Historical Social Research
Historische Sozialforschung

Special Issue

Andrea Westermann & Christian Rohr (Eds.)

Climate and Beyond. The Production of Knowledge about the Earth as a Signpost of Social Change

Mixed Issue

Articles

No. 152
HSR Vol. 40 (2015) 2

The Journal: Editorial Board

Main Editors

Heinrich Best (Jena), Wilhelm H. Schröder (Cologne)

Managing Editors

Wilhelm H. Schröder, In-Chief (Cologne), Nina Baur (Berlin), Rainer Diaz-Bone (Lucerne), Johannes Marx (Bamberg)

Co-operating Editors

Onno Boonstra (Nijmegen), Joanna Bornat (London), Franz Breuer (Münster), Leen Breure (Utrecht), Christoph Classen (Potsdam), Jürgen Danyel (Potsdam), Bert De Munck (Antwerp), Claude Didry (Paris), Claude Diebolt (Strasbourg), Georg Fertig (Halle), Gudrun Gersmann (Cologne), Karen Hagemann (Chapel Hill, NC), M. Michaela Hampf (Berlin), Rüdiger Hohls (Berlin), Jason Hughes (Leicester), Ralph Jessen (Cologne), Claire Judde de Larivière (Toulouse), Hans Jørgen Marker (Gothenburg), Günter Mey (Magdeburg), Jürgen Mittag (Cologne), Katja Mruck (Berlin), Dieter Ohr (Berlin), Thomas Rahlf (Bonn), Kai Ruffing (Cassel), Patrick Sahle (Cologne), Kevin Schürer (Leicester), Jürgen Sensch (Cologne), Manfred Thaller (Cologne), Paul W. Thurner (Munich), Roland Wenzlhuemer (Heidelberg), Jens O. Zinn (Melbourne)

Consulting Editors

Erik W. Austin (Ann Arbor), Francesca Bocchi (Bologna), Leonid Borodkin (Moscow), Gerhard Botz (Vienna), Christiane Eisenberg (Berlin), Josef Ehmer (Vienna), Richard J. Evans (Cambridge), Jürgen W. Falter (Mainz), Harvey J. Graff (Columbus, OH), Arthur E. Imhof (Berlin), Konrad H. Jarausch (Chapel Hill, NC), Eric A. Johnson (Mt. Pleasant, MI), Hartmut Kaelble (Berlin), Hans Mathias Kepplinger (Mainz), Jürgen Kocka (Berlin), John Komlos (Munich), Jean-Paul Lehners (Luxembourg), Jan Oldervoll (Bergen), Eva Österberg (Lund), Janice Reiff (Los Angeles), Ernesto A. Ruiz (Florianopolis), Martin Sabrow (Potsdam), Rick Trainor (Oxford), Louise Tilly (New York), Jürgen Wilke (Mainz)

CONTENTS

Special Issue: Climate and Beyond

Introduction

Andrea Westermann & Christian Rohr 7
Climate and Beyond. The Production of Knowledge about the Earth as a Signpost of Social Change. An Introduction.

The Politics of Deep Time

Matthias Dörries 22
Politics, Geological Past, and the Future of the Earth.

Christoph Rosol 37
Hauling Data. Anthropocene Analogues, Paleoceanography and Missing Paradigm Shifts.

Bernhard C. Schär 67
Earth Scientists as Time Travelers and Agents of Colonial Conquest. Swiss Naturalists in the Dutch East Indies.

Knowledge of Natural Disasters

Lorena B. Valderrama 81
Seismic Forces and State Power: The Creation of the Chilean Seismological Service at the Beginning of the Twentieth Century.

Kerry Smith 105
Earthquake Prediction in Occupied Japan.

Brian Rumsey 134
From Flood Flows to Flood Maps: The Understanding of Flood Probabilities in the United States.

Earth Governance

Andrea Westermann 151
Geology and World Politics: Mineral Resource Appraisals as Tools of Geopolitical Calculation, 1919-1939.

Perrin Selcer 174
Fabricating Unity: The FAO-UNESCO Soil Map of the World.

Christian Kehrt 202
Gondwana's Promises. German Geologists in Antarctica between Basic Science and Resource Exploration in the Late 1970s.

Elena Aronova 222
Environmental Monitoring in the Making: From Surveying Nature's Resources to Monitoring Nature's Change.

Naomi Oreskes 246
How Earth Science Has Become a Social Science.

Ola Uhrqvist 271
One Model to Fit All? The Pursuit of Integrated Earth System Models in GAIM and AIMES.

Mixed Issue

Jørgen Møller, Alexander Schmotz & Svend-Erik Skaaning 301
Economic Crisis and Democratic Breakdown in the Interwar Years: A Reassessment.

Paul Puschmann, Nina Van den Driessche, Per-Olof Grönberg, Bart Van de Putte & Koen Matthijs 319
From Outsiders to Insiders? Partner Choice and Marriage among Internal Migrants in Antwerp, Rotterdam & Stockholm, 1850-1930.

Climate and Beyond. The Production of Knowledge about the Earth as a Signpost of Social Change. An Introduction

Andrea Westermann & Christian Rohr[*]

Abstract: *»Klima und anderes mehr. Wissensproduktion über die Erde als Indikator für Sozialen Wandel. Eine Einleitung«.* Environmental history and the history of the earth and environmental sciences are now converging in three fields of research: analyzing the politics of deep time, reconstructing the making of natural disaster knowledge, and exploring the national and transnational devices and strategies of earth governance established in the twentieth century. We argue that including the global physical world in our historical analysis will help us to better understand the social world – past and present.

Keywords: Environmental history, history of earth sciences, deep time, natural disasters, earth governance.

1. Introduction

Since the early 1980s, when the history and sociology of science took a practice turn and studied knowledge in the making, social factors have become a common explanatory resource for the production and validation of scientific knowledge. From early on, historians of geology and other earth sciences have contributed to this trend. Roy Porter was one of the first to explore the notion that the making of modern geology was deeply embedded in upper-class Victorian culture (Porter 1973, 1978).[1] Martin Rudwick and James Secord did pioneering research in field sciences by analyzing the visual methods and collecting practices of geologists amid an overwhelming wealth of stratigraphic details; they also highlighted the subjective and physical aspects of fieldwork, which are difficult to standardize (Rudwick 1976, 1985; Secord 1986). Given the territorial dimension of geological research, the imperial aspects of the earth sciences became another topic of research. Robert Stafford paved the way by showing

[*] Andrea Westermann, Historical Seminar, University of Zurich, Karl Schmid-Strasse 4, CH-8006 Zurich, Switzerland; andrea.westermann@hist.uzh.ch.
Christian Rohr, Institute of History, University of Bern, Länggassstrasse 49, CH-3012 Bern, Switzerland; christian.rohr@hist.unibe.ch.

[1] Possibly for the sake of his argument, Porter downplayed the quest for mineral resources (Stafford 1990, 68; Lucier 2009, 109).

that the British system of stratigraphic nomenclature was universalized by its application to far-flung geographical regions (Stafford 1984, 1990).

Since then, the methodological approach to invoke society as an analytical category in the history of science has continued to gain momentum. However, it is still less common to reverse the perspective and ask: what does the production of geoscientific knowledge tell us about the social world generating and demanding this knowledge? What can we learn about societies, their norms, and collective mentalities from analyzing how people dealt with planet earth, its history, climate, surface patterns, or the mechanisms underlying its dynamic structure?

Historians of the earth and environmental sciences are in a good position to include "the physical world, as they describe what humans do to one another," as one prominent historian outlined the challenge for his discipline today (Iriye 2008, 643). Our HSR Special Issue focuses on using the history of the earth and environmental sciences as an entry point from which to study broader societal change.

2. Environmental History as *Gesellschaftsgeschichte*[2]

"Climate and beyond" started out as a title that complied with the Oeschger Center for Climate Change Research's funding programs.[3] The phrase soon revealed its true guiding power. Throughout our conference, it became apparent that the recent historicization of today's climate-related studies and concerns has been invigorating the history of the earth and environmental sciences on a wider scale. Much of the new work comes from environmental historians (Fleming 1998; Griffiths 2007; White 2007; Pfister 2010; Carey 2010), which is why we start our *tour d'horizon* by examining how the social world is conceptualized in their field.

In environmental history, the desire to learn more about society by analyzing its 'other' side – nature and the environment – has long been a driving force. Environmental historians often deal with the same topics as historians of the geosciences: the climate, rivers, oceans, mountains, the atmosphere, natural resources, or nuclear waste storage. In doing so, they very successfully extract the images society has of and creates for itself. They are able to show that, throughout history, regional and national societies have developed a "second nature" (William Cronon) by incorporating natural resources and environmental structures like rivers into their built and market environments. They also explore the consequences of creating such socio-physical systems for both

[2] *Gesellschaftsgeschichte:* History of Society.

[3] The conference has been sponsored by the Oeschger Center for Climate Change Research, the Swiss National Science Foundation, the Fondation Johanna Dürmüller-Bol, and the Historical Seminar of the University of Zurich, all of whom we cordially thank for their generous support.

nature and humans (see Worster 1985; Cronon 1991; White 1996; Cioc 2002; Culver 2010; Curtis 2013; also Sieferle 2001; Tucker 2010; Radkau 2012, for transnational perspectives). Furthermore, environmental historians have described the production and substantiation of social inequalities (Mitman, Murphy and Sellers 2004; Melillo 2014).

In the 1920s, the founders of the *Annales* school, such as Lucien Febvre, stressed the role of geography and other earth sciences for a *histoire totale*. The *Annales* historians were among the first to base climate history on man-made documentary and early instrumental sources. Their environmentalist approach to history became widely acknowledged after World War II, when Fernand Braudel published his epochal book *The Mediterranean and the Mediterranean World in the Age of Philip II* in 1949 (Braudel 1966). In a radical departure from his Parisian colleagues, Emmanuel LeRoy Ladurie even promoted a "history without humans" (LeRoy Ladurie 1967, 1972). Others focused on the direct or indirect influence of weather and climate on the social, economic and political history of societies; they explained riots, the emergence of witch hunts, or the outcome of battles in conjunction with climatic conditions and weather patterns (Wigley, Ingram and Farmer 1981; Lamb 1982; Behringer 2010).

Among German speaking researchers, Christian Pfister has embraced climate history from early on. Combining the findings of the humanities and natural sciences, he established research on climate reconstruction and impacts within the historiographical disciplines (Pfister 1984, 1999). According to Pfister and many scholars thereafter, both non-human climate history and societal developments explained only by climate and weather patterns tend to be monocausal and climate-deterministic, thus betraying a key concept of historical research, contingency. Arguably, such a "history without humans" cannot be written at all, given that all documentary and instrumental sources related to weather and climate are informed by the interests and mind frames of the observers (Mauelshagen 2009). For historians of science, this claim leads directly to the issues at stake.

3. History of the Earth and Environmental Sciences as *Gesellschaftsgeschichte*

In times of controversial climate policy debates, historians of the earth and environmental sciences are now viewing the issue of social change through the lens of earth matters. Recognizing and contextualizing major climate-related trends in contemporary societies, they have helped to establish three threads of research. First, in a move away from traditional accounts of the discovery and popularization of deep time, these historians deal with what we call, in this HSR Special Issue, the politics of deep time. Second, in an attempt to recover past experiences of rapid environmental change, they have delved into the

creation and characteristics of disaster knowledge. Last but not least, they contribute to the study of ideas, practices, and organizations of earth governance.

3.1 The Politics of Deep Time

The discovery and history of deep time fascinated nineteenth-century poets and novelists like Johann Wolfgang von Goethe, Novalis, Adalbert Stifter, Jules Verne, and Charles Dickens. They populated their works with contemporary scientific personae, contemplated the imperceptibility of geological change, sought analogies between the inner earth and inner life of man or were inspired by the fragmentary outcrops of rock strata to depict the fragmentation of social reality (Ziolkowski 1990; Buckland 2013; Schnyder 2013).

In the mid-twentieth century, deep time as conceptualized by stratigraphy inspired structural historians and ethnologists like Fernand Braudel and Claude Lévi-Strauss to call for a layering of historical time in order to grasp underlying, previously buried patterns of social organization. Geohistory or "une histoire quasi immobile" (Braudel 1966, 16) was what Braudel had in mind while developing his analytical category of "*longue durée*" (325), as distinguished from "social time" and "individual time" (17). Lévi-Strauss admired a "method of which geology had established the canon," and Marxism represented the "application" to society. It was a method, he explained, where the investigator started out "with apparently impenetrable phenomena," only to find that "understanding consists in the reduction of one type of reality to another; that true reality is never the most obvious in realities, and that its nature is already apparent in the care which it takes to evade our detection" (Lévi-Strauss 1961, 61).

Since the turn of the twenty-first century, a new wave of historians and literary scholars has reexamined the scientific making of deep time and its broader reception (Rudwick 2005; O'Connor 2007; Buckland 2013; Krüger 2013). Their studies have provided us with a cultural history of deep time. They analyzed what the rupture that opened up the "dark abyss of time" (Rossi 1984) meant to mankind's history of mentalities and explored the devices of scientific imagination involved in the geo-historical enterprise. In a complementary perspective, historians began to write the political history of deep time. This is not so much a contribution to the history of nineteenth-century historicism or inner scientific controversies (as political as these developments may be). Rather it is a late twentieth-century history of regional and global economies (for instance Valencius 2013, 293 and 308-310) or international politics (Martin-Nielsen 2013).

With the call for a new, man-made geological epoch, the Anthropocene, and the closely related topics of dwindling fossil fuels and climate change, deep time has become the backdrop against which we not only see or predict our societal future, but also rewrite our recent history (Heymann 2013; Bonneuil and Fressoz 2013). For instance, the making and mechanisms of our fossil fuel dependency have become an urgent research issue (Pfister 2010; Jones 2010;

Mitchell 2011; Wells 2012). Historian Dipesh Chakrabarty pushes us to make the concurrent advent of two secular trends in the late 1980s and early 1990s our focus of historical research: "If, indeed, globalization and global warming are born of overlapping processes, the question is, How do we bring them together in our understanding of the world?" (Chakrabarty 2000, 198).

In this HSR Special Issue, *Matthias Dörries* explores the political opportunities and uses scientists have made of deep time, emphasizing their – sometimes manipulative – efforts to make geohistorical and historical time compatible. He argues that forecasting (global) societies' climatic future has become possible only after deep time was furnished with ever more geohistorical events lending themselves to detailed narratives of change and paleoecological interpretation.

Christoph Rosol, in his article on the working practices of paleoclimatology, explores the longstanding role of the earth sciences in filling the vast stretches of deep time with climate events. In a pragmatic acknowledgment of their purely heuristic strategies, paleoclimatologists combine descriptive, explanative, and speculative methods of scientific inquiry to successfully deal with epistemic uncertainties and achieve robust interpretations of past earth processes. Despite not examining the role of climate modeling expertise in environmental decision-making, Rosol's analysis lends further evidence to the new politics of deep time. Having resisted any clear-cut categorization into exact or inexact sciences, the earth sciences were considered slow to adopt the standards of cutting-edge (laboratory) research, and unwilling, in an era of disciplinarity, to abandon the fundamentally interdisciplinary character of their research (Frängsmyr 2007, 133; Forman 2012). Today, the earth and environmental sciences are praised, Rosol argues, by both science studies and politics, as exemplary models of acting in the face of complexity and uncertainty.

In fact, a "politics of deep time" was already put to work in the nineteenth century when Imperial Geology "annexed the landscapes of the past" of Britain's colonies (Stafford 1990). *Bernhard Schär*, in his case study on Swiss naturalists in the Dutch East Indies, argues that the spatialization of time in stratigraphy and the temporalization of space in anthropology were widespread and interconnected practices of the European nineteenth-century sciences which mattered politically. The earth scientific representations impacted as much on European identity politics as the scientific exploration campaigns cleared the way into foreign inner territories for the colonial powers.

3.2 Knowledge of Natural Disasters

Before climate change became a public issue, historians considered earthquakes and floods the most obvious events for studying the impact of the earth sciences on society. Natural disaster studies of the past two decades have not only focused on the reconstruction of natural disasters or the frequency of recurrent extreme events, but also on aspects such as local knowledge, learned

discourses, processes of collective learning, societal vulnerability, resilience and adaptation (Pfister 2002; Schenk 2007; Rohr 2007). In her study on "human seismographs," Deborah Coen recently called for a better understanding of how individuals experience and remember a changing, active environment (Coen 2013; her approach resonates with the efforts of cultural and climate historians like Bankoff 2003; Endfield 2014). She proposed studying "disaster science" as the knowledge produced at the intersection of geology, psychology and the humanities. Drawing on the many individual and community experiences of earth tremors documented in the archives, Coen's study fully reinforces the traditional strength of historical analyses, i.e. the importance we attach to the local and the particular.

Lorena Valderrama deals with the emergence of a seismic monitoring service in Chile, a hotspot of earthquake activity. Like the authors above, she makes the case for analyzing institutional change as a 'proxy' of environmental hazard knowledge. In 1906, the Valparaiso earthquake marked a major breakthrough in Chilean earthquake observation. Just as in turn-of-the-century Japan, continuous earthquake monitoring – by both mechanical seismographs and lay observers – and new building regulations were deemed necessary to mitigate the country's vulnerability. And just as in Japan, Chile's government brought in European geologists as early institution builders. What becomes evident is that despite the emergence of international political and scientific organizations, nationalizing the world and acquiring more knowledge about the earth were inextricably linked ambitions for much of the twentieth century.

In his article, *Kerry Smith* focuses on Japan, fixated on disaster planning in the aftermath of atomic war. A group of leading Japanese earth scientists warned the nation that major earthquakes might soon occur. The debates in Japan's early postwar era made the geologists guardians of public safety. Smith explores the tensions between individual scientists and newly formed official bodies charged with coordinating earthquake prediction research. The experts struggled over the question of how legitimate it is to predict the unpredictable. Smith's detailed account could tempt us to conclude that the Cold War notion of disaster preparedness was depoliticized by eagerly focusing on natural rather than nuclear hazards. We believe that twentieth-century Japanese history can greatly benefit from further developing this line of analysis.

Brian Rumsey analyzes flood probability studies in the USA as a means of understanding flood recurrences and magnitudes in the twentieth century. Whereas most people living near European rivers had been there for generations, this long-time local knowledge was not available to many of the new settlers in America. Early efforts in the first half of the twentieth century had focused on projecting flood volumes in scientific studies, which could only be accessed and understood by specialists. Later on, maps of flood risk created flood awareness among a broad audience. The concepts of the 100-year flood and the 100-year floodplain were established as standard terminology to communi-

cate flood risk. Rumsey concludes by pointing out that, in the face of rapid climate change, this terminology is about to become dangerously misleading.

3.3 Earth Governance

Flourishing research on the creation of global environments indicates that globalization and global warming are indeed concurrent developments of the twentieth century. Many studies on the history of the earth and environmental sciences are dedicated to what Robert Kohler, following Braudel's *longue durée*, has called histories of "the long degree" (Kohler 2011, 216). By now, we are comparably well-informed about the beginnings of our "planet management" in the 1970s, when the earth and its large-scale structures became objects of global ecological concern and planning (Elichirigoity 1999; Edwards 2010; Höhler 2015; see also Fleming 2011).

Obviously, planet earth and its global environments have not only been objects of ecological, but also of political concern. They have recurrently served as vehicles or sites of managing worldly affairs (Oreskes and Doel 2002, 552; Doel 2003; Oreskes 2003). Cultural geographer Denis Cosgrove has given a compelling reason for the ecological and political co-construction of our planet. He observed that "contested global visions" have emerged from the famous Apollo space photographs: "whole earth" versus "one world" (Cosgrove 1994). Both visions have distinct but closely related histories which are inextricably linked to European and Western epistemology (Burton 2007, 326; Deparis and Legros 2000; Cosgrove 2001; Shen 2014, 4).

A common theme explored in this section is earth governance by means of global surveying and monitoring. As a rule, these practices amounted to the assessment of global natural resources and other environmental services (but see, for instance, Barth 2003; Edwards 2010, 207-15 on the geoscientific monitoring of international nuclear test activities).

Andrea Westermann explains how, over the twentieth century, nonfuel mineral resource appraisals, i.e. attempts to quantify the metal content of the earth's crust, became tools of geopolitical calculation: They aimed to measure and manage natural resources as well as state power relations. Building on studies dealing with the cameralistic practices of calculation, bookkeeping, and improvement in agriculture and forestry in the early modern period, she outlines how, around 1900, geologists and mineral resource experts began making a global inventory of the earth's crust in order to secure future mining opportunities. At the same time, they were surveying trends in the worldwide production and consumption of minerals. After World War I, governments would regularly rely on this ever-varying set of aggregate numbers called "mineral resources" to consider the globe in terms of world economy and world politics.

Knowledge of the global environment and its state of health has been one of the most prolific fields of global governance since the 1960s because of the

interconnection with development and security politics. This was clearly demonstrated by the Soil Map of the World project, initiated in 1962 along with FAO's "Freedom from Hunger" campaign and the establishment of the World Food Program. In his essay, *Perrin Selcer* discusses the history of surveying the planet's arable soil and mapping its type and quality patterns. In the mid-twentieth century, soil, in principle a renewable resource, but one threatened by erosion over large parts of the earth's crust, was seen as an accurate measurement of the state of our ecosystems and our ability to survive – just like climate and climate change are today. Selcer points out that, over the years, the tediously assembled and standardized soil map proved to be a weak tool of political guidance. Yet it incorporated a resolutely inclusive "view from everywhere." It thus became a medium of global communication on sustainability and equity as testimony to the heydays of postwar transnationalism in the UN organizations. Arguably on a more disillusioned note, global climate models seem to serve the same purpose.

The changing climates of polar environments and geopolitics since 1989 have been pressing for the economic and geopolitical refashioning of the Arctic (Doel, Wråkberg and Zeller 2014). They have also been decisive for the fashioning of the Antarctic. *Christian Kehrt* examines the political, geoscientific, and economic reframing of Antarctica – from the globe's last wilderness to be left untouched if not unexamined by decree (the Antarctic Treaty System of 1959) – to a global common, subject to the resource-oriented research agenda of the Environmental Age. This agenda has informed the Conventions on the Conservation of Antarctic Marine Living Resources (1980) and the Regulation of Antarctic Mineral Resource Activities (1988). Kehrt does so from the perspective of the Federal Republic of Germany and its ambition to catch up with the GDR's and other countries' geoscientific and ecological experience in the polar regions. Gaining diplomatic and scientific recognition as a consultative member of the Antarctic Treaty System was as much an aim of the economically potent but politically semi-sovereign West German state, the author argues, as was capitalizing on a global food resource, krill, and perhaps even on fuel mineral resources.

Acknowledging the fact that the comparison and integration of regional data sets inevitably lead to their reinterpretation, *Elena Aronova* works from 'above and below' towards a history of monitoring global environmental change. Internationally coordinated monitoring was first institutionalized in the 1960s and early 1970s. The global monitoring networks relied on observational stations in areas with minimal levels of human ecological interference to establish the baseline for measuring and calibrating the changes in various environmental parameters. One such baseline was the Russian limnologist Mikhail Kozhov's record from Siberian Lake Baikal, starting in 1945. Aronova shows how the data of the intergovernmental global monitoring program were used since the inclusion of Siberian measuring stations in the 1980s to justify continuing

with the environmental pollution of Lake Baikal. Soviet officials defined as average changes what, in view of the singularly deep lake, should have counted as indicators of "early warming" (Dean 2008). In contrast, political activists in the Soviet Union took Kozhov's records as direly needed evidence of environmentalism under the conditions of dictatorship and tried to make Kozhov a public dissident.

As for studying broader social change through the lens of earth science history, *Naomi Oreskes* starts out from an important observation: drawing on the three fields of hydrology, climate science, and seismology, she underscores that earth systems and social systems are interacting entities. However, the multifaceted knowledge that historians and social scientists have of modern societies and their political, economic, and cultural specificities is difficult to handle in terms of scientific quantification and modeling. One general key lesson of the humanities, Oreskes reminds us, is that neither humans nor society necessarily act consistently over time. Hence, every statement on economic growth or social adaptation strategies gained by extrapolating from past trends or relying on present norms and values will almost certainly weaken the model's performance and reliability. She argues that competent communication about assessment, appraisal and forecasting methods will be as important as refined attempts to include social scientific and historical knowledge in earth scientific research; by competent communication, she means that experts, natural and social scientists alike, explain to decision-makers and the public the uncertainties not only of ongoing natural but also of social and political processes. The explanation should include, we might add, the pitfalls of economic calculation as tools for policy-making (e.g. Speich Chassé 2013).

Ola Uhrqvist further illustrates these difficulties by historicizing the prediction capacities of global environmental modeling. He analyzes how, since the 1980s, the International Geosphere-Biosphere Program (IGBP) has endeavored to produce a predictive understanding of the planet as an 'Earth System.' The program suggested that integrated numerical models could provide a common framework for the various disciplines involved. The IGBP fostered the advancement of 'Earth System' modeling in three phases. Only in the third phase, since 2004, have scientists incorporated humans as a dynamic component in the 'Earth System.' In view of this latest turn, Uhrqvist asserts that accounting for the paths and consequences of human activities makes the creation of robust scenarios an utterly problematic task. Another problem is also deeply political: Who exactly are the managers of a transition to global sustainability whom the 'Earth system' modelers offer their decision-supporting tool? As the author notes, the scientific issues of environmental modeling have taken precedence over envisioning adequate global and regional regimes of regulation and decision-making.

4. Conclusion

In conclusion, we wish to stress an insight taken from reviewing the collected essays, which testifies to the programmatic argument Naomi Oreskes has made in her contribution. The intersecting of social and natural scientific knowledge is typical for many research fields in the earth sciences (see also page 15, above; Sörlin 2013; Carey 2014). This is true not only for the "impact sciences" determining and monitoring the environmental consequences of social action (Schnaiberg 1980). It also applies to the traditional "production sciences" such as economic geology or engineering. Our conclusion therefore leans toward considering the interplay of earth scientific and environmental knowledge with other forms of knowledge on which modern societies rely for organization and problem solving.

Historians will need to analyze and reconstruct this confluence of heterogeneous data streams and forms of knowledge. For example, first of all, we are called to critically analyze the methods of data gathering and interpretation in economics and the social sciences, methods which were applied in past and present efforts of environmental and natural resource management (e.g. Goldman 2005; Dahan Dalmedico 2007; Robertson 2012; Höhler 2014).

Secondly, we will also need to pay closer attention to the legal knowledge and institutions involved (e.g. Schrijver 2010). Neither the scientists mentioned by Ola Uhrqvist, nor our essays highlight the different legal cultures expected to process and implement the advancements of the earth and environmental sciences. Yet we firmly believe that familiarizing ourselves with the industrious making of environmental laws, environmental human rights and natural resource management laws, with the many and diverse national mining regulations or instruments such as environmental taxation and emissions trading, will help explain how producing knowledge about the earth and the global environment has shaped the actions and institutions of past and contemporary societies.

Special References

Contributions within this HSR Special Issue
Climate and Beyond. The Production of Knowledge
about the Earth as a Signpost of Social Change

Aronova, Elena. 2015. Environmental Monitoring in the Making: From Surveying Nature's Resources to Monitoring Nature's Change. *Historical Social Research* 40 (2): 222-45. doi: 10.12759/hsr.40.2015.2.222-245.

Dörries, Matthias. 2015. Politics, Geological Past, and the Future of the Earth. *Historical Social Research* 40 (2): 22-36. doi: 10.12759/hsr.40.2015.2.22-36.

Kehrt, Christian. 2015. Gondwana's Promises. German Geologists in Antarctica between Basic Science and Resource Exploration in the Late 1970s. *Historical Social Research* 40 (2): 202-21. doi: 10.12759/hsr.40.2015.2.202-221.

Oreskes, Naomi. 2015. How Earth Science Has Become a Social Science. *Historical Social Research* 40 (2): 246-70. doi: 10.12759/hsr.40.2015.2.246-270.

Rosol, Christoph. 2015. Hauling Data. Anthropocene Analogues, Paleoceanography and Missing Paradigm Shifts. *Historical Social Research* 40 (2): 37-66. doi: 10.12759/hsr.40.2015.2.37-66.

Rumsey, Brian. 2015. From Flood Flows to Flood Maps: The Understanding of Flood Probabilities in the United States. *Historical Social Research* 40 (2): 134-50. doi: 10.12759/hsr.40.2015.2.134-150.

Schär, Bernhard C. 2015. Earth Scientists as Time Travelers and Agents of Colonial Conquest. Swiss Naturalists in the Dutch East Indies. *Historical Social Research* 40 (2): 67-80. doi: 10.12759/hsr.40.2015.2.67-80.

Selcer, Perrin. 2015. Fabricating Unity: The FAO-UNESCO Soil Map of the World. *Historical Social Research* 40 (2): 174-201. doi: 10.12759/hsr.40.2015.2.174-201.

Smith, Kerry. 2015. Earthquake Prediction in Occupied Japan. *Historical Social Research* 40 (2): 105-33. doi: 10.12759/hsr.40.2015.2.105-133.

Uhrqvist, Ola. 2015. One Model to Fit All? The Pursuit of Integrated Earth System Models in GAIM and AIMES. *Historical Social Research* 40 (2): 271-97. doi: 10.12759/hsr.40.2015.2.271-297.

Valderrama, Lorena B. 2015. Seismic Forces and State Power: The Creation of the Chilean Seismological Service at the Beginning of the Twentieth Century. *Historical Social Research* 40 (2): 81-104. doi: 10.12759/hsr.40.2015.2.81-104.

Westermann, Andrea. 2015. Geology and World Politics: Mineral Resource Appraisals as Tools of Geopolitical Calculation, 1919-1939. *Historical Social Research* 40 (2): 151-73. doi: 10.12759/hsr.40.2015.2.151-73.

References

Bankoff, Greg. 2003. *Cultures of Disaster. Society and natural hazards in the Philippines*. London: Routledge Curzon.

Barth, Kai-Henrik. 2003. The Politics of Seismology: Nuclear Testing, Arms Control, and the Transformation of a Discipline. *Social Studies of Science* 33 (5): 743-81.

Behringer, Wolfgang. 2010. *A Cultural History of Climate*. Cambridge: Polity Press.

Bonneuil, Christophe, and Jean-Baptiste Fressoz. 2013. *L'événement anthropocène: la terre, l'histoire et nous*. Paris: Éditions du Seuil.

Braudel, Fernand. 1966. *La méditerranée et le monde méditerranéen à l'époque de Philippe II*, 2nd ed. Paris: A. Colin.

Buckland, Adelene. 2013. Novel Science. *Fiction and the Invention of Nineteenth-Century Geology*. Chicago: University of Chicago Press.

Burton, Antoinette. 2007. Not Even Remotely Global? Method and Scale in World History. *History Workshop Journal* 64: 323-8.

Carey, Mark 2010. *In the Shadow of Melting Glaciers: Climate Change and Andean Society*. Oxford: Oxford University Press.

Carey, Mark. 2014. Science, Models, and Historians: Toward a Critical Climate History. *Environmental History* 19 (2): 354-64.
Chakrabarty, Dipesh. 2000. *Provincializing Europe: Postcolonial Thought and Historical Difference*. Princeton: Princeton University Press.
Cioc, Mark. 2002. *The Rhine. An Eco-Biography*. Seattle: University of Washington Press.
Coen, Deborah. 2013. *The Earthquake Observers. Disaster Science from Lisbon to Richter*. Chicago: University of Chicago Press.
Cosgrove, Denis. 1994. Contested Global Visions: One-World, Whole-Earth, and the Apollo Space Photographs. *Annals of the Association of American Geographers* 84 (2): 270-94.
Cosgrove, Denis. 2001. *Apollo's Eye. A Cartographic Genealogy of the Earth in the Western Imagination*. Baltimore and London: The Johns Hopkins University Press.
Cronon, William. 1991. *Nature's Metropolis*. *Chicago and the Great West*. New York: Norton.
Culver Lawrence. 2010. *The Frontier of Leisure: Southern California and the Shaping of Modern America*. New York: Oxford University Press.
Curtis, Kent. 2013. *Gambling on Ore. The Nature of Metal Mining in the United States, 1860-1910*. Boulder: University Press of Colorado.
Dahan Dalmedico, Amy, ed. 2007. *Les modèles du futur. Changement climatiques et scénarios économiques: enjeux scientifiques et politiques*. Paris: La Découverte.
Dean, Cornelia. 2008. Family Science Project Yields Surprising Data about a Siberian Lake. *New York Times*, May 6.
Deparis, Vincent, and Hilaire Legros. 2000. *Voyage à l'intérieur de la terre. De la géographie antique à la géophysique moderne. Une histoire des idées*. Paris: CNRS Editions.
Doel, Ronald E. 2003. Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945. *Social Studies of Science* 33 (5): 635-66.
Doel, Ronald E., Urban Wråkberg, and Suzanne Zeller. 2014. Science, Environment, and the New Arctic. *Journal of Historical Geograph*y 44: 2-14.
Edwards, Paul N. 2010. *A Vast Machine. Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge, MA: MIT Press.
Elichirigoity, Fernando. 1999. *Planet Management: Limits to Growth, Computer Simulation, and the Emergence of Global Spaces*. Evanston, IL: Northwestern University Press.
Endfield, Georgina. 2014. Exploring Particularity: Vulnerability, Resilience, and Memory in Climate Change Discourse. *Environmental History* 19 (2): 303-10.
Fleming, James Rodger. 1998. *Historical Perspectives on Climate Change*. Oxford: Oxford University Press.
Fleming, James Rodger. 2011. Planetary-Scale Fieldworld: Harry Wexler and the Possibilities of Ozone Depletion and Climate Control. In *Knowing Global Environments. New Historical Perspectives on the Field Sciences*, ed. Jeremy Vetter, 190-211. New Brunswick, NJ: Rutgers University Press.
Forman, Paul. 2012. On the Historical Forms of Knowledge Production and Curation: Modernity Entailed Disciplinarity, Postmodernity Entails Antidisciplinarity. *Osiris* 27: 56-97.

Frängsmyr, Tore. 2007. Between the Deluge and the Ice Age. Advancements of Learning. In *Essays in Honour of Paolo Rossi*, ed. John L. Heilbron, 133-52. Firenze: Leo S. Olschki.

Goldman, Michael. 2005. *Imperial Nature. The World Bank and Struggles for Social Justice in the Age of Globalization*. New Haven: Yale University Press.

Griffiths, Tom. 2007. *Slicing the Silence: Voyaging to Antarctica*. Cambridge, MA: Harvard University Press.

Heymann, Matthias. 2013. 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*, ed. Kirsten Hastrup and Martin Skrydstrup, 202-24. London: Routledge.

Höhler, Sabine. 2014. Von Biodiversität zu Biodiversifizierung: Eine Neue Ökonomie der Natur? *Berichte zur Wissenschaftsgeschichte* 37 (1): 60-77.

Höhler, Sabine. 2015. *Spaceship Earth in the Environmental Age, 1960-1990*. London: Pickering & Chatto Publishers.

Iriye, Akira. 2008. Environmental History and International History. *Diplomatic History* 32 (4): 643-6.

Jones, Christopher F. 2010. A Landscape of Energy Abundance: Anthracite Coal, Canals, and the Roots of American Fossil Fuel Dependence, 1820-1860. *Environmental History* 15: 449-84.

Kohler, Robert E. 2011. History of Field Science: Trends and Prospects. In *Knowing Global Environments. New Historical Perspectives on the Field Sciences*, ed. Jeremy Vetter, 2012-40. New Brunswick, NJ: Rutgers University Press.

Krüger, Tobias. 2013. *Discovering the Ice Ages. International Reception and Consequences for a Historical Understanding of Climate*. Leiden: Brill.

Lamb, Horace Hubert. 1982. *Climate, History and the Modern World*. London and New York: Methuen.

LeRoy Ladurie, Emmanuel. 1967. *Histoire du climat depuis l'an mil*. Paris: Flammarion.

LeRoy Ladurie, Emmanuel. 1972. *Times of Feast, Times of Famine. A History of Climate since the Year 1000*. London: Allen & Unwin.

Lévi-Strauss, Claude. 1961. *Tristes Tropiques*. New York: Criterion Books.

Lucier, Paul. 2009. Geological Industries. In *The Modern Biological and Earth Sciences*, ed. Peter Bowler and John V. Pickstone, 108-25. Cambridge: Cambridge University Press.

Martin-Nielsen, Janet. 2013. 'The Deepest and Most Rewarding Hole Ever Drilled.' Ice Cores and the Cold War in Greenland. *Annals of Science* 70 (1): 47-70.

Mauelshagen, Franz. 2009. Keine Geschichte ohne Menschen. Die Erneuerung der historischen Klimawirkungsforschung aus der Klimakatastrophe. In *Nachhaltige Geschichte. Festschrift für Christian Pfister*, ed. André Kirchhofer, Daniel Krämer, Christoph Maria Merki, Guido Poliwoda, Martin Stuber and Stephanie Summermatter, 169-93. Zürich: Chronos.

Melillo, Edward D. 2014. The First Green Revolution: Debt Peonage and the Making of the Nitrogen Fertilizer Trade, 1840-1930. *American Historical Review* 117 (4): 1028-60.

Mitchell, Timothy. 2011. *Carbon Democracy. Political Power in the Age of Oil*. London and New York: Verso.

Mitman, Gregg, Michelle Murphy, and Christopher Sellers, eds. 2004. Landscapes of Exposure: Knowledge and Illness in Modern Environments. Chicago: University of Chicago Press (*Osiris* 19).

O'Connor, Ralph. 2007. *The Earth on Show. Fossils and the Poetics of Popular Science, 1802-1856.* Chicago: University of Chicago Press.

Oreskes, Naomi. 2003. A Context of Motivation: US Navy Oceanographic Research and the Discovery of Sea-Floor Hydrothermal Vents. *Social Studies of Science* 33 (5): 697-742.

Oreskes, Naomi, and Ronald E. Doel. 2002. The Physics and Chemistry of the Earth. In *The Cambridge History of Science, Vol. V: Modern Physical and Mathematical Sciences,* ed. Mary Nye, 538-57. Cambridge: Cambridge University Press.

Pfister, Christian. 1984. Das Klima der Schweiz von 1525-1860 und seine Bedeutung in der Geschichte von Bevölkerung und Landwirtschaft. *Academica helvetica* 6 (1). Bern: Paul Haupt.

Pfister, Christian. 1999. *Wetternachhersage. 500 Jahre Klimavariationen und Naturkatastrophen 1496-1995*. Bern: Paul Haupt.

Pfister, Christian, ed. 2002. *Am Tag danach. Zur Bewältigung von Naturkatastrophen in der Schweiz 1500-2000*. Bern: Paul Haupt.

Pfister, Christian. 2010. The "1950s Syndrome" and the Transition from a Slow-Going to a Rapid Loss of Global Sustainability. In *Turning Points in Environmental History*, ed. Frank Uekötter, 90-117. Pittsburgh: University of Pittsburgh Press.

Porter, Roy. 1973. The Industrial Revolution and the Rise of the Science of Geology. In *Changing Perspectives in the History of Science*, ed. Mikulas Teich and Robert Young, 320-43. London: Heinemann.

Porter, Roy. 1978. Gentlemen and Geology: The Emergence of a Scientific Career, 1660-1920. *The Historical Journal* 21 (4): 809-36.

Radkau, Joachim. 2012. *Wood. A History*. Cambridge and Malden: Polity Press.

Robertson, Thomas. 2012. *The Malthusian Moment: Global Population Growth and the Birth of American Environmentalism*. New Brunswick, NJ: Rutgers University Press.

Rohr, Christian. 2007. Extreme Naturereignisse im Ostalpenraum. Naturerfahrung im Spätmittelalter und am Beginn der Neuzeit. *Umwelthistorische Forschungen* 4. Köln, Weimar and Wien: Böhlau.

Rossi, Paolo. 1984. *The Dark Abyss of Time. The History of the Earth and the History of the Nations from Hooke to Vico*. Chicago: University of Chicago Press.

Rudwick, Martin. 1976. The Emergence of a Visual Language for Geological Science, 1760-1840. *History of Science* 14: 149-95.

Rudwick, Martin. 1985. *The Great Devonian Controversy. The Shaping of Scientific Knowledge among Gentlemanly Specialists*. Chicago: The University of Chicago Press.

Rudwick, Martin J. S. 2005. *Bursting the Limits of Time. The Reconstruction of Geohistory in the Age of Revolution*. Chicago: University of Chicago Press.

Schenk, Gerrit Jasper. 2007. Historical Disaster Research. State of Research, Concepts, Methods and Case Studies. *Historical Social Research* 32 (3): 9-31 <http://www.ssoar.info/ssoar/handle/document/29142>.

Schnaiberg, Allan. 1980. *The Environment: From Surplus to Scarcity*. New York and Oxford: Oxford University Press.

Schnyder, Peter. 2013. Das Wechselspiel der Gattungen. Zur literarischen Reflexion der Darstellung geologischen Wissens bei Gustave Flaubert und Jules Verne. In *Gattungs-Wissen. Wissenspoetologie und literarische Form*, ed. Michael Bies, Michael Gamper and Ingrid Kleeberg, 227-46. Göttingen: Wallstein.

Schrijver, Nico. 2010. *Development Without Destruction. The UN and Global Resource Magagement*. Bloomington: Indiana University Press.

Secord, James. 1986. *Controversy in Victorian Geology. The Cambrian-Silurian Dispute.* Princeton, NJ: Princeton University Press.

Shen, Grace Yen. 2014. *Unearthing the Nation: Modern Geology and Nationalism in Republican China*. Chicago: University of Chicago Press.

Sieferle, Rolf Peter. 2001. *The Subterranean Forest. Energy Systems and the Industrial Revolution*. Cambridge: The White Horse Press.

Sörlin, Sverker. 2013. Reconfiguring Environmental Expertise. *Environmental Science and Policy* 28: 14-24.

Speich Chassé, Daniel. 2013. *Die Erfindung des Bruttosozialprodukts. Globale Ungleichheit in der Wissensgeschichte der Ökonomie*. Göttingen: Vandenhoeck & Ruprecht.

Stafford, Robert A. 1984. Geological Surveys, Mineral Discoveries, and British Expansion, 1835-71. *The Journal of Imperial and Commonwealth History* 12 (3): 5-32.

Stafford, Robert A. 1990. Annexing the Landscapes of the Past. British Imperial Geology in the Nineteenth Century. In *Imperialism and the Natural World*, ed. John MacDonald MacKenzie, 67-89. New York: Manchester University Press.

Tucker, Richard P. 2010. The Global Ecological Reach of the United States: Exporting Capital and Importing Commodities. In *A Companion to American Environmental History*, ed. Douglas Casaux Sackman, 502-28. New York: Blackwell.

Valencius, Conevery Bolton. 2013. *The Lost History of the New Madrid Earthquakes*. Chicago: University of Chicago Press.

Wells, Christopher W. 2012. *Car Country. An Environmental History*. Seattle and London: University of Washington Press.

White, Richard. 1996. *The Organic Machine. The Remaking of the Columbia River*. New York: Hill and Wang.

White, Sam. 2007. Climate Change in Global Environmental History. In *A Companion to Global Environmental History*, ed. John McNeill and Erin Stewart Mauldin, 394-410. Chichester: Wiley Blackwell.

Wigley, Tom M. L., Martin J. Ingram, and Graham Farmer, eds. 1981. *Climate and History. Studies in Past Climates and their Impact on Man*. Cambridge and New York: Cambridge University Press.

Worster, Donald. 1985. *Rivers of Empire. Water, Aridity, and the Growth of the American West*. New York: Pantheon Books.

Ziolkowski, Theodore. 1990. *German Romanticism and its Institutions*. Princeton, NJ: Princeton University Press.

Cooperating Associations / Networks / Journals

QUANTUM (Association for Quantification and Methods in Historical and Social Research) http://www.gesis.org/en/hsr/profile/quantum/.

INTERQUANT (International Commission of the application of Quantitative Methods in History) http://www.gesis.org/en/hsr/profile/quantum/.

H-SOZ-U-KULT (Humanities, Sozial und Kulturgeschichte) http://hsozkult.geschichte.hu-berlin.de.

AFC (Association Française de Cliométrie) http://www.cliometrie.org/.

AGE (Arbeitsgemeinschaft Geschichte und EDV) http://www.age-net.de.

AHC (International Association for History and Computing) http://odur.let.rug.nl/ahc/.

FQS (Forum Qualitative Sozialforschung – Forum Qualitative Social Research; http://www.qualitative-research.net/fqs/.

HISTORICUM.NET http://www.historicum.net/.

ZOL (Zeitgeschichte-online) http://www.zeitgeschichte-online.de/.

PERSPECTIVIA.NET http://www.perspectivia.net.

Archiving by Information Services

JSTOR (ITHAKA) http://www.jstor.org/r/histsocres/.

SSOAR (Social Science Open Access Repository / GESIS) http://www.ssoar.info/hsr.

Coverage by Information Services

In recognition of "the high quality and relevance to the scientific community" our journal *Historical Social Research / Historische Sozialforschung* has been selected for coverage / archiving in the following databases:

Social Science Citation Index (Thomson Scientific) http://scientific.thomson.com/products/ssci/.

SCOPUS (Elsevier) http://www.scopus.com/.

SocINDEX with FULL TEXT (EBSCO) http://www.epnet.com/.

Sociological Abstracts (Cambridge Scientific Abstracts) http://www.csa.com/.

Historical Abstracts (ABC-CLIO) http://www.abc-clio.com/.

International Political Science Abstracts (SAGE) http://www.sagepub.co.uk.

Social Research Methodology Database (SAGE / NIWI) http://www.srm-online.nl/index.htm.

SOLIS (Social Science Literature Information System / GESIS) http://www.gesis.org/en/services/specialized-information/.