his method, he shows that even if we can enrich science by increasing detailed analysis of a delineated area, if we fail to connect it to a larger picture much of the insight will be lost. Analyzing relationships is thus not mere "contextualizing," but rather an integral part of the knowledge itself. The idea that one can isolate a scientific fact from other related but potentially distracting facts is refuted by Humboldt and resonates with the challenge we face today as historians of nature and culture.

In his analysis of the geological makeup of the Americas and the volcanoes of the Andes and Mexico, Humboldt came to view volcanoes not as isolated phenomenon, which was the prevailing position among many scholars, but as eruptions of subterranean lava connected as a bed under the crust of the planet and springing forth in the weaker areas. In doing so, he connected the world history of the Americas with the geological timescale.

> These lines of volcanoes, these upheavings across continued rents, these subterraneous noises which are heard in the midst of a district of schist and transition porphyry, connect, in our imaginations, the still active forces of the New World, with those which in the most remote times heaved up chains of mountains, fractured the surface, and made fountains of liquefied matter (lavas) gush out amidst strata more anciently consolidated. Even in our days this liquefied matter does not constantly issue from the same openings in

> the orifice of a mountain (crater at the summit of a volcano) or its shattered flank; the earth sometimes (Iceland, table-land of Quito) opens in the plains, from whence currents of lava issue, overflow, cross, and cover each other; or small cones of a muddy substance (moya de Pelileo de Riobamba viejo, February 4, 1797) which seems to have been a trachyte-pumice, and which, being combustible and staining the fingers black, is mixed with the carburet of hydrogen. The rocks which we are accustomed to arrange together under the name of substances of volcanic formation exclusively, have been hitherto more considered as to the oryctognostic and chemical relations of their composition, or those of their origin, than according to the geognostic connection of their position and their relative age. At every epocha, since the first oxidation of the crust of the globe, the fire of volcanoes has acted across the rocks of the intermediary, secondary, and tertiary formations. With the exception of some freshwater rocks, volcanic rocks alone continue to be formed in modern times. If the lavas of the same volcanoes (the intermitting springs of liquefied matter) vary at different epochas in their eruptions, it may well be conceived that volcanic matter, which during thousands of years has been progressively raised towards the surface of our planet in such different circumstances of mixture, pressure, and cooling, must display both contrasts and analogies.[36]

Here Humboldt paints a vivid portrait of what has recently been termed geosocial formations, the staging ground for encounters between earth science and social science playing on the dual meaning of formations in both fields as the outcome of dynamic spatio-temporal processes.[37] The lines of volcanoes seen in the Americas are felt to connect humans with the forces of formation from deep time. The making of rocks and mountains come vividly to life in Humboldt's account and he observes that the crust can spring open in less dramatic places than volcanoes too. He engages with the combustible substances of carbon and hydrogen, noting their black coloring effect. His main point however, is that these igneous rock formations continue and connect his present moment with the deep time of stratigraphic layers and suggest the need for deeper engagement with these processes. As an interesting point of comparison, Humboldt's contemporary and compatriot Hegel, who followed Buffon and de Pauw in propagating the theory of New World degeneracy, declared in 1817 that geological processes belonged to the distant past and was now superseded by human development and having no philosophical significance whatsoever. Reading "philosophical" as "social" or "political" as Hegel intended, Nigel Clark and Kathryn Yusoff suggest this position sums up the role ascribed to geophysical processes in mainstream social thought over the last two centuries, a position now looking rather shaky.[38] It is telling that while Humboldt has spent most of this time in the shadows, dismissed as an eccentric and uncontrolled thinker, Hegel has been hailed as the greatest philosopher of the modern era.

Cultural Techniques of Conveying Deep Time

In the *Geognostical Essay* from 1823 Humboldt also first presented the visual sign system called pasigraphy that he had invented in Mexico for the purpose of geological education in the national school of mining and metallurgy. The name pasigraphy stems from the Greek words *pasi* (everything) and *graphe* (writing), and the word was used by philosophers like G. W. Leibniz and René Descartes to express dreams of a universal language. In Humboldt's version however, it was the universality of mathematics that inspired him and the idea was that these signs would be universally recognizable and transcend linguistic borders. It was first published in Spanish in 1805 as an appendix to the first American book on fossils and mineralogy by the Mexican geologist Andrés del Rio, an old friend of Humboldt's from Werner's Freiburg school and who was also principal of the school of mining. Apart from the narrative technique of conveying deep time discussed so far in this text, a cultural technique of visual depiction of geological matters was developing around this time.

In the 1805 Spanish text *Introducción a la Pasigrafía Geólogica*, Humboldt explains that he has invented a sign system for geological charts so that the public can easily take part in the new insights about the earth. His rationale for inventing this time-binding technique is clearly oriented towards media and perception, as he discusses the difficulty of remembering the verbal description of a stratigraphic layering even from the best geological text. The visual system is meant to immediately convey to the reader the immense scale of geological layering in a chart, and being sign-based meant it could also be used algebraically as a quote in a verbal text. The complex structure of geological formations and the understanding of their relation to deep time in terms of the age of each stratum would be improved, Humboldt explains, if one could quickly assess the layers and then compare them with others in the next chart of an atlas.

This insight was crucial for the development of geology, and while Humboldt developed these ideas in Mexico in working with Andrés del Rio in 1804, the English canal builder William Smith had similar ideas while mapping British coal mines. Like Humboldt, he had noticed how rocks and fossils repeated themselves in a predictable manner. Smith developed a coloring pattern for his geological map, giving each type of strata a particular color.[39] Smith's map (Figure 7.1) was the first of its kind and would have a huge impact on the development of geology in general, and cultural techniques of representing deep time in particular.[40] The coloring code of rock layers was represented in a stratigraphic table published alongside the map.[41] The technique would be deployed in most geological maps and became standard first in England and later throughout Europe.

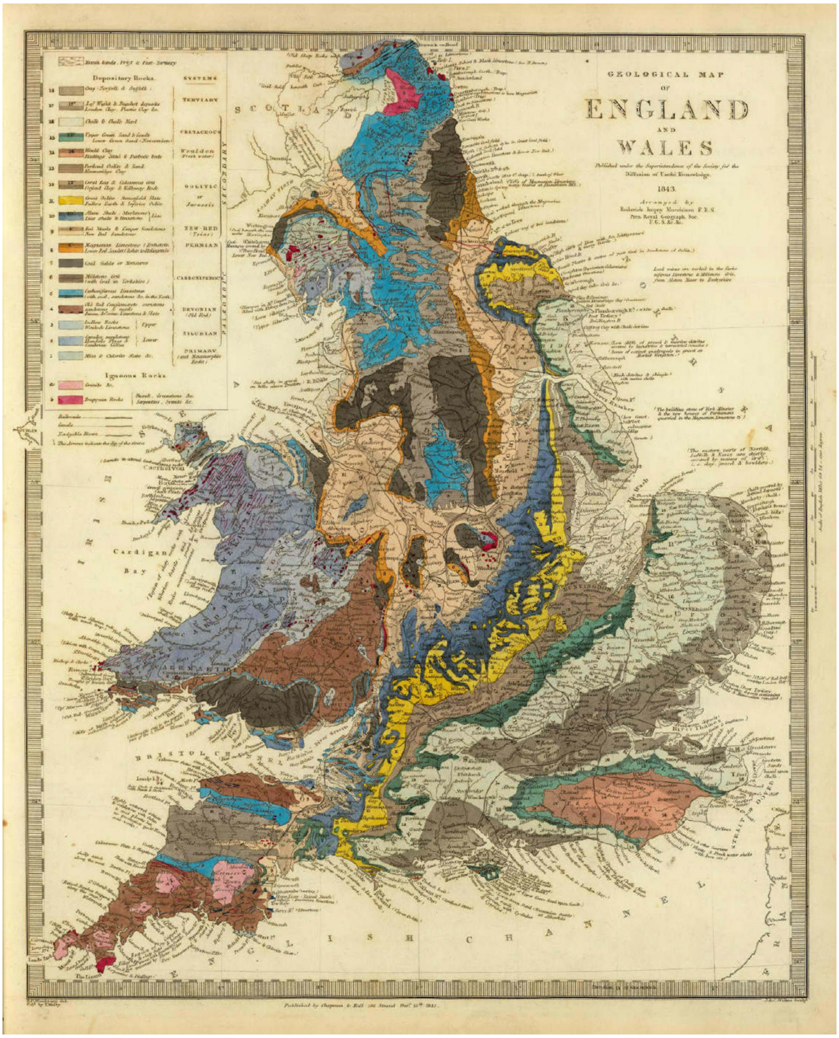

Figure 7.1 William Smith's *Geological Map of England and Wales* (1815). Wikimedia Commons, public domain.

While Smith is generally credited as the inventor of the first geological map, the technique was developed simultaneously by Humboldt, although he used the pasigraphic sign system instead of color coding. By the mid-nineteenth century, pasigraphy was forgotten and when Humboldt published his physical atlas with Berghaus that was meant to accompany and illustrate his final work *Kosmos*, he used Smith's coloring table rather than his own pasigraphic sign system (Figure 7.2). Perhaps he recognized that his sign system would have difficulty reaching a vast audience and opted for Smith's system because of the communicative value, which would fit well with his position on science as a field that needed to be communicated broadly.

Humboldt insisted that a crucial condition for improving knowledge of the earth and its history is the development of better visual media, and the improvement should spring from a combination of more accurate data and more effective visualization techniques. "The most instructive projection for geology is the vertical profile, and in the beginning of 1795, I tried to figure whole countries like mines" he explains.[42] He also discusses other attempts of geological charts from the end of the eighteenth century, but dismisses them all for confusing rather than clarifying stratigraphic layering. The choice of a sign-based system instead of colors is motivated by the difficulty of distinguishing color nuances and remembering them, and he therefore limited himself to three main colors. As he returned to his pasigraphy in 1822, Humboldt explained his geological methodology as double, in that it can express itself "figurative representing the superposed beds by parallelograms placed above one another; or algorithmic, indicating the superposition of rocks, and the age of their formation, as the terms of a series."[43] The first method was exemplified in the plates for his Spanish 1804 text and "it offers the advantage of addressing itself to the eye more directly, and of expressing *simultaneously in space* two series or systems of rocks, which cover the same formations."[44] This cultural technique was meant to convey the complexity of deep time formations understood as layers in what he calls parallelograms, allowing one to see several strata simultaneously. "It offers the advantage of addressing itself to the eye more directly, and of expressing simultaneously in space two series or systems of rocks, which cover the same formation."[45] Humboldt thus directs knowledge through the visual faculty by rendering complex information perceptible at a glance, which also facilitates its repetition. In his view, eighteen signs representing eighteen types of rock are enough to form a geological table, just like we express everything through the twenty-four letters of the alphabet. He is explicitly seeking simplicity in complexity for reasons of communication of knowledge. Worrying that too much detail can obscure the more important insights of science—an idea that clearly resonates with twenty-first-century critique of the great epistemic divide—he draws on ideas of mathematics and visuality as he develops the pasigraphic system.[46]

As geological insight was rapidly progressing during these first decades of the nineteenth century, cultural techniques of conveying the structural and temporal dimension of the earth's crust became important. The solving of how to convey the complexities was thus not just a matter of adding an illustration, but of rendering and making legible the layering of geological

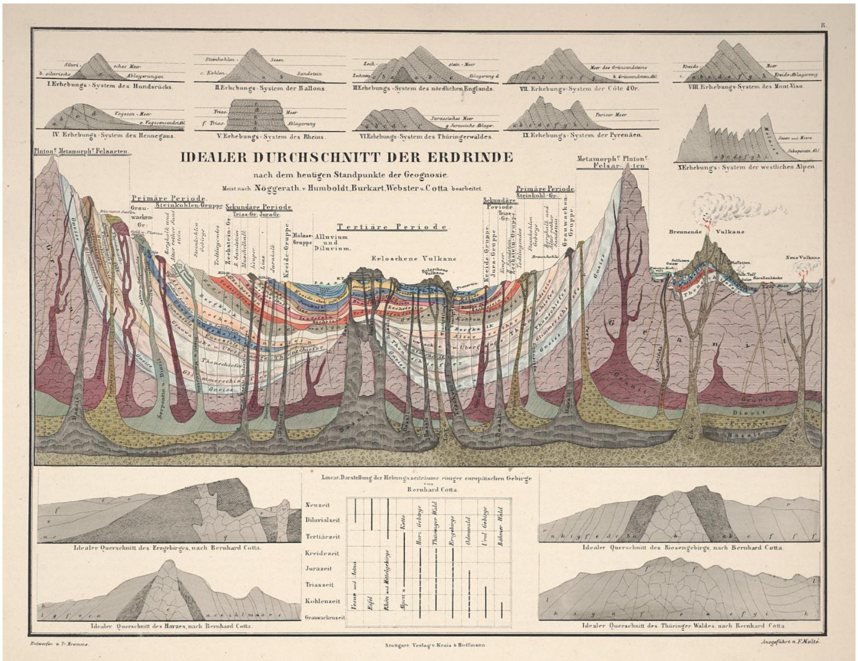

Figure 7.2 Alexander von Humboldt's *Idealer Durchschnitt der Erdrinde* (1851), Berghaus, *Atlas zu Humboldt's Kosmos*. Photo by Missouri Botanical Garden, Peter H. Raven Library, public domain.

makeup. According to Martin Rudwick, it was only after the 1820s that geohistory truly entered the scene of international geology, in the work of Charles Lyell, Georges Cuvier and Alexandre Brongniart, among others, while geognosy remained primarily focused on structural aspects.[47] However, it is clear from a close reading of Humboldt's *Geognostical Essay* that relative age of formations is just as important as structure. Above all, while it was never adopted, the attempt to develop a new technique for visually conveying the structure and temporality of formations seemed to have served the purpose of advancing knowledge by changing scale from the local to the global by means of comparison, which presupposes a quick and effective overview. Lyell visited Humboldt and became his friend in 1823 just as the *Geognostical Essay* had been published, and the two corresponded over the coming decades. The fact that this text is written with geochronological advancement in mind can be seen in the frequent references to fossils and the discussion of how different species' appearance and disappearance determine the age of epochs. "Since in consequence of the important researches of MM. Cuvier and Brongniart, a profound examination of fossil organic bodies has diffused new spirit into the study of tertiary deposits, the discovery of the same fossils in the analogous beds of very distant countries has rendered still more probable the isochronism of widely extended formations."[48]

The second part of Humboldt's pasigraphic method used the same signs taken from the letters of the Greek alphabet with superscripts to express a series of layers as a notation. This part focused on efficient expression of the relation of "relative position, alternation and superposition."[49] The method represents the ambition of using the "conciseness of algebraic language" to capture the complexity of stratigraphic relations. Abstraction here served to express the succession and relative age of formations. The cultural technique of pasigraphy thus emerged as a sign-based and mathematical way of explaining how geological age and structure related to each other. The method was more concise and precise than lengthy narratives, in which the reader could easily be lost and find it hard to memorize and then visualize and compare local formations on a global scale. As Humboldt approached the issue of deep time from a polymath perspective before the great epistemic divide, he was concerned not just with scientific precision but also with the communicative quality of knowledge production. Time could not be understood in isolation, but had to be related to both human observation and planetary transformation.

Humboldt's transdisciplinary methods led him to develop cultural techniques for efficient expression of scientific insights. Figuring the geological makeup of a larger landscape or even a whole country makes possible the comparison and scaling, which is a precondition for knowledge of the earth as a planet. Combining narrative text, which verbally temporalizes the earth, with the visual cultural technique of pasigraphy and charts was further aimed at producing a cognitive simultaneity in the perception of knowledge. This pasigraphic technique was the basis for Humboldt's iconic *naturgemälde* of Chimborazo, where he switched from conveying deep time to climate zones and plant geography, which he of course understood as part of the same general project.

Conclusion

My purpose in discussing the instances related to scientific temporalization of the earth where Humboldt turned out be correct or to have prefigured modern scientific insights is not to say that he was an early visionary, which has already been said by others, but rather to pose the question of why and how he could see certain phenomena more clearly as a polymath before the great epistemic divide, and how this approach to transdisciplinary human and natural sciences may resonate with scientific needs in the present era of climate change and Anthropocene time, which collapse century-old distinctions.[50]

The well-known cosmological and global vision of space and climate zones here finds its counterpart in a planetary geological vision of time and the history of the earth.

In examining closely the geochronological arguments of Humboldt in figuring the geological makeup of Americas in a global perspective, it becomes increasingly clear that he was not only prefiguring modern insights about global spatial relations like climate zones, but also temporal ones. This decisive contribution to the emerging deep temporality of the earth in the early nineteenth century has been rather overlooked. Humboldt's work with temporalizing the history of the earth paved the way for the emerging geochronology of the first half of the nineteenth century. His unifying perspective came to an equally strong expression in his scientific narrative skills as in his infographic cultural techniques of charts and tables and served to place human history within the horizon of planetary history.

But the conclusion to draw from these insights is not so much the oft repeated and quite tiresome trope that Humboldt was a man of genius, but rather that it was his overt and explicitly polymath scientific practice moving effortlessly between geology and poetry, climate science and world history, that enabled his insights. In the same way, we might consider the lack of what we now call transdisciplinary openness as a major obstacle to such planetary and crucial insight in the age of specialization and reductionism. In this chapter I have tried to shift the perspective from the focus on the certainly fascinating individual and his life story of breakthroughs to interrogate his transdisciplinary method in investigating natural and cultural time.

We may also recall how a decade ago, following the failure of the UN Climate Change Conference in Copenhagen (COP15), Gaia theorist and Earth System Science founder James Lovelock lamented the separation of earth's climate problem into very separate specialties, preventing any one scientist from seeing it as a whole topic involving earth as an entirety, including humans, living organisms, the ocean, atmosphere, and surface rocks.[51] Already in the 1970s, he concluded that the bottom-up perspective of mainstream science obscured the proper understanding of the scale of earth's systems, which could only be seen in a top-down approach.[52] His ideas are foundational to the transdisciplinary field of Earth System Science, which aims at understanding the physical, chemical, biological, and human interactions that determine the past, present, and future of the earth, but his ideas have long been met with resistance from conservative scientists. Still today, the epistemic heritage of the twentieth-century specialization prevents many individual scientists, policymakers, and politicians from seeing the earth and life on it as a dynamic interactive system.[53] Humboldt's perspective and insights resonate strongly with Lovelock's, and together they represent two scientists that challenged the great epistemic divide in their respective century and who are therefore enjoying a strong renaissance today.

For the multiple timescales of deep time and human time to become integrated and comprehensible, an epistemic unity is necessary. Everything happening since the postwar in terms of human impact on the global environment has been termed the Great Acceleration because of the rapid increase in virtually all areas of impact. This process was visualized in the so-called hockey stick curves presented by Will Steffen in 2009. Arguably, this acceleration of impact is related to the epistemic divide in terms of the lack of insight, which formed a condition of possibility for its continuation. This is not the place to speculate on why emerging insights in the 1970s of human impact on the earth system did not lead to a rapid transformation, but other authors suggest neoliberalism may have played a part.[54] This synchronicity of the Great Acceleration and the great epistemic divide has still not been fully explored.[55] It now seems possible to postulate that were it not for super specialization and prohibition of large scale perspectives, knowledge and insight on anthropogenic effects on climate, oceans, and biodiversity would have been attainable much earlier. My sense in investigating Humboldt's transdisciplinary methods of understanding earth's history against the background of a twenty-first-century escalating ecological crisis is that there is a relation between the lack of integrated perspectives over the past two centuries and the increase in anthropogenic change in the earth system. To curb the Great Acceleration, we may first have to bridge the great epistemic divide.

Adam Wickberg is a Researcher in the History of Media and Environment at KTH Royal Institue of Technology, Stockholm and visiting researcher at Max Planck Institute for the History of Science, Berlin. His research focuses on media and environment from the sixteenth to the twenty-first century. Current research includes a collaborative project called *The Mediated Planet* on the politics and uses of global environmental data and a book project on oceans and colonialism in early modern globalization. Among recent publications is his monograph *Pellucid Paper: Poetry and Bureaucratic Media in Early Modern Spain* (Open Humanities Press, 2018).

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Discovering Moravian History

The Many Times and Sources of an Unknown Land, 1830–1860

Emma Hagström Molin

In this chapter I analyze how actors in a specific region—Habsburg Moravia (*Mähren*)—discovered their land's history through a variety of time-binding techniques: knowledge-making practices that connected different notions and layers of time.[1] In 1846, Moravia's first official historiographer Antonin Boček (1802–1847) expressed his deepest concerns regarding the region's past. According to Boček, Moravia was embarrassingly far behind the rest of Europe, especially in comparison to the neighboring, rival region of Bohemia, and was thus treated like a *terra incognita*—an unknown land—in European historiography.[2]

Boček stated this at a time when cultural heritage and historiography were being nationalized and scientific history had become a new scholarly ideal in Europe.[3] Since the 1830s, he had tried to catch up with these developments by collecting sources of Moravian history. Finally, in 1860, Moravia's official historiographer at the time, Beda Dudík (1815–1890), published part one of the first written critical and general history of Moravia: *Mährens allgemeine Geschichte*. To uncover the discovery of Moravian history, then, I will scrutinize the many times Dudík elaborated within his epos, and the decades of discovery between Boček's collecting and Dudík's publication of 1860, when Moravia's historical existence was at stake.

This chapter follows a variety of actors and their knowledge practices in a number of places, institutions, and media; people and spaces that were sometimes only partly connected to universities and modern disciplinary history, the latter being of little relevance here. Instead, Moravian history emerged due to scholars who in thought and practice transcended the boundaries of the modern sciences, at least as we perceive them today. Similar to Staffan Bergwik's chapter in this book on the methods of geologists and dendrochronologists (Chapter 9), my contribution deals with the intersection of natural and historical times, but from a historiographical perspective. Martin Rudwick has proven that the sciences of the earth became historical at the end of the eighteenth century by borrowing thoughts and methods from human history.[4] Dudík's work, as I will demonstrate, equally illuminates the imprint of geohistory on historical scholarship. In direct connection to this, I will underscore that the knowledge practices used to manifest Moravian history had two distinct directions. One was vertical, digging deep into the Moravian ground, as Dudík considered sources hidden in the earth as he underpinned Moravia's ancient past. The other course was horizontal, going along the lines of historical time: meaning that archivists and historians perceived and organized Moravian sources (*Moravica*) according to a chronological timeline. Most importantly, and as the cream of the crop, Dudík synchronized vertical and horizontal notions of time in *Mährens allgemeine Geschichte*, as his work brought to the fore multiple times. Despite these forceful efforts made to manifest the region's past, there never was a Moravian nation, and even after its definitive inclusion in Czech history, Moravia remained a periphery.[5] Even so, the time-binding techniques of Moravian actors illuminate how the times of nature and culture interconnected, as well as shed light on a general and significant problem of nineteenth-century European historiography: its material vulnerability and dependency.

Introducing Moravia

The discovery of Moravian history can be said to constitute a particularly interesting case because it is atypical and nonteleological, the margravate being a small historical region that never developed into a modern and independent state. Under Habsburg rule for centuries, it then became a part of Czechoslovakia, and today, the Czech Republic. It should also be recognized that nationalism in nineteenth-century *Vielvölkerstaat* Austria clearly differed from the nationalism in the Western European nation-states: an Austrian nation never existed in a similar sense.[6] Within the Habsburg realm, Moravia was one of seventeen crownlands that differed in status, size, and degree of autonomy. Each crownland was a political entity, with its own regional constitution and coat of arms. Three strings of government were at work: the state administration, which reported to the central ministries in Vienna; and two regional ones, the dynastic administration directed by a representative of a Habsburg ruler (a governor, or after 1850 a *Statthalter*), and the independent administration controlled by the regional parliament and its administrative committee, the *Landesausschuss*, or the Committee of the Estates. This system of two- or threefold responsibility was complicated and made the crownlands difficult to govern.[7]

Societal spaces—such as a region with its political institutions—do not simply exist; they need to be made through various communicative practices that concretize them in spatial and temporal terms.[8] In this regard, the Moravian *Landesausschuss*, with its powerful individual members, was an important organ that supported and promoted scholarship and publications dealing with the region's past. As Boček initially illustrated, there were Moravians who eagerly tried to catch up with the European scholarly competition. Besides Boček, other male public actors like archivists, historians, and politicians—most of them privileged German-speaking noblemen but also others, like Dudík, of simpler backgrounds—were the driving forces in the Moravian historical enterprise. They understood the importance of establishing local institutions and providing both scholars and the public with access to historical evidence in order to support the Moravian past. A Moravian museum—*Franzensmuseum*—was inaugurated in 1817, and thus became the first public institution for Moravian knowledge and history in the Habsburg realm. The *Mährisches Landesarchiv*—Moravia's first historiographical archive—was established in the regional capital of Brno in 1839, and, at the same time Antonin Boček was appointed chief archivist and official Moravian historiographer. Alongside this, in the decades that followed several works were published presenting the archive's resources, together with historical source collections held in other Moravian locations.

The known Moravian sources at these institutions, however, were limited and could not provide evidence old enough to underpin the region's sovereignty during antiquity and the Early Middle Ages. These older periods were tremendously important, as little Moravia had its golden age then: the Greater Moravian Empire emerged in the 830s, only to be destroyed by the Magyars in 906. Greater Moravia covered far more territory than the Moravian margravate of the nineteenth century would, roughly today's Czech Republic, Slovakia, Poland with Silesia, Hungary, and Serbia, with the actual margravate at its core. In the tenth century, the political shape of Central Europe as we know it today was gradually fleshed out. The then dynastically interlaced Bohemian and Moravian regions were conquered by the Holy Roman Empire, but retained a great amount of independence within this political sphere. Moravian-Bohemian expansions to the south in the thirteenth century eventually collided with the Habsburgs, who in time came to rule Moravia, along with Bohemia and Silesia, from 1526 until 1918.[9] The historical interlacements with the rivalry region of Bohemia were, as this chapter will underscore, problematic. Not only had the Moravian geographical scope decreased over time; it was a contested space that in 1848 had been proclaimed as Czech by historian Frantisek Palacký (1798–1876).[10] Twelve years later, Beda Dudík finally came to Moravia's defense.

The Multiple Times of *Mährens allgemeine Geschichte*

Mährens allgemeine Geschichte was published in twelve parts and covered approximately 1,350 years of the Moravian past. The large-scale project followed Beda Dudík throughout his career; the final book was not released until 1888, only two years before the author's death. Before Dudík's *opus magnum*, scholars had mainly collected Moravian sources and presented events and facts, but without producing a coherent historical narrative.[11] Dudík's approach to Moravian history reflected the qualities of Moravian patriotism and the state of the region's sources, as well as the author's scholarly profile. Dudík had studied history and theology in Brno, before entering the Benedictine Order and the Rajhrad monastery, where he was ordained in 1840. He then taught classical languages and history at the academy in Brno, adding geography and the natural sciences after the educational reform of 1848.[12] Dudík published a work dealing with Moravian statistics the same year, which underlines his engagement with the auxiliary sciences.[13] Other early-career missions included evaluating and organizing documents for the *Mährisches Landesarchiv* and collecting Moravian sources in Sweden and Rome, events I will return to later in this chapter. The latter missions were ultimately considered very successful, and were key to the Moravian estates appointing Dudík as Moravia's official historiographer in 1858.[14]

Mährens allgemeine Geschichte has been interpreted as conservative, and perceived as outdated even in its own time. The religious overtone in a time of secularization is one reason for this, while another is Dudík's advocation of *Landespatriotismus*—a common feature of the crownlands in the late eighteenth century—at a time when ethnic nationalism had already won.[15] I argue, however, that Dudík's work is intriguing when we consider it in terms of how multiple timescales can be put to use, as this is a major feature of *Mährens allgemeine Geschichte*. Regarding national history and time, Bonnie G. Smith has argued that, just as natural scientists produced a deep time in their studies of the earth, historians produced a similar time for the nation-state, which they filled with great national events. According to Smith, the historical time of a nation was cleansed from temporal localisms, ritual, and household qualities in order to create a transcendent, secular, and serial timeline.[16] While this fit well with the grand narrative of how the study of nature and of human culture was separated, Dudík's Moravian history deviates from this notion in several respects.

First, the crucial part Dudík ascribed to Christianity should not be dismissed as obsolete; rather, it vividly expressed the prominent position the Catholic faith held among the Moravians, which was a feature that *separated* them from most Bohemians, who were generally Protestant.[17] Conversely, Frantisek Palacký viewed the Proto-Protestant Hussite movement of the early fifteenth century to be Bohemia's golden age, even if Palacký's narrative was far more secular than Dudík's.[18] Second, Catholic devotion influenced where Dudík began Moravian time, as he strove to unite Moravia with Christian chronology. The third and main part of volume one of *Mährens allgemeine Geschichte* indeed dealt with the Christianizing of Moravia, between the years 863 and 906. It was furthermore the Slavs, who arrived in Moravia in the seventh century, and then somewhat later Christianity, that gave Moravia its cultural history.[19] When establishing the origin of Moravia, then, Dudík intriguingly never gave an exact starting point for the region's history. Instead, he began by giving an account of the Celtic settlements in the "oldest times." However, it is clear that he placed Moravia's birth close to the year 0 according to Christian chronology. This reflects not only religious conviction but also a political choice. In the preface, Dudík reinterpreted a long existing Slavic-German antagonism, depicting the Moravian Slavs as agents of the Roman curia and thus making them into the patrons of Christianity as a whole. Moravia, Dudík wrote, had been a fortress against ancient Germany, which was seen as the great threat to the Church in those days.[20] The fortress metaphor certainly reflected the geopolitics of his own time; a possible German unification brought much anxiety to Central Europe.[21]

On the subject of historical time, Reinhardt Koselleck has argued that it is subjective and inherently tied to social and political events—the actions of humans, and their institutions and organizations. Each of these units has its own temporal rhythm. Instead of talking about one historical time, Koselleck has suggested that one should think in terms of many times, which overlap one another.[22] Drawing on Koselleck, Helge Jordheim has claimed that the modern temporal regime, which began being established at the end of the eighteenth century, has constantly been challenged since then, especially in its youth. A way to handle these challenges was to combine different times through what Jordheim has called "practices of synchronization."[23] Taking this into account, Dudík's time-binding work, in which he clearly wanted to unite Moravian time with the birth of Christ, can be seen as such an act of synchronization.

But Dudík did not limit himself to the Christian and Moravian chronologies; he addressed Moravian geography, and additionally introduced a third time regime by going even further into the past. By digging deep into the Moravian earth, Dudík actually brought human history closer to the time of nature. It has been maintained that when European historians started paying less attention to God and more to earth, and simultaneously acknowledged civilizations other than the Christian ones, history became indefinitely longer. This meant that in the late eighteenth century, some historians could not even see a definite beginning or end to historical time.[24] To reconnect with Koselleck, he has furthermore argued that "every historically relative chronology is based in a time that is pregiven by nature," thus underlining the former's dependency on the latter.[25] Intriguingly, while Dudík chose not to start Moravian history in an exact year, he effortlessly invoked nature, claiming that the key to understanding a region's history all too often lies in its geographical location and geological characteristics, a statement that clearly interlaces nature with culture.[26] Dudík argued that the Moravian borders were natural, and in this way manifested the region as a distinct geographical space. In the west, Dudík wrote, the Moravian highlands separated the region from Bohemia; in the north, the Sudetes mountains provided a border with Silesia; in the east, the Carpathians formed the frontier to Hungary. Conveniently enough, it was only toward Austria in the south that a natural border was lacking, but the Danube could possibly be seen as such.[27] In other words, the area he initially described in *Mährens allgemeine Geschichte* was not the Greater Moravia of the ninth century but the Moravian borders of his own time.

Dudík's scholarly antagonist, Palacký, had also turned to nature and the earth in his *Geschichte von Böhmen*, where he embedded the origin of the Bohemian nation in prehistorical time. He even included a history of Bohemia's geological formation written by a naturalist (*Naturforscher*), Franz Xaver Zippe (1791–1863).[28] Monika Baár, who has studied East-Central European historians and nationalism, has argued that a geographical base for a nation's origin was one way of handling the fact that nineteenth-century borders were not fixed according to ethnicity or languages. This circumstance generally divided the imagined national communities into diverse political entities, which were difficult to unite.[29]

Placing national origin in a specific geography and geology, however, could solve yet another problem. In *Mährens allgemeine Geschichte,* Dudík had to acknowledge that the critical study of Moravian history had indeed begun with Palacký. When Dudík positioned himself against Palacký, the former claimed that his polarization was based on a thorough examination of evidence and the latest research; history was an empirical science.[30] But Palacký had pointed out something that troubled Dudík as well: that Bohemia and Moravia almost completely lacked written sources for the time before the twelfth century.[31] Dudík, then, openly expressed frustration at the fact that there were no internal writings that spoke about how the Moravians felt, thought, or acted in the oldest times. Instead, he had to rely on texts written by the enemy in times of war, which naturally reflected their point of view.[32] As Moravia's golden age had taken place between the ninth century and the year 906, it was crucial to present this period as well as earlier periods with reliable evidence. This meant that Dudík, unlike Palacký, turned to archaeological evidence to underpin this period. Dudík wrote that, luckily, there were unwritten sources that "Mother Earth faithfully and unaltered has preserved for us." He named places of sacrifice, graves, shafts, jewelry, household utensils, weapons, castle and city ruins, old wall ruins, coins, and inscriptions; what the archaeologist of today would call material culture.[33] This kind of evidence had once been considered by Dudík's teacher Georg Wolný (1793–1871) in his Moravian topography, and later by Dudík himself in his 1854 publication on pagan burial sites.[34] Dudík described archaeological evidence as the historian's mine lantern, guiding him through the tunnels of prehistory, just as fossils do for the geologist.[35]

Dudík's use of this geological metaphor is intriguing. Many scholars occupied with the history of historiography of the nineteenth century have paid attention to the use of metaphors in relation to practices in researching and writing history. For example, Bonnie G. Smith has brought attention to the analogy between modern disciplinary history, established as a science of facts, and the natural sciences. Using the natural sciences when describing the historian's task was not uncommon in the nineteenth century.[36] Furthermore, Anthony Grafton has pointed out that Leopold von Ranke (1785–1886) saw himself as an explorer, arguing that the darkness of the archives should be investigated by the historian in the same way that great men had discovered Africa and the Near East.[37] Boček's portrayal of Moravian history as an unknown territory, cited in the introduction, works in a similar, surface-oriented, way. Dudík's metaphors, however, went in a deep vertical direction, referring to mines and fossils. He considered hidden prehistorical evidence rather than evoking unexplored territories on the face of the earth. Remarkably, these geological types of metaphors shadow the opposite phenomenon within geology, as noted by Rudwick and Bergwik, whereby nature is likened to an archive or a calendar. As the cream of the crop, and to conclude the times put to work in *Mährens allgemeine Geschichte*, Dudík synchronized vertical and horizontal time, in a seemingly effortless way. To Dudík in 1860, thinking with multiple times and excavating metaphors were useful means for the historical legitimization of Moravia. And, as he firmly placed the nation in the ground, this harmonized culture and nature.

Discovering an Unknown Land

The following takes a look at how Moravian archivists and historians perceived and organized written sources of Moravian history. A source, *eine Quelle*, literally means "a place of origin."[38] Just as objects and fossils hidden in the Moravian soil were evidence that supported the region's deep time, texts—being the historian's most common resource—inherently served the same purpose. Evidence in the form of archival documents and manuscripts was collected and arranged chronologically by Moravian scholars in the 1830s, 40s, and 50s, and I argue that they imagined the region's past in the shape of a timeline. By timeline, I am not referring to actual graphical representations of time but rather how history was *perceived*, organized, and presented in printed inventories and catalogs.[39] Source collecting had been done before, of course, but for private purposes and on a more modest scale. From the 1830s, however, it was carried out with the intention that history should serve the public.[40] Step by step, the largely unknown Moravian historical landscape was mapped by archivists and historians, tracing and taking inventory of sources in city archives as well as in ecclesiastical and private collections.[41] As pointed out at the beginning of this chapter, the possibility for Moravia to have an independent history at all was at stake, hence Antonin Boček's dramatic phrasing.

Several political events in the past had given Boček and his fellows reason to worry. Archives and other forms of heritage had been threatened by political turbulence and destruction since the French Revolution, the Napoleonic Wars, and the revolutions that followed. This transformed endangered archives into places of mystery, and many prominent historians, like Ranke, fetishized sources in their private correspondence and diaries.[42] Moreover, archives all over Europe were centralized, as this, along with publishing sources, was seen as a significant tool for preserving the past.[43] Archival centralization gave birth to the provenance principle, as it was convenient: instead of reorganizing incoming material, the origin of the collection was respected and thus documents remained together.[44]

Against this backdrop, I will circle the fact that evidence collected by Boček, Dudík, and others was first given value based on its ability or inability to be defined as Moravian, so-called *Moravica*. This category was made up of sources produced within Moravia and/or dealing with Moravia in one way or the other, mainly in Latin. Classification, being a subjective and interpretive practice, was inherently affected by nationalism.[45] As national identities were transferred to historical objects in post-Napoleonic Europe, the perception of heritage was forever changed.[46] Nonetheless, Susan Crane has argued that European nationalism could easily have been expressed without historical objects and the collecting of them. According to her, heritage spoke about historicity rather than the nation, and its value was determined by the ability to refer to already existing historical knowledge.[47] The already existing historical knowledge in the Moravian case was the timeline, materialized through collections, collecting, and source publications. Thus, one should not underestimate the role that material historicity played in nineteenth-century Europe; and most importantly, the new scientific history of the nineteenth century, as a science of facts, could not be performed without authentic sources.[48] Without historical evidence, then, the imagined community had a severe problem concerning legitimacy. This is also why archeological evidence could complement writings, as well as why forged sources were created.[49]

When the *Mährisches Landesarchiv* was established in 1839, it was the first institution solely dedicated to Moravian history. It was in some competition with the *Franzensmuseum*, which had been established by the Moravian Society for Agriculture twenty years earlier. From the beginning, the museum housed an archive and a library together with natural historical and science collections. Later, paintings, coins, and seals were added.[50] Importantly, the *Franzensmuseum* already functioned as an institution for archival protection, and received some documents from neglected archives and registries in the Moravian region.[51] Marlies Raffler has shown that the provincial museums in the Habsburg Empire were simultaneously regional and universal, as their collections served both a specific place and the universal history of mankind. Interestingly, the origins of these Austrian provincial museums can be found in the so-called *Ländesbeschreibungen*, documents depicting the different Habsburg regions and their inhabitants, compiled in order to inform the rulers.[52] This means that Moravian actors were drawing upon the older tradition of the *Ländesbeschreibungen* when they established their museum in 1817, the *Franzensmuseum* being one of the first of its kind in the Empire. Contrastingly, the archive came to deal with Moravian history only.

Just as in many other European cases, the establishment of historical institutions relied heavily on the benevolence of the local elite. Count Anton Friedrich von Mittrowsky (1770–1842) was one of the most generous patrons of Moravian history, involved in establishing both the *Franzensmuseum* and the *Landesarchiv*. He also solely financed the first volumes of *Codex diplomaticus et epistolaris Moraviae*, an edition of official Moravian documents published in fifteen volumes between 1836 and 1903 as a Moravian counterpart to the German *Monumenta germaniae historica.*[53] Boček had worked as a private tutor for the Mittrowsky family, before becoming a professor in Bohemian language and literature at the academy in Olomouc. Being Mittrowsky's protégé, Boček was appointed the first chief archivist and official historiographer of Moravia. As head of the archive, he kept himself busy with source collecting rather than writing. He had already started this as a private person, and now as an official it kept him and his assistant occupied for most of the 1840s, when sources were bought, transcribed, and excerpted for the benefit of the archive.[54]

During his collecting days in the early 1830s, Boček crossed paths with Frantisek Palacký. Interestingly, their interaction illuminates how Moravian history gradually came to be defined in relation to Bohemian history, and the political and scientific tensions between the two regions. Both Boček and Palacký were born in Moravia, but chose different paths in their scholarly lives. Palacký settled in Prague, where he became a vital figure within the Czech nationalist movement, and clearly thought of Moravia as part of the Czech nation.[55] Boček, on the other hand, was a Moravian patriot and separatist, who consequently came to work with dividing the regions' histories.[56]

Nonetheless, the initial contact between Boček and Palacký was collaborative: they exchanged sources, and even discussed the possibility of publishing a joint *diplomatar* for Bohemia and Moravia at the expense of the Bohemian estates. Their correspondence illustrates how the histories of the two regions could sometimes be perceived as one, but simultaneously, sources were understood as either Bohemian or Moravian and thus separate pasts were suggested. Palacký, for example, argued that Bohemians and Moravians were one people, and that a *diplomatar* for their ancient history was more or less inseparable. At the same time, however, he claimed that "several pure *Bohemica*" (*viele reine Bohemica*) were to be found in Moravian archives.[57] And, when he wrote to Boček regarding documents from the eleventh century he requested copies of them, even if "they only were strict *Moravica*" (*auch wenn sie nur stricte Moravica wären*).[58] While these phrases capture a nationalization of sources, in this case they also reflect an ambiguity. Indeed, Beda Dudík later brought up the entangled annals of Bohemia and Moravia in *Mährens allgemeine Geschichte*.[59] Trying to split these regions' histories from each other, then, was an ongoing process, which Dudík was still struggling with later in Sweden and Rome in the early 1850s. Ultimately, Boček's and Palacký's collaboration ended with a severe argument, reflecting their different understandings of the identity of sources. Boček accused Palacký of withholding evidence from him; Palacký answered that he was not aware that Boček perceived all Bohemian deeds as *Moravica*.[60] This clash in interpretation, then, underlines the politics of claiming sources from a national perspective. It should be noted that, while the rivalry between Bohemia and Moravia expressed here can hardly be contested, the sovereignty of Austria was never mentioned or questioned in this context. While Palacký came to fight for a federalization of the Habsburg Empire, he still considered it to be necessary well into the 1860s.[61]

The Moravian Timeline and Its Gaps

The collecting and organizing of Moravian materials not only strove to identify sources as *Moravica* and separate them from other regions' and nations' histories, but, as the following will point out, mapping was also carried out in order to evaluate the Moravian past. As this evaluation was done, gaps were identified in the Moravian chronology, which raised questions regarding the loss and actual whereabouts of *Moravica*. Could the missing pieces still be found somewhere?

Boček died in 1847, before he had the chance to finish a "critically compiled history" of Moravia (*eine kritisch bearbeitete Geschichte*); the *opus magnum* is still missing.[62] The results of his vast source mapping were published, though, presented in chronological order by his successor as chief archivist, Peter von Chlumecky (1825–1863). The publication included a preface Boček had written shortly before he died, and it was here that he expressed his deepest concerns regarding Moravian historiography, openly comparing it with that of Bohemia. While the latter had experienced six stages of historical scholarship, starting with Cosmas of Prague in the tenth century, Moravia barely had one. According to Boček, there were mainly two reasons why Moravia had turned into the *terra incognita* of continental historiography: the region lacked a learned society that exclusively engaged with and supported Moravian history; and the *Landesarchiv* was an inadequate historical resource. It was not only a question of too little existing material to support Moravian history, but the sources at hand had not even been processed enough.[63]

As Boček's successor von Chlumecky argued, the conditions for Moravia's history had recently improved. For example, new valuable source collections had been added to the *Landesarchiv*. Von Chlumecky did, however, point out gaps in the Moravian chronology. As the *Codex diplomaticus et epistolaris Moraviae* was a long-term project, a summary of all Moravian sources produced before 1620 present in Moravia was given in von Chlumecky's report.[64] The documents of the Moravian estates were presented as the region's most important sources. They had been stored in the Brno city hall since the mid-seventeenth century, but according to von Chlumecky there were substantial gaps in their chronology, as many documents dated before 1650 had been lost somehow.[65] These historical losses were combined with fears of new loss; that what yet remained in the country was under constant threat of destruction. These anxieties were not unique to Moravian actors, but had been expressed by historians and other intellectuals across Europe since the French Revolution, as pointed out earlier.[66] In the Moravian case, though, the anxiety was grounded in the severe fact that the region's history had not been fully explored yet. The Moravian historical landscape was still partly unknown and unorganized; Beda Dudík's history was not finished until the 1880s; and the *Codex diplomaticus et epistolaris Moraviae* was completed as late as 1903.

This became evident shortly after Boček's death, when the social unrest of 1848 spread to the Habsburg Empire. In Moravia, the turbulence placed history at the top of the political agenda; representatives from all classes came together in an advisory parliament, which agreed that one of the main issues was saving the Moravian historical enterprise. The *Landesausschuss* supported the wishes of the parliament in 1849, giving Beda Dudík the mission to continue Boček's work by inventorying a recently purchased collection, the J. P. Ceroni collection, and evaluating the documents Boček had compiled himself.[67] Both collections were regarded to be of national interest. J. P. Ceroni (1753–1826) was a prominent Moravian politician, historian, and collector;

he had acquired documents and manuscripts from dissolved monasteries and at library auctions, and over time his private collection had grown into one of the richest in the Bohemian crownlands.[68] Mittrowsky, until his death in 1842, had struggled for the collection to be bought from Ceroni's heir in Vienna, for Moravia's benefit. When this was finalized in 1844, sixty-eight manuscripts had already been sold off and were thus lost. The collection was nonetheless moved from Vienna to Brno the same year, where it was declared Moravian property.[69]

The purchase was seen as inestimable for Moravian history. In the introduction to Dudík's published inventory, he stated that his purpose was to describe the sources in a way that would protect them from "loss and exchange" (*Verluste und Auswechselungen*), by summarizing their main content and historical peculiarities.[70] Making inventories, then, in which sources were classified and described, and mediating them to the public was a way to protect history and secure its livelihood. Dudík did, however, have methodological concerns when bringing the collection into scientific order. His problem reflects the fact that the mentioned principle of provenance, which to this day is the Western archival regime, had not yet reached its full breakthrough, and nineteenth-century historians actually seem to have preferred sources in chronological order.[71] Dudík regretted that he could not apply what he called a "paleological-chronological" (*die Paläologisch-chronologische*) order when presenting Ceroni's treasures. In other words, while chronological organization was seen as the most appropriate, for Dudík it was impossible in the Ceroni case. Dudík felt obligated to respect the order already imposed by the former owner, despite its flaws.[72] About a decade before *Mährens allgemeine Geschichte*, then, Dudík united nature's deep history with the Moravian timeline when discussing ordering principles. Thus, the winning order, based on the Moravian collector's legacy, reflects the emerging importance of provenance. Accordingly, Dudík presented the Ceroni collection's contribution to Moravia's political history in its table of contents. It is nevertheless remarkable that he did not perceive provenance as the most scientific order, but merely the simplest one.

The Moravian museum, the establishment of the *Landesarchiv*, Bočeks collecting, and Dudík's inventorying practices reveal how Moravian history was defined in an independent manner, through attempts to separate it from Bohemia, and without involving Austria. As the Moravian historical landscape started to emerge with more clarity, new problems arose. Dudík had stated that historical research could not be done without descriptions of sources, as there was no way for scholars to know where to begin, or which gaps needed to be filled.[73] History was thought of as a whole—and the expectations for its evidence were high. The missing pieces, however, needed to be found and processed. Before his death, Boček had indicated several locations outside Moravia where its history had been displaced. These places included Bohemia, Rome, and Sweden; Frantisek Palacký, through his Roman research, had shown that the Papal Archives were relevant to Moravia, and the source mapping in Moravia had brought new attention to historical events of looting.[74] The following will consider some of these dislocations and sources of Moravian history abroad.

Excavating Moravica in Stockholm and Rome

Beda Dudík published *Forschungen in Schweden für Mährens Geschichte* in 1852, and as the title suggests, he had explored the Moravian past in Sweden. The historical background was well known to him and his fellow historians. During the leadership of Swedish Chancellor of Realm Axel Oxenstierna (1583–1654), archives and libraries in Bohemia and Moravia had been plundered during the Thirty Years' War, and ever since, politicians and scholars in the Habsburg realm had made efforts to retrieve the material. According to information circulating in the Moravian press in 1850, as many as seven to eight thousand volumes of printed books and manuscripts, along with other kinds of *Bohemica* and *Moravica*, were still to be found in Swedish collections. In 1851, the Moravian *Landesausschuss* decided to send an expert, Dudík, to investigate the veracity of these rumors.[75] In 1852 and 1853 he continued this mission in Rome, primarily to research the manuscripts Swedish Queen Christina had taken with her in 1654 when she abdicated and left for Rome. Her books were now housed in the Vatican Library.

During these two journeys, Dudík accomplished an extensive mapping and evaluation of a great number of sources, which generated new knowledge about Moravian history and contributed to filling holes in the Moravian timeline. The new knowledge was mediated through several publications: the summaries *Forschungen in Schweden* and *Iter Romanum I–II* (1855), which included a limited selection of important sources as appendices; and additional publications of single works printed later. Dudík's diplomatic skills even led to restitution, as twenty-one manuscripts in the Bohemian language were donated by the Swedish King to the Austrian Government in 1878. These manuscripts were transferred to the *Landesarchiv* in Brno, where they are still preserved today.[76]

In the following, I zoom in on Dudík's work in the archives. Even though his concern was Moravia he could not exclude Bohemia, or Austria, from his investigations. In a way similar to Boček's, when he was collecting for the *diplomatar* in the 1830s and 40s, the histories of Bohemia and Moravia were entangled in the foreign archives. In the introduction to *Forschungen in Schweden für Mährens Geschichte*, Dudík discusses the historical fate of the two crownlands together, and concludes that the Swedish National Archives were essential to Austria, Bohemia, and Moravia.[77] The National Archives indeed became one of the most important sites of findings for Dudík in Sweden, and he argued that this collection was indispensable for an impartial history of the Thirty Years' War. Without this treasure, as he phrased it, Austrian history could not attain a true picture of these difficult times, and the sources at hand in Sweden were described as invaluable. In conclusion, Dudík valued this archive as equally important as the historical collections in Vienna.[78]

Hardly surprising, Dudík chose to focus on the Swedish occupation of Moravia during the period 1642–48. Despite this perimeter, he came across material that served history in general, as he expressed it. He used his findings in the Swedish archive to criticize a Prussian colleague, Friedrich Förster (1791–1868), who had written a three-part biography on the Bohemian baron Albrecht von Waldstein (1583–1634). Förster had based his study on records held in Vienna only, while Dudík—thanks to his Swedish research—could question Förster's knowledge on the subject. Consequently, Dudík listed evidence that essentially modified Förster's narrative.[79] Dudík's second most important archival finding was the fourth part of the *Könligichen schwedischen in Teutschland geführte Krieg*, written by official Swedish historiographer Bogislav von Chemnitz (1605–1678). Unlike the first parts, the fourth had never reached the printing press. This original manuscript, upon Dudík's closer inspection, dealt with the Swedish occupation of Moravia, making it a main piece of evidence in his eyes. He therefore presented the content of the full folio in *Forschungen in Schweden*, and made sure to copy two hundred letters and other documents used by Chemnitz, almost all of them strict *Moravica*, as he saw it. Having had the opportunity to compare Chemnitz's work with the original sources, Dudík offered much praise regarding the former's accuracy and craft.[80]

Dudík was extremely efficient during his eight-month stay in Rome. He examined all 2,322 manuscripts that had once belonged to Queen Christina. Besides the Vatican, he visited twelve other archives and libraries in Rome, and traveled to the monastery of Monte Cassino south of the city. In fact, the main part of *Iter Romanum I* deals with collections other than Queen Christina's manuscripts in the Vatican Library, and the second part is completely dedicated to the Papal registry. To the Benedictine Dudík, the Papal archive was the most important archive in the world, and even if he mentioned material that was relevant to Austria there, his main concern was to discover Moravian sources. It should be noted, though, that evidence associated with Moravia in the thirteenth century was sorted under Germany, or the Holy Roman Empire, of which the former was a part.[81] As mentioned, thanks to Frantisek Palacký's earlier research, Moravian scholars knew the Papal registry was relevant to their region. Dudík got permission from the chief archivist, Marino

Marini (1783–1855), to continue Palacký's review, which had been disrupted in 1837. Dudík started where Palacký had stopped his inquiry, in 1307, and went through fifty-nine folio volumes containing more than 68,000 deeds. It was not without pride that Dudík compared his endeavor with that of Palacký, who had worked through only forty-six volumes and approximately 4,500 deeds.[82] This was another example of how the scholarly rivalry was articulated.

What, then, did Dudík's archival work in Sweden and Rome mean for the discovery of Moravian history? Previous scholarship has rightly pointed out that collecting heritage and compiling source editions were manifestations of national pride, and means for legitimization.[83] In this way, Dudík's publications, with their catalogue and source edition parts, were important tools, helping the reader imagine what had once been lost as coherent collections and understand sources' scientific value, and allowing the reader to peruse some texts in full.[84] If publishing Moravian sources located within the region was a way to prevent future loss, the Swedish and Roman publications explored a loss that had already taken place. This made the mediations even more central; they contributed to the Moravian timeline and verified the region's historical existence.

Dudík's manuscript draft regarding his work in Sweden bears the working title *Forschungen in Schwedischen Archiven und Bibliotheken.*[85] The published version, however, with Moravian history in its title, consequently puts this in the spotlight. Bohemian history might have been impossible to separate from that of Moravia in the archives; still, the former region was not mentioned anywhere near Dudík's title. *Iter Romanum*, on the other hand, acknowledged the Papal registry as the finest historical resource in the world, which was also planetary. Dudík's research highlighted the precious relationship between Moravia and the Catholic Church. As Catholicism was such an important feature of Moravian identity, exploring this historical link was of great significance. A bit unconventionally, though, Dudík's research placed one of the nineteenth century's most coveted archives in the world—the Papal Archives in Rome—in relation to something as peripheral as the Swedish National Archives in the north. His work in Stockholm shows that this remote location held undiscovered treasures never studied by established continental scholars, and knowing the Stockholm sources allowed him to criticize his peers. Just like Ranke, Dudík was an explorer of unknown territories.

In the end, regardless of location, or other nations and regions embedded in the works, these publications manifested Moravian history: its deep time as well as its horizontal timeline. When Dudík described the historian's task at the beginning of *Iter Romanum I*, he interestingly used excavating and other vertical metaphors similar to those that would reappear in *Mährens allgemeine Geschichte* some years later. History, Dudík wrote, is a shaft (*Schact*) where the historian must be able to separate precious fossil from useless granite.[86] In other words, the historian's attention had to be pointed in the right direction, in order to excavate the right sources, before the actual interpretation of them could begin. Furthermore, Dudík described both the Royal Library and the National Archives in Stockholm as a *Fundgrube*, a mine rich of findings. This expression had multiple meanings. *Fundgrube* could of course be used in the literal sense, signifying a place where a valuable metal like gold was found; but it could also have a metaphorical meaning, and had been used since the fifteenth century to describe a book, a location, or a collection where knowledge was stored.[87] To Dudík, then, the Stockholm collections were sites of key findings for historical knowledge—and not just any kind, but Moravian knowledge.

Moravian History Discovered

This chapter has analyzed the time-binding techniques of an unknown land. In 1846, historian Antonin Boček judged Moravia's history to be inadequate. Successively, though, Moravia did come into being as a historical space—through different knowledge-making practices of collecting, organizing, and mediating sources, and with the help of archaeological evidence, geological metaphors, and temporal synchronizations. Beda Dudík's way of framing Moravian history in 1860, based on an outdated *Landespatriotismus* and permeated by Catholic devotion, had specific consequences for establishing Moravian time. Dudík brought Moravia's history into sync with Christian chronology, as well as with the deep time of the earth. Thus, Moravia was related to far more extensive and planetary time scales than that of a nation. The collecting, organizing, and mediating of Moravian history that preceded Dudík's epos were carried out intensively in the 1830s, 40s, and 50s, with the purpose of finding *Moravica*, and establishing a Moravian timeline so that the region could finally be marked out on the European historiographical map. In this context, Moravian history was perceived as a chronology, materialized through a lineage of sources. When gaps were identified in this timeline they interrupted the historical whole, and Moravian historians eventually searched for *Moravica* abroad. While this source collecting was transnational, Moravia's past needed to be separated from that of other regions and nations, in knowledge practices as well as publications. The actors involved worked under severe pressure, seeing Moravian history as being threatened; in the past, the present, and the future.

In conclusion, the history of how Moravian history was discovered contributes to current scholarly debates on temporal regimes, and to deepening the knowledge of how the times of nature and humans were understood, used, and fused in the nineteenth century. Moreover, while Western European perspectives have dominated research dealing with nationalism, heritage, and historiography so far, this chapter has demonstrated that the Moravian case can bring new insights to these discussions. It is widely acknowledged that the Rankean ambition to study the past "how it actually happened" has dominated Western historiography for the last two hundred years. However, historians of marginal regions, such as Boček and Dudík, were rather occupied with asking themselves where the past is located and to whom does it, in its material forms, actually belong? Moravia's history can certainly be ruled as failed; especially considering Dudík's *Mährens allgemeine Geschichte*, which was outdated before it was even finished. Even so, the idea that there once existed a Greater Moravia is still alive in the part of the Czech Republic that once constituted the Moravian margravate. As this chapter has demonstrated, Moravian actors came up with energetic solutions for dealing with being inferior in a European context; and mapping and mediating history was a significant strategy for dealing with loss. The founding of a Moravian timeline was primarily about securing a material source base. Mediations of dislocated sources could fill holes in the Moravian historical void, as lost evidence was uncovered. There was indeed never a Moravian nation according to Western standards. Even so, by its own qualities, Moravian history ultimately shows that knowing historical matter and time, vertically as well as horizontally, both literally and metaphorically, is fundamental to all historiography.

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Emma Hagström Molin is a Researcher at the Department of the History of Science and Ideas at Uppsala University, Sweden. Her first book, to be published by Brill in 2022, explores the fate of seventeenth-century spoils of war taken by Swedish regents and field marshals during their respective military campaigns in Central and Eastern Europe. Her current project analyzes provenance, as a historically contingent concept, organizing principle, and research practice that emerged in nineteenth-century Europe.

NOTES

1. See Staffan Bergwik and Anders Ekström's discussion of "time-binding techniques" in the introduction to this book.
2. *Die Regesten der Archive im Markgrafthume Mähren, und Anton Boczck's Berichte über die Forschungen in diesem Lande* (Brno: Nitsch & Grosse, 1856), xv.
3. See for example Peter Aronsson and Gabriella Elgenius, eds., *Building National Museums in Europe 1750–2010: Conference Proceedings from EuNaMus, European National Museums: Identity Politics, the Uses of the Past and the European Citizen, Bologna 28–30 April 2011* (Linköping: Linköping University Electronic Press, 2011); Monika Baár, *Historians and Nationalism: East-Central Europe in the Nineteenth Century* (Oxford, UK: Oxford University Press: 2010); Mitchell G. Ash and Jan Surman, eds., *The Nationalization of Scientific Knowledge in the Habsburg Empire, 1848–1918* (Basingstoke: Palgrave Macmillan, 2012); Ilaria Porciani and Raphael Lutz, eds., *Atlas of European Historiography: The Making of a Profession, 1800–2005* (Basingstoke: Palgrave Macmillan, 2010).
4. Martin J. S. Rudwick, *Bursting the Limits of Time: The Reconstruction of Geohistory in the Age of Revolution* (Chicago: University of Chicago Press, 2005), 182.
5. Miroslav Hroch and Jitka Malecková, "The Construction of Czech National History," *Historein* 1 (1999): 105.
6. Emma Bentz and Marlies Raffler, "National Museums in Austria," in *Building National Museums in Europe 1750–2010: Conference Proceedings from EuNaMus, European National Museums: Identity Politics, the Uses of the Past and the European Citizen, Bologna 28–30 April 2011*, ed. Peter Aronsson and Gabriella Elgenius (Linköping: Linköping University Electronic Press, 2011), 25–26.
7. Peter Haslinger, "How to Run a Multilingual Society: Statehood, Administration and Regional Dynamics in Austria-Hungary, 1867–1914," in *Region and State in Nineteenth-Century Europe: Nation-Building, Regional Identities and Separatism*, ed. Joost Augusteijn and Eric Storm (Basingstoke: Palgrave Macmillan, 2012), 119–20.
8. Konstanze N'Guessan, Carola Lentz, and Marie-Christin Gabriel, "Performing the National Territory: The Geography of National-Day Celebrations," *Nations and Nationalism* 23, no. 4 (2017): 687.
9. Tomasz Kamusella, *The Politics of Language and Nationalism in Modern Central Europe* (Basingstoke: Palgrave Macmillan, 2008), 16–19. The idea of Greater Moravia already existed in the eighteenth century, see Milan Horňáček, "Imaginiertes Großmähren: Zur Erfindung von Traditionen in der mährischen Historiographie des langes 19. Jahrhunderts," *Brücken: Germanistisches Jahrbuch Tschechien Slowakei* 18 (2010): 242–44; and is still represented in the Moravian *Landesmuseum*; see "Grossmähren," last modified January 26, 2021, http://www.mzm.cz/de/grossmaehren.
10. Hroch and Malecková, "Czech National History," 105.
11. Maurus Kinter, *Der mährische Landeshistoriograph Dr. Beda Dudík* (Brno: Carl Winiker, 1890), 10. Two forerunners worth mentioning are Joseph W. Monse, see Horňáček, "Imaginiertes Großmähren," 242–45; and Dudík's teacher Georg Wolný's *Die Markgrafschaft Mähren: Topographisch statistisch und historisch geschildert* (Brno: Selbstverlag des Verfassers, 1835).

12. Kinter, *Dr. Beda Dudík*, 5–6.
13. Beda Dudík, *Mähren's gegenwärtige Zustände vom Standpunkte der Statistik* (Brno: Carl Winiker, 1848); Kinter, *Dr. Beda Dudík*, 4.
14. Kinter, *Dr. Beda Dudík*, 6–7.
15. Horňáček, "Imaginiertes Großmähren," 247; Hroch and Malecková, "Czech National History," 107.
16. Bonnie G. Smith, *The Gender of History*: *Men, Women, and Historical Practice* (Cambridge, MA: Harvard University Press, 1998), 151.
17. Horňáček, "Imaginiertes Großmähren," 245–47; Kamusella, *Language and Nationalism*, 501.
18. Baár, *Historians*, 237–39.
19. Beda Dudík, *Mährens allgemeine Geschichte* (Brno: Georg Gastl, 1860), 60–62, 79–80.
20. Dudík, *Mährens allgemeine*, viii.
21. Horňáček, "Imaginiertes Großmähren," 245, 247–48; Kamusella, *Language and Nationalism*, 18–19.
22. Reinhardt Koselleck, *The Practice of Conceptual History: Timing History, Spacing Concepts* (Stanford: Stanford University Press, 2002), 110.
23. Helge Jordheim, "Multiple Times and the Work of Synchronization," *History and Theory* 53, no. 4 (2014): 513–18.
24. Lucien Höschler, "Time Gardens: Historical Concepts in Modern Historiography," *History and Theory* 53, no. 4 (2014): 581.
25. Koselleck, *The Practice*, 106.
26. Dudík writes "geognostische Beschaffenheit," from "Geognosie," literally "earth knowledge"; Dudík, *Mährens allgemeine*, 1; see Rudwick, *Limits of Time,* 84–87.
27. Dudík. *Mährens allgemeine*, 6. Dudík writes of the Moravian mountains; today, however, the area is referred to as the Bohemian-Moravian highlands.
28. František Palacký, *Geschichte von Böhmen: Grösstentheils nach Urkunden und Handschriften* (Prague: Kronberger und Weber, 1836), 10–17.
29. Baár, *Historians*, 68.
30. Dudík, *Mährens allgemeine,* xi–xii.
31. Palacký, *Böhmen, vi–vii.*
32. Dudík, *Mährens allgemeine*, vii–viii.
33. Dudík, 4.
34. Beda Dudík, *Über die alten heidnischen Begräbnissplätze in Mähren* (Vienna: Kaiserlich-königlichen Hof- und Staatsdruckerei zu Wien, 1854).
35. Dudík, *Mährens allgemeine,* 4.
36. Smith, *Gender*, 133–35.
37. Anthony Grafton, *The Footnote: A Curious History* (London: Faber, 1997), 48–49.
38. "Source," last modified January 27, 2021, https://www.merriam-webster.com/dictionary/source; "Quelle," last modified January 27, 2021, https://www.duden.de/rechtschreibung/Quelle.
39. Regarding graphic representations of time, see Daniel Rosenberg and Anthony Grafton, *Cartographies of Time: A History of the Timeline* (New York: Princeton Architectural Press, 2010), 10–12.

40. Baár, *Historians*, 47–48.
41. A summary of this enterprise is given in *Die Regesten*, i–xxi.
42. Smith, *Gender,* 116–20.
43. Susan A. Crane, *Collecting and Historical Consciousness in Early Nineteenth-Century Germany* (Ithaca: Cornell University Press, 2000), 38–44.
44. Bodo Uhl, "The Significance of the Principle of Provenance for Archival Science and Historical Research," *Archivalische Zeitschrift* 84, no. 1 (2001): 95–96.
45. Geoffrey C. Bowker and Susan Leigh Star, *Sorting Things Out: Classification and Its Consequences* (Cambridge, MA: MIT Press, 1999), 1–6.
46. Bénédicte Savoy, *Kunstraub: Napoleons Konfiszierungen in Deutschland und die europäischen Folgen* (Vienna: Böhlau, 2011), 392–97.
47. Crane, *Collecting*, 7–8, 19–21.
48. Smith, *Gender*, 133, 135–37; in the sources, actors speak about "critical" history; *Die Regesten,* xv.
49. Baár, *Historians*, 32.
50. Marlies Raffler, *Museum—Spiegel der Nation? Zugänge zur historischen Museologie am Beispiel der Genese von Landes- und Nationalmuseen in der Habsburgermonarchie* (Vienna: Böhlau, 2007), 247–50.
51. Michael Hochedlinger, *Österreichische Archivgeschichte: Vom Spätmittelalter bis zum Ende des Papierzeitalters* (Vienna: Böhlau, 2013), 86–87.
52. Bentz and Raffler, "Austria," 25–26.
53. Hochedlinger, *Archivgeschichte,* 91; regarding *Monumenta*, see David Knowles, *Great Historical Enterprises: Problems in Monastic History* (London: Thomas Nelson and Sons, 1963), 65–97.
54. Hochedlinger, *Archivgeschichte,* 91.
55. This was made clear in the title of Palacký's *Dějiny národu českého v Čechách a v Moravě*, or "The History of the Czech Nation in Bohemia and Moravia," which was the Czech version of Palacký's *Geschichte von Böhmen*, first published in 1848, see Baár, *Historians*, 142–44, 240.
56. Emil Schieche, "Frantisek Palacký, Antonin Boček und der Mährische Separatismus," *Bohemia* 13, no. 1 (1972): 211–52.
57. Schieche, "Mährische Separatismus," 213. I am relying on Schieche's translations and quotations; his interpretation of the sources clearly speaks in favor of Palacký.
58. Schieche, "Mährische Separatismus," 225.
59. Dudík, *Mährens allgemeine,* xi.
60. Schieche, "Mährische Separatismus," 246–48.
61. Baár, *Historians*, 241.
62. *Die Regesten,* xv.
63. *Die Regesten,* xiv–xv.
64. *Die Regesten,* i–xxi. 1620 was the year of the Battle of White Mountain, where Bohemian Protestants were defeated by combined Catholic armies.
65. *Die Regesten,* xiii; see Hochedlinger, *Archivgeschichte,* 91; the deeds, *Urkunden*, of the estates constituted category 1 in the archive, *Bericht über das mährische ständische Landes-Archiv* (Brünn: Georg Gastl, 1858), 3.

66. Smith, *Gender*, 116–17; Crane, *Collecting*, 111–12.
67. Beda Dudík, *J.P. Ceroni's Handschriften-Sammlung* (Brno: Carl Winiker, 1850), viii–ix; Kinter, *Dr. Beda Dudík*, 6.
68. Constantin von Wurzbach, *Biographisches Lexikon des Kaiserthums Oesterreich: Zweiter Theil* (Vienna: Verlag der typografisch-literarisch-artistischen Anstalt, 1857), 324.
69. Dudík, *Handschriften-Sammlung*, 1–7.
70. Dudík, *Handschriften-Sammlung*, x.
71. Tomas Lidman, *Libraries and Archives: A Comparative Study* (Oxford, UK: Chandos, 2012), 45.
72. Dudík, *Handschriften-Sammlung,* xiv.
73. Dudík, xi–xii.
74. *Die Regesten*, xvi.
75. Beda Dudík, *Forschungen in Schweden für Mährens Geschichte* (Brno: Carl Winiker, 1852), v–vi, 9–11.
76. Emma Hagström Molin, "*Dudík: Correspondence with Gustaf Edvard Klemming," Translocations: Anthologie: Eine Sammlung kommentierter Quellentexte zu Kulturgutverlagerungen seit der Antike, last modified January 28, 2021,* https://translanth.hypotheses.org/ueber/dudik.
77. Dudík, *Forschungen*, 4–16.
78. Dudík, 288–90.
79. Mainly correspondence from and to Swedish Chancellor of Realm Oxenstierna; see Dudík, *Forschungen*, 290–92.
80. Dudík, 292–96. The importance of the Chemnitz manuscript is highlighted by Kinter, *Dr. Beda Dudík*, 7.
81. Beda Dudík, *Iter Romanum 2 Theil: Das päpstliche Regestenwesen* (Vienna: F. Manz & Comp., 1855), 67.
82. Dudík, *Iter Romanum 2 Theil*, 4–5.
83. See for example Astrid Swenson, *The Rise of Heritage: Preserving the Past in France, Germany and England 1789–1914* (Cambridge, UK: Cambridge University Press, 2013); Per Widén, "Creating a Patriotic History: Historical Source-Editions as National Monuments," *Romantik* 5 (2016): 9–31. Source editions were important for the professionalization of the historical discipline; see for example Christine Ottner, "'Für den Mann vom Fache': Redaktion und Standardisierung historischer Publikationen der Kaiserlichen Akademie der Wissenschaften in Wien," in *Geschichtsforschung in Deutschland und Österreich im 19. Jahrhundert: Ideen, Akteure, Institutionen*, ed. Christine Ottner and Klaus Ries (Stuttgart: Steiner, 2014), 241–65.
84. On the meaning of catalogs, see Sophie Raux, "From Mariette to Joullain: Provenance and Value in Eighteenth-Century French Auction Catalogs," in *Provenance: An Alternate History of Art*, ed. Gail Feigenbaum and Inge Rest (Los Angeles: Getty Publications, 2012), 87.
85. Box 167, E6 (Benediktini Rajhrad), Moravský Zemský Archive, Brno.
86. Beda Dudík, *Iter Romanum 1 Theil: Historische Forschungen* (Vienna: F. Manz & Comp., 1855), viii.

87. Fundgrube, in *Trübners deutsches Wörterbuch. Bd 2, C-F,* ed. Karl Trübner and Alfred Götze (Berlin: Walter de Gruyter, 1940), 475–476; Etymologisches Wörterbuch der deutschen Sprache, "Fundgrube," last modified January 27, 2021, https://www.dwds.de/wb/etymwb/Fundgrube.

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9

Synchronizing Nature and Culture

Mediating Time in Geochronology and Dendrochronology, 1900–1945

Staffan Bergwik

Throughout the nineteenth century, geology opened previously incomprehensible timescales, displayed deep time, and produced an enormous expansion of temporal horizons accessible to human understanding. Knowledge about geological strata burst "the limits of time," and natural philosophers instructed onlookers that nature had a history existing long before the creation of humankind.[1] During the same period, history as a scholarly field and historicism as an idea emerged. Historians temporalized humanity and turned progress into the overarching idea about mankind's direction and changes. Multiple narratives were coordinated into ideas of time as linear, homogenous, and teleological. Both geology and history ushered in a temporalization, however at the turn of the twentieth century they had become two distinct enterprises.[2] While natural philosophers illuminated the deep and multiple times of nature, historians limited themselves to speaking about the history of humanity.

Present-day scholarship has repeated the divide, leaving history "a curiously fragmented subject." As methods develop and knowledge accumulates, hyperspecialization follows in their wake.[3] Nevertheless, the divide has been questioned in theoretical debates within the humanities during the last decade. Dipesh Chakrabarty has suggested that climate change brings with it the end of the old distinction between natural and human history. The recorded past of humans along with social and cultural histories of modernity, Chakrabarty argues, should be linked to a deep, species history of humanity. Moreover, the temporality of human history has to be connected to the geological temporality of nature.[4] Naomi Oreskes addresses historians of science with a similar argument, asserting that descriptions of humans as geological agents have scaled up our imagination. "Times have changed" she claims, and we "can no longer sustain a demarcation between natural history and human history."[5]

While these arguments are provocative, even visionary, they threaten to gloss over important aspects of combining natural history and human history. First, while pointing to the importance of turn of the twenty-first-century thinking about global warming and the Anthropocene is highly relevant, arguments such as Chakrabarty's and Oreskes's threaten to render invisible a longer history of efforts to coordinate "earth history" and "world history" in the former's words.[6] As Helge Jordheim has argued, while this distinction has been upheld in certain scholarship, detailed empirical studies reveal the many instances between 1700 and 2000 where natural and historical times became amalgamated in concrete historiographical activities.[7] Second, there are profound differences between geological temporality and human history. In fact, Chakrabarty has pointed to this very fact. While the Anthropocene debate has generated traffic between earth history and world history, the two are marked by inherently varying timescales, mirroring larger "planet-centered" and "human-centered" ideas. Moreover, representatives of the two ways of thinking are poorly trained to discuss both forms of history.[8]

The questions of intermingling earth history and world history—as well as of the knowledge system addressing the issue—come to life in the interconnected scientific fields of geochronology and dendrochronology. Both are examples of an historical and scholarly practice located at the crossroads of nature's times and historical times. This chapter focuses on Swedish geologist Gerard De Geer (1858–1943) and American astronomer Andrew Ellicott Douglass (1867–1962). De Geer established geochronology and studied layered clay, or "clay varves." According to celebratory stories, the Swede translated these inconspicuous chunks of matter into legible images of the past. Andrew Ellicott Douglass contributed to the founding of dendrochronology. This field studies tree rings and has created records of periodical changes in the climate going back to earlier times than other types of meteorological data.[9]

The two fields introduced and studied a shorter time period than the classic work of nineteenth-century geology, yet a longer timescale than academic history writing. The semi-long period they explored covered the last twenty thousand years; both fields tried to access a past where the long period of earth history and the shorter time of world history coalesced, and a fixed chronology of prehistoric times could be determined. Importantly moreover, both fields assigned great importance to the climate. They wanted to understand climatic rhythms and shifts between warmer and colder periods. My aim in the following is to move from the theoretical idea of combining natural history and human history to an exploration of how it was done in practice in geochronology and dendrochronology. First, I will investigate the temporal narrative created within the fields. I argue that they were media intensive, and I suggest that nature's time and historical time were synchronized and aligned in and through media turning abstract time into a legible account. Second, I will indicate how the fields were located in a broader knowledge ecology at the time. Since they addressed a semi-long time period, geochronology and dendrochronology envisioned scientific collaborations across the natural and cultural sciences, yet ultimately failed to create them in practice. It is my contention that this case serves to historicize and critically engage with current proposals to write earth history and world history in tandem, as well as with the difficulties involved in doing so.

My method in the following is to use two analytical lenses—media formats and knowledge organization—to investigate how geochronology and dendrochronology coordinated the timescales and rhythms of nature's time and historical time. After a brief introduction to how the fields were established, I engage with the literary and visual formats, through which the fields mediated nature's time and historical time. I indicate how they used the year as a culturally intelligible temporal unit to synchronize natural and cultural chronologies. Second, I investigate how De Geer and Douglass transposed the two timescales onto each other through metaphors of cultural documents: clay varves and tree rings were described as "diaries," "annals," and "calendar." Moreover, I highlight how they utilized timelines as a visual format to open and pin down abstract chronologies into intelligible temporal overview. The timeline served to translate the cyclical rhythm of nature into the linear time of history. In the final section, I turn to how geochronology and dendrochronology were part of, and envisioned, a knowledge organization based on the idea of a science of time measurement of the earth. Albeit part of a contemporary trend toward increased scholarly specialization, I will suggest that the two fields offer a case of interdisciplinarity—with a term smacking of anachronism—based on studies of time and chronology.

Establishing Geochronology and Dendrochronology

Starting in the mid-nineteenth century, geologists increasingly took an interest in the periods of glaciation, which apparently had occurred in the past. Rejected by many in the 1830s and 40s, the theory of Ice Ages had gained acceptance by most geologists in the 1860s. As a result, geologists tried to understand external factors working on the heating and cooling of the earth. Hence, the climate in more recent periods and the heat from sun radiation became key interests. Naturalist James Croll was among the first to discuss astronomical causation in geology, and in 1875 he argued that a varied radiation from the sun was a crucial climatological factor behind the Ice Ages.[10]

De Geer and Douglass approached these questions in their respective work, and they addressed a past where earth history and world history were brought together through the interest in the climate.

In the early stages of his career, Gerard De Geer worked at the Geological Survey of Sweden. From 1897 until his demise in 1943 he served as professor of geology at the University College in Stockholm. Albeit seldom mentioned in overviews of the turn of the twentieth century geology, he was a well-established scholar receiving honors from, and membership in, the geological societies in Berlin, London, Paris, New York, and St Petersburg. He was elected a member of the Royal Society, one of only fifteen Swedes since the seventeenth century to receive the honor.[11] De Geer's research treated the youngest geological period, Quaternary, taking place "but a brief moment ago" compared to older geological eras.[12] In 1879, De Geer performed his first measurements of varved clay, and he published a small study on the subject in 1882. In the mid-1880s he also started using the word chronology to describe layered clay. However, only in 1910 when he presided as chairman of the International Geological Congress in Stockholm did he launch the terms "geochronology" and "clay varves." Subsequently, he introduced his geochronological research program with considerable tenacity. Already in 1913, newspapers declared that his geochronological methods were known to broader publics.[13]

There was a public discourse on temporality at the turn of the twentieth century. Partly due to the interest in the natural history of nations, partly because of the fascination with the age of the earth, geology had become a public science. Geological museums and popular books, discussing and displaying time, had become widespread.[14] Gerard De Geer was among those who presented geological work to broader audiences, for example through the book *Om Skandinaviens geografiska utveckling efter istiden*, which consisted of lectures held in public and was printed in 1896.[15]

Clay varves became the key empirical object in De Geer's research. The clay sediments were excavated in areas once covered by inland ice: Scandinavia, North America, South America and the Himalayas.[16] They had been deposited in water since the Ice Age and a vital ambition for De Geer was to date the latest Ice Age and the ensuing, slow processes of deglaciation. During that era, the land had risen and the clay layers had become accessible for scientific study.[17] The clay varves ostensibly registered how many years had passed since the Ice Ages, and revealed the speed of melting and the rhythm of climatic changes.[18] Clay varves offered the opportunity to create a geological chronology—a geochronology—of the Ice Age and the gradual transition to present-day climate.[19] In the 1930s, an article presenting geochronology in a Swedish encyclopedia argued that De Geer had succeeded in creating a chronology covering eighteen thousand years leading up to our historical time.[20]

Andrew Ellicott Douglass is a virtually unrecognized actor in the history of astronomy.[21] In 1906, he moved to the University of Arizona at Tucson where he founded the Laboratory of Tree Ring Research, the first of its kind, in 1937. In Arizona, Douglass measured tree rings and focused on the great Sequoias of the American West. He published his first scientific paper on dendrochronology in 1909, and named his field of study "dendrochronology" for the first time in 1923.[22] The American astronomer argued that the study of tree rings offered information about climatic conditions and cycles in the past.[23] Already in the eighteenth century, natural philosophers had suggested that tree rings recorded effects of the weather, but Douglass turned dendrochronology into an academic field devoted to understanding time.[24] A chief concern for him was to create a chronology through meteorological data reaching back to prehistory. He created a long chronology through cross dating living and dead trees. Individual specimens were overlapped backwards in time, and Douglass sought progressively older wood specimens from a restricted area.[25] Newspapers described how he had managed to construct a "register of the climate covering 3,200 years."[26]

The field of dendrochronology has not been given a coherent history outside of scholars offering glimpses of their own history.[27] Gerard De Geer and geochronology has been researched in the Swedish history of science, but mainly through an interest in how natural and cultural history were performed in a nationalistic minded science with an interest in the importance of the Ice Age. Certainly, geochronology was a nationalistic project. According to De Geer, "the Swedish timescale" could form a basis for an international prehistoric time measurement.[28] In the following, I leave the nationalism aside to read geochronology and dendrochronology as part of a larger discourse on temporality at the turn of the twentieth century. Already in 1908, Gerard De Geer noticed the resemblance between tree rings and clay varves, surmising that the two types of layers were caused by the same phenomena.[29] The actual connection between De Geer and Douglass emerged only at a late stage in their careers, in the 1930s. De Geer's wife and assistant Ebba Hult De Geer described the fields as "doubles" to each other.[30] Even though the fields had developed in parallel for a couple of decades, they formed the basis for a joint science of chronology. When Douglass came to visit De Geer in Stockholm in 1930 both were intrigued by the resemblances in their respective research.[31]

Synchronizing Nature's Rhythm and Human Culture: The Year as a Temporal Unit

In an influential study, François Hartog claims that "the modern regime of historicity," which in its basic form held sway between the eighteenth and twentieth centuries, was marked by a dominant idea about the relationship between past, present, and future as well as about the rhythm and direction of history.[32] Taking issues with Hartog's ideas, Helge Jordheim has argued that the dominant regime of temporality, emphasizing progress as a teleological, homogenous and modern idea of time, was continuously challenged by other narratives. Natural and historical times have been compared and unified since the eighteenth century through what Jordheim calls "practices of synchronization." Rather than one overarching regime spanning two hundred years, synchronicity is the result of contingent "linguistic, conceptual and technological practices."[33] Geochronology and dendrochronology are examples of such practices. Both fields described a period in time marked by early forms of human culture and interrelated climatic factors. They portrayed a temporal organization between nature's time and historical time, and the individual year became key in their synchronizing effort.

Geologists throughout the nineteenth century argued that transformations in nature occurred through uniform, cyclical, and incredibly slow developments of building and erosion. Geochronology and dendrochronology both described the rhythm of change in nature in similar ways. Gerard De Geer explained that major transformations in the development of the earth occurred slowly and without sudden shifts.[34] The long timescale of nature was also highlighted in the presentation of dendrochronology. Sequoias were portrayed as nature's living monuments to a long-lost time.[35] Moreover, De Geer and Douglass both underscored the importance of repeated cycles. They referred to "rhythms" in the earth's climate, including "the eleven-year sunspot cycle."[36] In a presentation of geochronology, *New York Times* described both shorter cycles of approximately fifteen hundred years with varying climate and rainfall and the "greatest super cycle of all" labeled the "ice age cycle, covering 21.500 years."[37] The radiation from the sun was pivotal for the slow, regular, and cyclical rhythm of nature.[38]

In the mid-1920s, Gerard De Geer argued that the existing timescale for the melting of the inland ice should be connected to the history of humanity.[39] Piece by piece, the timescale could be put together into a "coherent whole."[40] The Swedish geologist maintained that changes in nature provided a basic condition for culture. According to him, quaternary geology explored geological timescales as a "framework for knowledge about the origin of human culture."[41] His results were important for the study of "early man" and the "oldest history of our species."[42] Existing written and cultural records of human culture reached back five to six thousand years, while the longer era, during which "prehistoric stages of culture" occurred, was "dependent upon information gathered in geology."[43] The synchronizing ambition resonated with Gerard De Geer's wish to produce a worldwide chronology with the Swedish timescale as a "fixed system of time."[44] According to Swedish newspapers—stating the case with implicit national pride—the Swedish timescale was an international standard of the same importance as the Greenwich mean time.[45] In a celebratory remark on De Geer's research, his protégé Anton Sörlin argued that the Swedish geologist enabled a "time-parallel" in ancient time.[46]

A critical part of De Geer's and Douglass's ideas was to describe nature's processes in categories that were culturally intelligible. The year as a temporal entity became particularly important as temporal unit and literary media format. On the one hand, the year was a natural phenomenon, depending on orbits of celestial bodies and different climatic seasons displayed by clay layers and tree rings. Each varve represented a year, shifting from bright to dark, and the different tints showed alterations in the weather occurring over an annual season.[47] The individual tree ring displayed a lighter part formed during the spring and summer when the tree had grown because of ample access to light, warmth, and water, and a darker part of less porous wood formed during fall and winter when the weather inhibited its growth.[48] On the other hand, using the annual unit meant transforming nature's time into a cultural frame of reference, established and maintained through social and institutional practices—including calendars and clocks—with a long history.

Natural scientists at the end of the twentieth century did not typically discuss time in terms of years, even in the thousands or millions. Gerard De Geer, gesturing at existing geological research, maintained that the deep past of the earth had only been described through "vague chronological concepts."[49] In particular, he claimed that no universal measurement of time had been achieved regarding the youngest geological period. Existing efforts left little more than a "hint of the amount of time passed" to enable the development of culture.[50] The Swedish geologist addressed this lacunae, and aimed for a connection between the relative calendar of geology and the absolute human timescale.[51] In public presentations, De Geer explained that nature had produced a "fundamental keeping of time," which allowed us to "far beyond humanity's oldest written records" create "reliable" and "exact" determinations of the "immense epochs" preceding the development of human culture.[52] Research on the Ice Age and its disappearance promised the possibility to measure and define the order of years, thus enabling a "true measurement" of time.[53] De Geer sought a detailed calendar, down to the individual year, where nature's changes could become visible and interpreted against the advent of history. According to newspapers, the Swede had "introduced the year as a measure of time," also in geology.[54] Upon launching the term geochronology in 1910 he had turned "geology into a historical science with years."[55] Clay varves were the "annual rings of the earth," and they could provide an almanac of a long history.[56]

Andrew Ellicott Douglass harbored the same wish to connect climatic chronologies visible in tree rings to fixed years. Early on, he collected wood samples, which indicated shifts in nature, but which were floating chronologically as there was no way to date them exactly. In 1929 he managed to determine when a wood sample from an archeological site had been cut down, and achieved the desired synchronization.[57] In 1937, he stated that the long ring chronologies were accurately dated, displaying "annual changes." Indeed, the "ring of a tree is an annual affair," and the fundamental value of tree rings to the study of climate was their "yearly identity."[58] Moreover, sequoias were put in a context of cultural and political history in the presentation of dendrochronology. The "great events of world history are here marked in the form of thin layers of wood."[59] Douglass himself claimed that the trees opened a deeper history of the Americas; they revealed climatic events, which occurred at the time of William the Conqueror or the Moorish conquest of Spain.[60] Newspapers repeated the connection of natural and cultural history, and highlighted how some of the trees had stood tall already at the birth of Jesus Christ, or at the time of "the Trojan War" and the "exodus of the Jews from Egypt."[61] In the 1950s, an exhibition at the American Museum of Natural History displayed a cross section of a giant sequoia containing 1,342 annual rings. The rings were inscribed with historical events, including the invention of Galileo's refracting telescope and Napoleon's coronation as French emperor.[62] As synchronizing practices, geochronology and dendrochronology balanced the heterogeneity of natural and human history. The year as a temporal entity proved to be a productive locus of time organization because it was both a natural phenomenon and a cultural product.

Metaphors of Cultural Documents

In 1921, the Swedish daily *Dagens Nyheter* offered a thought-provoking proposition: "Imagine a historian suddenly finding whole packs of ancient diaries, covering thousands of years, with not a single year missing!"[63] Furthermore, the newspaper suggested, "imagine that these diaries contained detailed information about events, on a day-to-day basis!"[64] The article brought together a source for history writing—the diary—with the timescale of geochronology and dendrochronology. Examples from the nineteenth century where concepts from human historiography affected the understanding of nature abound. Natural philosophers Charles Lyell and James Hutton spoke about the analogy of geology and history as well as about "nature's archive."[65] They were not alone in using such descriptions. In fact, according to Martin Rudwick, the study of human history was a crucial source for efforts to historicize nature from the late eighteenth century onwards. Ideas, concepts, and methods from historical investigations were "transposed" into natural history. This was no coincidence as the study of human history took its modern shape during that very period with a more rigorous reading of sources and with ideas about the otherness of earlier historical periods.[66] At the turn of the twentieth century, descriptions of nature's documents and annals had become widespread, and they were repeated in geochronology and dendrochronology. Gerard De Geer and Andrew Ellicott Douglass, as well as reporters covering their work, used metaphors of cultural documents—including "diaries," "record," "books," "annals," and "calendar"—as a literary format to present the two fields of knowledge.

In presenting dendrochronology, Andrew Ellicott Douglass stated that the trees were "the yearbook of the sun."[67] In public presentations, he spoke of how the forest was nature's book presenting a "long and vivid story."[68] Each ring became "an annual report" and the trees offered "prehistoric records."[69] By the 1920s, Douglass gained some public appeal as he was interviewed on the radio and wrote popular texts. In these lectures and texts, he repeated the metaphors bringing together nature and document: trees were "nature's stenographers" and "monkish penmen."[70] In 1929, *The National Geographic Magazine* published a paper by Douglass on his expedition to Arizona to study tree rings. The editor introduced the text by stating that "talkative tree rings" had carried American history back to the year 700 and offered "a calendar" for twelve hundred years.[71] According to Douglass, the stories and chronology established by tree rings were more accurate than "if human hands had written down the major events."[72] In the rhetoric of this public presentation, the American astronomer claimed that dendrochronologists had learned to read the "diaries of trees."[73] The trees were "chronographs, recording clocks, by which the succeeding seasons are set down through definite imprints."[74]

Gerard De Geer argued that a "natural chronology" could be "registered" in clay.[75] In the mid-1920s, the geologist claimed that he and his collaborators had collected and put together "nature's annals" into a chronology spanning roughly eighteen thousand years.[76] Newspapers stated that "bulletins of the weather going back twenty thousand years" were "hidden in the clay varves."[77] The layered clay formed nature's own massive and "fascinating document."[78]

The calendar offered yet another cultural document, based on the year, to make nature's time meaningful.[79] In the face of these metaphors, the issue of readability was also discussed. After all, layered clay lacked every form of written signs, and they needed to be read and interpreted to become meaningful. The language of the clay was hidden and decipherable only if one read the thickness of the varves.[80] Therefore, the scholars and their knowledge production were repeatedly emphasized. The geochronologist and dendrochronologist had not only collected the annals of nature, they also made an impact through the act of interpretation.[81] Since the records of nature did not contain written signs, "the key to their meaning" lie in the "measurements of their varying thickness."[82]

Reporters and scholars blurred boundaries between clay, wood, and cultural documents to capture and read time. The study of clay varves and tree rings coalesced with the practice of keeping, reading, and deciphering records. But perhaps these descriptions were merely rhetoric meant to engage the audience and make the study of natural history intelligible to nonexperts? There were certainly aspirations to create an engaging story in newspapers, yet a deeper connection was also at stake. Reports on cultural documents worked to connect nature's time and historical time as it allowed the two versions of history writing to communicate and shape a joint reading of the past.

To elaborate the point, I wish to extrapolate a discussion on calendars from media scholar John Durham Peters. His arguments about calendars are valid for the other metaphors of cultural documents as well, including "diary" and "annals." In practice, according to Peters, calendars are impacted by natural phenomena—in particular astronomical facts—yet in any calendar, there is cultural arbitrariness. The heavens as well as cultural mores are equally important as the source material for constructing them.[83] In geochronology and dendrochronology, clay and trees were important as natural materials to construct calendars in practice, yet they were also tied to the emergence of human culture as indicated by the importance of the year as a temporal unit. According to John Durham Peters moreover, calendars are "logistical media" in the sense that they negotiate between nature and culture; they coordinate astronomic, biological, and cultural events.[84] The metaphors of cultural documents used in presenting geochronology and dendrochronology were media that displayed the long-term and stored and extrapolated the past. The idea of "diary," "annals," and "calendars" bound, measured, organized, and made sense of abstract time. Put differently in this context, they served to render intelligible the potentially obscure images of times past that were produced in geochronology and dendrochronology.

Moreover, as indicated by Martin Rudwick, the usage of metaphors from history writing from the late eighteenth century onwards resonated with an ambition to create a chronology of nature, of creating a temporal structure with specific events taking place at particular dates. Interpreting documents in history writing was a method to construct a dating and a sequence. In the same way, the usage of documents and annals could create a reconstruction of an actual categorization of distinctive events in nature's history. A critical evaluation and reading of the records of nature could, like in history writing, give witness to historical reality in precise historical natural events.[85]

Timelines as a Visual Media Format

In academic journals, newspapers, and popular journals, geochronology and dendrochronology introduced and discussed timelines as a visual media format. The timelines were "chronographics," which registered, displayed,

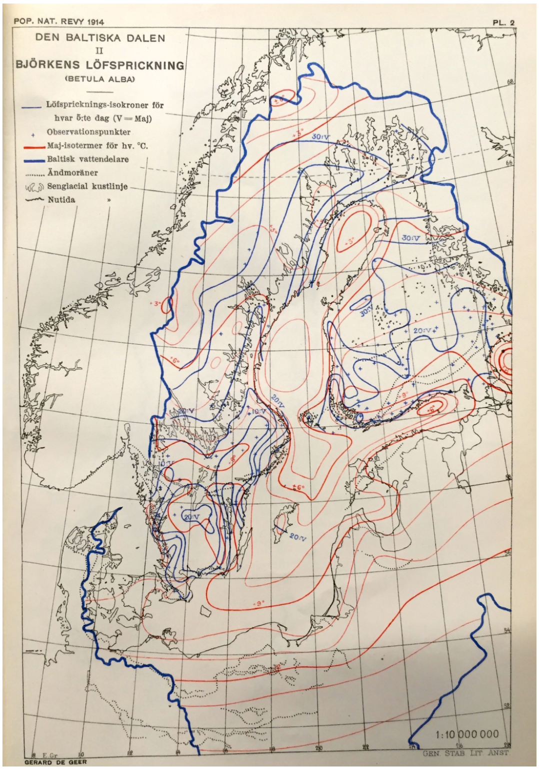

Figure 9.1 Temporal map of the deglaciation of Scandinavia, 1914, Gerard De Geer, "Om naturhistoriska kartor öfver den baltiska dalen," *Populär naturvetenskaplig revy* 4. National Library of Sweden (Kungliga biblioteket). Public domain.

and distributed temporal phenomena.[86] They translated the abstract matter of long timescales into concrete images of temporal overview. Moreover, they were templates that, just like the metaphors of cultural documents described above, created a temporal organization between nature's time and historical time. Indeed, they served to translate the cyclical time of nature into the linear time of history.

In 1914, at the very outset of his effort to launch geochronology, Gerard De Geer constructed a timeline in the form of a temporal map meant to display the gradual receding of the inland ice over Scandinavia (Figure 9.1). The production of geological maps was part of normal science in geology at the turn of the twentieth century, as they described the presence of natural resources but also geological time.[87] De Geer made several other temporal maps covering changes between the Ice Age and the Neolithic Age, several of which were published as an appendix to the book *Om Skandinaviens* *geografiska utveckling efter istiden*. The maps had also been put on display at the International Geological Congress in London in 1895.[88]

The temporal map in Figure 9.1 had originally been part of exhibition material at the Baltic Exposition in Malmö in 1914, and it was later printed in the popular magazine *Populär naturvetenskaplig revy*. De Geer made four different maps, three of which displayed the chronological migration and evolution of species after the Ice Age in Scandinavia. The first map, the one I focus on here, instead described the chronology of the melting of the inland ice. It displayed the main phases and the chronology, during which Scandinavia was gradually freed from the ice, which had halted the developments of virtually all life forms. The image created an overview of the geochronological studies De Geer had performed. The template was a map produced for Swedish schools, printed at the Lithographic Institute of the General Staff of the Swedish Army.[89]

The three blue solid lines, named *ekvicess* by De Geer, in the southern part of contemporary Sweden marked the recession of the ice in intervals of five hundred years. The blue horizontal lines, with segments of small blue vertical lines within them, marked the phases in the melting that De Geer had named the Daniglacial, the Gotiglacial, the Finiglacial and the Postglacial stages. The first designated the period when the inland ice receded over the Danish landmass, while the second covered the period when the ice disappeared from southern Sweden. The Finiglacial period was described as the final stage of the Ice Age, when the inland ice receded over the middle part of Sweden. During the Postglacial phase, the last remnants of the inland ice were still present and slowly melting in Sweden's most northern parts; segments of the ice remained in glaciers in the very north, and mountainous landscape, of Scandinavia. This stage lasted eight thousand years up until the present.[90]

My second example is a timeline created by De Geer to illustrate his article "*Förhistoriska tidsbestämningar*," published in 1925 in *Ymer*, the journal for the Swedish Society for Anthropology and Geography (Figure 9.2).

The timeline displayed the "Swedish timescale," i.e., a chronology of periods, fixed in time and given names indicating their order: Middle Quaternary, Late Quaternary, Lateglacial, and Postglacial. In addition, the periods were layered so that the overarching era of Late Quaternary encapsulated the Late Glacial and Postglacial epochs. These periods in turn spanned the time of the melting of the ice. The period Late Quaternary contained the epochs Daniglacial, Gotiglacial and Finiglacial.[91] Moreover, the times of nature were juxtaposed with the cultural time of Neolithic, Bronze, Iron, and Historical. Moreover, the year was crucial as a basis to anchor the timeline in a chronology possible to relate to the now. While the actual year for the start of Late Quaternary could not be exactly determined according to De Geer, the ambition was to turn the chronology of phases in nature and culture into actual years.

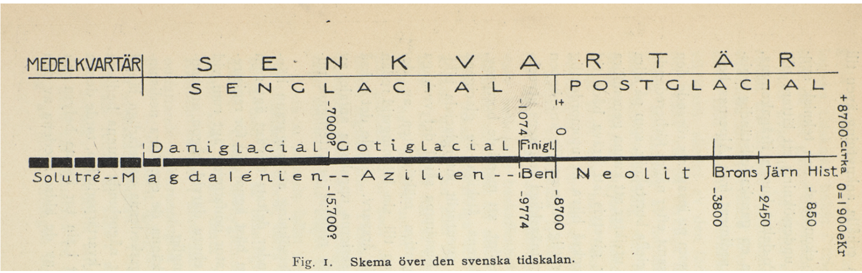

Figure 9.2 Gerard De Geer, "Förhistoriska tidsbestämningar," *Ymer: Tidskrift utgiven av Svenska sällskapet för antropologi och geografi* 45, no. 1 (1925). National Library of Sweden (Kungliga biblioteket). Public domain.

It should be emphasized that timelines have their own rich and varied history, even though it has rarely been made the subject of scholarship. As Daniel Rosenberg and Anthony Grafton discuss in *Cartographies of Time*, "the line," although crucial for visual chronologies, is a fairly recent innovation. Visual representations of time along an axis with a regular distribution of dates only started to flourish in the late eighteenth century. As with many other timelines, the ones produced by Gerard De Geer were visual chronologies displaying "scale, succession, and simultaneity." Moreover, they collected "masses of facts in a single, unified structure."[92] Both timelines constructed by De Geer served as a visual technique where time was conceptualized, conveyed, and circulated.

In what sense then were these examples literally time*lines*? The second example (Figure 9.2) has a clear chronological structure, where time moves from left to right. The first example (Figure 9.1) is a time map. While less obviously a line, time has a chronological direction as the recession of the ice in a northerly course demonstrated the passing of time. These illustrations were a crucial tool to transfer nature's time into a legible and comprehensible chronology, turning time into an arrow with a direction. An image published in the Swedish daily *Dagens Nyheter* from May 5, 1935 is yet another case in point (Figure 9.3).

A whole page was devoted to dendrochronology under the heading "*Träden som förhistoriska tidmätare.*"[93] Besides contributing to the popular presentation of dendrochronology, the photograph presented tree rings, and with them the climatic cycles of nature. The written marks on the wood indicated the eleven-year cycles of the sunspots as the accompanying text explained. Accordingly, the image resonated with the descriptions of nature's cyclical timescale, yet the photograph of the tree rings also conveyed a timeline going from the innermost ring outwards in the trunk. The wood in combination with the written inscriptions—as well as the photograph capturing both—drew

DAGENS NYHETER Söndagen den 5 Maj 1935

TRÄDEN som förhistoriska tidmätare.

Av ANTON SÖRLIN.

ANDREW ELLICOT DOUGLASS.

HÄR NEDAN DETALJER AV TVÅ TALLSTOCKAR, DEN ÖVRE FRÅN EBERSWALDE, PREUSSEN, DEN UNDRE FRÅN BULVERKET I TINGSTÄDE TRÄSK, BÅDA UTVISANDE DEN 11-ÅRIGA SOLFLÄCKSPERIODEN. BULVERKSSTOCKEN INGÅR I DET MATERIAL SOM GIVIT VID HANDEN ATT BULVERKET BÖRJADE UPPFÖRAS OMKRING 450 E. KR.

Figure 9.3 *Dagens Nyheter*, May 5, 1935. National Library of Sweden (Kungliga biblioteket). Public domain.

together large chunks of time, making the onlooker see nature's changes and rhythms as well as chronology going from a prehistorical *then* to a historical *now*.

Varves and rings taken in isolation merely displayed chronologically free-floating cycles. They became linked to an intelligible chronology only when they were translated into a meaningful timeline, and this in turn contributed to the order between nature's time and historical time. Gerard De Geer claimed that the temporal map in Figure 9.1 covered the period up until the present when the "people of the Baltic region" had contributed to "human culture."[94] The timeline in Figure 9.2 placed the two timescales within the same template. Geological time captured in the eras Middle Quaternary, Late Quaternary, Lateglacial, Postglacial, Daniglacial, and Gotiglacial was visually connected to the era of prehistory and history through a juxtaposition with the Bronze, Iron, and Historical periods. Placed alongside each other in the timeline meant coinciding in the past. As De Geer described it, the timeline displayed "phases in time" fixated through geochronology, as well as "corresponding stages of culture."[95]

It is important to note that at least Gerard De Geer was a firm believer in evolutionary theories and the progress of western scientific culture. He understood culture as linear, and he maintained that it continuously gained in strength. However, neither he nor Douglass contributed to the writing on cultural history and its standard, diachronic narrative at the time. Both geochronology and dendrochronology instead focused on a longer timescale than historicism, and the timeline as an abstract space worked to synchronize events and periods during thousands of years. As noted by Helge Jordheim, timelines organized and represented different temporalities in one synchronic space.[96] Above all, geochronology and dendrochronology linked two temporal regimes: cyclical nature was coordinated with linear culture.

Timescales and Knowledge Organization

Existing studies have suggested that before the mid-nineteenth century the human and natural sciences constituted a single field of time study, primarily held together by the biblical vision of creation and history. Subsequently, a major change occurred as the study of time was caught in a "straitjacket of disciplinary history," leaving history isolated from geology or paleontology.[97] Indeed, it is a commonplace in the history of science that the specialization of the scientific community increased throughout the nineteenth and twentieth centuries. New professional positions, specialized societies, and disciplinary journals drove the change.[98] However, coexisting with this overarching trend were research fields where emerging disciplines were still intermingled. These contradictory trends marked geochronology and dendrochronology: both fields envisioned links to related research areas, yet they did not succeed in shaping them in practice. In particular, the issue of temporality was considered an interdisciplinary undertaking by Gerard De Geer and Andrew Ellicott Douglass. The combination of the two fields offered opportunities to include archaeology, paleontology, meteorology, astronomy, biology, and cultural history.[99] Their effort to coordinate and synchronize different times created a corresponding ambition to integrate knowledge.

Swedish newspapers declared that Gerard De Geer represented a new science called "time-measurement of the earth."[100] The Swede suggested a coherent science of developments and historical trajectories where several disciplines could coexist. He argued that the interest in the evolution of humans had put the younger geological strata and quaternary geology center stage.[101] The geologist advocated a scholarly collaboration based on particular locales, which were once covered by ice. In the study of such places, the "geophysical, biological and archaeological development" could be examined. Moreover, De Geer argued that geochronology had a bearing on geophysics and on the physics of the sun.[102]

In particular, De Geer proposed a close connection between geochronology and archaeology. The fact that archaeology bordered both history and geology is a well-known fact in histories of the discipline.[103] As the science historian Christer Nordlund has discussed in a study of late nineteenth-century research on the Ice Age in Sweden, scholars from fields studying both nature and culture dug for remnants of the Swedish past. In Sweden, connections between geology and archaeology were also facilitated through the anthropological society—established in 1873 with Gerard De Geer as one of its founders—and its journal *Ymer*. Moreover, the Geological Survey of Sweden repeated an international practice to map and document archaeological findings alongside its geological examinations of the landscape.[104]

Already in the book *Om Skandinaviens geografiska utveckling efter istiden* from 1896 did De Geer include a whole chapter on the geography of the Neolithic age, with the ambition of tying geology to archaeology.[105] Throughout the first decades of the twentieth century, he repeatedly stated how he tried to match studies of clay layers with the archaeological study of prehistoric tools and fossils.[106] Presentations in the newspapers argued that the fields shared an interest in "the development of culture from the dawn of humanity up until the present."[107] Knowledge produced by De Geer benefitted the effort among archaeologists to research the "earliest history of Sweden" and "prehistoric stages of culture."[108] In fact, when De Geer suggested cooperation he was simultaneously arguing the particular value of his own research program. According to him, geochronology could form a scholarly basis, and it had the capacity to strengthen, and even correct, the work of archaeologists.[109] From the perspective of the geologist, archaeological findings only offered an approximate idea of the age of the findings. A chronology based on clay varves instead supplied archaeology with a "firm ground to build upon."[110] Indeed, geochronology was introduced as a new dating method in Swedish archaeology in the 1920s since it created an absolute time when the ice receded and humans colonized the landscape.[111]

Dendrochronology was also described as an interdisciplinary undertaking. De Geer's wife Ebba Hult characterized Andrew Douglass as a representative of an exact mathematical science studying biological material to measure solar phenomena precisely. His work connected botany with studies of the history of the earth and the climate, as well as with explorations of the rhythm of the sun.[112] Douglass himself also discussed the relatedness of dendrochronology to geochronology, meteorology, botany, and anthropology. The connection to meteorology consisted in the ambition to create long chronologies of climate and weather patterns, while the botanical connection concerned the understanding of ring morphology.[113] Between 1915 and the mid-1920s, Douglass linked his research to studies of ancient building sites in the American Southwest more explicitly. He built on archaeological dating efforts to determine the age of old ruins made of wood, which he analyzed with the tools of dendrochronology.[114] According to the American astronomer, the "transition to archaeology" was easy, and the archaeological studies would enable an understanding of movements and traditions among "tribes" of the American Southwest. This in turn would lead to insights into "tribal activities" and climatic conditions, and thus a study of the "influence of climate on human history."[115]

Douglass himself declared that even though the study of the relation between solar activity and the weather was part of astrophysics, the research also generated "contacts."[116] In his John Wesley Powell lecture from 1937, he explained that tree-ring work was "a co-operative search for nature's secrets along the paths of astronomy, botany, and climate."[117] Tree-ring research also dovetailed with anthropology; in collaboration with dendrochronology, anthropologists could "secure the exact construction dates of their prehistoric buildings."[118] Indeed, his studies of climatological conditions offered the possibilities of a study of the influence of the climate on "the history of man."[119]

While both Gerard De Geer and Andrew Ellicott Douglass suggested scholarly liaisons across the nature–culture divide, their efforts occurred at a time of increasing specialization of the academic disciplines. For example, the nineteenth century practice of mapping both geological and archaeological findings in the field waned at the turn of the twentieth century, in Sweden and abroad, adding to the divide between the two fields of knowledge making.[120] Indicative of these structural changes, De Geer and Douglass did not manage to leave a science of time measurement of the earth behind. At the same time that they published the bulk of their studies, academic history went through changes, which at first glance should have brought geochronology, dendrochronology, and history closer together. History writing in the nineteenth century had been shaped by metaphysical ideas about progress and an interest in the nation as a political entity.[121] From the 1920s onwards however, influential historians—for example Fernand Braudel and the early *Annales* school—began to search for slower temporalities, taking an interest in cycles, layers, strata, and sediments. Braudel picked up on findings in other scientific fields showing the longer history of hominids. The fact that time was measured in millions of years, and that even the Neolithic Age was recent in this perspective, impacted his idea about the *longue durée*. To the Frenchman, history became a dialectic between different structures and levels, understood as having separate temporalities. History was increasingly given a multilayered character.[122]

Nevertheless, to my knowledge, there are no cross references or influences between this type of history writing on the one hand and geochronology and dendrochronology on the other. At most, it seems that the connection is of a vague, discursive nature, in particular through the interest in layers of time to capture the long-term. When juxtaposing them, the commonalities are accompanied by an apparent breakage between the projects. Braudel directed his attention to the emerging social sciences, and he has primarily been the interest of scholars in the history of historiography. Conversely, Gerard De Geer and Andrew Ellicott Douglass play a role (although marginal) only in history writing about the natural sciences. The rift mirrors a broader history of knowledge organization based on *Naturwissenschaften* and *Geisteswissenschaften* as they were increasingly launched in the early twentieth century.[123] History, geology, and dendrochronology were all shaped by rising professionalization and disciplinary identity through the elaboration of methods and objects of study, as well as through institutional belonging. Regardless of the causal factors behind the rift, in the modern, twentieth century, knowledge divides separated nature from culture, natural sciences from humanities, geologists from historians, and Gerard De Geer from Fernand Braudel.

Conclusion

Through their interest in the semi-long period of the last twenty thousand years, researchers in geochronology and dendrochronology coordinated and synchronized multiple timescales across the nature–culture divide. De Geer and Douglass portrayed how nature had a cyclical and slow rhythm, and they took particular interest in the climatological changes, while also linking it to the linear and more rapid temporality of historical cultures. In particular, I have analyzed the organization of nature's time and historical time through media formats and knowledge organization, both of which were ways to envision joint knowledge-making about time measurement.

First, I discussed how times of nature and times of history were integrated through the year as a temporal unit. It was both a natural phenomenon and a culturally intelligible category, making it possible for nature and culture to share a calendar. Second, I indicated how metaphors of cultural documents illustrated the long-term processes of nature. As media formats, the metaphors displayed the interconnected timescale of nature and culture. Drawing together, binding and organizing different temporalities, they specifically turned nature's cycles into discrete chronological events. Just like in history writing, using clay and wood as annals, diaries and records meant constructing knowledge about precise natural events in a sequence—"on a day-to-day basis."

Third, I discussed timelines as a media format, which offered an abstract visual space where time could be written down, captured, and displayed. Within that space moreover, nature's time and historical time could be integrated and literally seen simultaneously. Both the literal and visual media formats organized, measured, and visualized the multiple times that geochronology and dendrochronology explored and presented. On the one hand, they illuminated the prehistory of humanity through the interest in climate and cycles. On the other, the formats served to translate the cyclical timescale of nature into a linear, chronological, and culturally fixated time down to the individual year. Fourth, I have suggested that the interest in temporality also emanated in a suggested, interdisciplinary knowledge organization built around the issue of time measurement. The two fields grew out of an academic landscape marked by both existing scholarly collaborations and an emerging specialization of science.

In closing, I wish to return to the theses put forward by Dipesh Chakrabarty and Naomi Oreskes. While there is no doubt that the discussions about climate change and the Anthropocene have had a disruptive power in the late twentieth century and reformed the field of history writing broadly construed, overemphasizing this shift threatens to render invisible the many historical examples of efforts to write nature's time and historical time in tandem. The case of geochronology and dendrochronology displays an example of concrete practices and discourses in the past where earth history and world history were combined. In fact, judging from this historical case, the divide between scholarship on nature's time and historical time has a strikingly short history in the deep time of knowledge. Moreover, while this case indicates efforts to transgress nature and culture, it also illustrates the difficulties in doing so in the face of structural changes in modern knowledge organization. The response from historians to geochronology and dendrochronology was, as far as the empirical material indicates, virtually nonexistent, and De Geer's version of geochronology even abandoned in geology. As Chakrabarty himself has noted, time as it has come to be understood and defined in the historically produced disciplines of geology and history is not the same.

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Staffan Bergwik is Professor of the History of Science and Ideas at the Department of Culture and Aesthetics at Stockholm University. His research focuses on the cultural history of the modern sciences, including topics like science and verticality, science and temporality, history of emotions, history of knowledge, and science and the media. Recent publications include "Elevation and Emotion: Sven Hedin's Mountain Expedition to Transhimalaya 1906–1908," *Centaurus* (2020); "Standing on Whose Shoulders? A Critical Comment on the History of Knowledge," *Forms of Knowledge: Developing the History of Knowledge* (Nordic Academic Press, 2020); and *Domesticity in the Making of Modern Science* (Palgrave MacMillan, 2015).

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21. Donald J. McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia in the Development of Dendrochronology* (Lewiston: Edwin Mellen Press, 2001); Donald J. McGraw, "Andrew Ellicott Douglass and the Giant Sequoias in the Founding of Dendrochronology," *Tree-Ring Research* 59, no. 1 (2003): 21–27.
22. McGraw, "Andrew Ellicott Douglass and the Giant Sequoias," 21–23; McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia*, 11 and 71.
23. Andrew Ellicott Douglass, "Tree Rings and Climate," *The Scientific Monthly* 21, no. 1 (1925): 98.
24. McGraw, "Andrew Ellicott Douglass and the Giant Sequoias," 21; McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia*, 10.
25. McGraw, "Andrew Ellicott Douglass and the Giant Sequoias," 25.
26. "Mr och mrs Bliss skänka Högskolan ett en bit jätteträd," *Dagens Nyheter*, March 6, 1927 and Anton Sörlin, "Träden som förhistoriska tidmätare," *Dagens Nyheter*, May 5, 1935. See also Andrew Ellicott Douglass, "Tree Rings and Chronology," *University of Arizona Bulletin* 8 (1937): 8; McGraw, "Andrew Ellicott Douglass and the Giant Sequoias," 23–26.
27. Its history has been touched upon by scholars within the field. See for example Fritz Hans Schweingruber, *Tree Rings: Basics and Applications of Dendrochronology* (Dordrecht: Kluwer, 1988).
28. Nordlund, *Det upphöjda landet*, 23; Tore Frängsmyr, *Upptäckten av istiden: Studier i den moderna geologins framväxt* (Stockholm: Almqvist & Wicksell, 1976).
29. Gerard De Geer, "Geokronologien: Tioårsminnen och framtidsplaner," *Svenska dagbladet*, July 18, 1934; De Geer, "En förhistorisk tideräkning," 78.
30. Ebba Hult De Geer, "Geokronologi och biokronologi," *YMER: Tidskrift utgiven av Svenska sällskapet för antropologi och geografi* 51 (1931): 249.

31. Hult De Geer, "Geokronologi och biokronologi," 250; Douglass, *Climatic Cycles and Tree Growth*, 115.
32. François Hartog, *Regimes of Historicity: Presentism and Experiences of Time* (New York: Columbia University Press, 2015).
33. Jordheim, "Introduction," 505.
34. Gerard De Geer, "Om snön som föll ifjol," *Ord och bild* 36 (1928): 212.
35. "Mr och mrs Bliss," *Dagens Nyheter*.
36. Ansgar Roth, "Kosmisk rytm," *Svenska dagbladet*, July 13, 1938; Douglass, "Tree Rings and Chronology," 6. See also Andrew Ellicott Douglass, "Solar Records in Tree Growths," *Science* 65, no. 1679 (1927): 221.
37. "Holds the Planets Control Rainfall," *New York Times*, June 21, 1931.
38. "To Study Early Man," *New York Times*, August 16, 1920; "Prof. Gerard De Geer 70 år," *Svenska dagbladet,* October 1, 1928.
39. De Geer, "Förhistoriska tidsbestämningar," 2 and 5.
40. "Naturvetenskap som vägbrytare för sann kultur," *Dagens Nyheter,* July 20, 1925. See also De Geer, "Förhistoriska tidsbestämningar," 6.
41. De Geer, "Förhistoriska tidsbestämningar," 1–2 and 8–9. See also De Geer, "Om snön som föll ifjol," 210.
42. Gerard De Geer, "Om den senkvartära tidens indelning," *Geologiska föreningens förhandlingar* 33, no. 6 (1911): 464; De Geer, "Förhistoriska tidsbestämningar," 1 and 6. See also "Naturvetenskap som vägbrytare," *Dagens Nyheter*.
43. De Geer, "Förhistoriska tidsbestämningar," 3. See also "To Study Early Man," *New York Times*.
44. Lennart von Post, "En svensk forskarbragd i Patagonien," *Dagens Nyheter,* November 15, 1932.
45. "En fullständig utvandring av svenska geologer," *Svenska dagbladet,* February 10, 1927.
46. Anton Sörlin, "Den varviga leran som geologisk tidsmätare," *Ord och bild* 42 (1933): 540.
47. "Väderleksbulletiner för nära 20,000 år," *Dagens Nyheter,* January 12, 1921.
48. See for example Douglass, "Tree Rings and Climate," 95–96; Andrew Ellicott Douglass, "Some Aspects of the Use of the Annual Rings of Trees in Climatic Study," *The Scientific Monthly* 15, no. 1 (1922): 7.
49. De Geer, "En förhistorisk tideräkning," 78; De Geer, "Om solens spår: En kort sannsaga om långa tidsåldrar," *Nordisk tidskrift* 1927: 341; De Geer, "Om den senkvartära tidens indelning," 463–64.
50. "Naturvetenskap som vägbrytare," *Dagens Nyheter*. See also De Geer, "Förhistoriska tidsbestämningar," 3.
51. Gerard De Geer, "Om grunderna för den senkvartära tidsindelningen," *Geologiska föreningens i Stockholm förhandlingar* 34, no. 2 (1912): 252–53.
52. "Naturvetenskap som vägbrytare," *Dagens Nyheter*; De Geer, "Geokronologien: Tioårsminnen och framtidsplaner."
53. De Geer, "Förhistoriska tidsbestämningar," 2 and 5.

54. De Geer, “Om grunderna för den senkvartära tidsindelningen,” 253; Lennart von Post, “Ett livsmonument,” *Dagens Nyheter,* October 2, 1940.
55. Roth, “Kosmisk rytm.” See also De Geer, “En förhistorisk tideräkning,” 80; “Väderleksbulletiner för nära 20,000 år,” *Dagens Nyheter*.
56. De Geer, “Om solens spår,” 342; “Holds the Planets Control Rainfall,” *New York Times*; Sörlin, “Den varviga leran som geologisk tidmätare,” 540.
57. Douglass, “Tree Rings and Chronology,” 9. See also McGraw, “Andrew Ellicott Douglass and the Giant Sequoias,” 26.
58. Douglass, “Tree Rings and Chronology,” 5. See also McGraw, “Andrew Ellicott Douglass and the Giant Sequoias,” 9; Douglass, “Some Aspects of the Use of the Annual Rings of Trees in Climatic Study,” 7.
59. “Mr och mrs Bliss,” *Dagens Nyheter*.
60. Quoted in Hult De Geer, “Geokronologi och biokronologi,” 300.
61. “Mr och mrs Bliss,” *Dagens Nyheter*.
62. Daniel Rosenberg and Anthony Grafton, *Cartographies of Time: A History of the Timeline* (New York: Princeton Architectural Press, 2010), 21.
63. “Väderleksbulletiner för nära 20,000 år,” *Dagens Nyheter*.
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65. Nordlund, *Det upphöjda landet*, 36.
66. Rudwick, *Bursting the Limits of Time*, 6 and 181–83.
67. Andrew Ellicott Douglass, “Weather Cycles in the Growth of Big Trees,” *Monthly Weather Review* 37 (1909): 226; Hult De Geer, “Geokronologi och biokronologi,” 251.
68. Douglass, “Some Aspects of the Use of the Annual Rings of Trees in Climatic Study,” 5. See also McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia*, 71–72.
69. Douglass, “Tree Rings and Climate,” 95; Douglass, “Some Aspects of the Use of the Annual Rings of Trees in Climatic Study,” 18.
70. Quoted from McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia*, 77.
71. Andrew Ellicott Douglass, “The Secret of the Southwest Solved by Talkative Tree Rings,” *The National Geographic Magazine* 65, no. 6 (1929): 737.
72. Douglass, “The Secret of the Southwest,” 737.
73. Douglass, 738–41.
74. Douglass, 741.
75. De Geer, “Om grunderna för den senkvartära tidsindelningen,” 252.
76. De Geer, “Om snön som föll ifjol,” 211.
77. “Väderleksbulletiner för nära 20,000 år,” *Dagens Nyheter*.
78. “Expeditionen till Himalaya mycket lyckad,” *Dagens Nyheter*, November 7, 1924 and “Naturvetenskap som vägbrytare,” *Dagens Nyheter*. See also Hult De Geer, “Geokronologi och biokronologi,” 251.
79. McGraw, “Andrew Ellicott Douglass and the Giant Sequoias,” 21.
80. “Naturvetenskap som vägbrytare,” *Dagens Nyheter*.
81. De Geer, “Om snön som föll ifjol,” 211.
82. De Geer, 211.

83. John Durham Peters, *The Marvelous Clouds: Towards a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015), 182–83.
84. Peters, *The Marvelous Clouds*, 176–77, 194 and 213.
85. Rudwick, *Bursting the Limits of Time*, 236.
86. Rosenberg and Grafton, *Cartographies of Time*, 19.
87. Nordlund, *Det upphöjda landet*, 34–37; Cristián Simonetti, "Between the Vertical and the Horizontal: Time and Space in Archaeology," *History of the Human Sciences* 26, no. 1 (2013): 97.
88. Nordlund, *Det upphöjda landet*, 123–24.
89. Gerard De Geer, "Om naturhistoriska kartor öfver den baltiska dalen," *Populär naturvetenskaplig revy* (Popular science revue) 4 (1914): 189–90.
90. De Geer, "Om naturhistoriska kartor öfver den baltiska dalen," 189–94.
91. In another text, De Geer declared that the Gotiglacial era spanned the time when the ice melted in the southern part of Sweden while the Scandiglacial period occurred when the ice finally melted in northern Sweden. De Geer, "Om den senkvartära tidens indelning," 466.
92. Rosenberg and Grafton, *Cartographies of Time*, 10, 13–15. Quote on page 238.
93. "The trees as instruments to measure prehistoric time."
94. De Geer, "Om naturhistoriska kartor öfver den baltiska dalen," 189.
95. De Geer, "Förhistoriska tidsbestämningar," 8.
96. Jordheim, "Introduction," 515.
97. Shryock and Smail, "Introduction," 5–7.
98. Peter J. Bowler and Iwan Rhys Morus, *Making Modern Science: A Historical Survey* (Chicago: University of Chicago Press, 2005), 329–37; Bowler, *The Earth Encompassed*, 382–92.
99. Sörlin, "Träden som förhistoriska tidmätare"; "Prof. Gerard De Geer 70 år," *Svenska dagbladet*.
100. "Prof. Gerard De Geer 70 år," *Svenska dagbladet*. See also "Geokronologiska institutets hem skall öppnas idag," *Dagens Nyheter,* April 25, 1925.
101. De Geer, "Förhistoriska tidsbestämningar," 1.
102. De Geer, "Om solens spår," 345–47. The suggestion was echoed by one of the most eager popularizers of geochronology and dendrochronology, Anton Sörlin. Sörlin, "Den varviga leran som geologisk tidsmätare," 538.
103. Shryock, Trautmann, and Gamble, "Imagining the Human in Deep Time," in *Deep History*, 29.
104. Nordlund, 23 and 221–29.
105. Nordlund, *Det upphöjda landet*, 225–26.
106. De Geer, "Förhistoriska tidsbestämningar," 2.
107. Sörlin, "Träden som förhistoriska tidmätare."
108. "Väderleksbulletiner för nära 20,000 år," *Dagens Nyheter*; De Geer, "Förhistoriska tidsbestämningar," 2 and 8–9.
109. De Geer, "Förhistoriska tidsbestämningar," 2. See also De Geer, "Om solens spår," 345; Sörlin, "Den varviga leran som geologisk tidsmätare," 538.

110. Sörlin, "Träden som förhistoriska tidmätare." See also De Geer, "Om den senkvartära tidens indelning," 470; De Geer, "Förhistoriska tidsbestämningar," 5.
111. Nordlund, *Det upphöjda landet*, 247 and 254.
112. Hult De Geer, "Geokronologi och biokronologi," 290.
113. McGraw, *Andrew Ellicott Douglass and the Role of the Giant Sequoia*, 67.
114. Douglass, "Some Aspects of the Use of the Annual Rings of Trees in Climatic Study," 20–21; McGraw, "Andrew Ellicott Douglass and the Giant Sequoias," 25.
115. Douglass, "The Secret of the Southwest," 745 and 770.
116. Douglass, "Some Aspects of the Use of the Annual Rings of Trees in Climatic Study," 6–7.
117. Douglass, "Tree Rings and Chronology," 5. See also Douglass, "Some Aspects of the Use of the Annual Rings of Trees in Climatic Study," 15.
118. Douglass, "Tree Rings and Chronology," 5, 15; Douglass, "Some Aspects of the Use of the Annual Rings of Trees in Climatic Study," 6–7.
119. Hult De Geer, "Geokronologi och biokronologi," 307.
120. Nordlund, *Det upphöjda landet*, 221–24.
121. Iggers, Wang, and Mukherjee, *A Global History of Modern Historiography*, 73–74 and 130.
122. Hartog, *Regimes of Historicity*, 13–14; Jordheim, Chapter 1, this volume; Jordheim, "Introduction," 506–7.
123. Iggers, Wang, and Mukherjee, *A Global History of Modern Historiography*, 73–74, 119–33, and 166–69.

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Part IV

RECORDING AND ENVISIONING CLIMATE TIMES

10

On Record

Political Temperature and the Temporalities of Climate Change

Eric Paglia and Erik Isberg

The year 2020 tied with 2016 for the warmest ever recorded for the planet, concluding a decade that was the hottest on record.[1] The 2010s also included multiple record-breaking years for the earth's average temperature, as estimated by the scientific institutions that process vast amounts of meteorological data recorded around the world to produce a global mean surface temperature (GMST).[2] Since the 1980s, when what are today the three primary keepers of the instrumental temperature record were established, the idea of a singular GMST has helped underpin climate crisis discourse, providing a benchmark and frame of reference for anthropogenic disruption to the climate system as well as a baseline for political temperature targets.[3] The 2°C target in particular has become a dominant feature of climate policy since it was adopted at the COP 15 meeting of the United Nations Framework Convention on Climate Change (UNFCCC) and inserted into the 2009 Copenhagen Accord. The target was further enshrined as the goal of international climate negotiations in the 2015 Paris Agreement, which called for "holding the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels."[4]

Temporality is embedded in the political temperature target, although somewhat opaquely, as it is meant to keep the earth from warming no more than 2°C above the ambiguous aforementioned "preindustrial" baseline temperature. This figure is presumably derived from one or more of the time-series records, which are not specifically mentioned as such in either the Copenhagen or Paris pronouncements. Even though the expression "on record"—as in for example "the hottest year on record"—seems to suggest a unified climatic record with a single, linear temporality, various estimates of past global temperatures have been comprised through different means of measurement at radically divergent timescales. For example, 800,000-year-old ice core proxy data extracted from Antarctic ice sheets is, through the concept of a unified climate record, synchronized with the instrumental data of thousands of thermometer readings from terrestrial and marine installations positioned across the planet that have been averaged into monthly and annual temperature anomalies. The elaborate reconciliation of alternate timescales from different traditions, methodologies, and disciplines has created a new kind of governmentality of temperature, bringing the distant past and the future of the earth's climate into the domain of the governable.

Climate crisis discourse is further saturated with an array of auxiliary records that support perceptions of extraordinary changes in the climate system, which, like temperature, have an intrinsic temporal component: "record-breaking" droughts, hurricanes, wildfires, and floods, for instance, or the minimum extent of Arctic sea ice—a record based on satellite data that despite only extending back to 1979 has drawn significant media attention.[5]

The evolution of 2°C as a political temperature target has attracted great interest from a wide range of scholars as well as journalists.[6] However, similar to the lack of direct reference to particular temperature records in, for example, the Paris Agreement, the temporal aspect of the target—the long-term time-series data upon which change is tracked over time—is often taken for granted and not explicitly considered as an essential component of climate governance in histories of the 2°C target. This chapter hence aims to highlight and historicize the multiple layers of temporality that underpin political temperature targets and the wider contemporary discourse surrounding climate change. In line with scientific terminology and measurement practices, we distinguish two categories of records—proxy and instrumental—that not only, as alluded to above, operate on vastly different temporal registers, but also serve certain scientific and political functions.[7]

Drawing from Reinhart Koselleck's distinction between the historical (what is normally perceived as human history), and the metahistorical (natural conditions beyond the impact of human activity), we trace the emergence of different temperature records as the process of translating the metahistorical into the domain of the historical. This process was intertwined with new representations of temporal change, as the vertical, stratigraphic form of representing time—visible in ice cores for example—were enrolled in the horizontal spatiality of timelines and climate graphs. The act of *recording* temperature became, in a world with an increasingly complicated relationship between human and natural timescales, a practice that operated on multiple temporal levels and moved the global average temperature into the domain of the governable.[8] We conceive of this process, in which global average temperature became a political as well as scientific issue, as the emergence of *political temperature*.

From the Metahistorical to the Historical: Temperature Records and Temporality

The history of the 2°C target and the establishment of a global annual temperature record is messier than suggested by the monolithic number "2"—what Marselleto, Biermann, and Pattberg refer to as a "reductio ad unum."[9] Previous scholarship has shown how the temperature target was coproduced through scientific and political institutions, appearing on the geopolitical stage partly by chance and individual advocacy as well as through the compression of different climate records into a unified number.[10] Despite the rich attention paid by scholars from an array of disciplines to the emergence of temperature targets, the matter of how different timescales and climate records are synchronized and compressed into singular digits is yet to be investigated. The history of political temperature targets and the establishment of standardized temperature records can thus be seen not solely as a history of science and policy but as a process of negotiating different temperature records into a singular timescale of anthropogenic climate change. The concepts of climate science do indeed have a politics of their own, but they could also be said to carry with them implicit temporal understandings, connecting distant pasts to contemporary politics and planetary futures.[11]

As historians have increasingly turned their attention to the social and historical aspects of anthropogenic climate change, temporality has re-emerged as an analytical category in a partly new form.[12] Mark Carey and Alessandro Antonello have argued that environmental historians have mostly been preoccupied with spatial and material elements of the past, while largely overlooking the way time is constructed and temporalities are constituted within societies.[13] In recent years the perceived linearity and unity of climate change temporality, manifested in ice core records, CO_2 measurements, and aggregated global simulations of changes in the earth system, have been questioned and contextualized by scholars from different disciplines.[14] Additionally, the entangled human-planetary relationship, popularized through concepts such as the Anthropocene, has brought conversations about time and temporality into the growing interdisciplinary field of environmental humanities.[15]

The "change" in climate change relies on implicit temporal knowledge: from when has something changed? At what pace are we experiencing these changes? What are the futures, pasts, and presents that are being taken into consideration? Without an understanding of past climates, contextualizing change and imagining climatic futures becomes an impossible task.[16] Considering the many variables operating on different timescales involved in the making of the 2°C target, temporality has always been present throughout the target's existence, although in a somewhat hidden capacity, obscured by the linearity of the record. Behind the singular timeline of the 2°C target hide many layers of time.

The ways through which climatic changes on different scales have been known concern a multitude of methodologies, geographies, and practitioners that gradually merged into the timeline of the 2°C target. The data which underpin climate graphs are products of scientific practice and material technologies—both through temperature measurements in real time as well as the production and establishment of proxy records such as ice cores, deep sea cores, tree rings, and pollen analysis of lake sediments. In this context, the 2°C target appears as a fundamentally temporal concept, binding many different times into a one-digit political temperature target. The many different records—both in terms of temperature measurements and in the sense of abnormal climatic events—have to be reconciled and synchronized in order for the 2°C target to function.

By placing temporality at the center of analysis, the multiplicity of times embedded in the 2°C temperature target, and the increasingly complicated relationship between human historical time and the timescales of planetary dynamics, becomes visible. The German historian Reinhart Koselleck—who already in the 1970s questioned the quasi-natural position of a linear and unified order of historical experience and instead invoked the notion of multiple times existing simultaneously[17]—made the distinction between "historical" and "metahistorical." According to Koselleck, the historical is what is normally perceived as human history and the metahistorical is the natural conditions beyond the impact of human activity. However, the boundary between the two is not predetermined, but is in itself the outcome of historical processes, and the way the separation between historical and metahistorical is produced can be studied as contextually dependent phenomena.[18] In contrast to the Braudelian tripartite of historical time, Koselleck's concepts of metahistorical and historical allow for some fluidity between the categories. He writes: "Theoretically this would entail asking where the metahistorical pregivens of the human *Lebensraum* shift or are transformed into historical pregivens that humans can influence, master, or exploit . . . Seen in this light, the relational scale between space and history shifts depending on whether spatial pregivens are conceived of as metahistorical or historical."[19]

The emergence of political temperature targets, and global average temperature as an object of governance, highlights the contingency of Koselleck's boundaries. Seeing the annual global climate record and the 2°C target as not solely a coproduction of science and politics, but also as the outcome of temporal work, involving means of negotiating, representing, measuring, and knowing changes over time, open up new questions regarding the historicity of climate discourse. In the history of attempts to unify a multiplicity of temperature records into a one-digit political temperature target, temporality played a hidden yet important role.

The Evolution of the Instrumental Temperature Record

The most significant contemporary manifestation of the policy-science interface in regard to international efforts to set limits on global mean temperature is the 2018 Special Report on Global Warming of 1.5°C produced by the Intergovernmental Panel on Climate Change (IPCC) at the behest of UNFCCC following the 2015 Paris Agreement.[20] Following the fifth IPCC assessment report (AR5) from 2013–14, the Special Report provides a useful example of how the premier international institution for climate science has engaged with temporality in terms of the somewhat vague political imperative, as stated in Article 2 of the Paris Agreement, of "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels."[21]

The multiple temporalities—and questionable start date for the industrial era—embedded in global climate policy-science are apparent in the working definition of warming the Special Report applies: "warming at a given point in time is defined as the global average of combined land surface air and sea surface temperatures for a thirty-year period centred on that time, expressed relative to the reference period 1850–1900."[22] Like in AR5, the 1850–1900 timespan is employed as an "approximation" or "proxy" for preindustrial conditions when humans had marginal impact on the climate system. Rather than proposing that the year 1850 represented a turning point in industrial activity or anthropogenic carbon emissions, the choice of reference period is in fact more closely related to nonhuman natural factors and the availability of reliable temperature data—which were sparse before the middle of the nineteenth century[23]—collected at locations across most areas of the planet. As stated in the IPCC Special Report, the reference period entails "a compromise between data coverage and representativeness of typical pre-industrial solar and volcanic forcing conditions."[24]

Labeling 1850–1900 as "preindustrial" proved politically controversial among government delegations at the AR5 plenary approval session, and the association of that timespan with the term was subsequently deleted from the draft. Similar to Jones and Briffa's designation of 1850 and onward as the "instrumental period" from when the availability of temperature data recorded across large spatial scales enabled near global averaging, some countries present at the AR5 plenary favored calling 1850–1900 the "early instrumental period," an idea echoed in the 2018 Special Report, which labels the timespan starting in 1850 as "the period of instrumental observations."[25] Preindustrial was however used elsewhere—often inconsistently—in AR5, with, for example, 1750 being mentioned as the threshold for significant anthropogenic interference in the climate system.[26] Despite this, the Special Report applies the same 1850–1900 baseline as AR5, which Hawkins et al. note was a pragmatic yet suboptimal selection.[27] "Ideally, a preindustrial period should represent the mean climate state just before human activities demonstrably started to change the climate through combustion of fossil fuels," which, the authors explain, were already well underway by 1850.[28] They argue instead for 1720–1800 as a more suitable surrogate for preindustrial conditions, due to the relative lack of anthropogenic forcing, and similarities to the current period in terms of natural forcings.[29]

The working definition of industrial-era warming employed in the 2018 IPCC Special Report is an average of three institutionalized datasets that calculate warming since the latter half of the nineteenth century.[30] The data series of HadCRUT—a collaborative effort of the University of East Anglia and the Hadley Centre at the UK Met Office—starts in 1850, while 1880 is the point of departure for both GISTEMP at NASAs Goddard Center for Space Studies and NOAAGlobalTemp at the National Centers for Environmental Information (NCEI) within the US National Oceanic and Atmospheric Administration. Employing historic instrumental readings, these three temperature analysis systems reconstruct past climates and track long-term changes in global mean surface temperature (GMST) on a monthly basis. Given their central position within IPCC-UNFCCC deliberations, and as the empirical bases for media framings of current temperatures as historical aberrations, HadCRUT, GISTEMP, and NOAAGlobalTemp together constitute the de facto record of global warming for science, society, and politics.

Although the instrumental data they draw upon date back to as early as the middle of the nineteenth century, the three guardians of the instrumental temperature record did not emerge until the 1980s, demonstrating the relatively recent development of an ongoing, institutionalized timeseries of warming that could serve as an anchor point for the science-policy discussions on climate change that gained traction during that decade. GISTEMP resulted from the work of James Hansen and colleagues, whose initial calculations of changes in global mean temperature from 1880–1980 were published in a 1981 article in *Science*.[31] The data selection efforts that eventually led to HadCRUT were initiated in the late 1970s at Climate Research Unit—founded by climate historian Hubert Lamb in 1971 at UEA—and by 1986 came to include temperature data from marine environments in addition to the land-based measurements that earlier GMST estimates were based upon.[32] By the end of the 1980s, the increasing interest in climate change prompted the National Climatic Data Center (which was merged into NCEI in 2015) to launch its own analysis of historic temperature data, leading to the NOAAGlobalTemp time series.[33]

Efforts to estimate changes in global average temperature over time predate the advent of today's institutionalized datasets by about a century, facilitated by the invention and increased availability of thermometers, and major leaps in the collection and standardization of meteorological data by scientists and governments (primarily in eastern North America and Western Europe) in the latter half of the nineteenth century—a process further abetted by the founding of the International Meteorological Organization (IMO) in 1873.[34] In the 1870s to 1880s, the Russian-German climatologist Wladimir Köppen, for example, drew on data from over one hundred land-based monitoring stations in the tropics and temperature zones to construct a near-global time series of average annual temperatures from 1841–75 in order to assess whether temperature changes could be connected to sunspot cycles.[35] Despite the advances taking place at that time, access, quality control, homogenization, and spatial gaps in data still represented formidable challenges, which Köppen was the first scientist to adequately overcome.[36]

The establishment of the World Weather Records (WWR) on the initiative of the IMO and first published by the Smithsonian Institution in 1923 provided an immense source of meteorological data from hundreds of stations around the world, with some records reaching back to the early 1800s. This data trove enabled Guy Stewart Callendar, who was intent on proving the carbon dioxide theory of climate change, to create a global average temperature timeseries spanning 1880–1934, and demonstrate for the first time that global temperatures were in fact rising—by approximately 0.3–0.4°C.[37] Initially examining readings from some two hundred locations, Callendar carefully selected WWR data from 147 land-based stations situated between 60° North and 60° South, with the polar regions being excluded due to the sparsity of Arctic observations (only two stations) and nonexistence of Antarctic data (not monitored regularly until the 1950s).[38] Representative of the multiple temporalities embedded in climate discourse, the notion of anomaly, or departure from a longer-term mean, was a key element of Callendar's and subsequent attempts to estimate and contextualize warming. For example, the fifty-five-year record that Callendar constructed also included departures, expressed as a ten-year moving average, from the mean surface temperature of a thirty-year (1901–30) reference period.[39]

Hurd Willett, a meteorologist at M.I.T., developed the next significant timeseries of global average temperature, which was published in 1950.[40] Drawing on updated WWR data extending to 1940, and employing different averaging methods and station selection criteria than Callendar, Willett selected 129 stations to represent a global temperature record reaching back to 1845, and used a five-year period (1935–39) from which to measure for anomalies.[41] Willett's work was subsequently influential on both Callendar, who in

1961 updated his near-global timeseries based on data from 450 stations, and Murray Mitchell Jr. from the Office of Climatology at the US Weather Bureau, who had previously studied under Willett.[42] At a meeting of meteorologists in New York in January 1961, Mitchell presented his findings from a timeseries of global temperature based on data from some two hundred stations dating back to 1882, which demonstrated that temperatures had been rising until 1940, at which time they began to fall.[43]

The Political Trajectory of the 2 °C Temperature Target

These pioneering efforts of Callendar, Willett, and Mitchell were important scientific interventions in terms of conceptualizing and estimating global average temperature at a time when climate change was yet to become an issue of great public and political concern. Although their work predated the advent of what we call political temperature, it represented an essential step in the process of rendering the earth a governable object through policies connected to quantified data. The institutionalization of GMST in the 1980s, starting with the establishment of GISTEMP, provided advocates of international political action on climate change a continuous (updated monthly and annually) temperature record and benchmark upon which policies could be based and evaluated over time.[44] By the mid-1990s, with the European Union's decision to aim for limiting global temperature to 2°C above preindustrial levels, the target had begun its ascent as a central object of international climate policy, eventually enshrined in the 2015 Paris Agreement.[45] The prehistory of the political target can however be traced back exactly a century before the EU adoption of 2°C in 1996, to the calculations of the Swedish atmospheric chemist Svante Arrhenius attempting to estimate the impact on global temperature from a doubling of carbon dioxide concentrations in the atmosphere.

Without explicitly elaborating the advent or institutionalization of GMST as such, Samuel Randalls notes that policy measures to govern climate change, whether based on temperature limits or carbon dioxide concentrations, would have been impossible without the quantitative analysis of the climate system pioneered by scientists such as Stockholm University's Svante Arrhenius towards the end of the nineteenth century.[46] Climate sensitivity—expressed as the increase in global temperature resulting from a doubling of CO_2—was a key concept for Arrhenius, and continued to be for his successors in the second half of the twentieth century.[47] While Arrhenius—who saw the prospect of global warming as largely benign—initially estimated in 1896 that doubling CO_2 would lead to 5–6°C warming (reducing his estimate in 1906 to 4°C), some later scientists calculated climate sensitivity to be in the range of 2–3°C.[48] Demonstrating the ongoing uncertainty surrounding climate sensitivity, and the contemporary relevance of Arrhenius's calculations, the most recent fifth IPCC assessment report estimates climate sensitivity to be between 1.5–4.5°C, the same range as the influential Charney Report of 1979.[49]

These scientific efforts to establish the relationship between CO_2 concentrations and global temperature can be seen as precursors to the political target of 2°C.[50] The two components of climate sensitivity provided the economist William Nordhaus, whom Jaeger and Jaeger credit with first proposing the 2°C limit as a basis for climate policy, with the quantitative indicators to perform cost-benefit analyses for climate change starting in the mid-1970s.[51] Drawing on contemporary science, Nordhaus associated 2°C with a doubling of CO_2 and as representing an upper limit of the "normal range of long-term climatic variation," i.e., a maximum global temperature recorded over the past 100,000 years as compared with a 1880–84 mean temperature.[52] Randalls contends that Nordhaus, similar to scientists who earlier applied CO_2 and global temperature in their modeling of climate sensitivity, employed these concepts as heuristics in his economic models of climate change, rather than proposing 2°C as a normative basis for climate policy.[53] Jaeger and Jaeger, acknowledging that Nordhaus's "intuition" did not influence policy at the time, imply that his introduction of 2°C into the climate debate had a latent yet decisive effect on later science-policy discussions.[54]

Science-based policy proposals employing temperature targets became more explicit in the late-1980s. Following a landmark conference in Villach, Austria in 1985, where scientists concluded that climate change warranted international political action, workshops in 1987 in Villach and Bellagio set out to produce potential options for policymakers.[55] One result of the 1987 workshops was a report published in 1990 by the Stockholm Environment Institute (SEI) under the auspices of the Advisory Group on Greenhouse Gases (AGGG)—a blue ribbon scientific panel established after the 1985 Villach Conference and considered the forerunner of the IPCC.[56] One section of the SEI/AGGG report put forward 2°C as a potential—albeit high-risk—benchmark to guide international climate policy, which was in the process of becoming institutionalized in the lead-up to the Rio Earth Summit and the establishment of the UNFCCC in 1992.[57] Following the SEI/AGGG publication, another key intervention in establishing 2°C as a political temperature target was a 1991 editorial in the specialist journal *Climatic Change* by Vellinga and Swart—coauthors of sections of the aforementioned report—that framed 2°C in explicitly normative terms.[58]

The most apparent line of transmission for 2°C between the realms of science and policy can be seen in the efforts of the German Advisory Council on Global Change (WBGU) and one of its leading members, the politically influential physicist Hans-Joachim Schellnhuber, who has served as science advisor to Angela Merkel from her time as Germany's environment minister starting in 1994.[59] For the first UNFCCC Conference of the Parties, held in Berlin in 1995, WBGU submitted a statement that evoked a "tolerable 'temperature window' . . . derived from the range of fluctuation for the earth's mean temperature in the late Quarternary [*sic*] period," corresponding to a circa 2°C temperature increase above preindustrial levels.[60] Claiming responsibility for initiating the political process—partly through his proximity to Merkel—that led to the adoption of 2°C by the European Union (in 1996) and UNFCCC (in the 2009 Copenhagen Accord), Schellnhuber acknowledges that the target represents a politically expedient benchmark rather than a scientifically-calculated critical limit, based on the idea that humans have never existed in a world warmer than 2°C above preindustrial levels.[61]

Proxy Records and the Compression of Time

Ever since the 2°C target first emerged as a political concept, multiple measurements of temporal change have been invoked in order to establish its legitimacy.[62] In William Nordhaus's 1977 article "Strategies for the Control of Carbon Dioxide" an early visualization of the temperature trajectory of the planet comprises two different timescales, 100,000 years and the twentieth century, in the same diagram.[63] Nordhaus admitted that his estimations, particularly concerning the long-term dynamic of the planet's climate, were not based on any solid data, but should rather be considered "rough guesses."[64] As the 2°C target gradually became institutionalized as a frame of reference and a political global target, new scientific data were added to the conceptual framework.

Additional dating methods were drawn into the making of climate graphs in order to establish rates of change of the climate system over timespans that far surpassed that of the global average temperature estimates that, following the proliferation of thermometers and the early efforts of scientists to process copious amounts of instrumental data, had existed since the mid-nineteenth century. Climate proxies, such as corals, deep sea cores, lake sediment samples, tree rings, and ice cores have all been utilized in different contexts to track climatic changes over vast periods of time.[65] Proxies for past climates can even encompass documentary evidence; one example is the written records of the varying dates of grape harvests in France since early modern times that Emmanuel Le Roy Ladurie drew upon in his pioneering work in the field of historical climatology.[66] By invoking longer, much deeper temporal frameworks, the proxy records became crucial technologies in distinguishing the scales against which humanity's impact is measured. The increasingly textured records of the deep past, together with the expansion of human impact on planetary dynamics, brought events in deep time into politics and

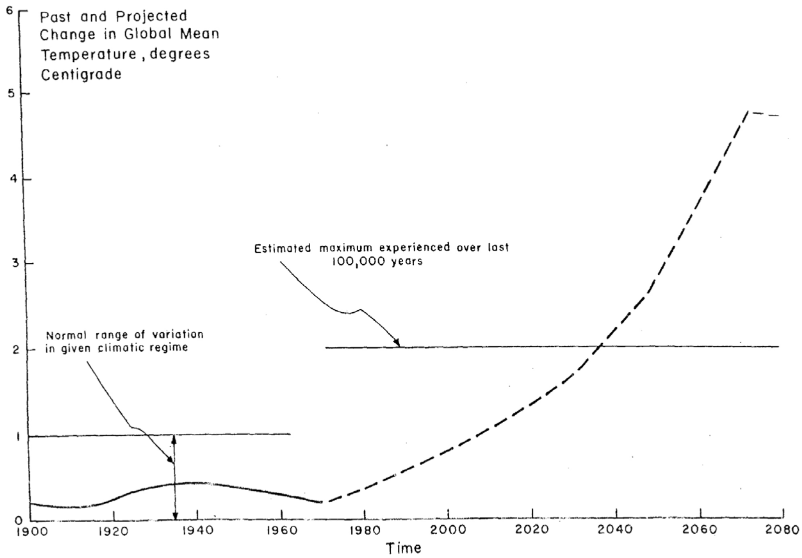

Figure 1. Past and projected global mean temperature, relative to 1880-84 mean. Solid curve up to 1970 is actual temperature. Broken curve from 1970 on is projection using 1970 actual as a base and adding the estimated increase due to uncontrolled buildup of atmospheric carbon dioxide.

Figure 10.1 An early suggestion of 2°C as a governance target. Figure by William Nordhaus, 1977. Used with permission from William Nordhaus and the Cowles Foundation.

economic considerations.[67] In Koselleck's terms, the proxy records ventured from the metahistorical to the historical when they became immersed in the making and establishing of political temperature targets and issues of environmental governance.

Proxy records emerged from several different disciplines, such as oceanography, glaciology, atmospheric sciences, and geology, bringing in both a multiplicity of temporal frameworks as well as a multiplicity of geographies.[68] With the formation of Earth System Science in the 1980s, the conception of a planetary system which could be regulated through scientific practice and environmental governance gave further importance to proxy records, as they provided a frame of reference for long-term changes on a planetary scale.[69] Separate ways of measuring planetary change became increasingly integrated during the 1980s following efforts to synchronize the "archives" which were available to the earth system scientists at the time.[70]

Despite the seemingly unequivocally layered and prearranged manner in which time appears in material climate records, it was not self-evident how the many different times stored in trees, ocean floors, corals, ice, and lake sediments could be made to fit within the framework of political temperature targets. Rather, this work of synchronization unfolded as a historical process in itself, and the calibration of various proxy records was the subject of negotiation among scientists from different fields. The process of translating material proxy records into datasets, to be utilized in large-scale climate modeling, rendered possible aggregated timescales beyond disciplinary boundaries. There were also concerns raised, for example among palynologists, that the planetary scope of the timescales would obscure regional varieties and locally situated ecological processes.[71]

This concern was not as prominent among ice core scientists and ice cores have increasingly emerged as perhaps the most iconic and well-known proxy record to date.[72] The vast records of climatic changes made visible through ice cores were less sensitive to local variance and fit well with the planetary scope of Earth System Science. Ice cores can also serve as an emblematic example of how deep time has been invoked, represented, and synchronized into a framework of political temperature. During the 1970s and 1980s, several ice core scientists were instrumental in bringing ice core timescales into the climate modeling community and ice core data were increasingly picked up in scientific communities beyond glaciology.[73] Their long, vertical shape, with clearly distinguishable layers of past atmospheric conditions stored in the ice, made them adhere to a familiar stratigraphic way of arranging time.

Kathryn Yusoff locates one of the most appealing characteristics of ice cores in the way they speak to already existing Western notions of temporality by making history appear in a linear fashion ordered through clearly separated layers.[74] When they enter human history, as is the case when ice cores are used as proxies in establishing human impact and projecting planetary futures, their status as objective messengers from the deep past ventures into other spheres of engagement and concern. They are in this sense not only recording devices used by humans to measure the earth, but devices that are recording humanity itself, and how the latter is affecting the planet.[75] The temporal boundaries of political temperature can thereby be expanded through the ice core data and add an additional layer to the already existing notion of measuring and governing anthropogenic impact on the global temperature levels.

With the particular case of the 2°C target, proxy records have been gradually drawn into the political temperature framework. One emblematic example of such a process dates back to 1987, when new data made possible through ice core drilling at the Soviet Vostok Station in Antarctica provided greatly enhanced records of past climates. Temperature data gathered through ice core drilling had first appeared in the postwar years, and it gained greater temporal scope and accuracy in the 1960s, predating the notion of a political temperature target.[76] The timescales made visible in the early ice cores were not automatically perceived as being connected to the timescales of environmental policy. From early ice core drilling in the 1960s to the integration of the Vostok ice core into notions of 2°C in 1987, different ways of measuring, representing and experiencing time had moved closer to one another.[77] The long and detailed records from the Antarctic ice sheet could enter an already existing conceptual and temporal framework that preceded its recovery. The first Vostok ice core recovered in 1987, in Spencer Weart's words, "tipped the balance in the greenhouse-effect controversy, nailing down an emerging scientific consensus."[78]

Even though Nordhaus, in his 1977 model, had used his own intuition as the main reason for setting a 2°C target, the data from the ice core aligned with the initial hypothesis and confirmed that the past 100,000 years had not seen global mean temperature reaching much higher than 2°C above the preindustrial average. An additional temporal layer, that of the deep past contained in the Vostok ice core, could be added to the already existing visualizations of climate change, bridging and combining ice core data, global average temperature measurements, and political temperature targets into one unified timeline.

Conclusion

The invocation of records is a widespread discursive practice for contextualizing and benchmarking social and environmental phenomena that can be variously characterized as normal, abnormal, average, anomalous, outstanding, or exceptional, as well as indicators of trends and trajectories pointing towards alternatively bright or frightening futures. In the case of climate elaborated in this chapter, we have demonstrated that the temperature record—often alluded to yet seldom specified in terms of its temporal, material, or methodological underpinnings—is essentially a synthesis of some two centuries worth of curated instrumental measurements averaged globally, and various natural climate archives accumulated over millennia that have in recent years been retrieved, interpreted, and integrated into the expanding corpus of climate knowledge by specialists from a range of scientific disciplines.

While the three primary institutions that today calculate global mean surface temperature constitute the de facto guardians of the instrumental record, the *longue durée* temperature timeline also incorporates the array of proxies, that serve to, in Koselleck's terms, synchronize the historical and metahistorical and effectively transport the deep past into the policy present. This temporal work has resulted in a far more comprehensive and convincing record of a changing climate—a record *of* record, so to speak—that has underpinned efforts to govern the global climate on the basis of a single temperature target established at the interface of science and politics.

Rendering temperature governable, or, in other words, creating *political temperature*, was, we argue, more than a process of coproduction of science and politics. It was fundamentally a process concerned with temporality, and with ways of measuring, recording, and representing a multiplicity of temperature records in order to fit them into preexisting governance frameworks. By drawing attention to the way scientists have taken part in producing climate pasts, presents, and futures, the history of temperature records and political temperature targets can be understood as a history of mediating between multiple ways of sensing and knowing time. As new objects enter the domain of governance due to human planetary impact, with global average temperature being one example, the process of temporalizing these phenomena moves to the forefront of political discourse. Yet, implicit assumptions of how to represent and record temporality are often held in a quasi-natural position, as is the case of the ambiguous notion of "the record." Behind this seemingly unified timeline lies decades of scientific and temporal work, which despite its hidden role, has been instrumental in defining the climates of the past, as well of those to come.

Eric Paglia is a Researcher in the ERC-funded project SPHERE (Study of the Planetary Human-Environment Relationship) at the Division of History of Science, Technology and Environment at KTH Royal Institute of Technology in Stockholm. He has published within a range of fields: environmental history, polar studies, political science, and crisis management. His research currently centers on the history and evolution of global environmental governance, including the 1972 United Nations Conference on the Human Environment and the role of Sweden in this long-term process.

Erik Isberg is a PhD Candidate at the Division of History of Science, Technology, and Environment at KTH Royal Institute of Technology in Stockholm. He is a member of the ERC-funded research project SPHERE (Study of the Planetary Human-Environment Relationship) and is currently working on a thesis concerning postwar paleoclimatology and its historiographical implications. His most recent publication is cowritten with Sverker Sörlin and is entitled "Synchronizing Earthly Timescales: Ice, Pollen, and the Making of Proto-Anthropocene Knowledge in the North Atlantic Region," *Annals of the American Association of Geographers* (2020).

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⟩• 11 •⟨

Model Time and Target Years

On the End of Time in IPCC Futures

Nina Wormbs

For some time and to many, climate change has arguably been an issue that lies in the future. Repeated reports have talked about temperatures in another time than ours, of rising sea levels and vanishing ice in a temporal distance that many alive today will not experience. Only recently, have these recurring messages of the future as the time for climate change been challenged by repeated communication of present and ongoing change. This focus on the future has in itself become one of many obstacles to combatting global warming with forceful measures in the present, as the urgency of something temporally distant is hard to convey. There are certainly other arguments against acting now, such as the trope that the economy will be stronger in the future, and therefore mitigation will be less costly, or the idea that the future will bring efficient and modern technology, which will be carbon neutral or even carbon negative. However, the framing of climate change itself as a temporally distant reality is what also legitimizes these other excuses for nonaction.

It is clear that the Anthropocene has turned long-standing temporal concepts on their head, where the word itself illustrates something that hitherto was unthinkable for most people. For historians this new understanding is exemplified by the implosion of the Braudelian terminology. The geographical time of the environment can no longer be separated from the very short term of human actions, which have placed the planet in a new state.[1] Great effort is now put into unpacking and reevaluating the temporalities that can help us understand this new history.[2] In this chapter I argue that we also need to put effort into understanding the new future from a temporal perspective.

Both history and future are temporal concepts, however, less attention has arguably been given to analyzing the temporalities of the future, which just like the past are complex and nontrivial. There are many ways to approach the future and my interest here is how the future is conveyed in the simulated futures of the earth system in response to different scenarios of greenhouse gas emissions. These simulations are made with computer-based models into which certain parameters are put.

I suggest that we need to pay close attention to what me might call model time, a temporality introduced through the climate modeling community and central to much of the discussions on the societal and political responses to anthropogenic climate change. I will not attempt a firm definition of model time but rather unpack the different temporalities that can be discerned when looking at the processes and calculations involved in trying to say something substantial about the future, given different boundary conditions such as initial conditions and forcing. The boundaries of the modeling are key as they allow for comparison between the results. But the results themselves also constitute boundaries and create a space that illustrates the limits of climate change given certain living conditions.

Of particular interest is the mediation of time through the visual representations of model runs that appear in the assessment reports from the Intergovernmental Panel on Climate Change (IPCC), as presented in the summaries for policymakers. Here time is projected along the horizontal x-axis, as we usually recognize it, and some kind of change is displayed on the y-axis. At times, several changes can be merged into the same graph. I will focus specifically on what can be called the target year, which is where the x-axis ends, and time stops in the graph. In other words, I am interested in the end of time, as visualized by the IPCC graphs in the five assessment reports published between 1990 and 2014.

Given the emerging reevaluation of time in the Anthropocene, I want to ask if we also can understand the future in a new temporal perspective. Moreover, I ask how these possibly new understandings can interact with educational efforts around climate change and the possibilities of conveying messages and results to a broader audience and in a policy arena. To connect the past with the future is an effort undertaken by the IPCC and the climate-science community. In an effort to both simplify and stretch my argument, I ask if it is possible to flip the temporalities of Fernand Braudel, which are concerned with the past but now have imploded, onto the future as it is projected by the modeling community. By that I mean if we can discern events, conjunctures, and a *longue durée* also in the time that lies ahead. Alternatively, there might be other temporalities that can do this translational work more efficiently.

The chapter begins with a section that discusses the emergence and proliferation of 2100 as a target year in simulations. I then move to climate science that is occupied with recording and make an argument on the meaning of event for time-binding temporalities. After that follows a reflection on the language of future talk in the IPCC assessment reports, and whether that can contribute to our understanding. I finally analyze the transformation of the long-term limit to the short-term by ways of budget thinking, before I move to a general discussion and conclusion.

Target Years: Life in the Year 2100

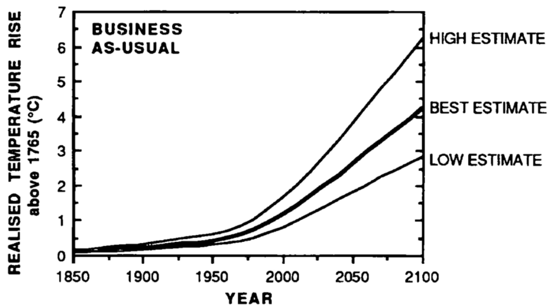
The IPCC releases assessment reports with some regularity. The first one, FAR, was published in 1990 with a supplement in 1992. The second assessment report, SAR, was released in 1995 and the third, TAR, following the same naming structure, was made available in 2001. Assessment reports four and five, AR4 and AR5, were published in 2007 and 2014 respectively.[3] The assessment reports contain results from the three working groups: WG I on the physical science; WG II on impacts, adaptation, and vulnerability; and WG III on mitigation and adaptation of climate change, all of which are also accessible separately, and with a synthesis report, including a summary for policymakers (SPM). Sometimes there is a time difference between these different outputs. It is very likely that the synthesis reports are the most read and disseminated and thus the language and the communication efforts in these reports are of particular interest.[4]

The range of visual components in the synthesis reports has increased with time even though there is no linear development of the layout of the publications. The first report was black and white, while the second also made use of blue in headings and some graphical illustrations. Full color came only in 2001, enabling yet another dimension of communication. There were more graphs in FAR than in SAR, and in several of the later synthesis reports illustrations were merged and more information was fitted into single images and graphs making them exceedingly dense and complex.

There is a growing transdisciplinary literature on the visualizations of climate change with contributions from, for example, geography, rhetoric, cultural and visual studies, and history of science.[5] The color of climate change imagery has been discussed and analyzed meritoriously.[6] The temporality has likewise attracted attention in earlier research.[7] The larger literature on climate modeling is rightfully focusing on interrogating the uncertainty of the models, the predictions, and the scenarios.[8] Thus, one central issue is how trust in models is created.[9] Like Lynda Walsh in her rhetoric analyses, I depart from the assumption that graphs make an argument, which is intended to persuade the audience of a particular scientific claim.[10] The claim I want to investigate is the target year in many of the graphical representations of future change.

Time is central to the reports and appears in many forms in the images. There can be comparisons between two different years or periods and the

Scientific Assessment of Climate Change



Simulation of the increase in global mean temperature from 1850-1990 due to observed increases in greenhouse gases, and predictions of the rise between 1990 and 2100 resulting from the Business-as-Usual scenario.

Figure 11.1 Scenarios in the *First Assessment Report*, target year 2100. Policymaker Summary of Working Group I, section 5.1, page 74. © IPCC 1990.

change can be illustrated by color coding, like the famous burning globes of AR5 for example. Bars of energy mixes or change in GDP can be grouped around specific years on an axis. Images can illustrate emissions or surface temperatures up until today, with different starting years. Sometimes these historic graphs are extended with a projection of the future change into 2100.[11] There are images where the relation between emissions, concentration, and resulting temperature are displayed and where years are introduced to show change over time. One of the most common images of the future is the one with particular greenhouse gas emission scenarios and the resulting temperature change, sea level rise, or concentration of greenhouse gas in the atmosphere. Above is an example from the First Assessment Report displaying three estimates of temperature change based on scenarios where greenhouses gases are released in a way that can be termed business as usual, and where the end of the simulation is 2100.

I am interested in how time features in these graphs as years on the x-axis. A first assessment might be quantitative and to that end I have looked at all the visual representations in the material. In FAR, all of the sixteen graphs dealing with the future displayed 2100 as the end year.[12] In SAR, a shorter report and sparsely staffed with illustrations, there are only three graphs in total, one with 2100 as the end year and two with 2300. The synthesis of the third report increased to an impressive four hundred pages and the summary for policymakers had thirteen graphs ending in 2100 and three in 2300.[13] In the following synthesis many were repeated. In the fourth report the summary for policymakers had two graphs both with 2100 as the target year, and in the fifth report the year 2100 was the target for the four graphs where time was linear in years on the x-axis.[14]

In conclusion, the target year 2100 is dominating the illustrations of future scenarios in the assessment reports. It is most striking in the first and third report where graphs are many; however, in the fourth and fifth reports the earlier longer time frame does not receive any attention. In TAR this focus on 2100 also comes as a result of questions that governments had submitted and which had been approved by the IPCC in April 1999. One of these questions asked about "consequences in the next 25, 50, and 100 years."[15] The dominating role of 2100 is also supported by James Risbey who in 2008 argued that a series of reports from 1990, 1996, and 2001 allowed for this temporal framing by the IPCC of the "climate change problem."[16]

The original reasons for this target year are probably several and to fully relate that story is beyond the scope of this chapter. However, it is quite clear that a long time frame was regarded necessary since the processes of global warming were slow. When climatologist James Hansen in 1981 finally managed to publish a then controversial but today well-noted article on modeled long-term effects of increased CO_2 in the journal *Science*, the target year was 2100.[17] 2100 was also a year used when sea level rise was calculated in the 1970s and early 1980s.[18] A 1986 volume on the greenhouse effect and climate change edited by Bert Bolin, first chairman of the IPCC, featured a number of contributions that gathered existing modeling and 2100 was a recurrent target year.[19] In fact, 2100 seems to have been a common target year in many simulations preceding the IPCC compilations of state of the art science, even though others were also possible.[20]

The computational power also played a role and affected what kinds of simulations were possible. Computer performance increased exponentially from the early 1960s, a phenomenon referred to as Moore's law, and this capacity was crucial for having longer runs and increased detail in the simulations, like the spatial resolution.[21] Some of the early simulations were simple and did not require massive data management and could be carried out more easily. They were so-called equilibrium simulations that for example doubled the amount of CO_2 at a particular time and then looked at how equilibrium was reached. More advanced models demanded powerful machines. The possibility to introduce a large number of physical properties into the models and thereby increase their complexity also depended on computer capacity and was in turn central to qualities related to the issue of uncertainty; with complexity comes uncertainty.[22] So-called transient Global Circulation Models came in the 1990s where the concentrations of greenhouse gases vary gradually over time and thus displayed a more realistic simulation.

Thus, the length of a simulation was dependent on the model construction and the tools for modeling. However, whether or not the length was

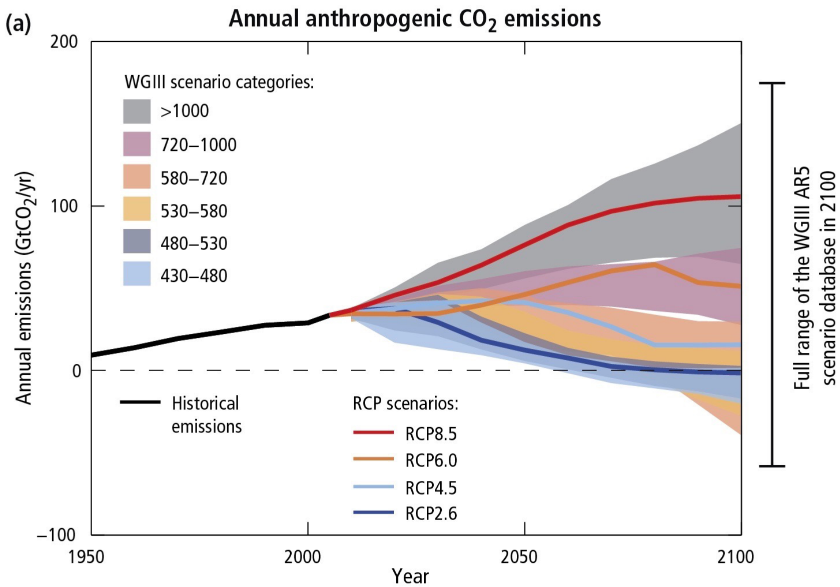


Figure 11.2 Scenarios in the *Fifth Assessment Report*, target year 2100. Summary for Policymakers, AR5 Synthesis Report, Figure SPM. 5a, page 9. © IPCC 2014.

connected to a calendar year is a whole different issue. To relate the model time to calendar time also related simulated climate change to the social or political dimension of climate models. The very first simulations were of a more theoretical type, aimed at answering basic science questions, and the concentration of CO_2 was not a major issue before 1970.[23] It has been argued that climate models should primarily function as heuristic tools, partly for epistemic reasons of proof.[24] The modeling community, however, split in 1971 when William Kellogg argued for "Predicting the Climate," as his chapter on the issue was titled. He meant that not only scientific motives were relevant for modeling but also that modeling could provide politically useful information about the future climate.[25] This is of central interest in trying to understand the target year of 2100. Modeling climate change after 2100 in effect also means looking at a "different climate system," as Risbey has put it, since the warmings are so large. This might be a reason for abstaining from stretching the simulations further in the policy-relevant IPCC reports.[26]

Modeling for basic scientific reasons could and would of course continue in parallel after the settling of 2100 as a policy-relevant target year. Sometimes the reason could also be connected to the trustworthiness related to the temporal dimension. Modelers at the British Met Office at Hadley Centre for example, consciously distinguished between "experimental time" and "real time" to "avoid giving the impression of undue realism." Their early runs were seventy years long and deliberately not connected to any calendar.[27]

When there is slow change, a certain time frame is needed to get a significant signal. This is also stressed in the First Assessment Report, stating that "100 years or more are necessary to support study of potential anthropogenic impacts on the climate system."[28] Central for early modeling and continuously so is precisely this possibility to distinguish natural variability from anthropogenic change. This is of both scientific and political interest.

In 1981 the year 2000 seemed far away for many, as James Hansen has put it, but a long period was needed since climate change was slow.[29] He thus touches upon the appreciation of specific calendar years that are imbued with cultural meaning. The end of a millennium is such a calendar year. During the second half of the twentieth century, referring to the year 2000 was not uncommon. Visions were both utopian and techno determinist, like the well-circulated booklet produced by Ford in 1956 called "Life in the year 2000," or dystopian, often of religious character, proclamations of the end of the world. The most famous future prediction of all in the 1970s, *The Limits to Growth*, also had 2100 as target year.[30] The next century ending could thus be regarded a way of *synchronizing* a useful experimental time with a culturally significant time, to use the terminology of Helge Jordheim.[31]

Eventization of Continuous Change: Fixing History

A target year is a choice for modeling, even though it can be argued whether modelers actually choose 2100 as the standard target year; as pointed to above, there seems to be strong path dependency. Much climate change science does not work with target years, but is instead interested in monitoring and assessing historic and present ongoing change. One of the most famous measurements is from Mauna Lua by Charles David Keeling of the concentrations of CO_2 in the atmosphere on Hawaii. The resulting Keeling curve displays the increasing levels of the greenhouse gas as parts per million versus time.[32] Here as well, change can be displayed more efficiently using a long time frame.

Similar historic change is also portrayed in many of the graphs of the IPCC reports. Due to the use of several types of proxy data the extension of the x-axis can vary, and a multitude of sources can be merged into the same graph. To fixate this change onto a calendar temporality, merging culture time with nature time, has been key to understanding and communicating climate change, forming comprehensible narratives of means and global change. Temperature can also be put on the y-axis, and the resulting curve, if the time is extended to the present day, has been called the hockey stick curve and is likely among the most famous graphs in climate change science. Anne Pasek has called this display of data charismatic.[33]

Global mean temperature has become the most prominent marker of global warming, and it has been transformed into the political goals of the Paris Agreement. From a communications perspective it is also most likely a measure possible to relate to as people experience temperature change. However, local temperatures seem to serve that purpose easier than global mean temperatures, since the local also offers an experience, which can be key to understanding.[34] This might be one reason for the proliferation of temperature records. They can bind local change to a larger narrative of global change through the process of eventization and individualization through experience. At the same time, it also fits the present media logic of newsworthiness.[35]

Warming in itself does not make an event, which can be firmly timed and fixed. However, temperature records constitute a time-binding process that synchronizes the change with a standard time frame.[36] In the public discourse on climate change, events that can be experienced have been important for the public understanding of climate change and the need and willingness to act. Thus, this effort to fix climate change has significance in the broader discussion on policy implications. The discussions on the relations between extreme weather and climate change are longstanding; however, research now shows that they are indeed connected.[37] This is truer for some weather than other, and for extreme heat, the evidence is strong.[38] This means that record temperatures, such as the mean temperature of July 2019 globally, or the year 2017 globally, can be made into events synchronizing the rising mercury with a calendar. Also, absolute temperatures—such as the French village Gallargues-le-Montueux with 45.9 °C—can be fitted into a chronology of global warming. The framing of the record is also important, exemplified here by the title of the news item: "July matched, and maybe broke, the record for the hottest month since analysis began."[39] Putting the record in relation to a history to which there are limits created by lack of earlier records also places the present in an uncertain context. The temperature event becomes a temporal anomaly.

How long an event can be and still be regarded an event is a question that highlights challenges in understanding and framing these different temporalities. Extended timings where a specific month or year is announced as the warmest ever for a particular region or globally are given meaning in a context that is also temporal. These records can become marks on an imagined timeline of climate change, marks that are increasingly crowding up to the present. However, if the resolution is low, i.e., the time perspective is long, years appear as marks the same way as days would on a scale with high resolution, that is a shorter time frame. I suggest that in a general media discourse, the extension of the temperature record is of lesser importance for the general message of dramatic change. Or rather, a record year is just as useful as a media event as is a record day. Thus, the eventization of climate change in this respect has a flexible temporality that might stretch, quite contrary to the temporalities of Braudel. In a longer perspective, the same logic might apply, and a scaling of time is possible. Just as a model run has to be long in order for change to appear, a stable trend also requires an extended period.

Media reporting on these records often includes information on how many record years there have been recently. The increased frequency is underscored, and the urgency is stressed by pointing to a very recent extreme. The reported events, accumulating on an imagined timeline, are sometimes illustrated in a bar diagram with different types of extreme events on the y-axis and years on the x-axis. As these events increase, the subsequent graph is rising. In such a representation, the extension of the event is also of less importance.

Together, the reporting on climate change as records of temperature, or records of records, and the repeated return to the elaborate science of historic change, form a narrative that binds local experience to global change and inserts the present in a longer context. An extended now can be related to a long history of change, conveyed in the historic graphs of the IPCC. The future is at the heart of the scenarios of the IPCC, but its extension seems to shift as the political discussion on mitigation changes character. Presently, great scientific focus is put on attribution studies, trying to connect extreme weather events to climate change.[40] This moves the gaze from the future to the present, with the aid of the recently experienced.

Translating Scenarios and the Unprecise Use of Terms

At the core of the IPCC remit is to "provide a comprehensive summary of what is known about the drivers of climate change, its impacts and future risks, and how adaptation and mitigation can reduce those risks" on the basis of scientific publications, quoted from the website. Thus, to deal with impact and future risks is a primary undertaking of the UN organization and the thousands of scientists collating up-to-date knowledge. This means that terminology on the future needs to be agreed on.

That talk on the future is inherently difficult is a truism, which holds also for terminology reasons. A great array of words is used to describe practices and outcomes, among them prediction, simulation, foresight, modeling, projection, scenario, and forecast. The advent of computer modeling allowed for new types of simulations, involving enormous amounts of data. The areas where scientists and economists projected the future spanned both the worlds of nature and of culture. *The Limits to Growth* stands out as a well-known example of how a particular kind of future talk is laden with ideology and has great consequences for the public discourse on the future.[41] In parallel, global climate models started to emerge with groundbreaking achievements in the 1970s, even though, contrary to expected CO_2 concentration, the development did not follow a trajectory.[42] This was also the decade when future studies and futurology emerged as intellectual endeavors in a more systematic way.[43]

Prediction, projection, forecast, and scenario are terms used and found in the assessment reports of the IPCC. In 2007, the IPCC defined a "prediction" as a probabilistic estimate of climate in some future. Predictions differ from "projections," which are not probabilistic even though they of course are subject to uncertainty. Projections are instead focused on how the climate system will respond to changing emissions or concentrations and are often based on climate models. These projections in turn can result in various possible "scenarios" depending on both the input values and the given workings of the models.[44] A survey in 2008 disclosed that many climate scientists themselves did not pay attention to the difference between prediction and projection but used them interchangeably.[45] Interestingly enough, in AR5, the term prediction can be found only in the glossary, not as a term in itself, but in relation to other terms, such as climate model or projection. In preparing for the fifth assessment report, a guide dealing with the related issue of uncertainty was published to enable a use across the different working groups.[46] Already in the update to the first report, published in 1992, did the IPCC underline the difference between scenarios and predictions and stressed the way in which uncertainty increased with the time horizon.[47]

To say something about the future is also a continuing social practice. It is, with the terminology of historian of science Matthias Heymann et al., possible to talk about "cultures of prediction."[48] The authority of predictions is created through complex processes, supporting and supported by politics.[49] However, to have a consistent language of future talk and being clear about the uncertainty of the statements at the same time, together forms a veritable challenge to climate change communication. The possible futures increase and are increasingly difficult to relate to.

Birgit Schneider has instead proposed that possible futures can be visualized in order to mediate and convey meaning. She suggests that there are archetypes of futures, which can be framed either as a worst case, that is, a disaster, as a technological fix, or as an ecological solution. She compares the different scenarios of the IPCC with the future visions as portrayed in 1981 by the American artist and cartoonist Robert Crumb, and finds a striking similarity. The great difference is that the colored illustrations make sense to us.

We can relate to a landscape after the catastrophe with broken technology in a deserted and desert-like environment under a burning sun, to a modernist clean cityscape with high tech center stage and flying cars, and finally a fairy tale and cozy small-scale community in the midst of a healthy forest.[50]

A fair amount of attention is given to the language of the future, however, as illustrated above, the terminology is blurry. To instead have the graphs speak poses a challenge to the message conveyed, as Schneider has shown. In the absence of art, among the few things that can easily be drawn from the graphs in the IPCC reports, is that temperatures will rise, and that 2100 is the end of time.

From Target to Budget: From the Distant to the Near Future

A vanishing future is a contemporary trope. It can be said to characterize much of the more dystopic discourse on the Anthropocene, exemplified by scholarship and literature, political statements and social movements.[51] The idea that time is running out can be connected to the binding of temperature. During the summer of 2019, the Secretary General of the World Meteorological Organization, Petteri Taalas, stated: "WMO expects that 2019 will be in the five top warmest years on record, and that 2015–19 will be the warmest of any equivalent five year period on record. Time is running out to reign in dangerous temperature increases with multiple impacts on our planet."[52]

It can likewise be found in the idea of a carbon budget, first suggested in the late 1980s but taken up more broadly twenty years later. It entered the IPCC process between assessments four and five and was a key element of the special report from 2018.[53] With the Paris Agreement in 2015, states abruptly turned from the long established goal of 2°C to 1.5°C, which means that only a certain amount of CO_2 can still be released into the atmosphere.[54] This transformed the mitigation issue from a "flow problem (emissions in a given year) to a stock problem (total allowable CO_2 emissions over a time period)," as expressed by a group of scholars troubled by this framing.[55] As the anthropogenic emissions have already amounted to a warming of on average 1°C this calculated budget is decreasing.[56] The managing of this budget can be translated into a time when CO_2 concentrations need to be lowered for the target to be reached and thus a deadline for action is produced. The IPCC special report on the 1.5°C target, released in 2018, allowed for a scientific language stating "we have only 12 years left."[57]

This "deadline-ism" has been criticized for several reasons, perhaps primarily because the acute urgency and subsequent crisis can result in drastic and unwise mitigation, like irreversible geoengineering. However, critics have also recognized the attractiveness of the process that can result in a countdown. "Neither global temperature nor carbon budgets convey any great sense of urgency to non-experts, whereas time—and the associated notion of a deadline—is a metric that converts the abstract, statistical notion of climate change to a more recognizably human experience."[58]

In the absence of projected climate events of the simulations displayed by the IPCC assessment reports, this future deadline binds calculated time to calendar time, modeled time to culture time. The process was one where the boundaries of science and policy were dissolved. The framing became "attractive," as it conveyed the need for climate change action in an easier way. Initially the budget idea was regarded as a simplification that could not do the science justice, but with its revival, the argument was the opposite, claiming it was sturdier than for example CO_2 concentrations. In preparation for the special report in 2018, however, uncertainty reappeared as it became evident that also this measure is dependent on estimations. Thus, there is a growing literature on the physical science of the budget, while it remains a framing that illustrates the failure of earlier policy, as Bård Lahn has put it.[59]

Interestingly enough, the perspective of a budget and a deadline has proven attractive for the youth climate movement and served to support intergenerational arguments of resource allocations. The climate activist Greta Thunberg, influenced by the British climate scientist Kevin Anderson, is the prominent example.[60] The target year 2100 has not featured at all in the #FridaysforFuture movement with school strikes and manifestations. Instead, the future has been brought closer in their use of recent scientific claims on limits and budgets. One widely spread visualization of this budget thinking has no classic timeline along the x-axis even though years are displayed and tick like a clock at the top of the image. Instead change is the amount of anthropogenic CO_2 released into the atmosphere and the limit for reaching 1.5 °C is conveyed through a bucket that is filling up.

Historic temperature measurements or parts per million of CO_2 are put together in many of the IPCC illustrations, merging the past with the future.[61] Burning globes alert us to warming of the planet and global perspectives suggest that mean values are of importance. The budget framing in the form of the bucket, however, translates the issue to domestic materiality of global significance. The bucket is a ubiquitous household technology, and many have experienced carrying one that overflows.[62] To furthermore mark the content with origin leaves the imagined viewer with the weight of historical emissions, which are blatantly unequally distributed. The budget bucket becomes a visual tool of urgency, altering the timeline of importance while simultaneously bringing the issue from the calculated mean to a local experience.

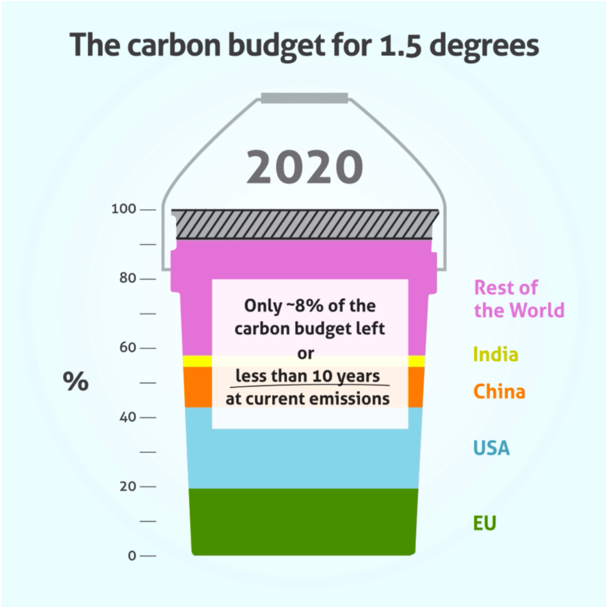


Figure 11.3 The carbon budget in the form of a multimedia bucket. Global Carbon Project, CC license, 2021.

Discussion: A Limit or a Horizon

Dire futures are sometimes clearly timed. George Orwell's novel *1984* is a prime example of a literary work that captured what turned out to be the fears of not just one generation. The fact that we have lived past the year does not make the dystopia less interesting, rather its features seem to speak to new audiences in new times.[63]

The target year of 2100 has been set by those not able to live through it. There is an ethical challenge in this if we accept that what at first was a model time, has for long been calendar time and thus moved from a scientific arena to a political one. The path dependency of this year also seems very strong. In the recent literature on shared socioeconomic pathways (SSP) that are suggested to be a complement to the previous ways for looking forward by the IPCC, the year is still used. Risbey has called this focus "2100ism" and criticized it for limiting the problem of climate change to a confined temporal space, disregarding the impacts in the next century. At the same time Risbey acknowledges 2100 as a "convenient" time frame for possible human planning.[64]

This planning, however, is depending on the audience and its will and power to act. The urgency of climate change has shifted over time. If urgency is considered low, target years can be chosen primarily in relation to modeling conditions and secondly to allow for long-term planning of mitigation. If urgency is high on the other hand, target years far into the future can undermine that precise message. Considering that a fifteen-year time frame is what people on average manage to think about when they imagine the future, and longer time frames do not make sense, the translational task is taxing.[65]

As climate change has been allowed to proceed, the question of urgency has been well established and politically formalized through the Paris Agreement. At the same time the target year of 2100 remains in the IPCC reports. Between the first assessment report and the fifth there are twenty-four years. Yet, the dominating future year remains the same and is not moved forward as time passes, on the contrary the target year of 2100 is even more dominating as the end of time in the fourth and fifth assessment reports.

Humankind has experienced end of time before. Most recently, the "end year" 2000 was invoked in many visions in the second half of the twentieth century. It had both secular and religious dimensions. As the turn of the millennium came closer, it was also possible to understand the future as vanishing. Much like the enormously noticed countdowns of the Apollo project and in particular the moon landing of 1969, approaching the end of 1999 could be regarded as a countdown of apocalyptic measures existing on the sole basis of Christian time keeping.[66] The calendar year allowed for a construed apocalyptic vision.

In climate change it is the opposite. The apocalypse cannot be firmly fixed as a short projected real-life event when the earth will split and the heavens open. It is a continuous and ongoing catastrophe, possible to view only through mediated science and technology. Events can indeed be projected. This is partly what climate models do when they aim to fix the future time of 1.5 °C or four hundred ppm, on average. But when these global measures occur, they will not be accompanied by thunder and lightning, nor will it be locally felt at the particular projected time. The target year of climate simulations instead represents the limit. In the graphic representation it constitutes that particular outer boundary of a scientific experiment, but given its rhetorical function, it can also be read as the end of time.

This is underscored by the fact that the limit has not changed, like a true horizon would if one travels. The limit is the same. A static target year means that the future comes closer and closer to the present day, or alternatively that the given time until a certain state is reached continuously shrinks. To maintain 2100 as a standard target year must undoubtedly have a number of advantages, in particular when it comes to comparisons over time. However, the consequence might also be a reading where the future is disappearing.

It is striking, however, that at the same time, contemporary public discourse does not engage with the target year of 2100. Neither does the terminology issues of future language permeate the discussion to any visible extent. Instead, the climate-change issue and the Paris Agreement of 1.5 °C have been translated to budget thinking, moving the end closer to the present. The above budget works with the shortest of Braudel's temporalities, *histoire événementielle*, which makes sense to people, being able to imagine similar timelines. Model time as represented by 2100 on the other hand, arguably corresponding to the *conjonctures* of transforming social change with the terminology of the *Annales* school, does not become meaningful to the individual. It is nontranslatable and abstract.

This is an illustration of what Anne Pasek has called tensions "between scales germane to the problem and scales germane to individuals."[67] The science demands one scale whereas action needs another. The issue of temporalities is not so much a question of whether or not Braudelian terminology is valid in the Anthropocene, but rather in which context time works. The target year of the IPCC simulations might indeed be a limit and not a horizon. However, in the terminology of Reinhart Koselleck, the horizon might still be a functional metaphor when thinking about the future, as it affords an expectation, something that is absolutely central to politics and action.

Conclusion

As the Anthropocene unfolds, temporalities of the past might also be stretching into the future, much like the compound graphs of the IPCC that merge historic measured climate with future modeled climate. Helge Jordheim has claimed that there has never been a clear distinction between what might be called nature time and culture time. Likewise, this chapter has shown that even though the scientific community at large can be said to use model time, as soon as these scenarios came into the circulation of the public discourse on climate policy, model time could not be separated from culture time.

Graphs mediating the temporality of climate change as it is understood from computer-based scenarios, are visual expressions with an extensive reach. When words of the future are hard to grasp and the projected temperature or CO_2 concentration escape our senses and imaginary capacity, the end of time might offer a concrete framing to relate to. Yet, even though the target year is absolute and more concrete than other measures, it seems to lack meaning in both a policy and public discourse. The fact that 2100 has not moved from the realm of meticulously thought through communication practices of the IPCC to the public sphere is an indication of its comparatively weak rhetorical power.

When the climate issue is instead transferred to weather through attribution studies, or to budget thinking through a temperature goal, time resurfaces as meaningful. Anne Pasek has drawn attention to the dynamics of scale when climate change is being mediated, stating that "all representations of climate are fundamentally representations of scale."[68] This is true also for the future climate. However, the fundamental difference in relation to the temporality of Braudel is of course that meaning must first and foremost be created in relation to the possibilities to act in the present. To act on the basis of knowledge is a human challenge acknowledged for millennia. Bringing the end closer might help.

Nina Wormbs is Professor of History of Technology at KTH Royal Institute of Technology, Stockholm. Her interests span media and communication history, technology dependent commons, remote sensing and the sublime, and climate change from an environmental humanities perspective. Ongoing research focuses on arguments for non-action and the internal deliberation of individuals, analyzed with topos theory. Recent publications include the edited volume, *Competing Arctic Futures* (Palgrave MacMillan, 2018) and a coauthored article, "Environing Technology: A Theory of Making Environment," *History & Technology* (2018).

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1. Fernand Braudel, *On History* (Chicago: University of Chicago Press, 1980); Will Steffen, Paul Crutzen, and John McNeill, "The Anthropocene: Are Humans Now Overwhelming the Great Forces of Nature?" *Ambio* 36 (2007): 614–21; Will Steffen et al., "The Trajectory of the Anthropocene: The Great Acceleration," *The Anthropocene Review* 2, no. 1 (2015): 81–98, https://www.doi.org/10.1177/2053019614564785.
2. Helge Jordheim, "Introduction: Multiple Times and the Work of Synchronization," *History and Theory* 53, no. 4 (2014): 498–518, https://www.doi.org/10.1111/hith.10728.
3. They are all available on line at the IPCC website. Research on IPCC is vast. For an overview see Mike Hulme and Martin Mahony, "Climate Change: What do we Know About the IPCC?" *Progress in Physical Geography: Earth and Environment* 34, no. 5 (2010): 705–18. In the first two reports the setup was not established and there is no real synthesis report in the first assessment report. There is always a discernable summary for policy makers, even though it can be divided into different sections. I will refer to them by the shorthand mentioned in the text. IPCC First Assessment Report Overview and Policymaker Summaries and 1992 IPCC Supplement; IPCC Second Assessment, Climate Change 1995, A report of the Intergovernmental Panel on Climate Change; IPCC, *Climate Change 2001: Synthesis Report. A Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, ed. R. T. Watson and the Core Writing Team (Cambridge, UK: Cambridge University Press, 2001), 398 pp; IPCC, *Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report*

of the Intergovernmental Panel on Climate Change, ed. the Core Writing Team, R. K. Pachauri, and A. Reisinger (Geneva: IPCC, 2007), 104 pp; IPCC, *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. the Core Writing Team, R. K. Pachauri, and L. A. Meyer (Geneva: IPCC, 2014), 151 pp.

4. The same assumption of the dissemination and impact of the different reports is made by Walsh, Mahoney, and Schneider: Lynda Walsh, *Scientists as Prophets: A Rhetorical Genealogy* (New York: Oxford University Press, 2013); Martin Mahony, "Climate Change and the Geographies of Objectivity: The Case of the IPCC's Burning Embers Diagram," *Transactions of the Institute of British Geographers* 40, no. 2 (2015): 153–67, https://www.doi.org/10.1111/tran.12064; Birgit Schneider, "The Future Face of the Earth: The Visual Semantics of the Future in the Climate Change Imagery of the IPC," in *Cultures of Prediction in Atmospheric and Climate Science, Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, ed. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 231–51.
5. The standard reference is Birgit Schneider and Thomas Nocke, eds., *Image Politics of Climate Change: Visualizations, Imaginations, Documentations* (Bielefeld: Transcript Verlag, 2014). See also Birgit Schneider, "Climate Model Simulation Visualization from a Visual Studies Perspective," *WIREs Climate Change* 3, no. 2 (2012): 185–93; Birgit Schneider, "Future Face of the Earth"; Lynda Walsh, "The Visual Rhetoric of Climate Change," *WIREs Climate Change* 6, no. 4 (2015): 361–68, https://www.doi.org/10.1002/wcc.342.
6. Martin Mahony and Mike Hulme, "The Color of Risk: Expert Judgment and Diagrammatic Reasoning in the IPCC's 'Burning Embers,'" in *Image Politics of Climate Change: Visualizations, Imaginations, Documentations*, ed. Birgit Schneider and Thomas Nocke (Bielefeld: Transcript Verlag, 2014), 105–24; Birgit Schneider, "Burning Worlds of Cartography: A Critical Approach to Climate Cosmograms of the Anthropocene," *Geo: Geography and Environment* 3, no. 2 (2016): e00027.
7. Sabine Pahl et al., "Perceptions of Time in Relation to Climate Change," *WIRE Climate Change* 5 (2014): 375–88; Elizabeth Callaway, "A Space For Justice: Messianic Time in the Graphs of Climate Change," *Environmental Humanities* 5 (2014):13–33; Anne Pasek, "Mediating Climate, Mediating Scale," *Humanities* 8, no. 4 (2019): 159, https://www.doi.org/10.3390/h8040159.
8. Kirsten Hastrup and Martin Skrydstrup, eds., *The Social Life of Climate Change Models: Anticipating Nature* (New York: Routledge, 2013); Catharina Landström, "Tracing Uncertainty Management Through Four IPCC Assessment Reports and Beyond," in *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, eds. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 214–30; Kirsten Hastrup, "Anticipating Nature: The Productive Uncertainty of Climate Models," in *The Social Life of Climate Change Models: Anticipating Nature,* eds. Kirsten Hastrup and Martin Skrydstrup (New York: Routledge, 2013), 1–29. See also Walsh, "Climate Change and Prophecy," in *Scientists as Prophets*.

9. Matthias Heymann, "Constructing Evidence and Trust: How Did Climate Scientists' Confidence in Their Models and Simulations Emerge?" in *The Social Life of Climate Change Models: Anticipating Nature,* eds. Kirsten Hastrup and Martin Skrydstrup (London: Routledge, 2013), 203–24; Mike Hulme, "How Climate Models Gain and Exercise Authority," in *The Social Life of Climate Change Models: Anticipating Nature,* ed. Kirsten Hastrup and Martin Skrydstrup (New York: Routledge, 2013), 30–44.
10. Walsh, "The Visual Rhetoric."
11. Callaway suggests that this merging of history and the future does not happen, but that is not correct even for her case of TAR if you also look at the Synthesis report. See for example SPM 10a, page 33 and SPM 10b, 34.
12. Here I count only the 1990 report, beginning on page 47. In the 1992 supplement there are another three, all target year 2100.
13. There was also a graph for GDP reduction with target year 2050, SPM 9, 28.
14. A group of illustrations on page 23 show different outcomes for different greenhouse gas emission reductions up until 2030. The target year for those outcomes is also 2100, but time features differently on the x-axis.
15. "What is known about the regional and global climatic, environmental, and socio-economic consequences in the next 25, 50, and 100 years associated with a range of greenhouse gas emissions arising from scenarios used in the TAR (projections which involve no climate policy intervention)." SYR TAR, 8.
16. James S. Risbey, "The New Climate Discourse: Alarmist or Alarming?" *Global Environmental Change* 18, no. 1 (2008): 26–37, https://www.doi.org/10.1016/j.gloenvcha.2007.06.003.
17. Matthias Heymann and Nils Randlev Hundebøl, "From Heuristic to Predictive: Making Climate Models into Political Instruments," in *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation*, eds. Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony (New York: Routledge, 2017), 100–19; J. Hansen et al., "Climate Impact of Increasing Atmospheric Carbon Dioxide," *Science* 213, no. 4511 (1981): 957, https://www.doi.org/10.1126/science.213.4511.957. Personal correspondence with Hansen August 19, 2019.
18. Spencer R. Weart, *The Discovery of Global Warming* (Cambridge, MA: Harvard University Press, 2008). In the update to the FAR, a common methodology for assessing the impact of accelerated sea level rise was presented, which built on the simulated sea level rise for 2100. FAR, 38.
19. Bert Bolin and Bo R. Döös, *The Greenhouse Effect, Climatic Change and Ecosystems* (Chichester: Wiley, 1986). The year 2050 is also prevalent.
20. William Kellogg, for example, published an early prediction in 1977 that stretched until 2050. Heymann and Hundebøl, "From Heuristic."
21. Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2010).
22. Hulme, "How Climate Models," 32.
23. Heymann and Hundebøl, "From Heuristic," 105.

24. This was the stance of the Oreskes et al. *Science* article in 1994, referenced in Hulme, "How Climate Models," 33.
25. Heymann and Hundebøl, "From Heuristic," 106. On the social authority of models see also Hulme, "How Climate Models."
26. Risbey, "The New Climate Discourse," 33.
27. Martin Mahony, email to author, August 20, 2019. On the proliferation of the models developed by the Hadley Centre see Martin Mahony and Mike Hulme, "Model Migrations: Mobility and Boundary Crossings in Regional Climate Prediction," *Transactions of the Institute of British Geographers* 37, no. 2 (2012): 197–211; Martin Mahony and Mike Hulme, "Modelling and the Nation: Institutionalising Climate Prediction in the UK, 1988–92," *Minerva* 54, no. 4 (2016): 445–70, https://www.doi.org/10.1007/s11024-016-9302-0. Much work on future scenarios completed at the Climatic Research Unit at the University of East Anglia in the late 1980s was "atemporal." Mike Hulme, email to author, August 21, 2019.
28. FAR, 11.
29. James Hansen, email to author, August 19, 2019.
30. Donella H. Meadows, Dennis L. Meadows, Jørgen Randers, and William W. Behrens, III, *The Limits to Growth: A Report for The Club of Rome's Project on the Predicament of Mankind* (London: Earth Island, 1972).
31. Jordheim, "Introduction."
32. Joshua P. Howe, *Behind the Curve: Science and the Politics of Global Warming* (Seattle: University of Washington Press, 2014).
33. The hockey stick curve has also been the focus of great debate and attack. See for example Pasek, "Mediating Climate."
34. For several examples, see Pahl et al., "Perceptions of Time," 380.
35. For a discussion on the role of media logic in framing the public discourse on climate change see for example Miyase Christensen, Annika E. Nilsson, and Nina Wormbs, eds, *Media and the Politics of Arctic Climate Change: When the Ice Breaks* (New York: Palgrave Macmillan, 2013).
36. See also Paglia and Isberg, Chapter 10 in this volume, who deal mainly with the recording of temperature rather than specific highs or lows.
37. Peter A. Stott et al., "Attribution of Extreme Weather and Climate-Related Events," *WIREs Climate Change* 7, no. 1 (2016): 23–41, https://www.doi.org/10.1002/wcc.380.
38. AR5, 53. Italics in original.
39. World Meteorological Organization, "July Matched, and Maybe Broke, the Record for the Hottest Month since Analysis Began," August 1, 2019, retrieved October 3, 2021 from https://public.wmo.int/en/media/news/july-matched-and-maybe-broke-record-hottest-month-analysis-began; Jon Henley, Angelique Chrisafis, and Sam Jones, "France Records All-Time Highest Temperature of 45.9C," *The Guardian*, June 28, 2019, https://www.theguardian.com/world/2019/jun/28/france-on-red-alert-as-heatwave-forecast-to-reach-record-45c.
40. Mike Hulme, email to author, August 20, 2019.
41. See for example Elodie Vieille Blanchard, "Technoscientific Cornucopian Futures versus Doomsday Futures: The World Models and The Limits to Growth," in *The*

Struggle for the Long-Term in Transnational Science and Politics: Forging the Future, ed. Jenny Andersson and Eglė Rindzevičiūtė (New York: Routledge, 2015), 92–114.

42. Heymann and Hundebøl, "From Heuristic."
43. Jenny Andersson and Eglė Rindzevičiūtė, eds., *The Struggle for the Long-Term in Transnational Science and Politics: Forging the Future* (New York: Routledge, 2015).
44. Christopher P. Weaver et al., "Improving the Contribution of Climate Model Information to Decision Making: The Value and Demands of Robust Decision Frameworks," *WIREs Climate Change* 4, no. 1 (2013): 39–60, https://www.doi.org/10.1002/wcc.202.
45. Dennis Bray and Hans von Storch, "'Prediction' or 'Projection'?: The Nomenclature of Climate Science," *Science Communication* 30, no. 4 (2009): 534–43, https://doi.org/10.1177/1075547009333698.
46. Michael D. Mastrandrea et al., "The IPCC AR5 Guidance Note on Consistent Treatment of Uncertainties: A Common Approach across the Working Groups," *Climatic Change* 108, no. 4 (2011): 675, https://www.doi.org/10.1007/s10584-011-0178-6.
47. FAR, 11. The terminology issue of the future is greater than this summary treatment, including issues of epistemology and historical grounding. I thank Emil Henrik Flatø for truly valuable comments particularly in relation to this but also on the chapter as a whole.
48. Compare Matthias Heymann, Gabriele Gramelsberger, and Martin Mahony, eds., *Cultures of Prediction in Atmospheric and Climate Science: Epistemic and Cultural Shifts in Computer-Based Modelling and Simulation* (New York: Routledge, 2017), 5.
49. Heymann, Gramelsberger, and Mahony, *Cultures of Prediction*, 7; Hulme, "How Climate Models."
50. Schneider, "Future Face of the Earth."
51. See for example Roy Scranton or Clive Hamilton.
52. WMO, "July matched."
53. Bård Lahn, "A History of the Global Carbon Budget," *WIREs Climate Change* 11, no. 3 (2020): e636, https://www.doi.org/10.1002/wcc.636.
54. Hélène Guillemot, "The Necessary and Inaccessible 1.5°C Objective: A Turning Point in the Relations Between Climate Science and Politics?" in *Globalising the Climate: COP21 and the Climatisation of Global Debates*, ed. Stefan C. Aykut, Jean Foyer, and Edouard Morena (London: Routledge, 2017), 39–56.
55. Shinichiro Asayama et al., "Why Setting a Climate Deadline is Dangerous," *Nature Climate Change* 9, no. 8 (2019): 570–72, quote 570, https://www.doi.org/10.1038/s41558-019-0543-4.
56. Richard J. Millar et al., "Emission Budgets and Pathways Consistent with Limiting Warming to 1.5 °C," *Nature Geoscience* 10 (18 September 2017): 741.
57. Asayama et al., "Climate Deadline," 570.
58. Asayama et al., 570.
59. Lahn, "Global Carbon Budget." See also Bård Lahn, "Changing Climate Change: The Carbon Budget and the Modifying-Work of the IPCC," *Social Studies of Science*, July 16, 2020, https://www.doi.org/10.1177/0306312720941933.
60. Malena Ernman and Svante Thunberg, *Scener ur hjärtat* (Stockholm: Polaris, 2018).

61. See Walsh, *Scientists as Prophets*.
62. In the English language, "to kick the bucket" is slang for "to die." Correspondingly, a bucket list is something you want to do before you die. I am not exploring the possible associated framings here.
63. Amazon reported soaring sales in relation to Trump being elected president in the US, November 2016.
64. Risbey, "The New Climate Discourse," 33.
65. Pahl et al., "Perceptions of Time," 376.
66. C. P. Snow claimed that the moon-landing in effect killed futurism as we had reached as far as we possibly could.
67. Pasek, "Mediating Climate."
68. Pasek, 1, with reference to Derek Woods, "Scale Variance and the Concept of Matter," in *The New Politics of Materialism*, ed. Sarah Ellenzweig and John H. Zammito (New York: Routledge, 2017).

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⤚• 12 •⤙

Encountering the Geological Live

Temporalization in the Age of Natural Media

Anders Ekström

A New Version of the Present

A major aspect of the struggle with climate change concerns matters of temporal imagination. From the seminal essay of Dipesh Chakrabarty on "The Climate of History" from 2009, and through the following decade, many have argued that the arrival of the Anthropocene requires new modes of scaling and visualizing historical times and temporalities. One side of this argument is that the temporal scope of the climate crisis is abstract and hard to fathom, and therefore needs to be translated and sensitized to become a motivating force in political action. This view emphasizes the importance of cultural work for affecting change and creating an increased awareness of the impact of human societies on the physical environment. According to Bruno Latour, we have to "*generate alternative descriptions*" to overcome what he and many others refer to as a "deficit of representation" in politics for comprehending, and acting on, the collapse of geohistorical scales.[1]

The broad engagement with temporality in the context of anthropogenic climate change has lessened the divide between history and geology, with scholars in both fields asking how their timescales interact, and developing a commitment to forms of integrative knowledge that resonate with eras of convergence in the past.[2] For instance, as has been demonstrated throughout this volume, this has activated strands of historical thinking that deal with historical times, speeds and layers in plural, reestablishing the connection between the time-binding techniques and imaginaries of seventeenth- and eighteenth-century natural historians, and the work of twentieth-century historians such as Fernand Braudel and Reinhart Koselleck.[3]

But despite this focus on rethinking temporal scales, rhythms, and durations, and reconciling natural and historical times, the understanding and cultural reception of climate change continue to be deeply conflicted between rapid change and slow continuity, or, in terms of historical experience, between rupture and repetition. This tension emerges from the simultaneous perception of climate change as a sudden event, which was only discovered in the late twentieth century, and through deep time perspectives. When translated into cultural critique, this "schizo temporality" is typically represented by a mix of fossil poetry and presentism, juxtaposing current events with processes rooted in a very distant past. Some writers try to bridge this divide by arguing for the radicalism of deep time perspectives, and how they provides a means for reimagining the present and building a sense of intertemporal responsibility and connection stretching over millions of years.[4] Others, however, claim that to become a political object the Anthropocene needs to be turned into an historical event, which appeared under different names but was integrated with the struggles and conflicts of Western capitalism in the last 250 years.[5]

However, as much as the abstraction of the climate crisis continue to dwell in the chasm between the conflicting scales of earth history and presentism, this cannot be explained by a lack of representations of the complexity of climate change temporalities. To the contrary, in global news media the multiple and extended timescales of climate change have become increasingly visible in the last two decades in an overwhelming amount of images and emerging news formats that connect contemporary emergencies with temperature records and long-term planetary change. The clash between temporalities has also been reflected in numerous exhibitions, art works, and cross-institutional educational efforts around the world, joining in an ongoing global effort to create an active sense of human impact on abstract atmospheric and geological processes.[6] Indeed, given the scope of the political and cultural engagement with climate times since the formation of the Intergovernmental Panel on Climate Change (IPCC) in 1988, it is now possible to sketch the historical contours of how the issue of anthropogenic climate change entered the mainstream of public discourse in the 1980s and 1990s, which also prepared for the introduction and widespread use of the concept of the Anthropocene in the early 2000s.[7]

In the early twenty-first century, cultural and scientific contexts for working on and visualizing climate change temporalities merged with a digital monitoring culture. The affordances and news styles of online environments favor a mode of imagining global warming through continuous updates on fast and slow emergencies in real-time templates. It has also created an open-ended relation between public and scientific records of climate change, installing a sense of urgency and flux in diagrams and abstract numbers, and a sense of objectivity and elementality in political and cultural matters.[8] The digital shift has thus reinforced the perception of the Anthropocene as an ongoing event that is composed of different speeds and durations, creating an abundance

Figure 12.1 Live streaming of erosion of the mountain Mannen (The Man) in Rauma, Norway, from an around the clock camera. Norwegian Broadcasting Corporation. Screen capture by Anders Ekström.

of image genres and media habits that link temporalities of local floods and seasonal storms with deep time frames and planetary prognosis.[9]

Digital media infrastructures and monitoring systems also enable new modes of viewing deep time unfold, emphasizing the event character of geological processes. For example, in online environments, the monitoring of volcanic activities that registers change in millenium-long intervals easily slips into news stories about forecasted hazards and risks. Likewise, the live streaming of erosion and expected landslides adds a sense of reality and suspense to slow geological time.

An empirical study of mainstream online news sites, which I conducted between 2011 and 2016, established an increasing trend of connecting current events with the long-term.[10] It showed that the climate crisis was an established, and increasingly important, common frame of reference in a growing number of news postings on four types of events: 1) climate-related disasters such as heatwaves, floods, storms, fires, and landslides; 2) geological events such as earthquakes and volcanic eruptions; 3) reports and prognostications of melting glaciers and rising sea levels, carbon emissions, and record temperatures; and 4) slow and accelerating processes of landscape change, for example deforestation and habitat loss. It was concluded from this study that by drawing the different events and their durations closer together, and associating them to the overall theme of human interaction with earth systems, mainstream news frames told stories of the temporal complexity of

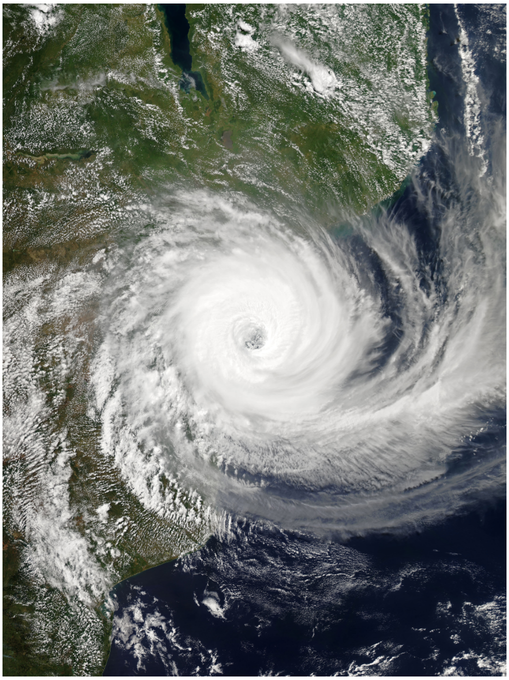

Figure 12.2 Satellite image of the cyclone Idai approaching Mozambique in March 2019. Captured by NASA's Aqua satellite. Source: EOSDIS Worldview, public domain.

climate change on an almost daily basis. It means that for at least a decade now, we have been surrounded by a new version of the global present, which is defined by an ever-increasing number of images and reports of climate-related emergencies.[11]

This view of the present was further accentuated by a language of *extreme* weather events and *record* temperatures, which expanded notions of acceleration and interacting temporalities to atmospheric systems, and framed changes in temperatures and weather patterns as historical events. The term "extreme weather" was introduced in several languages in the mid-1990s and has become widely used in both public and institutional contexts in the last fifteen years.[12] Another set of increasingly common metaphors in headlines and captions merged natural and cultural phenomena by referring to storms and rainfalls as "weather bombs" and "monster hurricanes." Indeed, it is characteristic of modern discourses on crisis to turn to nature for descriptions of social and economic calamities—making "financial storms" and "debt storms" the weather of capitalism—and to culture for descriptions of emergencies in nature.

Alongside the linguistic overlaps between cultural and natural realms, climate change temporalities were also typically mediated by visual technologies that extended the sense of urgency from on-the-ground experiences to abstract satellite images and drone overviews. The profusion of survey images in online news of damaged landscapes and ruined habitats reinforce the monitoring mode of the contemporary reception of climate change. But it also points to a long-standing connection between (elemental) media and meteorology, which goes back to early warning systems for sharing knowledge about signs in the skies.

Taken together these emerging genres and visual responses shape and reflect the ongoing struggle to comprehend the staggering complexity of climate change temporalities, encompassing multiple entanglements between past and present, sudden feedback loops, and a reversal of natural and cultural rhythms. There is in the context of mainstream online news no "deficit of representations" of the collapsing divide between geological and historical timescales. Rather, as global news audiences have been steered toward small screen outlets in the twenty-first century, climate emergencies and weather disasters have become matters of topical repetition, feeding the economy of live streams and continuous updates.

After two decades of coexploration of climate change temporalities and digital infrastructures, floods, storms, and heatwaves are typically related as "news" in three temporal registers. The first is prognostic, both in the sense of meteorological forecast—monitoring storms from coast to coast—and in the sense of media buildup on expected events, which is what media scholar Richard Grusin refers to as "premediation."[13] The second is historical, referring back through genre and mode of address to similar events in the past as well as to atmospheric and geological processes of a much longer duration. Such comparative and connective practices within the interpretive framework of anthropogenic climate change have created online media archives packed with stories about extreme nature events. The third temporal register, more akin to traditional forms and meanings of "live," is oriented toward an intensified now, which is simultaneously ascribed to the events themselves and to the news styles that are developed to represent them.[14]

Certain aspects of online temporalities embrace crisis with so little friction that it becomes invisible. In a perspective of decades this effect is conditioned and enhanced by the affordances of digital infrastructures. In a perspective of centuries it coincides with a deep seated tendency in modernity of dealing with catastrophe through cultural repetition. Indeed, this new version of the present maintains continuities with notions of catastrophic time that are commonly described as early or premodern. One of its most striking aspects is the extent to which the future is understood to be conditioned by a past that the present can no longer influence. This notion points back in history to eschatological conceptions of the future. It means that droughts, fires, floods, and hurricanes are routinely referred to as premonitions of future events. For example, when the cyclone Idai caused massive flooding and destruction on the east coast of Africa in March 2019, it was broadly covered as an *exemplum* of the expected severity of similar events in the future.[15] This way of seeing and representing the future through ongoing disasters has become increasingly common over the last decade and is widely reflected in global news streams. Simultaneously, however, the temporal line between present and future tense in the premediation of climate change has got thinner, making ongoing and expected events coalesce in a continuous process, providing the present with a strange and yet undisputable sense of geohistorical directionality.

In terms of historical experience, this reflects an ongoing subversion of the modern divide between natural and historical times. Through this reversal, long-standing ideas about the speed and scale of change in modern societies slip into descriptions of processes in the earth and atmosphere. Landscapes and geological events are losing their background identity in human history and take on a new agency.[16] Nature is no longer externalized and perceived in terms of surroundings or mere resources, but it accelerates and is eventalized.[17] Emerging climate change temporalities also challenge more advanced theories of historical time. For example, and as discussed in the introduction to this volume, Fernand Braudel's tripartite division of the layers and rhythms of the human past is turned on its head.[18] In his epic work of the history of the Mediterranean, Braudel distinguished the rush of the history of events from that of conjunctural time, which was located within social patterns and slow infrastructures, economic cycles, and the history of civilizations. The third layer was referred to as "a history slower still." It was, according to Braudel, the almost immobile "history of man in his intimate relationship to the earth." This aspect of the past was cyclical, static, and repetitive; it was "beyond time's reach and ravages."[19] But today it is precisely what Braudel described as a history without time that is increasingly perceived as eventful, constantly changing and accelerating, while progress in its modern guise appears to slow down and is stalled.

In this process of reimagining natural and historical times, slow geological and atmospheric processes are fuelled with real-time expectations. Also, it has become widely accepted that the acceleration of earth-historical time is conditioned by a past in which natural and historical archives became increasingly entangled. There is in this sense no *empty* geological time—rather, geological time is turned into a historical moment and imagined on a human scale.[20] Emerging from this shift in cultural imagination, I argue, is an experience of the present as being increasingly played out in what we might think of as *the geological live*. It is a hybrid experience in the sense that it is shaped both by the frantic visualization and technological monitoring of climate change temporalities, and an increased sense of being *in situ* witnesses to accelerating planetary changes. A part of this shift is also reflected in a different role and definition of media and historical events, which John Durham Peters has described as an elemental turn in media theory.[21] In this perspective, the weather of digital clouds and streams is not representing but rather signalling a new configuration of landscapes, infrastructure, and human society.[22]

The experiential aspect of this shift in temporal sensibilities is also reflected in the way that the concept of the Anthropocene is currently used as a designation both for the present and a new geohistorical epoch. Humans never lived in the Holocene. But in the early twenty-first century historical experience is shaped on the level of geological epochs.[23] This conflation of cultural and natural times also conditions contemporary politics, which cannot avoid an awkward sense of the geological (or geobiological) as an acting presence. Bruno Latour proposes to call this new actor the Terrestrial. The concept of geopolitics, he argues, usually refers to geology as a mere framework for political action. But today the prefix "geo" "designates an agent that participates fully in public life."[24]

In online news and monitoring culture, the presence of a terrestrial voice echoes in the revival of elemental media in the communication of the climate crisis. It is an historical irony that in an era when the planet is incessantly measured, monitored, and mediated by technological infrastructures, the importance of clouds, sea, and ice as messengers of past and future events is becoming more profound than ever.[25] And yet it repeates a cultural pattern well-known from the human past: "The sky, like the sea and earth, becomes a medium in emergencies."[26] This late modern attachment to elemental media can therefore be seen as forming part of a long-lasting *natural media history*. As exemplified in the next two sections, this points both to the contingency of the nature of media and historical events, and the means used for scaling and imagining abstract temporalities. It also coincides with a long-standing history of nature emergencies and geological disasters as cultural sources for conceptualizing the interaction and conflation of temporal scales and durations.

Stretching the Sense of Time

As this volume demonstrates, what I have described as a new version of the present is not without a history. A productive wave of historical critique followed the early versions of the Anthropocene narrative, tracing the Great Acceleration of human impact on earth systems to the cultural and economic struggles of Western capitalism in the last 250 years.[27] Both political and historical scholars have resisted the idea that climate change temporalities are beyond human imagination, pointing to the possibilities of alternative descriptions not on the metaphysical level of cosmology but on the scales of decades and centuries. Duncan Kelly, who refers to the plurality of time frames as the major challenge of the Anthropocene, warns against the fatalism of the notion that its timescales are incommensurable with modern political institutions. Instead, he suggests that abstract and accelerating temporalities of geological and environmental processes can be made comprehensible through a generational time frame of political and economic issues that became a growing concern from the 1960s and 1970s.[28]

Historian of science Deborah Coen also objects to the notion of climate change as developing in scales beyond the reach of human capacities. She points to the general contingency of temporality in human life and societies, and how different measurements and proportions have always been a subject of practices of scaling. Coen interestingly suggests, however, that at certain junctures in time "scaling may require an imaginative leap," in order to recalibrate temporal perspectives and other measurements to "encompass phenomena that were previously unimaginably large or small."[29] Following Jordheim, we might think of such junctures as historical moments of intensified synchronization.[30] Coen's observation also adds further detail to the synthesizing description in Sörlin's chapter of three waves of temporal synchronization in the modern era: the first centering on the introduction of progressive historical time around the turn of the eighteenth century; the second focusing on standardizing practices and infrastructures for universalizing time that developed from the second half of the nineteenth century; and the third emerging from the ongoing recalibration of time frames and temporal porportions in the context of climate change.[31]

The history of scaling is equally crucial to, and in many ways overlaps, these three phases of temporalization. As Coen notes, the nineteenth century was an era of great flexibility in scalar imagination.[32] In relation to time, this is evident from the introduction of a wide range of textual and visual genres that quite literally stretched temporal imaginations, and enabled new descriptions of abstract timescales and durations. From the early nineteenth century and onwards, various modes and models for visualizing time were key in the development of "historical" disciplines such as geology and archaeology, and carried images and ideas about times in history and nature between them. Some of these genres, such as stratigraphy and map making, had a long history, as did timelines and tabular knowledge.[33] Other visual forms and media, including statistics and advanced charts and graphic models, were more recent and developed across different branches of knowledge. Also, a sense of visual experimentation and elaborative ways of representing distance in time and space flourished in nineteenth-century public culture. A broad range of urban visual entertainments and educational media were explicitly oriented towards stretching scalar imaginations. For example, visitors to nineteenth-century world's fairs were expected to move between abstract overviews, miniature models, and visions of the globe from an elevated distance. The idea of scalar flexibility was key to their overall aesthetic of attraction.[34]

Another productive area for thinking about historical and natural times in the early nineteenth century was the intersection between science and literature. The work by literary historians such as Rosalind Williams and Adelene Buckland demonstrates how nineteenth-century geology was shaped by literary imagination.[35] Time travel more generally developed into a prominent theme in nineteenth-century literature, spanning from the invention of the historical novel in the beginning of the century to the increasingly popular genres of future-looking social critique and technological fantasy from mid-century and onwards.[36] Literary travel into the distant past represented the other side of modern utopian temporality. It developed in close affinity with new and emerging knowledge practices in fields such as history, archaeology, and geology. The expanding chronologies and narratives of the history of earth also drew on literary genres and were vividly displayed in nineteenth-century panoramas, exhibitions, and museums. This is richly exemplified by Ralph O'Connor in a comprehensive study of the public history of geology in Britain in the first half of the nineteenth century. O'Connor's study shows how theatrical and spectacular media both introduced large audiences to natural history, and played an important role in shaping new forms of temporal knowledge within the emerging discipline of geology.[37]

From these episodes in the early nineteenth-century history of knowledge we can conclude that the ability of imagining the long-term in a variety of time frames was not in opposition to but integral to modern temporal sensibilities. It is also evident from these and other examples of nineteenth-century knowledge practices that they presupposed an understanding of the radical malleability of human perception of distances and connections across time and space. The history of scaling thus points to the contingency not only of temporality but also of abstraction more generally, and a longer history of exploring the boundaries between different spatial and temporal registers through various media and visual languages.

The idea of the plasticity of the human mind and imagination was also elaborated in nineteenth-century pedagogical and epistemological discourses on sensory training. As I have discussed elsewhere, different ways of seeing in an abstract and survey manner was a matter of intense concern in the context of nineteenth-century pedagogical reform and civic training. New spectacular technologies and visual strategies, for example aerial photography, enabled perspectives that turned familiar views into grids and vertical abstractions. The act of seeing in a survey manner was also much discussed in relation to statistical knowledge and representation. Most importantly, this broader history of abstract sensibility was not confined to the formation of scientific concepts. Issues of sensorial training, virtual affect, and self-distancing forms of reflexivity became increasingly important to broader discourses on civic responsibility in the nineteenth century, and were eventually inscribed into the requirements of modern citizenship.[38]

Scalar imaginations are shaped in the interface of aesthetics in its ancient and modernist sense, merging embodied perception and technological mediation. As we have seen, the period from the late-eighteenth through the mid-nineteenth century was tremendously productive in combining emerging visual genres and knowledge practices for imagining new versions of the history of the earth and human societies. It was also in this period that the notion of modernity started to gain ground as a self-designation of Western industrial societies. As a temporal concept, it referred to a predominant orientation towards the present in contemporary society, and an inherent striving of the modern world to break with the past.[39] From this time on, Reinhart Koselleck notes, "historiography increasingly speaks of a *neue Zeit*."[40] In fact, the idea of a distinctively modern shape of time was part of a whole family of concepts that functioned as tools for formulating universalizing models of historical development in the decades around 1800. Common to increasingly elaborate notions of "culture," "civilization," "progress," and "evolution" in the nineteenth century was that they enforced a chronological hierarchy between human history and nature. Increasingly, "nature" came to designate the less advanced or that which was left behind, the "lower and slower" stages of progress, or simply the past. The externalization of nature from modern society thus comprised a temporal as well as spatial dimension.

Nicholas Mirzoeff suggests that an Anthropocene aesthetic, in the conventional meaning of an aesthetic as "beautiful," was inserted into the mainstream of Western art already from the mid-nineteenth century. It is visible, he argues, in the artistic perception of landscapes increasingly affected by industrial pollution and the burning of coal in Western metropoles. For example, Claude Monet's widely reproduced painting of the port of Le Havre from 1873, *Impression: Sun Rising*, "at once reveals and aestheticizes anthropogenic environmental destruction." The painting's light effects and stunning colors are created from the rising sun shimmering through the coal smoke from the steamers. The human-dominated seascapes, foggy skies, and dirt black water of urban environments were perceived by the modern artist as "natural, right, then beautiful." What Mirzoeff describes as the aesthetization of environmental degradation, and the impact of impressionism as an "anaesthetic to the actual physical conditions," thus takes the meaning of visual evidence of how the history of the Anthropocene was built into modern perceptions and sensory experiences.[41]

Human impact on landscapes and natural surroundings influenced a vast field of unconscious visibility in the nineteenth century. And yet, the sensorial regime of industrial modernity and coal-burning cities was anything but uncontroversial in nineteenth-century Europe. It was shaped in the context of violent struggles, local disagreements and public debates about issues of capitalist production, the organization of work, and the interaction between human societies and their surroundings. As Christophe Bonneuil and Jean-Baptiste Fressoz remark, the period from 1770 to 1830 was characterized by an intensified awareness of the interdependence of society and nature in Europe, for example in relation to issues of deforestation, pollution, and the influence of industrial structures on climate and health. Eventually, these and other controversies were played out in conflicting ideas about, on the one hand, the externalization of nature from society, and, on the other, the reciprocal and "systemic" concepts of "milieu" and "environment" that developed from the mid-nineteenth century.[42]

A Natural Media History

Another instance of human–nature interaction in the late eighteenth and nineteenth century that resonates with Anthropocene debates about the convergence of geological and historical time frames, and at the same time testifies to a broader history of complex temporalities, concerns the reception of major nature events. Earthquakes and volcanic eruptions evoke a stunning range of temporal experiences and reactions, which cut across distinctions of cultural and natural time as well as various speeds, timescales, and layers of historical time. In short, they are events with an extraordinary capacity to make the coexistence of temporal rhythms and durations visible. The interpretation of natural disasters by geologists and archaeologists was crucial to the expansion of historical and geological time frames in the period between 1750 and 1850.[43] But it was also part of a broader shift in cultural attentions, as indicated by the spectacular recreations of floods and eruptions, both historical and biblical, that attracted large crowds to nineteenth-century fairgrounds and exhibitions.[44]

Major geological events and natural hazards were also a powerful source for reflections on affinities and identification across large distances in time and space in the early nineteenth century. As the perception of weather disasters and geological extremes as occurrences external to human history is changing, we may explore a range of emotions strictly avoided by modern historicism with greater seriousness but without falling into the trap of moral reflection on species level. It concerns the morality of scale and the universalizing impulse that is triggered by major nature events. There is a pattern of revolt against conventional historical dimensions in the cultural reception of earthquakes and volcanic eruptions. It is reflected in a general sense of collapsing scales in the face of elemental emergencies, which manifests in a tendency of imagining and drawing times together in ways that would otherwise seem awkward and anachronistic.

Let us consider, for example, the vast school of Vesuvius painters in the decades around the turn of the nineteenth century. Ignoring any emerging divisions between natural and human history, these artists combined and moved between a variety of time frames. Their work conveyed an intense understanding of Vesuvius as a living mountain. This is visible in images that merge past and present versions of the volcano, and draws on historical sources as much as onsite observations of contemporary eruptions.[45] Among the many artists who witnessed Vesuvius erupt in 1779, 1794, 1822, or any other year of increased activity, were historical landscape painters from across Europe, for example Jacob More, Pierre-Henri de Valenciennes, and Johan Christian Dahl. Despite their different styles and temperaments, they all approached the eruptions through cultural meanings that had piled up around the mountain over the centuries. Geological details from recent eruptions were inserted into scenes from antique history, most of them extracted from the testimony of Pliny the Younger in the two letters he wrote to the historian Tacitus on the destruction of Pompeii and Herculaneum in 79 AD.[46]

It is difficult to detect any hierarchy between cultural and natural influences in the volcano paintings. Neither is past and present contrasted to each other in ways that can provide chronological lessons, explaining one time frame through another. Rather, these images collect an historical experience of closeness and communication between distant epochs, which is evoked and mediated by the rumbling mountain. In this sense, the paintings form a conjuncture of different rhythms and durations, which are drawn together in a time-transcending historical moment. This version of the idea of coexisting historical times is different from Koselleck's notion of the "contemporaneity of the noncontemporaneous" as it lacks the historicist impulse of measuring "temporal strata" against each other in terms of progress or chronology.[47] The prognostic element of this composition of historical times lies in the repetition of events, not in their progression.

In some respects, this way of superimposing different times and temporalities can be compared to other non-historicist approaches to the past. One example was the dramatic genre of the tableau. It was defined by Denis Diderot in the 1750s as a genre for nonchronological historical composition.[48] The increasing popularity of the dramatic tableau carried the idea of the *timelessness* of major events into the nineteenth century. Contrary to what is often thought, the "premodern" construction of the past through a rhetoric of *exemplum* was not outdated by the idea of progress.[49] The influence of the tableau can be traced across visual and textual genres, both fictional and nonfictional; it also flourished in the context of spectacular and

Figure 12.3 *Eruption of Vesuvius with Destruction of a Roman City*, Sebastian Pether, 1824. Museum of Fine Arts, Boston. Wikimedia Commons, public domain.

theatrical entertainments in the second half of the nineteenth century. One such example was the immensely popular genre of large-scale stage tableaux of historical and contemporary natural disasters, which were displayed in European and North American cities between 1870 and 1914.[50]

But what I want to draw attention to here is also how the work of the volcano painters reflects the nature of the mountain itself as a time-binding medium.[51] The temporality of repeated eruption mediated between historical and geological time frames. It created an experience that was equally conditioned by the past and included a heightened sense of the present. A certain sublimity of scale was simultaneously ascribed to the vastness of geological and cultural records. Among writers and painters, this translated into a sense of Vesuvius as a living archive. Early nineteenth-century visitors to the excavations of Herculaneum and Pompeii also testified to an experience of temporal copresence emerging from the encounter with rocks and bones. Indeed, while stratigraphic models construed the past in vertical piles of time, more or less closed off from each other, the volcano images conveyed ideas about reciprocity and openness between distant eras. It is visible in depictions of the ancient and contemporary landscape surrounding Vesuvius as two adjoining rooms, open to and equally illuminated by each other.

For example, the British landscape artist Sebastian Pether completely dissolved the distance between ancient and modern history. This is apparent already from the temporally vague title of his work, *Eruption of Vesuvius with Destruction of a Roman City*, from 1824. The geological details in the painting cannot be attributed to any particular eruption, but the city being destroyed by the lava stream is possibly ancient Herculaneum. However, in the lower left corner, positioned on the trunk of a hugh pine tree, two people dressed in nineteenth-century clothing are watching the disaster unfold from a safe distance. The inclusion of contemporary witnesses in the ancient motif emphasizes the spectacular reception of natural disasters. It also appealed to a broader movement of living history in the early nineteenth century.

A similar urge to reanimate the distant past is found in Francesco Piranesi's engravings of the repopulated ruins of Pompeii, which were published in *Antiquités de la Grande Grèce* in 1804. Piranesi worked from sketches made by his father Giovanni Battista Piranesi in the 1770s and his own visits to the site, carefully documenting the excavations in a series of maplike etchings. At some stage of his work, however, Piranesi started to insert fictional characters in the historical setting. As in Pether's painting, two different eras merge in one scene, only in this case it was ancient figures who became present in a contemporary landscape.

The way these early nineteenth-century artists superimposed past and present, and engaged with geological and historical time frames, contrasted sharply with the modern notion of an accelerating gap between past and present. In its approach to history, their work was closer to the rhetorical ethos of *phantasia*, calling upon the power of imagination to engage all senses in literally reviving the past.[52] As I have argued elsewhere, this can be seen in the context of a broader move towards reanimation of the past in the early nineteenth century, which was further boosted by the emerging genre of the historical novel and the immensely popular work by writers such as Sir Walter Scott and Edward Bulwer Lytton.[53] The volcano painters document how a sense of living history was shaped in relation to perceptions of historical landscapes and geological time frames as anything but a static background to human history. Rather, the experience of watching geological time unfold evoked emotions of identification across vast distances in time.

Later in the nineteenth century, other major geological events visualized ongoing temporal and spatial recalibrations on a global scale. The global repercussions of the 1883 Krakatoa eruption in the Sunda Strait between Sumatra and Java (then the Dutch East Indies) had a twofold character. One was connected to its rapid communication through telegraph networks and news agencies with an imperial reach.[54] The other was the climatic and

Figure 12.4 Etchings of the ruins of Pompeii. Francesco Piranesi, published in *Antiquités de la Grande Grèce*, vol. 1, plate 8 (1804). The Met, public domain.

atmospheric impact of the eruption. Several communities in the immediate surroundings were erased by pyroclastic flows and tsunami waves. At larger distances, the sheer magnitude of the event turned the volcano into its own messenger and the sky its global stage. The ash cloud covered an area of more than fifty kilometers, with the blast wave from the final explosion reaching around the globe. In the following decade, changing weather patterns and cooler temperatures were registered on a global scale. For several years following the eruption, spectacular light and coloring effects from the ash and pumice in the atmosphere could be watched from different parts of the world. Among the painters who depicted the glowing red skies was the British artist William Ashcroft, whose crayon sketches of afterglows from Krakatoa dated November 26, 1883 were reproduced as the frontispiece to the 1888 Royal Society geological report on the Krakatoa eruption.[55]

The combined technological and elemental impact not only defined how the eruption was perceived from a distance in space but also its temporal character. In the reception of the Krakatoa eruption, the speed of news left no doubt about the origin of the strange skies. With the globalization of audiences through telegraphic infrastructures a new common time emerged in the late nineteenth century, dividing the temporalities of the eruption into event and aftereffects. This was different from the reception of earlier large-scale natural

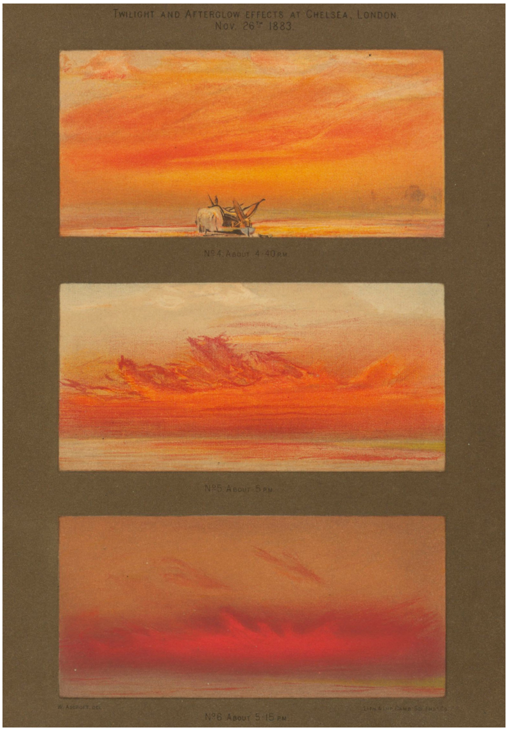

Figure 12.5 *Aftereffects*. Frontispiece to the 1888 Royal Society Report on Krakatoa. Crayon sketches by W. Ashcroft, November 26, 1883. 71–1250, Houghton Library, Harvard University, public domain.

disasters. For example, in connection with the Lisbon earthquake in 1755 reports from remote places in Northern Europe told about high waves rising from a windless sea. In the mid-eighteenth century, such phenomena were likely to be interpreted as foreboding oncoming events rather than as echoes of events occurring somewhere else. Following the pace of physical travel, it took about a month before news about the Lisbon earthquake arrived in the North. Once it did, the meaning of earlier events had already been fixed.[56]

The common time of technological communication therefore promoted a less eschatological and more linear sense of historical time. Electrical signals enabled a juncture of major temporal recalibrations. By the end of the nineteenth century, the earth, sea, and sky were literally crisscrossed by the infrastructure of telegraphic time. The acceleration of news emphasized the difference between the event time of the eruption and the temporalities of the atmosphere. But the increasing speed and synchronization of technological media did not make elemental shapes of time less visible or impressive.

When mediated through the earth system, the Krakatoa eruption unfolded in multiple scales and durations that exceeded the technological mediation of the event. This prompted an engagement with temporalities that were slower, more abstract and of planetary magnitude. Ashcroft's pastels of the atmospheric afterglows capture this fascination with the expanding spatial and temporal frames of the geological live, and its inescapable position of human detachment.

Temporalization Beyond Modernity

Climate change brings an increasing temporal complexity to life in the twenty-first century. When compared to long-established discourses on modern temporality and historical time, there are four major aspects that make climate change temporalities stand out. The first aspect is the emerging realization of the sheer multiplicity of time frames and durations that contemporary societies both influence and are conditioned by. The second is the reversal of familiar rhythms and paces of historical and natural times, which affect deep-seated temporalities of process and event, fast and slow, repetition and acceleration. The third is the unprecedented scope of the entanglement of processes in human and natural history that is revealed by anthropogenic climate change. The final aspect is a growing sense of the past as a living archive, which expands into and acts on present and future societies in multiple ways, for example through the sudden release of emissions that have gathered for centuries.

This constellation of temporalities is fundamentally different from any notion of the modern time regime.[57] It creates a chasm in historical experience that can neither be bridged by a shift to longer timescales in historical studies or by a flight from chronology.[58] The temporalities of climate change corrupt the notion of progress, shatter the experience of modern presentism, and subject the future to forces of the past. This shift entails major temporal recalibrations affecting all aspects of society. The incessant monitoring of nature emergencies in contemporary global society document the increasing anthropogenic impact on the earth and atmosphere. But it also displays the struggle to reimagine the temporal configuration of the present. The abstraction of climate change is often located in the clash between long, slow, and deep times, on the one hand, and accelerating, urgent, and disruptive times, on the other. But today, it is precisely these temporalities that are combined in the emerging sense that geological time, in the shape of the Anthropocene, is unfolding in real time.

When Koselleck writes about *Verzeitlichung* it refers to something seemingly simple and yet fundamental, namely the temporalization of Western societies in the late eighteenth century through the idea of the progressive nature of history. As a concequence, the past and present were increasingly separated in modernity, Koselleck and others have argued, creating an ever-increasing gap between experience and expectation in modern societies. Here, I have suggested that since the last three or four decades, we are experiencing an equally pervasive but different process of temporalization, precisely two centuries after the period Koselleck refers to as *Neuzeit*. How and when did the modern configuration of past, present, and future become inadequate for comprehending contemporary society? By the end of the twentieth century, the tradition of critical thought on presentism in Western modernity reached a point where a major contribution declared "the end of temporality."[59] However, at that time, a different historical experience of the temporal composition of the present was already beginning to take shape. Since then, an increasing number of aspects of human activity have become imbued with the intensities of climate change temporalities. This is reflected, for example, in the formation of social and political movements for which matters of time frames and intergenerational inequalities are the principal concern.

We have only started to think historically about contemporary temporalization. In this chapter, I have tried to indicate how one important aspect of this endeavor might be to look closer at the cultural reception of major nature events as instances of alternative configurations of historical and natural times. In a media historical perspective this also involves revisiting the distinction between technological and elemental media. As we know from the increasing interest in the material ecology of media, there are important links between the history of media and weather. But to uncover the genealogy of climate change temporalities we should also reconsider the modern emphasis on technological and infrastructural determinations of the nature of media. As the acceleration of nature changes the understanding of the character and duration of historical events, the notion of media is transformed through the present emphasis on elemental media in the communication of past and future events. These changing definitions concern fundamental aspects of modern historical thinking, and yet they reflect experiences that are shared over vast distances in time.

Anders Ekström is Professor of the History of Science and Ideas at Uppsala University, and currently Professor II of History of Knowledge at Oslo University. He has published broadly on modern cultural and media history and theory for three decades. His most recent work includes a series of essays on time and temporality in the history of natural disasters, which appeared in journals such as *Theory, Culture & Society*, and *Media, Culture & Society*. His ongoing research is focused on two main areas: cultural processes of temporalization in the context of climate change, and the modern history of publicness.

NOTES

1. Bruno Latour, *Down to Earth: Politics in the New Climatic Regime*, trans. Catherine Porter (Cambridge, UK: Polity, 2018), 94 (emphasis in original).
2. See, for example, Dipesh Chakrabarty, "Anthropocene Time," *History and Theory* 57, no. 1 (2018): 5–32. In the human sciences, the convergence between historical and geological thinking is also expressed by an increasing historical interest and theoretical influence of earth system thinking. It is also supported by a notable trend of co-writing between earth scientists and humanities scholars, providing a sign of a shared commitment to integrative knowledge production in the intersection between the study of historical and natural times. See, for example, Bruno Latour and Timothy M. Lenton, "Extending the Domain of Freedom, or Why Gaia Is So Hard to Understand," *Critical Inquiry* 45 (Spring 2019): 659–80. I have previously discussed this in a Scandinavian context together with geologist and earth scientist Henrik Svensen; see Anders Ekström and Henrik H. Svensen, "Naturkatastrofer i menneskets tidsalder: Mot en tverrfaglig forståelse av antropocen-begrepet," *Tidsskrift for kulturforskning* 13, no. 3 (2014): 6–21.
3. Helge Jordheim, "Introduction: Multiple Times and the Work of Synchronization," *History and Theory* 53, no. 4 (2014): 498–518. It is telling of the current direction of this strand of historical theory that the most recent translation of Koselleck's writings into English gives his concept of layers of historical time—*Zeitschichten*—a more pronounced geological twist by emphasizing its relation to geological concepts of time such as "strata" and "sediment." Reinhart Koselleck, *Sediments of Time: On Possible Histories*, trans. Sean Franzel and Stefan-Ludwig Hoffmann (Stanford: Stanford University Press, 2018).
4. See, for example, Robert Macfarlane, *Underland: A Deep Time Journey* (London: Hamish Hamilton, 2019), 15.
5. Christophe Bonneuil and Jean-Baptiste Fressoz, *The Shock of the Anthropocene: The Earth, History and Us*, trans. David Fernbach (London: Verso 2017), xiii, passim. See also J. R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge, MA: The Belknap Press of Harvard University Press, 2014).
6. See, for example, Nina Möllers, "Cur(at)ing the Planet—How to Exhibit the Anthropocene and Why," *RCC Perspectives* 3 (2013): 57–66; Dag Avango and Libby Robin, "Displaying the Anthropocene in and beyond Museums," in *Curating the Future: Museums, Communities and Climate Change*, ed. Jennifer Newell, Libby Robin, and Kirsten Wehner (New York: Routledge, 2017), 252–66; Gil Oliveira et al., "The Anthropocene in Natural History Museums: A Productive Lens of Engagement," *Curator: The Museum Journal* 63, no. 3 (2020): 333–51; Bergsveinn Thorsson, "Walking through the Anthropocene: Encountering Materialisations of the Geological Epoch in an Exhibition Space," *Nordisk Museologi* 28, no. 1 (2020): 103–19.
7. It remains an empirical question to pinpoint in time when this topic became a major theme in public debate, and any answer will depend on historical outlook and local context. But given current knowledge, and how emerging debates on human-induced

climate change was different from Western globalization debates in the 1960s and 1970s, this provisional generalization is reasonable. For a similar dating, see Dipesh Chakrabarty, "Postcolonial Studies and the Challenge of Climate Change," *New Literary History* 43, no. 1 (2012): 1–18.

8. Marit Ruge Bjærke describes a similar sense of constant and rapid change and accumulating knowledge as an affordance of open-ended databases and digital archives of species extinction; see Chapter 5, this volume.
9. Anders Ekström, "When Is the Now? Monitoring Disaster in the Expansion of Time," *International Journal of Communication* 10 (2016): 5342–61.
10. I conducted this case study as part of a larger research project entitled "From Pompeii to Fukushima: Time, Intermediality and Transregional Imaginaries in Disaster Discourse," which was funded by Riksbankens Jubileumsfond.
11. This is discussed at further length in Ekström, "When Is the Now?"
12. This builds on a Norwegian case study, but there are many examples that point to a similar development in other languages. Yngve Nilsen, "Da vesle Agnar ble ekstrem: Norsk meteorologi fra stormvarsel til ekstremværvarsel," *Tidsskrift for kulturforskning* 13, no. 3 (2014): 22–35. The circulation of temporal concepts and visual genres between public, institutional, and scientific contexts is also reflected in the IPCC reports, which is discussed in Nina Wormbs contribution to this volume, Chapter 11.
13. Richard Grusin, *Premediation: Affect and Mediality After 9/11* (Basingstoke: Palgrave Macmillan, 2010).
14. Ekström, "When is the Now?" On televisual meanings of "live" as a mode of news, see Paddy Scannell, *Television and the Meaning of "Live": An Enquiry into the Human Situation* (Cambridge, UK: Polity, 2014).
15. See, for example, Matthew Taylor, "Climate Change Making Storms Like Idai More Severe, Say Experts," *The Guardian*, March 19, 2019, retrieved October 12, 2021 from http://www.theguardian.com/world/2019/mar/19/climate-change-making-storms-like-idai-more-severe-say-experts. The early history of the rhetoric of example is discussed by John D. Lyons in *Exemplum: The Rhetoric of Example in Early Modern France and Italy* (Princeton: Princeton University Press, 1990).
16. Compare Bruno Latour, "Agency at the Time of the Anthropocene," *New Literary History* 45, no. 1 (2014): 1–18.
17. I use this term with Foucault in mind who argued for a methodology of "eventalization" as a way of making visible the historical forces at play in that which at a given moment in time was established as self-evident and universal. Michel Foucault, "Questions of Method," in *The Foucault Effect: Studies in Governmentality*, ed. Graham Burchell, Colin Gordon, and Peter Miller (Chicago: University of Chicago Press, 1991), 76–77.
18. Ekström and Svensen, "Naturkatastrofer i menneskets tidsalder," 14–15.
19. Fernand Braudel, "The Situation of History in 1950," in *On History*, trans. Sarah Matthews (Chicago: Chicago University Press, 1980), 12.
20. See the discussion on earth-historical time as "simply time" in Chakrabarty, "Anthropocene Time," 6–7. For examples of the turn to geology as a condition for reflection in contemporary art and cultural critique, see Elisabeth Ellsworth and

Jamie Kruse, eds., *Making the Geological Now: Responses to Material Conditions of Contemporary Life* (Brooklyn: Punctum Books, 2013); Heather Davies and Etienne Turpin, eds., *Art in the Anthropocene: Encounters Among Aesthetics, Politics, Environments and Epistemologies* (London: Open Humanities Press, 2015).

21. John Durham Peters, *The Marvelous Clouds: Toward a Philosophy of Elemental Media* (Chicago: University of Chicago Press, 2015).
22. On the increasing critical interest in media infrastructure, see, for example, Lisa Parks and Nicole Starosielski, eds., *Signal Traffic: Critical Studies of Media Infrastructures* (Champaign: University of Illinois Press, 2015); Jean-Christophe Plantin and Aswin Punathambekar, "Digital Media Infrastructures: Pipes, Platforms, and Politics," *Media, Culture & Society* 41, no. 2 (2019): 163–74.
23. This shift of existentialism's scale is also exemplified by the understanding of "the planet *as such* . . . as a site of existential concern." Dipesh Chakrabarty, "The Planet: An Emergent Humanist Category," *Critical Inquiry* 46 (Autumn 2019): 4.
24. Latour, *Down to Earth*, 40–41.
25. For a comprehensive history of climate modeling and weather data, see Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming* (Cambridge, MA: MIT Press, 2013). On ice cores as time-binding media, see for example Alessandro Antonello and Mark Carey, "Ice Cores and the Temporalities of the Global Environment," *Environmental Humanities* 9, no. 2 (2017): 181–203.
26. Peters, *Marvelous Clouds*, 243.
27. See, for example, Bonneuil and Fressoz, *Shock of the Anthropocene*; McNeill and Engelke, *Great Acceleration*; Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London: Verso, 2013).
28. Duncan Kelly, *Politics and the Anthropocene* (Cambridge, UK: Polity, 2019), 4–5.
29. Deborah R. Coen, "Big Is a Thing of the Past: Climate Change and Methodology in the History of Ideas," *Journal of the History of Ideas* 77, no. 2 (2016): 312.
30. See, for example, the discussion on Herder in Jordheim, "Introduction," 517–18.
31. See Chapter 3 by Sverker Sörlin in this book.
32. Compare Coen, "Big Is a Things of the Past," 314–15.
33. See, for example, Denis Cosgrove, *Geography and Vision: Seeing, Imagining, and Representing the World* (London: I.B. Tauris, 2008); Daniel Rosenberg and Anthony Crafton, *Cartographies of Time: A History of the Timeline* (New York: Princeton Architectural Press, 2010).
34. I have previously discussed these topics in several articles and books on nineteenth-century exhibitionary media; see, for example, Anders Ekström, "'Showing at One View': Ferdinand Boberg's 'Statistical Machinery' and the Visionary Pedagogy of Early Twentieth-Century Statistical Display," *Early Popular Visual Culture* 6, no. 1 (2008): 35–50; Anders Ekström, "Walk-In Media: International Exhibitions as Media Space," in *The Routledge Handbook of Museums, Media and Communication*, ed. Kirsten Drotner et al. (New York: Routledge, 2019), 17–30.
35. Rosalind Williams, *Notes on the Underground: An Essay on Technology, Society and the Imagination* (Cambridge, MA: MIT Press, 1992); Adelene Buckland, *Novel Science:*

Fiction and the Invention of the Nineteenth-Century Geology (Chicago: University of Chicago Press, 2013).

36. See, for example, Brian R. Hamnett, *The Historical Novel in Nineteenth-Century Europe: Representations of Reality in History and Fiction* (Oxford, UK: Oxford University Press, 2011).
37. Ralph O'Connor, *The Earth on Show: Fossils and the Poetics of Popular Science, 1802–1856* (Chicago: University of Chicago Press, 2007).
38. Anders Ekström, "Seeing From Above: A Particular History of the General Observer," *Nineteenth-Century Contexts: An Interdisciplinary Journal* 31, no. 3 (2009): 185–207.
39. The geneaology of the modern preoccupation with the category of the contemporary—or "today," as he also phrases it—is discussed by Michel Foucault in his essay on Immanuel Kant's 1784 essay *Was ist Aufklärung?* Here Foucault identifies the departure point for what he refers to as an "*attitude* of modernity," not an epoch or period, which focused critical reflection on its own actuality and introduced the idea of the contemporary as a distinctive temporality of modernity. Michel Foucault, "What Is Enlightenment?" in *The Foucault Reader*, ed. Paul Rabinow (New York: Pantheon Books, 1984), 38–39 (my italics).
40. Reinhart Koselleck, "'*Neuzeit*': Remarks on the Semantics of Modern Concepts of Movement," in *Futures Past: On the Semantics of Historical Time*, trans. Keith Tribe (New York: Columbia University Press, 2004), 224.
41. Nicholas Mirzoeff, "Visualizing the Anthropocene," *Public Culture* 26, no. 2 (2014): 220–23.
42. Bonneuil and Fressoz, *Shock of the Anthropocene*, chapter 8. See also Chapter 4 by Julia Nordblad in this volume, on forest policies in early nineteenth-century France.
43. Martin J. S. Rudwick, *Earth's Deep History: How It Was Discovered and Why It Matters* (Chicago: University of Chicago Press, 2014).
44. Anders Ekström, "Exhibiting Disasters: Mediation, Historicity and Spectatorship," *Media, Culture & Society* 34, no. 4 (2012): 472–87.
45. For a selection of works, see for example Victoria C. Gardner Coates, Kenneth Lapatin, and Jon L. Seydl, *The Last Days of Pompeii: Decadence, Apocalypse, Resurrection* (Los Angeles: J. Paul Getty Museum, 2012).
46. For a more thorough discussion of the millenia-long remediation of the ancient eruption of Vesuvius, see Anders Ekström, "Remediation, Time and Disaster," *Theory, Culture & Society* 33, no. 5 (2016): 117–38.
47. Reinhart Koselleck, "History, Histories, and Formal Time Structures," in *Futures Past: On the Semantics of Historical Time*, trans. Keith Tribe (New York: Columbia University Press, 2004), 93–104. For a discussion of the critique of the concept of *die Gleichzeitigkeit des Ungleichtzeitigen* as a version of modernization theory, see Jordheim, "Introduction," 504–5.
48. For an introduction to Diderot's writings on the tableau, see Romira Worvill, "From Prose *peinture* to Dramatic *tableau*: Diderot, Fénelon and the Emergence of the Pictorial Aesthetic in France," *Studies in Eighteenth-Century Culture* 39 (2010): 151–70.

49. On the early modern tradition, see Lyons, *Exemplum*.
50. Ekström, "Exhibiting Disasters."
51. I borrow this term from Harald Innis's distinction between time-binding and space-binding media. See Harold A. Innis, *Empire and Communications* (Toronto: Dundurn Press, 2007).
52. John D. Lyons, *Before Imagination: Embodied Thought from Montaigne to Rousseau* (Stanford: Stanford University Press, 2005), 24–26.
53. Ekström, "Remediation, Time and Disaster," especially 128–29; Hamnett, *The Historical Novel*.
54. On the nineteenth-century globalization of news agencies and telegraph networks, see Dwayne R. Winseck and Robert M. Pike, *Communication and Empire: Media, Markets, and Globalization, 1860–1930* (Durham, NC: Duke University Press, 2007); Simon J. Potter, "Webs, Networks, and Systems: Globalization and the Mass Media in the Nineteenth- and Twentieth-Century British Empire," *Journal of British Studies* 46, no. 3 (2007): 621–46; Gordon M. Winder, "London's Global Reach? Reuters News and Network, 1865, 1881, and 1914," *Journal of World History* 21, no. 2 (2010): 271–96. On the politics of common time, see also Vanessa Ogle, "Whose Time Is It? The Pluralization of Time and the Global Condition, 1870s–1940s," *The American Historical Review* 118, no. 5 (2013): 1376–1402.
55. The most comprehensive contemporary report on the Krakatoa eruption and its after-effects was G. J. Symons, ed., *The Eruption of Krakatoa, and Subsequent Phenomena: Report of the Krakatoa Committee of the Royal Society* (London: Trubner & Co., 1888). For a recent account, see Simon Winchester, *Krakatoa: The Day the World Exploded: August 27, 1883* (New York: Harper Perennial, 2004).
56. Peter Gould, "Lisbon 1755: Enlightenment, Catastrophe, and Communication," in *Geography and Enlightenment*, ed. David N. Livingstone and Charles W. J. Withers (Chicago: University of Chicago Press, 1999), especially 399–400.
57. Compare François Hartog, *Regimes of Historicity: Presentism and Experiences of Time*, trans. Saskia Brown (New York: Columbia University Press, 2015).
58. See, for example, Stefan Tanaka, "History without Chronology," *Public Culture* 28, no. 1 (2015): 161–86; Jo Guldi and David Armitage, *The History Manifesto* (Cambridge, UK: Cambridge University Press, 2014).
59. Fredric Jameson, "The End of Temporality," *Critical Inquiry* 29, no. 4 (2003): 695–718.

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Conclusion

Staffan Bergwik and Anders Ekström

Fernand Braudel maintained that historians can never get away from the issue of time: it sticks to the historian's thinking "like soil to a gardener's spade." Looking back on the gloomy circumstances in which he finished his masterpiece on the Mediterranean world in the era of Phillip II—imprisoned during World War II and trying to escape from the pressures of event time—he concluded that "it is not so much time which is the creation of our own minds, as the way in which we break it up." The different layers and rhythms of time that he discovered through his isolated writing were all interdependent and "measured on the same scale." The *longue durée*, conjuncture, and event fitted neatly into each other, he continued, and "to be able to achieve an imaginative understanding of one of these time spans is to be able to understand them all." Together, they formed an impression of the "weight of historical time," which distinguished the historian's work from that of sociologists and philosophers.[1]

In this volume, we have worked from a shared sense of the importance of addressing the "weight of historical time" in the present. This precisely involves the need to understand the relationship between different time spans that Braudel pointed to, but the conditions for the encounter with issues of historical and natural times have changed. Braudel was writing in the beginning of a period in Western history that has later been referred to as the Great Acceleration, and where he identified slow and unchanging patterns of repetition, we now see disruptive events and challenging patterns of intertemporal dependence.[2] At the same time as this volume has argued for the importance of taking a long perspective on the history of scaling, dividing, measuring, and visualizing times in history and nature, our approach to these issues was necessarily shaped by ongoing processes of temporalization that impinge on global society. As we write, the present displays increasing links between different temporal frames and durations, including altered divisions between natural and historical times. Ideas of a malleable future are increasingly challenged, and different eras open up to each other into what we might, with Rita Felski, call "temporal turbulence."[3]

The main contribution of this volume to the history of knowledge has been to explore the divides between times in history and times in nature since the eighteenth century. Moreover, we have opened multiple timescales and rhythms to historical understanding. While we wish to point to a multitude rather than to some coherent temporal regime, there emerges contours of a synthesis from the chapters. In particular, several contributors corroborate the overall trajectory of three eras of major temporal recalibration. A recurring feature in all these periods was the intensified efforts to display and organize time. Indeed, synchronization, coordination, and creation of common times stand out as crucial. What we in the introduction, with Harold Innis, called time-binding techniques are what divided, assembled, or organized timescales of natural and human history.

The first era of synchronization took place in the eighteenth century as time frames expanded and global histories of the earth appeared. Stratigraphy and notions of "layers" developed as a way of drawing together and eventually creating disciplinary divides between geological and phenomenological timescales, which were potentially in conflict (Chapter 1 by Jordheim, Chapter 3 by Sörlin). The second era of synchronization—illustrated in Chapter 2 by Holmberg and Chapter 4 by Nordblad—saw the emergence of national and international institutions that created infrastructures of timekeeping, ultimately on a global scale. In this era, organizations assumed responsibility for both the long-term and the short-term. Within nation states, crucial functions and even the lives of individuals were synchronized, resulting in a fine-grained ordering of time. The varying functions of the nation had to be on time and coordinated across regional and national borders (Chapter 2 by Holmberg). The third era of synchronization brings us into the twentieth century and the emergence of "environmental times." Long timescales of nature and culture were increasingly discussed in terms of climatic changes. Indeed, the environment as a concept gained traction throughout the twentieth century and had integrative qualities in terms of understanding temporality (Chapter 3 by Sörlin). Eventually, supported by increasingly interconnected public and scientific records and monitoring of anthropogenic climate change, the concern with climate change temporalities entered the mainstream of global news and public discourse around the turn of the twenty-first century (Chapter 12 by Ekström).

Actors in the first era drew heavily on geological metaphors like "layers" to describe times past and present. Actors in the second era built political institutions to govern social communities. Yet since at least the nineteenth century, dividing and assembling times have also included considerations of the history and future of multiple life-forms. Biocultural times have been crucial, set at the intersection of biology and culture. Biocultural times, moreover, have often been underpinned by political considerations concerning the long-term of species and the short-term of industry, markets, and individuals. The temporal character of plants, forests, or species threatened with extinction have resulted in vexing political questions about responsibilities across generations and epochs, as well as the need to create sustenance in the now. In that sense, notions of time have for long been fraught with controversy and differing visions of society. The past and the future of nature and biodiversity relate to how timescales have been formulated and governed in political contexts where time-binding techniques served as crucial backdrops (Chapter 4 by Nordblad and Chapter 5 by Bjærke). Organisms and organic material have multiple rhythms, and throughout the nineteenth and twentieth centuries they could scarcely be separated from the rhythm of human societies. Today, more than ever, cultural heritage and path dependency in industrial production rub against the long-term of nature and climate. The oil resting in the ground for millions of years, for instance, has been aligned with the times of industry and culture, and summoned into temporal concentrations with a bearing on national identities. Durations of earthly, industrial, and cultural temporalities have been arranged to make each other meaningful and comprehensible (Chapter 6 by Ruud).

Central to the volume has also been the argument that a history of dividing times is ultimately a history of knowledge. Displaying, coordinating, and synchronizing time depended upon time-binding knowledges and visual genres. Since the eighteenth century, practices, tools, media, and metaphors have been used to study, conceptualize, and display timescales and rhythms. Timelines, chronologies, and graphs connected and visualized frames, layers, and durations of time; both text and visual signs pinned down abstract time into legible products. The timeline, the year, and the archive were interfaces and visual spaces to capture different, yet related, rhythms and directions, e.g., nature's cyclical time and the linear time of history. The chronological timeline emerged as a narrative and textual element—or as a visual representation—to organize documents and the past. Moreover, narrative and visual time-binding techniques included universally acknowledged signs to display features of the human and natural world with a deep temporality (Chapter 8 by Hagström Molin; Chapter 9 by Bergwik; Chapter 7 by Wickberg; Chapter 12 by Ekström).

The time-binding knowledges and visual genres display a long history and a remarkable path dependence. They are certainly still in play. Nevertheless, important disruptions occurred in the twentieth century, during the third era of synchronization, with the emergence of environmental times. Clearly an innovation, the temperature target of 2°C is a political goal resting on efforts to record and envision the past and future climate of the earth. Yet, the way it is recorded and discussed builds on a plethora of measurements, models, and documents assembled into timelines that compress complex data on temperatures, climatic shifts, and CO_2-levels into "records" that speak to the past and the future. The assembling of geophysical, biological, and historical timescales has ushered in political debates and cultural perceptions of a distant past and a turbulent present. Recording the climate through time-binding techniques displays how temporality and the political context of global governance are profoundly entwined (Chapter 11 by Wormbs; Chapter 10 by Paglia and Isberg; Chapter 12 by Ekström).

A final overarching theme that emerges from the chapters in this volume is how dividing times was a product of, and had repercussions on, the modern organization of knowledge. The division of knowledge conditioned methods to understand and describe time frames and historical durations. While much research in the history of the sciences have rightly discussed the emerging academic disciplines in the nineteenth century, such classifications can be revisited with the issue of temporal knowledge as a critical lens. Throughout the eighteenth and nineteenth centuries, temporal knowledge was produced in ways preceding and transcending modern branches of knowledge making. Influential natural philosophers and whole areas of study spanned timescales and boundaries of natural and cultural history. They encapsulated deep time, natural history, and human history, as well as environmental and social sciences. *Historia naturalis* was part of a longer history where geological time was played out against knowledge about human history. Moreover, writing in the nineteenth century could still be deeply affected by the relations to the geosciences, or shaped by the perception of geohistorial time in the context of earthquakes and volcanic eruptions (Chapter 1 by Jordheim; Chapter 7 by Wickberg; Chapter 8 by Hagström Molin; Chapter 12 by Ekström).

Nevertheless, starting in the nineteenth century there was an overall process of branching out temporal knowledge into scholarly disciplines. Increasingly, scholarly fields were restricted to studying either the rhythms of nature or the rhythms of culture. Even fields of knowledge which envisioned a unified history of nature and culture failed to find purchase in academic history writing as the divides between natural and cultural history became increasingly fixed (Chapter 9 by Bergwik). The overall twentieth-century trend towards scientific specialization compartmentalized time knowledge. Nevertheless, there are examples of scholarship that sought a synchronization of cultural, social, and political temporalities in conceptualizations like "earth," "environment," "geography," or "climate." Work on environmental time however, gradually moved into the natural sciences with historians seeking other routes to understanding the past. Environmental time became the concern of disciplines like ecology, geography, and, from the 1980s, Earth System Science (Chapter 3 by Sörlin).

Our conclusion then, is one of multiple times coexisting, yet also with ongoing efforts to divide, assemble, and balance timescales since the eighteenth century. The overarching processes include the eras of intensified temporal recalibrations and the increasing branching out of temporal knowledge. However, at every turn in these processes, there were contradictions and counterexamples. Accordingly, we welcome further critical discussions, taking the *longue durée* of dividing times and organizing knowledge into consideration. The current temporal thickening should inspire re-evaluations both of transtemporal history in the tradition of Febvre and Braduel, and theories of historical time from Steno to Koselleck. It should spur historians to revisit perennial questions about forms of historical narrative, periodization, presentism, and the relation between natural and historical times. When W. J. T. Mitchell, in early 2021, speaks of a "tense present" (rather than a present tense) we interpret it as a call to historians to keep returning to the past and investigate how time has been divided, assembled, mediated, pinned down, and discussed.[4]

Staffan Bergwik is Professor of the History of Science and Ideas at the Department of Culture and Aesthetics at Stockholm University. His research focuses on the cultural history of the modern sciences, including topics like science and verticality, science and temporality, history of emotions, history of knowledge, and science and the media. Recent publications include "Elevation and Emotion: Sven Hedin's Mountain Expedition to Transhimalaya 1906–1908," *Centaurus* (2020); "Standing on Whose Shoulders? A Critical Comment on the History of Knowledge," *Forms of Knowledge: Developing the History of Knowledge* (Nordic Academic Press, 2020); and *Domesticity in the Making of Modern Science* (Palgrave MacMillan, 2015).

Anders Ekström is Professor of the History of Science and Ideas at Uppsala University, and currently Professor II of History of Knowledge at Oslo University. He has published broadly on modern cultural and media history and theory for three decades. His most recent work includes a series of essays on time and temporality in the history of natural disasters, which appeared in journals such as *Theory, Culture & Society*, and *Media, Culture & Society*. His ongoing research is focused on two main areas: cultural processes of temporalization in the context of climate change, and the modern history of publicness.

NOTES

1. Fernand Braudel, "History and Sociology," in *On History*, trans. Sarah Matthews (Chicago: University of Chicago Press, 1980), 77.
2. J. R. McNeill and Peter Engelke, *The Great Acceleration: An Environmental History of the Anthropocene since 1945* (Cambridge, MA: The Belknap Press of Harvard University Press, 2014).
3. Rita Felski, "Context Stinks!" *New Literary History* 42, no. 4 (2011): 576. 4.
4. W. J. T. Mitchell, "Present Tense 2020: An Iconology of the Epoch," *Critical Inquiry* 47, no. 1 (2021): 370–406.

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